

RENEWABLE ENERGY IN THE SOUTHERN AND EASTERN MEDITERRANEAN COUNTRIES

Current situation



June 2007



Observatoire Méditerranéen de l'Energie

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Abstract

The Mediterranean region is endowed with a high potential for renewable energy resources. However, the full potential and advantages of renewables are currently hindered in the region due to the existence of many barriers, amongst which the institutional barriers and the price of fossil fuels that do not always reflect their full cost. Prices for conventional energy sources are often subsidized in Southern and Eastern Mediterranean countries and the “externalities” associated with the use of such resources, such as additional health and environmental costs are not considered. Removing subsidies from fossil fuels would make renewables relatively more competitive.

For renewable energies to achieve their market potential, policy frameworks and financial instruments are necessary to give financiers the necessary assurance and incentives to shift investment away from carbon-emitting conventional technologies to large-scale investment in clean energy systems.

The study provides a comprehensive review of renewable energy and markets in Southern and Eastern Mediterranean countries. Part 1 deals with the energy and renewable energy context and current situation at the regional level. Part 2 contains profile for each targeted country.

The report has been prepared with contribution of experts from OME Renewable Energy and Sustainable Development Committee (RESDC) and is a yearly publication of the RESDC.

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Introduction

1. General Context

Southern and Eastern Mediterranean countries (SEMCs)¹ need to meet growing energy requirements closely linked to their socio-economic development. While conventional energy resource endowments greatly differ between countries, they all face increasing local and global environmental constraints. In addition, some well-endowed countries are facing a declining hydrocarbon production (in particular for oil) though hydrocarbon exports are the backbone of their economies. As such, their preservation and valorisation are essential to the sustainable development of the region. In this context, renewable energies can play an important role. It should also be noted that around 15 million inhabitants have currently no access to electricity in the region.

Renewable energy is inexhaustible and abundant. Ultimately it was the origin of fossil fuels which became the basis on which the Industrial Revolution was built. These sources of energy, however, will not last forever and have proven to be one of the main sources of our environmental problems. It is clear therefore that in due time renewable energies will dominate the world's energy system, due to their inherent advantages such as mitigation of climate change, generation of employment and reduction of poverty, as well as increased energy security and supply².

The Mediterranean region is endowed with a high potential for renewable energy resources. However, the full potential and advantages of renewables are currently hindered in the region (as is the case almost everywhere) due to the existence of many barriers, amongst which the institutional barriers and the price of fossil fuels that do not always reflect their full cost. Prices for conventional energy sources are often subsidized in Southern and Eastern Mediterranean countries and the "externalities" associated with the use of such resources, such as additional health and environmental costs are not considered. Removing subsidies from fossil fuels would make renewables relatively more competitive.

For renewable energies to achieve their market potential, policy frameworks and financial instruments are necessary to give financiers the necessary assurance and incentives to shift investment away from carbon-emitting conventional technologies to large-scale investment in clean energy systems.³

In general, the use of renewables would benefit from bilateral and regional cooperation. A regional cooperation in the field of renewable energy in the Mediterranean region is necessary and can significantly benefit sustainable development in the region while playing an important role in meeting the Kyoto targets of the North Mediterranean countries.

¹ The countries included in this study, which are called SEMCs are: Algeria, Egypt, Libya, Morocco Tunisia and Turkey.

² J. Goldemberg, 2004.

³ V. Sonntag-O'Brien, Base & Usher, UNEP, 2004.

2. Aim and scope of the Study

This report has been prepared by the Observatoire Méditerranéen de l'Energie (OME) with the support of OME members and partners of the Renewable Energy and Sustainable Development Committee (RESDC). It consists in an update of the previous version carried out by OME with support of the Italian Ministry of Environment and Territory (IMET) in the framework of MEDREP (Mediterranean Renewable Energy Programme) and the OME Renewable Energy and Sustainable Development Committee activities. The objective is to give a synthetic analysis of the present renewable energy situation in the selected countries and present their future objectives.

3. Methodology

This report is has been prepared based on information gathered from existing studies coordinated by OME and conducted in partnership with Euro-Mediterranean partners⁴ and information communicated by experts from OME members and partners of the RESDC.

For this update version, extensive use is also made of OME database, recent studies, reviews and policy documents, information gathered at the occasion of missions to the countries and information communicated through direct contacts (missions, e-mail, interviews ...).

4. About the report

The study provides a comprehensive review of renewable energy and markets in Southern and Eastern Mediterranean countries. Part 1 deals with the energy and renewable energy context and current situation at the regional level. Part 2 contains profile for each targeted country.

The report also introduces the priorities and targets for each country regarding the development of renewable energy in the coming decades. The report will be regularly updated.

⁴ These include in a chronological order: APAS, INTERSUDMED, IRESMED, MEMA, CDMED, MED 2010 and MEDSUPPLY. These studies have been co-funded by the EC DG Research (except MEDSUPPLY that has been co-funded by the EDC DG TREN). For more details, see <http://www.ome.org>.

Part 1.

Regional Overview

Chapter 1. Energy context in the SEMCs

Despite being neighbours and grouped around a commonly shared sea, the *Mare Nostrum*, SEMCS countries⁵ are not equally endowed with conventional energy resources. Algeria, Libya and Egypt are hydrocarbon exporting countries while Tunisia (small producer) and to a much greater degree Morocco are energy dependent. Despite large hydro resources, Turkey is highly dependent on oil and gas.

The SEMCs countries are facing a rapid demographic growth combined with relatively low incomes, rapid urbanisation and strong socio-economic development needs. This translates in new and growing demand for energy services and related infrastructures. Indeed, in all countries, energy demand, (electricity in particular) is increasing rapidly. All countries, however, have an important potential for improving their energy use and efficiency, thereby strengthening their security of supply, preserving their resources while contributing to a more sustainable energy development path.

The population of the SEMCS countries was 227 million in 2005 (Table 1), and is expected to increase to 280 million in 2020 according to the United Nations. The medium GDP per capita amounted to 2,406 US \$ (2000) in 2005 as compared to 17,300 US\$ in countries of the Northern shore of the Mediterranean. Moreover, the urban populations are expected to increase more rapidly. The majority of these populations is and will continue to be located in costal regions, which will increasingly become overcrowded and ecologically threatened. This double phenomenon of urbanisation and littoral concentration will have a marked influence on the nature of energy use in the future.

Table 1 **Population of the SEMCS Countries**

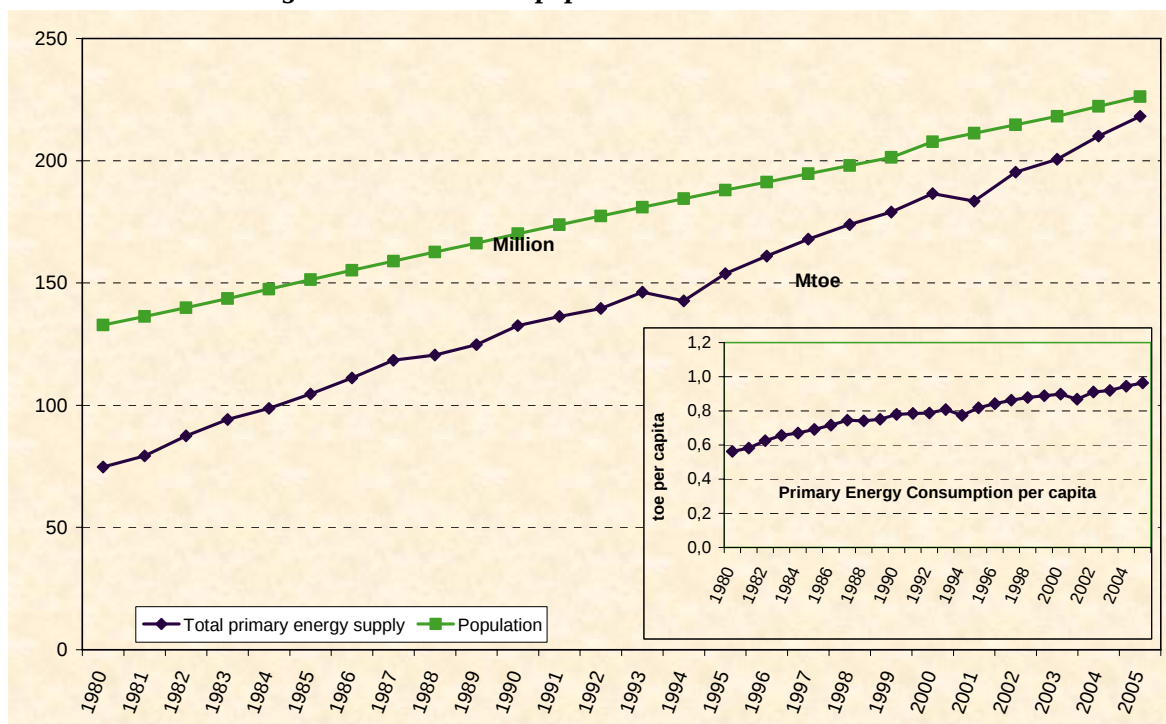
M people	Forecasts			
	1990	2005	2010	2020
Algeria	25.0	33	35	38
Egypt	52.4	74	81	94
Libya	04.4	6	7	8
Morocco	24.0	31	33	38
Tunisia	08.2	10	11	12
Turkey	56;0	73	78	88
SEMCs	170	227	245	278

Sources: UN, IEA

As illustrated in Figure 1, primary energy consumption in the SEMCs has been growing very rapidly during the last decades from 74.6 Mtoe in 1980 to 218.2 Mtoe in 2005 (around 4.5 % average annual increase over the period), mainly due to demographic growth, the improvement in the standard of living and the expansion of the industrial, commercial and residential sectors. This growth is also driven by the increase in electricity demand. In the same period, energy consumption per capita increased from 458 kWh to 1,577 kWh (more than 5% average annual increase over the period). It is important to underline here that the average level of energy consumption per capita in the SEMCs is much lower than that of the Northern Mediterranean countries (over 5 times in 2005 between France and the SEMCs).

⁵ Algeria, Egypt, Libya, Morocco, Tunisia and Turkey

Figure 1 TPES and population in SEMCs 1980-2005



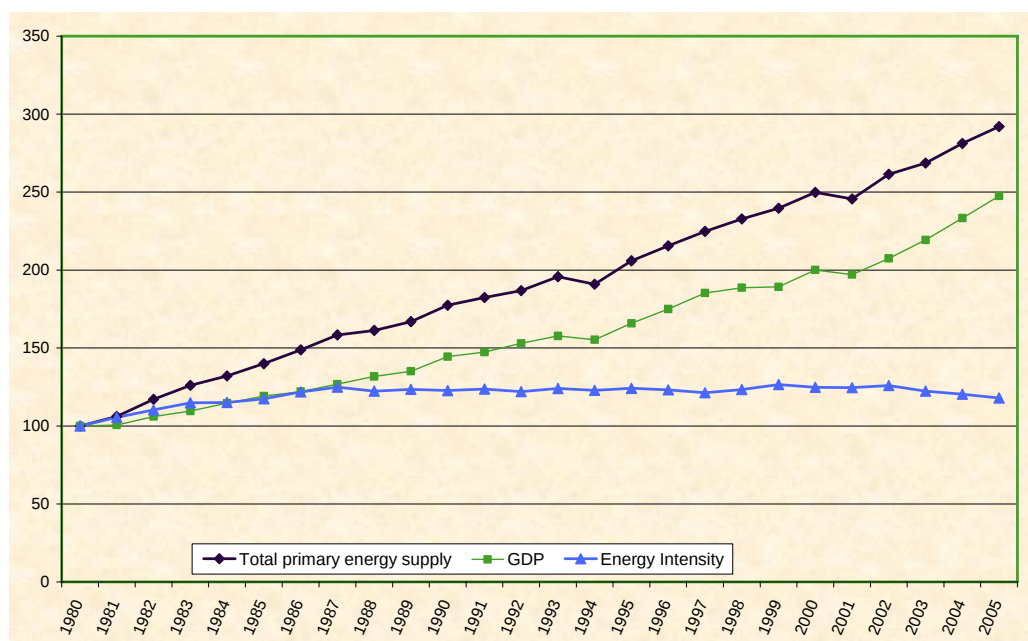
Source: OME

Figure 2 illustrates the trends for the TPES, GDP and energy intensity during the three last decades in the SEMCs (1980 = 100). It clearly shows that TPES is growing faster than GDP, indicating that the economic development in the region is increasingly energy intensive. The energy intensity has increase by more than 20% over the period 1980 - 2005 (1.2% annual growth rate over the period). This average situation hides large disparities between countries, which will be highlighted in the analysis by country presented in the second part of this report.

While SEMCs average energy intensity is relatively high in comparison to Western Europe (about 5-6 times higher than in Germany and France), it is comparable to other oil producing countries; the region as a whole being considered oil producing though all countries are not of course. It is important to underline that non-commercial biomass consumption is not considered here though its use is considerable in the region, representing over 25 % of TPES in Morocco for example. Taking biomass into consideration would substantially increase the energy intensity of the region.

The average energy intensity in the region should fall as countries in the region implement energy efficiency and conservation programs. It is clear that there is an important potential for energy efficiency and conservation in the region and that energy intensity may be reduced, along with the greenhouse gas energy related emissions. Most governments are aware of the benefits of promoting renewable, clean and efficient technologies in their countries along with demand side management measures, especially in the present context of high oil prices and of the growth of environmental concerns. As such, energy policy in all these countries aims at sustainable energy development trends, though implementation differs greatly between countries (see details in Part II of this report). These are indeed linked to the energy situation of each country.

Figure 2 *TPES, energy intensity and gross domestic product in Southern and Eastern Mediterranean region*



Source: OME

The SEMCs are also facing a very high growth in electricity demand. As we will see in the following section, despite the availability of large potential resources, renewable energies are still marginal in their contribution to electricity generation in the region. Electricity in the region is increasingly generated using natural gas, an energy source some countries in the region are well endowed with.

In the present context and in order to meet their growing electricity demand, the SEMCS countries are facing three major challenges in the development of their electricity sector:

- The first concerns the difficulties of mobilising financial resources both for new power generation capacity and transmission/distribution networks;
- The second deals with electricity interconnections and creation of regional power markets (both South-South and South-North);
- The third addresses sustainable development (that is, the rational use of energy and renewable energy sources).

These three challenges can be perceived, in the framework of the Euro-Mediterranean Partnership as an opportunity for investment, an opportunity for the promotion of a Mediterranean regional interconnected market⁶ and an opportunity for the promotion of sustainable development. This situation also highlights the importance of regional initiatives such as MEDREP in addressing these issues. Indeed, while developing renewable energies, MEDREP will allow addressing at least two of the above mentioned challenges (investment and sustainable development). Electricity being one of the essential factors for development, the Euro-Mediterranean region will gain from such enhanced co-operation.

⁶ The situation of the Mediterranean electric interconnections is given in Annex 1. These interconnections allow - inter alia- the reduction of new power plant construction and savings on investments and fuels. When completed, the "Mediterranean Loop" will offer the opportunity to link all the Mediterranean countries with clean and green power, contributing hopefully to the stability and sustainable development of the region.

More generally, the SEMCs are facing two major problems linked to the energy sector in the present context of liberalisation and rise of environmental concerns: 1- how to meet the increasing demand for commercial energy for those with access (principally in the cities), and 2- how to provide access to modern, efficient and clean forms of energy for the majority of the population in rural and isolated areas. Renewable energy technologies provide the best solution in many situations.

As for renewable energy (briefly noted in chapter 3), several projects carried out by national agencies and companies as well as studies coordinated by the OME⁷ have revealed the large untapped potential for the development of renewable energy that could be used to increase total energy supply especially, but not exclusively, by allowing access to energy to populations without access (mainly in rural areas and remote villages). The effective market penetration in most SEMCs countries, however, falls far below expectations.

In the following chapters, we will review the environmental context in the SEMCs which also constitute a driving force for the development of renewable energy in the region.

⁷ These include in a chronological order: APAS, INTERSUDMED, IRESMED, MEMA, CDMED and MED 2010. These studies have been co-funded by the EC DG Research and performed by a Consortium of Euro-Mediterranean partners.

Chapter 2. Environmental context in the SEMCs

The SEMCs are facing various environmental problems: desertification (97% of Egypt and 90% of Libya is desert) and land degradation, growing coastal urbanisation leading to soil, air and water pollution, increasing waste problems, oil pollution of coastal waters, increasing greenhouse gas emissions, etc. In this context and in the international context of growing environmental concerns, most SEMCs have clearly declared their willingness to pursue a sustainable development growth pattern. As detailed in Part 2 of the report for each country, this was translated among others into many concrete actions with the creation of ministries and dedicated agencies in charge of environment matters and integration of environment protection measures in the social, political and economic sphere.

As illustrated in Figure 3, CO₂ emission levels are increasing rapidly since 1990, the baseline year for the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC). Energy-related CO₂ emissions in the region indeed increased by 2.5 % average annual growth over the period 1990 - 2005, from 382 Mt to 551 Mt (5.7 % average annual growth over the period 1971 - 2005), mostly due to increased energy consumption. CO₂ emissions per capita are also increasing. In 2005, a Southern Mediterranean inhabitant emitted on average more than 2.5 tCO₂ per capita, a 3.4 % average annual growth rate over the period 1971 - 2005 level. The carbon intensity also increased as compared to its level in 1990 but is showing a decreasing trend for the last three years. This is mainly due to the development of natural gas in the region in substitution to oil. But as shown in Part 2. of the present report, the situation varies from a country to another.

Total emissions from energy consumption (in Mt CO₂) and total capita CO₂ emissions (in kg CO₂/cap.) are given for the MED countries in the following tables for 2005, as well as previsions for 2010 and 2020.

Table 2 Total emissions from energy consumption (in Mt CO₂)

	2005	2010	2020
Algeria	79	97	147
Egypt	146	188	268
Libya	47	58	70
Morocco	35	46	53
Tunisia	20	29	37
Turkey	224	326	582
Total	551	744	1117

Source: OME

It is important to underline that this situation is in reality exacerbated by the relatively low level of energy consumption per capita (in comparison to European countries), the important part of the population that still lacks access to energy and the very high share of non commercial biomass in energy consumption (not included in this analysis). One can easily conclude that carbon emissions will continue their upward trend and grow even more rapidly as populations gain access to more and modern energy services. But as non-annex I, SEMCs are not obligated to curtail carbon emissions.

Table 3 Total capita CO₂ emissions (in kg CO₂/cap.)

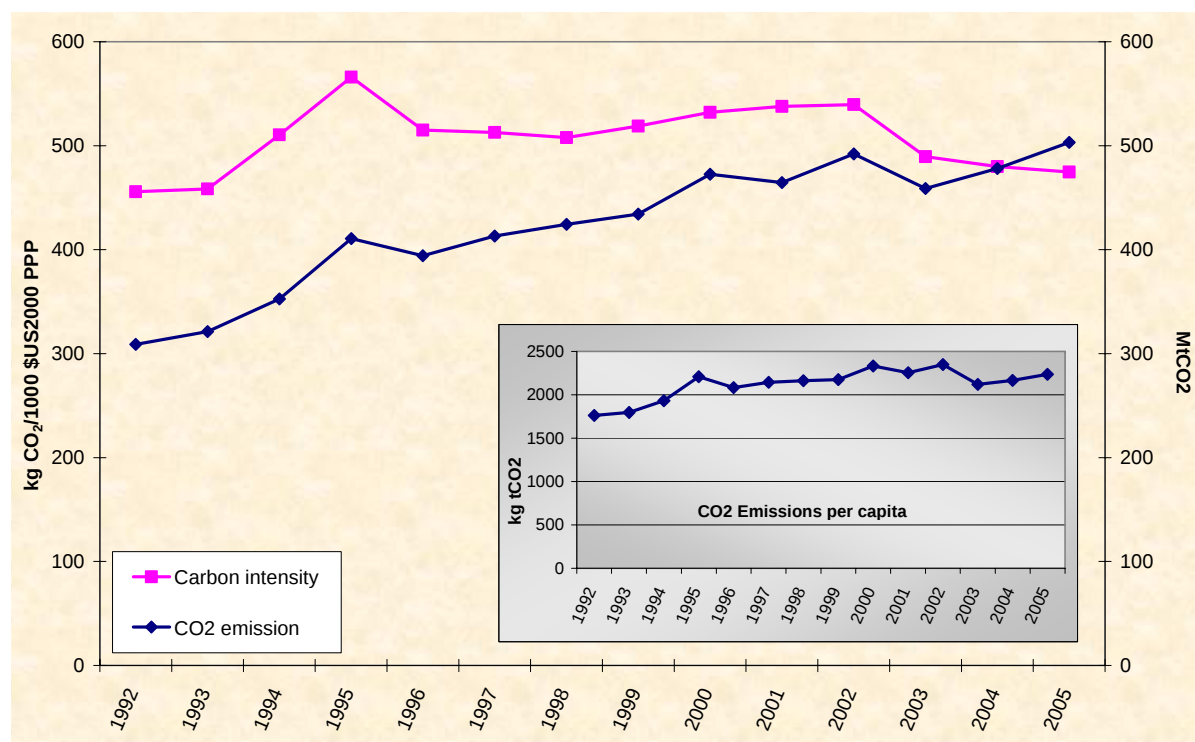
	2005	2010	2020
Algeria	2405	2753	3672
Egypt	1972	2314	2844
Libya	8139	8776	8562
Morocco	1126	1381	1416
Tunisia	1974	2698	2951
Turkey	3072	4153	6628
Average/cap.	2427	3037	4162

Source: OME

It should be noted, however, that most SEMCs have been fully engaged in the global effort to decrease GHG emissions very early in the process in order to participate, consolidate and reinforce their national Sustainable Development policy. In this context except Turkey which is not party of the Kyoto Protocol, all of them have ratified the Kyoto Protocol and are looking for opportunities in the framework of the Clean Development Mechanism (see Box 1) to foster financing clean projects such as renewable energy projects.

The full extent of the potential benefits available to the SEMCs under the Clean Development Mechanism (CDM) is difficult to forecast, but its potential to promote sustainable development and increase foreign investment flows is clear, especially for renewable energy projects. With thoughtful planning and the development of a national CDM strategy, it can also assist in addressing local and regional environmental problems and in promoting SEMCs social development goals as well as industrial and economic development in the wider Euro-Mediterranean region. The CDM allows SEMCs to participate to the global effort to combat climate change at a time when other development priorities may limit the funding for GHG emission reduction activities.

Figure 3 Energy-related carbon emissions (1992-2002)



Source: OME

Today, the SEMCs have reached an important stage in the process of developing projects that are eligible for financing by the CDM (details by country in Part 2):

- As stated above, except Turkey, all of them have ratified the Kyoto Protocol;
- Algeria, Egypt, Morocco and Tunisia have already implemented their Designated National Authority (DNA) while Libya is in the process of doing so.
- Options for reducing the emissions of GHG have been identified, among others by preparing an initial national communication.
- Portfolios of CDM projects have been prepared based on national priorities with regard to sustainable development. As detailed in the second part of the report, a large number of these priorities relate to renewable energy.
- Capacity building programmes have been and are being implemented.
- Several CDM projects are in the pipe (Egypt, Morocco and Tunisia).

Box 1 The Kyoto Protocol and the Clean Development Mechanism

A global strategy on climate change has been agreed under the 1992 United Nations Climate Change Convention and its 1997 Kyoto Protocol. This international legal regime promotes financial and technical co-operation to enable all countries to adopt more climate-friendly policies and technologies. It also sets targets and timetables for emission reductions by developed countries.

Specifically, the Protocol requires 39 developed countries to reduce their greenhouse gas (GHG) emissions by an average of 5.2% relative to 1990 levels. These annual emissions reductions must be reached by 2008-2012, referred to as the first commitment period. The developed countries with emission reduction targets are called Annex-I countries (industrialised countries), whereas those without targets are the non-Annex I countries (developing countries).

Within the Kyoto Protocol is a provision for the creation of a “bubble” of emissions commitments. The EU bubble allows the EU Member States to act as a group and to negotiate a formal, binding redistribution of their global commitments which, in total, account for an 8% reduction in GHG emissions. The agreement on these commitments will remain valid throughout the commitment period and therefore the EU cannot expand this bubble into the Accession States, where the commitments have already been far exceeded through economic decline.

The Protocol entered into force on February 16th, 2005 -- the ninetieth day after at least 55 Parties to the Convention, incorporating Annex I Parties which accounted in total for at least 55 % of the total carbon dioxide emissions for 1990 from that group, deposited their instruments of ratification, acceptance, approval or accession. From now on, the Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) will also serve as the formal Meeting of the Parties (MOP) for the Kyoto Protocol. This is referred to as the COP/MOP.

The Kyoto Protocol allows developed countries to reach their targets in different ways. They have to implement domestic Policies And Measures (PAM) and they are allowed to supplement these PAM with projects abroad and with market instruments, also called “flexibility mechanisms”. The following section describes these mechanisms as they were conceived by the Protocol and have been better defined during the ensuing negotiations.

International Emissions Trading (ET) as set out in Article 17 permits an Annex I Party to sell part of its “assigned amount” (the amount of emissions the Party may emit during the commitment period) to another Annex I Party (“Assigned Amount Units” - AAUs).

Joint Implementation (JI), defined in Article 6, allows Annex I Parties to implement projects that reduce greenhouse gas emissions by sources, or enhance removal by “sinks”, in the territories of other Annex I Parties, and to credit the resulting “Emissions Reduction Units” (ERU) against their own emission targets. (The term “Joint Implementation” does not appear in Article 6, but it has entered into common usage as convenient shorthand.)

The Clean Development Mechanism (CDM), defined in Article 12, allows Annex I Parties to implement projects that reduce greenhouse gas emissions in non-Annex I Parties and has the twin goal of assisting non-Annex I Parties to achieve sustainable development and contribute to the ultimate objective of the Convention, i.e. to stabilise greenhouse gas emissions at levels not dangerous to human development. Under the CDM, the Parties not included in Annex I will benefit from project activities resulting in Certified Emission Reductions (CER) while Parties included in Annex I may use the CER accruing from such project activities to contribute to their compliance with part of their quantified emission limitation and reduction commitments under Article 3. The CDM thus allows the transfer of CER to a party investing in GHG emission reduction projects. This transfer, or trade, is a market-based system that allows individual firms, as well as countries, to select the most effective solutions to achieving GHG emission reduction. The CDM is supervised by an Executive Board (EB), and a “share of the proceeds” from project activities will be used to assist particularly vulnerable developing countries in meeting the costs of adapting to climate change.

CDM projects can generate CER before the commitment period, i.e. the crediting period is different from the commitment period. The crediting period for CDM projects starts after registration at the earliest. Such registration can occur as soon as the procedures are settled. There is an exception for projects that have started as of the year 2000 and before 10 November 2001, where exceptionally the crediting period may start prior to registration, but not before 1 January 2000. The crediting period can be selected as being either seven years with twice the option of renewal or ten years without renewal

Source: OME adapted from UNFCCC publications, www.unfccc.int

Chapter 3. Energy context in the SEMCs

1. Definition of renewable energy

In general, the definition of renewable energy varies between countries and organisations. The various definitions for renewable sources are causing intensive disputes as the coverage of eligible renewable energy sources can make a great difference in implementation of renewable promotion initiatives. This is mainly due to the fact that the definition of renewable energy is used in different connections. In a broad sense, renewable energy refers to sources that can be used as energy resources without their eventual depletion. For instance, the Renewable Energy Working Party (REWP) of the International Energy Agency has set down the following definition: “*Renewable energy is energy that is derived from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth. Included in the definition is energy generated from solar, wind, biomass, geothermal, hydropower, and ocean energy and biofuels and hydrogen derived from renewable resources*”.⁸

In the context of the International Conference for Renewable Energies, Bonn 2004, *renewable energy sources and technologies include: solar energy, wind energy, hydropower, biomass energy including biofuels, and geothermal energy*.⁹

However, the most notable feature of renewable energy sources is the diversity of sources/resources and technologies, making it difficult to define the coverage of renewable energy sources in a universal format.

The complexity increases when the definition is related to a time-bound target on renewable share on a global scale. The key issues triggering controversies on eligibility of different sources as renewables essentially originate from the understanding of two concepts: renewability and sustainability¹⁰. The definitions of renewable energy sources adopted in this report as included in Box 2.

⁸ IEA, 2003.

⁹ ICRE, 2004.

¹⁰ NMC, 2004.

Box 2 Definitions of Renewable Energy Sources

Biofuels

All fuels generated from biomass, including solid (fuelwood, pellets), liquid (bioethanol, biodiesel, bio-oils), and gaseous (biogas, other gases).

Biomass

Biomass is defined as any plant matter used directly as fuel or converted into other forms before combustion. Included are wood, vegetal waste (including wood waste and crops used for energy production), animal materials/wastes, sulphite lyes and other solid biomass. It also includes charcoal produced from solid biomass.

Biomass use can roughly be divided into two categories, i.e. traditional use and modernised use of biomass. Modern biomass refers to more efficient and cleaner ways of using biomass for electricity generation, heat production and production of transportation fuels by adopting advanced technology such as gasification/pyrolysis, high efficient direct combustion, fermentation/hydrolysis and anaerobic digestion, rather than using biomass as fuelwood in a traditional way characterised by lower energy efficiency and indoor pollution. By traditional biomass we mean less efficient and more polluting combustion and other techniques (e.g. traditional stoves).

Geothermal

Geothermal energy is generated by converting hot water or steam from deep beneath the earth's surface into electricity. Geothermal energy can be used directly for heating or to produce electric power.

For electricity generation, unless the actual efficiency of the geothermal process is known, the quantity of geothermal energy input for electricity generation is inferred from the electricity production as geothermal plants assuming an average thermal efficiency of 10 %. Primary production/consumption is directly used as heat for district heating, agriculture or greenhouses. Geothermal plants cause very little air pollution and have minimal impacts on the environment.

Hydroelectric

Dams provide electricity by guiding water down a chute and over a turbine at high speed. Hydropower does not produce any air emissions, but large dams have environmental issues such as flood control, water quality, and fish and wildlife habitat to deal with.

Hydro power plants have thus been divided into two categories: small-scale hydro power (SHP) and large-scale hydro power. There is no general international consensus on the definition of SHP; the upper limit varies between 2.5 and 25 MW in different countries, but a value of 10 MW is becoming generally accepted.

Ocean energy

There are seven quite different ocean energy resources that could conceivably be developed, namely: offshore wind, tidal/marine currents, wave energy, ocean thermal conversion (OTEC), tidal barrages, salinity gradient/osmotic energy and marine biomass fuels.

Solar

The sun's radiation is used directly to produce hot water and electricity in two ways. Photovoltaic (PV) systems turn sunlight into electricity directly by photovoltaic cells. Solar thermal systems use the sun's heat to heat water (solar water heating) by flat plate collectors, creating steam to turn a turbine and generator (solar thermal power).

Wind

Wind energy is the kinetic energy of moving air. Wind turbines use the wind to create electricity.

2. Renewable energy resources and potential

2.1. Solar

The SEMCs are located in the world's solar belt and has an excellent solar availability. The annual average global solar radiation over the region ranges from about 1300 kWh/m²/year on the Mediterranean coast to a more than 3200 kWh/m²/year in the South and desert areas. The direct normal solar radiation reaches (2000-3200) kWh/m²/year with low levels of cloudiness. The total sunshine hours ranges between 2,650 and 3,600 hr/year.

2.2. Wind

The SEMCs are also endowed with very high wind resources in some locations, leading most of the countries to consider wind energy as one of the most promising renewable energy resources with solar. Several measurement programmes have been undertaken in the region in order to evaluate wind potential. Table 4 illustrates wind velocities and estimated wind potential in the different countries. Some sites identified especially in Morocco and Egypt, are qualified as being among the best locations in the world. National wind Atlases are being prepared in most of the countries. It would also be very useful to elaborate a regional wind atlas.

Table 4 Wind characteristics in the MEDREC region

	Algeria	Egypt	Libya	Morocco	Tunisia	Turkey
Wind velocities (m/s)	2 - 6	6 - 11	5 - 10.5	8 - 11	7 - 10	5-11
Wind potential (MW)	na	20,000	na	6,000	2,000	88000 (technical) and 10000 to 12000 economic

Source: OME

2.3. Biomass

Total waste resources potential is very high in the region. Some tentative estimation for their energy valorisation potential has been carried out in Algeria, Egypt, Morocco, Tunisia and Turkey (see details in Part 2) indicating significant results. The potential for waste resources in Egypt is estimated at 47 Mt per year. In Morocco, urban wastes are estimated at 3 Mt per year.

Non-commercial biomass potential is also relatively important, especially in Morocco where one third of the country's total energy requirements are currently met with biomass. The region is thus losing many thousands of forest each year (30,000 hectares per year in Morocco). But in general, biomass data for the region are not always available and when available, they are of poor quality.

2.4. Hydropower

The most important technical potential of hydropower in the region is available in Turkey (433 GW), Egypt (2.8 GW) and Morocco (2.5 GW). Existing generating power capacity in Turkey is 12.9 GW. In Egypt, however, potential for small hydro is rather small and does not exceed 25 MW. On contrary, the large potential in Morocco concerns small hydro and should be exploited in the near future. In Turkey, 4114 MW hydroelectric capacity are under construction.

2.5. Geothermal Energy

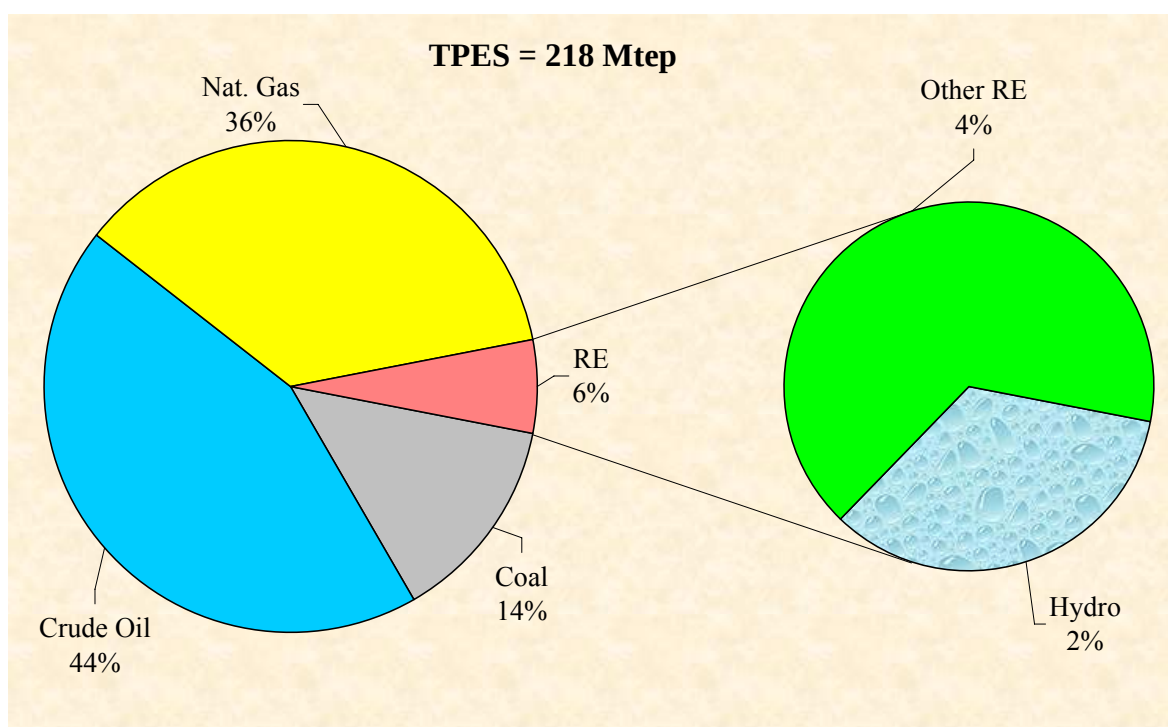
Geothermal potential is still not explored in the region except in Turkey. According to the information gathered, important potential is available in Turkey and also in Algeria and Morocco. Some potentially exploitable sites have already been located in these countries.

3. Current renewable energy situation

3.1. Contribution of RE to the energy balance

Despite high resources and the willingness of most countries to exploit them, RE integration in the SEMCs is rather slow. In 2005, the share of RE in primary energy consumption was 6.4% (excluding biomass, 4 % if biomass and large hydro are excluded). However, the regional situation hides large disparities between the countries, from Algeria (0.3 %) to Tunisia (12.5 %). One have also to underline the strong predominance of biomass which represents more than 87 % energy consumption of RE in the region. Figure 4 illustrates the structure of total primary energy supply (TPES) in the region in 2005.

Figure 4 Share of RE in total primary energy consumption in SEMCs (2005)



Source: OME based on questionnaires to OME members and MEDREP partners

The specificity of renewable energy consumption lies in the fact that a single source, namely biomass, remains the dominant renewable source with 87 % of total consumption. Biomass mainly consists of fuel wood for households (Morocco and to a lesser degree Tunisia) as well as some agricultural wastes used by industry (Egypt). Morocco and Egypt together account for over 88 % of total biomass consumption, characterised heavily by its non-commercial use. Including biomass increase the share of RE in the TPES to more than 15% in 2005.

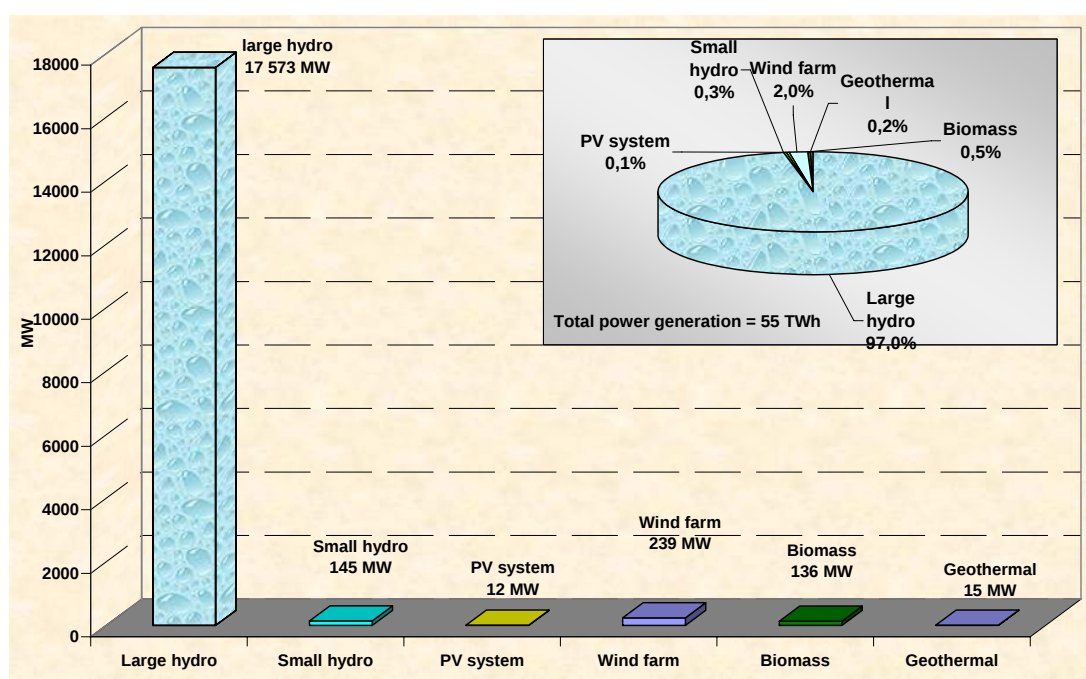
3.2. Contribution of RE to power installed capacity and generation

In mid-2007, total RE-based power installed capacity reached 17 718 MW, more than 93 % of which being large hydro with the greatest share located in Turkey, Egypt and to a much lesser degree in Morocco. The remaining 800 MW capacity is dominated by small hydro and wind (Figure 5):

- Concerning the **small hydro** (321 MW), the majority of the sites are located in Turkey (176 MW), Algeria (85 MW), Morocco (30 MW), Tunisia (30 MW) while in Egypt most of the hydro power plants are all larger than 10 MW.
- **Wind** is still a new but marginal energy source in the region. Total installed capacity (410 MW) includes sites in Zaafarana (Egypt, total 225 MW), Tetouan (Morocco, 53.2 MW), Cap Bon (Tunisia, 19.3 MW), and Algeria (0.5 MW).
- **Photovoltaic systems** reached 13.3 MWp capacity. PV kits supplied a total of 76,367 households with electricity (59,800 in Morocco alone, 11,000 in Tunisia, 4,657 in Egypt and 1,000 in Algeria), representing 8.5 MWp. The remaining 5 MWp capacity concern other applications, including telecoms, schools, mosques, pumping water for agriculture, street lighting, etc.
- **Geothermal energy** represented 20.4 MW (Exclusively in Turkey).

The total RE-based power generation in 2005 was 357 TWh, representing 15.5 % of total power generation for the same year. Large hydro sources dominate the use of renewable energy in power generation (97%), with Turkey, Egypt and Morocco accounting for most of the large hydro based generation (Table 5). Excluding large hydro, the level of RE-based generation falls to only about 1.6 TWh (0.45 % of total power generation). Egypt ranks first, followed by Turkey, Morocco, Tunisia and Algeria. Noteworthy is the dominance of wind for RES (excl.LH)-based power generation in Turkey, Egypt and Morocco.

Figure 5 RE-based power capacity and generation in SEMCS (2005)



Source: OME

Table 5 *Total power generation and share of renewable energy in 2006 (TWh / %)*

	Fossils	Large Hydro	Others RE	TOTAL	RE %	RE-LH %
Algeria	32.8	0.3	0.1	33.2	1.2	0.3
Egypt	92	12.6	0.8	105.4	13.2	0.8
Libya	22.4	0.0	0.1	22.5	0.00	0.00
Morocco	19.5	1.0	0.2	20.7	5.2	1.0
Tunisia	12.8	0.2	0.05	13.1	1.6	0.4
Turkey	122.1	39.7	0.3	162.1	24.7	0.2
TOTAL	301.6	53.8	1.6	357	15.5	0.5

Source: OME

3.3. Institutional and legislative framework

Main actors

The interest of developing renewable energies in the region started early in most of the countries of the region. This has been illustrated by the creation of specialised agencies and institutions. Part 2 presents the situation by country. It appears clearly that, even though many institutions exist, the present situation is characterised in the region by a lack of coordination and cooperation between these institutions regionally and also nationally.

As for the regional actors, two major institutions play an important role in promoting the regional cooperation in the field of renewable energies in the SEMCs and more generally in the Mediterranean region. These are:

- MEDENER: network of the Mediterranean agencies in charge with energy efficiency, which also supports regional renewable energy initiatives and projects (MEDREP, MEDA AESTBM ...).
- OME, Observatoire méditerranéen de l'Energie, association of some 30 leading energy operators (oil, gas, electricity) in the Mediterranean countries. The main objective of OME, a non-profit organisation, is to carry out mid- and long-term energy prospects as well as to promote energy cooperation among countries in the Euro-Mediterranean area through specific studies and research. Renewable energies and sustainable development are one of the most important issues addressed by OME. A Technical Committee devoted to these concerns is very active in that purpose.

Regulatory and legislative framework

Except in Algeria, there is no specific law to renewable energy in the SEMCs. Table 6 summarises the present deployment policies presently in each country. More details are available in Part 2 for each country.

Table 6 *Summary of regulatory and legislative framework in the region*

	Algeria	Egypt	Libya	Morocco	Tunisia	Turkey
RE specific law	Yes	Ongoing	No	Ongoing	Yes	Yes
Feed in tariffs	Yes	Yes	No	No	No	Yes
RE funds		Yes		Foreseen		
RE subsidies					Yes (SWH)	
R&D law	Yes	Yes		Yes	Yes	Yes
Public awareness programmes				Yes	Yes (strong)	

Source: OME

Chapter 4. Benefits and challenges for large-scale development of renewable energy in the SEMCs

1. Benefits of renewable energy development

The benefits of developing renewable energy in the SEMCs, as anywhere else, are well known. They can be summarized as follows:

- Renewable energy technologies offer new solutions to energy needs;
- Renewables have value beyond the energy they generate;
- Renewables contribute to increasing the availability of resources and the security of supply in the region
- Renewables have the lowest environmental impact of all energy sources;
- Renewables offer sustainable energy development in the region and worldwide.
- Renewables are a “win-win” and “no regrets” solution.

Renewable energy technologies offer new solutions to energy needs

Renewable energy technologies present a number of new solutions and options to policy makers, energy companies, and consumers. As a family of technologies, renewables can variously supply bulk power, distributed (embedded) generation, energy services for rural development, heat, and motive power. Several renewables will eventually offer competitive solutions to more than one of these energy needs.

Renewables have value beyond the energy they generate

Renewables are modular and flexible. Using renewables, consumers and energy companies can have energy that also provides cost savings and offsets pollution from conventional energy resources. Supporting renewables to widespread market competitiveness, policy makers enhance energy security through portfolio diversification, stimulate new economic development, competitiveness and jobs, and achieve environmental goals. Renewables have value beyond the energy they generate, but those values are not generally recognised in policy, nor can they be routinely included into traditional energy project finance.

Renewables contribute to increasing the availability of resources and the security of supply in the region

Both renewable energy and energy efficiency are very important in reducing dependence on imported hydrocarbon resources for importing countries and saving them for producing countries, especially in the present context of high oil prices and decreasing resources in the region. Hydrocarbon and especially their import dependency bring economic, societal, ecological, and safety policy problems. Energy supply is a vital service of public interest.

All value-added processes are dependent on energy supply and thereby also on energy prices. As energy demand is increasing rapidly in the region and the resources decreasing, most of the resources would be exploited during the 21st century. In the long term, unless important new discoveries are made, it is absolutely certain that the price for fossil fuel supply will increase steadily. The volatile world market prices for conventional energy sources, in particular oil, pose great risks for the economic and political stability of large parts of the world, the region included. The effects on importing countries (Morocco, Tunisia and Turkey) may be dramatic. In this context, renewable energies can help to diversify energy supply and to increase the security of energy supply. Additionally, in the medium and long term perspective, renewable energies prolong the availability of fossil fuels for the satisfaction of energy and non-energy needs that can now only be covered by fossil fuels.

Renewables have the lowest environmental impact of all energy sources

Renewable energy technologies do have an impact on the environment, as do all energy technologies. However, renewable energies have a far lower impact than fossil fuel. The EU ExternE study¹¹ concluded that when climate change and the possible impact of catastrophic accidents at nuclear plants are accounted for, renewable energies generally have a significant lower environmental impact.

The global challenge of climate protection demands a reformed, environmentally sound energy system that will be viable for the future. The international scientific community is calling for urgent and very strong actions in order to slow global warming and avoid catastrophic consequences for our planet. This is a global problem that concerns the population in the world. In order to achieve this, emissions for GHG must be reduced significantly. An important core element in the efforts can be a massive expansion of renewable energies.

Renewables offer sustainable energy development in the region and worldwide

Energy is central to concerns about sustainable development and poverty reduction. It affects practically all aspects of social and economic development, including livelihoods, water, agriculture, population, health, education, job creation and gender related issues.

As mentioned earlier in this report, per capita energy consumption is much lower in the region than in the European countries. In total 15 million people in the region are living without an electricity supply. At the same time, current patterns of energy production and consumption have direct negative impacts on the environment and natural resources at the local, regional and global levels.

Energy demand in the region is growing rapidly. In order to meet this demand and, at the same time, to achieve sustainable development objectives on a global scale, conventional approaches to energy have to be reoriented toward energy system based on renewable energy and energy efficiency, which will make it possible to address social, economic and environmental concerns simultaneously. Because of their decentralised character, renewable energies offer quick solutions without requiring investments in large-scale energy supply structures and network.

¹¹ <http://www.externe.info/>

For most of the isolated areas in the region, renewable energy is the only possible solution for this people to have access to energy. The related benefits in terms of poverty eradication and improvement of living conditions are very well known (safety, health, comfort, activities, business ...). Renewable energies (PV ...) are competitive in such areas.

As part of the Kyoto Protocol, the CDM aims to encourage sustainable development projects in developing countries such as the SEMCs, funded by industrialised countries. In line with the European strategy for global sustainability, the European union is committed to fostering the market growth of renewable energy sources in the developing countries. In this context, a Euro-Mediterranean partnership may benefit both for the renewable energy development in the region and the achievement of the EU goals, including helping achieve its Kyoto Protocol commitments.

Renewables are a “win-win” and “no regrets” solution

Renewables are win-win and “no regrets” solution to pressing problems, including energy security, economic development and performance, and the environment. Policies and incentives to support renewables are justified on the basis of the values and benefits that accrue to consumers and society from their use.

2. Challenges of large-scale deployment of renewable energy

Despite their significant benefits, renewable energies are facing many barriers and challenges to their large-scale development in the region. These barriers and challenges are the following:

Technical barriers still exist: Worldwide, experience with modern renewables began only about twenty-five years ago. Within that time, the considerable investment made in R&D has demonstrated the potential, and proven the technical viability of each technology; in some cases, it has led to successful and rapid market entry strategies. However, to reach their full potential, renewables require additional investment to further improve performance, and to develop products for specific markets along the pathway to widespread markets. To achieve a vision of significant contribution to the energy portfolio, a new generation of advanced technologies must be developed. Thus even though technologically proven, renewables still require additional development to become fully mature. These efforts have to be undertaken in international and regional scales.

Institutional and regulatory: Except Algeria and Turkey all the countries in the region lack an adapted and stable institutional and regulatory framework for renewables. Except Tunisia, all of them lack adapted and stable institutional and regulatory framework for energy efficiency. There are however many signals that this situation is going to favourably change in a near future. Moreover it is important to underline that policy recommendations to accelerate renewables markets must be specific to the sector of the energy market, e.g., bulk power, distributed (embedded) generation, rural energy services, heat, and transportation, and must be appropriate to the country's progress toward integration of renewables in its energy systems. In addition, strategies and policies to accelerate renewables must fit well into the country's overall economic, energy and environmental agendas, and should reflect the country's renewables aspirations in the context of the global effort to develop renewables and to bring them to competitiveness.

Financial: First, there is a lack of financing because of a considerable lack of knowledge and awareness among financial institutions towards clean energy technologies and how to evaluate investments in that sector. Second and most important the economics of some renewable energy technologies are in an unfavourable competitive position due to large energy subsidies in the market, specifically diesel fuel subsidy and electricity subsidies (even though there are quite differences between the SEMCs in this regard). Third, while most renewable fuels are free, RE projects have high up-front costs, and a number of factors combine to make many RE appear to be more expensive than conventional energy, which constitutes an important barrier, especially for poor populations.

Competing resources: in the SEMCs, RE are often competing with subsidised and less costly energy services. Even though RE are already competitive in limited markets, such as for rural electrification and water pumping applications in remote and isolated areas, they are not yet generally competitive in the broad energy market(s) in which they will ultimately compete. In addition, large hydrocarbon resources and discoveries in recent years continue to strategically shift the government's attention away from developing the renewable energy sector and markets, except large hydropower that has extensively been exploited in the region. Abundant conventional resources and absence of environmental constraints are major barriers for RE to be taken seriously into consideration. However, some renewables are closer to broad competitiveness than others, and it is impossible to develop one strategy to address all circumstances. The challenge is to clarify and facilitate the pathway to competitiveness for each technology in its widespread market targets. One can plot with some confidence the necessary market scale and level of incentives (learning investments) necessary to achieve the point of competitiveness to conventional technologies.

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

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

Human resource: There are very few specialized consultancy firms that provide consultancy services in the area of RE in the region. Companies active in the RE sector are basically capable of installing technologies and conducting needs assessment but little economic evaluation of least-cost options is conducted. In addition, curriculum in local engineering universities pays limited attention to renewable energy technologies. Also, a majority of managers in the RE company themselves lack appropriate business development training and are strictly engineers. Thus, there is a great need for capacity building programmes in the field of RE in the region and for different actors (decision makers, consultants, companies ...).

Each of these factors works to increase the perceived risks (technical, economical and financial) of investing in renewable energy. But if reliable adapted framework conditions and a favourable climate for investment are created, then renewables can quickly increase their contribution in the region. Technology transfer, support for research and demonstration activities and energy efficiency policies are also very important.

A recommended strategy is to bring SEMCs partners together to:

- To integrate renewables into broad North African and Euro-Mediterranean markets;
- Take benefit from the regional cooperation and strategies, and work for its strengthen (MEDREP, euro-Mediterranean cooperation, MEDENER, OME, MSSD ...);
- Work with the private sector;
- Attract private investment;
- Build public awareness.

3. Targets for renewable energies in the region and benefits of using a bigger share of renewables

It is widely recognised nowadays that targets are very important both for renewable energies and end-use energy efficiency development. Indeed, such targets can guide policy-makers during decision-making and send important signals to investors, entrepreneurs and the public.

There are several case studies worldwide that demonstrate how concrete targets lead to increased impacts in various fields. In the case of renewable energies, policy-makers formulate firm policies and support measures that foster their development, and investors develop related strategies and renewable businesses as the target convince them that their investment will yield the expected returns.

Following the WSSD in Johannesburg and the International Conference on Renewable Energies in Bonn 2004, most of the countries of the region set up global targets for renewables and also individual targets for each technology. These are summarised in Table 7. To reach both overall target and the sectorial targets, specific support actions have to be taken soon. Otherwise, it would be very difficult to achieve these targets.

If these targets are met, renewable energies will deliver the following benefits:

- *Investments*: the implementation of new policies to promote renewable energy will have a considerable impact on the amount of investments made in this sector.
- *Avoided fuel costs and external costs*: increasing prices in oil and gas supply resulting from scarcity of the resources, can to a large extent, be covered by using cost-free fuel and low to medium-cost renewable energy technologies. Wind, PV, solar thermal and hydropower have zero fuel costs as the resource is free for the lifetime of the operating plant. Moreover, the external costs to society from burning fossil fuels are not fully included in energy prices. These costs have both a local and global component, the latter mainly related to the consequences of climate change.

Table 7 Targets for RE development in the MEDREC countries

Algeria	- 2010 5 % power generation based on solar 400 MW solar capacity (for domestic market) - 2020 7,500 MW solar capacity (for domestic and export markets)
Egypt	- 2010 3 % electricity demand from RE 850 MW wind installed capacity 150 MW solar combined cycle power station - 2020 20 % electricity generation from RE 3,500 MW wind installed capacity
Libya	- 2020 6 % of RE share in electricity demand
Morocco	- 2012 10 % contrition of RES to national energy balance - 2012 20 % in electricity generation
Tunisia	- 2010 SWH 300,000 m² installed Wind: 180 MW installed capacity PV: 3.5 MW installed capacity biogas: 30 MW power capacity - 2020 SWH 1,000,000 m² installed Wind: 1130 MW installed capacity biogas: 50 MW power capacity - 2030 SWH 2,200,000 m² installed Wind: 1840 MW installed capacity biogas: 80 MW power capacity
Turkey	- 2006-2012 + 926 MW RE - 2010-2015 + 625 MW

- *Increasing revenues for hydrocarbon exporting countries:* reaching the targets set by the countries for RE penetration would lead to important savings of hydrocarbon resources by the producing countries that may constitute additional revenues through exports of the saved resources.
- *CO₂ emissions savings:* renewable energy offers the leading solution to climate change. By their very low and even zero GHG emissions, they offer a safe transition to a low-carbon economy in the region. CO₂ savings resulting from RE amounts 5 % between 2005 and 2020 (in comparison to a non RE scenario and natural gas development in place of RE). As the SEMCS are non-Annex I countries, part of these emissions reduction may be used in helping European countries achieving their Kyoto Protocol through CDM projects. In this context, additional sources of financing may be expected from developing renewables in the region.

- *Employment*: using renewable energy technologies creates employment at much higher rates than any other energy technologies. There are economic opportunities for new industries and industrial and craft jobs through production, installation and maintenance of renewables.

To conclude, factors favouring large scale RE integration in the region are numerous and include: close link between energy and sustainable development, clear willingness of countries to pursue a sustainable development path and the incontestable role of RE in this perspective, need to diversify energy resources, contribution of RE in the reduction of the GHG emissions, abundance of renewable resources in the region and technological progress in this field.

Moreover, there is a strong interest by the private sector actors to invest in such projects, notably to fulfil their obligations or those of their countries - in terms of green certificates and/or conformity with regard to Kyoto Protocol. But concretisations remain linked with the existence of attractive and stable conditions allowing return on investment.

In order for RE to play a significant role in future energy systems in the region and reach the countries' targets and SMDD objectives, it is mandatory that all countries provide necessary conditions. Thus, at national level, the main elements which should be considered are:

- Implementation of strong and coherent policies for RE market development.
- Creation of adapted financing mechanisms and reinforcement of capacity building.

These elements are widely recognised by the EC and the main international organisations (World Bank, UNDP, etc.) as key questions for sustainable development in the RE sector.

At the regional level, regional cooperation requires sufficient means and needs to be strengthened and better structured. The OME Renewable Energy and Sustainable Development Committee is working in this direction by initiating regional projects on several issues related to RE development in the Mediterranean region in cooperation with euro-mediterranean partners.

Part 2.

Country Profile

Chapter 1. Algeria

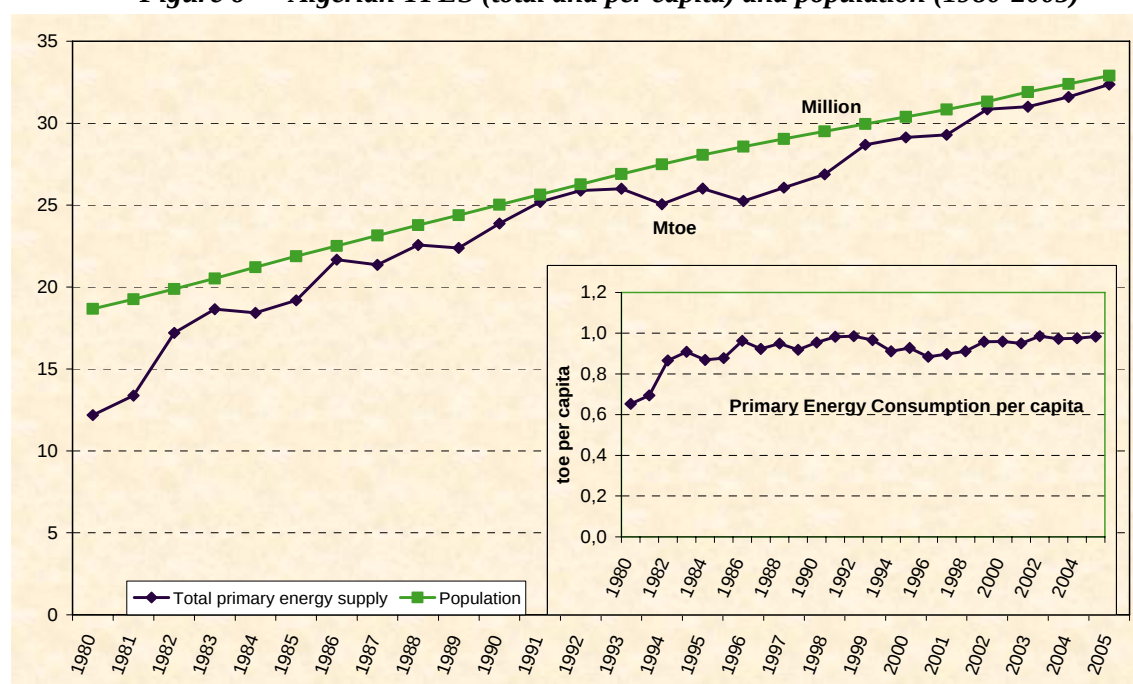
1. Energy Context

Well-endowed with hydrocarbon resources (gas in particular), Algerian energy policy has historically focused on their promotion. The energy sector has fuelled domestic economic growth both in terms of revenue generation and industrial competitiveness. In fact, the oil and gas industry alone represents about 30% of GDP, 60% of government revenue and over 95% of export revenues. As such, the share of RE in energy consumption has remained very low, except for some electrification programs of isolated communities.

Algeria has favoured the development of fossil fuels to satisfy domestic energy needs and subsidized prices have been used as a way of redistributing the benefits of oil exploitation to the population. Gasification of the country represented one of the main energy policy objectives since the 1970s with the aim of substituting oil products with natural gas for domestic consumption, thereby increasing oil export capacity. As such, 200 zones are connected representing about one-third of the housing stock. In the electricity sector, much effort was devoted to the development of networks, notably in rural areas. The country's rate of electrification has reached 96%.

Energy policy choices have contributed to the strong growth in total primary energy supply (TPES) observed over the past decades (see Figure 6). TPES has witnessed close to a three-fold increase in the period under consideration, reaching about 33 Mtoe in 2005. The average annual growth rate of TPES over the period was about 4% on average per year. In the same period, energy consumption per capita increased from 0.7 to close to 1 toe.

Figure 6 Algerian TPES (total and per capita) and population (1980-2005)

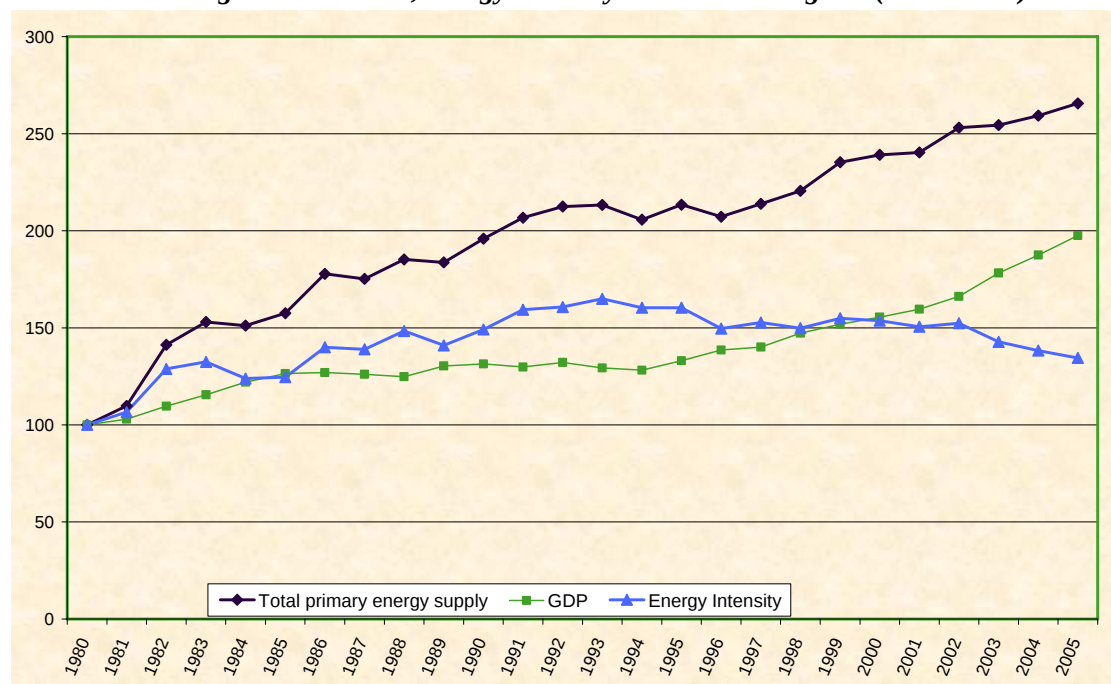


Source: OME.

Energy demand projections show that this growing trend should continue. Pressure on energy demand has therefore become a major concern. Being able to meet demand will require substantial investment in means of production, transport and distribution, and infrastructure developments for gas and electricity. Estimations of the Ministry of Energy and Mines evaluated investment needs for the domestic market for this decade at over US\$ 12 billion (10 for the electricity sector alone and the rest for gas)¹². The State alone cannot meet the investment needs, which is the reason why the energy sector has been opening to private national and international capital.

Figure 7 illustrates the trends for TPES, GDP and energy intensity (EI)¹³ during the three last decades in Algeria (1980 = 100). Well-endowed with hydrocarbon resources and pursuing a subsidized energy policy effectively encouraging consumption until relatively recently, Algeria has had little incentive to cut back on energy use. EI (measured in constant 2000 US\$ GDP) has reached a peak in the late 1990s, remained stable for a few years and has witnessed a decline over the past few years. It should be noted, however, that a more precise analysis of disaggregated data by economic sector and by energy source would be warranted to make conclusive meaningful observations.

Figure 7 TPES, energy intensity and GDP in Algeria (1980 = 100)



Source: based on OME and IEA Database

Generally, the development of alternative forms of energy was set around the following main policies:

- Provision of energy services to isolated regions of the Great South in an effort to promote economic and social cohesion. The Ministry of Energy and Mines and Sonelgaz have devoted considerable resources in this direction.
- Economic and social development of the Steppe mainly supervised by the High Commission for the Development of the Steppe (HCDS).

¹² See the website of the Ministry at <http://www.mem-algeria.org/fr/opportunites/index.htm>

¹³ It should be noted that this aggregate measure of energy intensity has several limits. For more information see McLachlan, M. and Itani, I. (1991) International Comparisons: Interpreting the Energy/GDP ratio.

- Conservation of hydrocarbons with the aim of managing resources in a sustainable way and increasing their commercial value in the export market.
- Contribution to the reduction in emission of pollutants.
- Contribution to research and development of several research centres and universities.

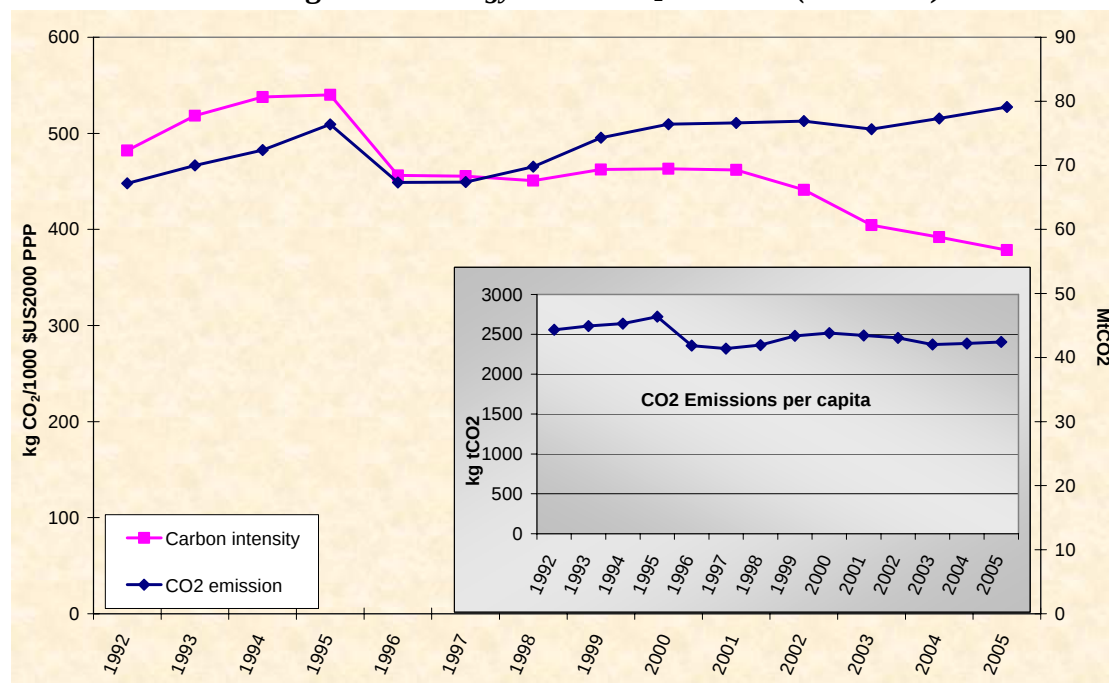
Over the past few years, the government has started implementing rules and regulations in an effort to curb pressure on energy demand and has shown strong commitment by mainstreaming environmental concerns in energy and energy-related policies. The section below provides an outline of the main measures that have been introduced.

2. Environmental Context

After experiencing a steady increase until the late 1980s, Algeria's CO₂ related-energy emissions per capita have been basically constant – albeit at a relatively high level. In 2005, Algeria emitted about 2.4 tCO₂ per capita and total carbon emissions reached 79 Mto CO₂ (see Figure 8).

On an increasing trend up to the early 1990s, Algeria's carbon intensity fell and remained relatively constant since the mid-1990s to finally witness a substantial fall in the past few years. In 2005, it stood at about 0.38 tCO₂ per thousand \$2000 (PPP) as opposed to 0.48 in the early 1990s. The decreasing trend in carbon intensity can be primarily explained by the government's commitment to heavily substitute oil with natural gas in all possible sectors of the economy.

Figure 8 *Energy-related CO₂ emissions (1992-2005)*



Source: OME

Concerning the Kyoto Protocol, the Council of Ministers ratified in April 2004. Algeria submitted the documents of ratification to the UNFCCC earlier 2005 year and since May 17th 2005 it has been able to participate in the Clean Development Mechanism (CDM).

Concerning the creation of a Designated National Authority (DNA) which is one of the institutional requirements for the participation of developing countries to the Kyoto Protocol, the *Inter-ministerial Decree* published in the Official Journal of March 1st, 2006 stipulates that the DNA is constituted of a Commission (DNA/CDM) placed under the authority of the Ministry of Environment and is presided jointly by the representative of the State Ministry, the Ministry of Foreign Affairs and the Ministry of Environment.

The Commission includes a representative from several ministries (Transport, Energy & Mines, Interior, Local Communities, Finance, Environment, etc.).

The Commission shall:

- define criteria for the approval of CDM projects in the context of sustainable development;
- ensure the dissemination of information regarding the eligibility criteria of CDM projects and the project cycle;
- control the process of project approval;
- evaluate CDM project eligibility;
- follow-up CDM projects until completion.

At the time of the writing, it is not yet clear how active the Algerian DNA is as there seems to be no contact person or contact office mentioned either in the website of the Ministry of Environment or in that of the UNFCCC listing countries' DNAs.

3. Integration of renewable energy sources

As other Southern Mediterranean Countries (SMCs), Algeria has a large RE potential, in particular in solar energy which the government is increasingly committed to exploit. This section provides a brief description of the existing RE potential, the current RE situation in the energy balance and the legislative/regulatory framework in place in Algeria.

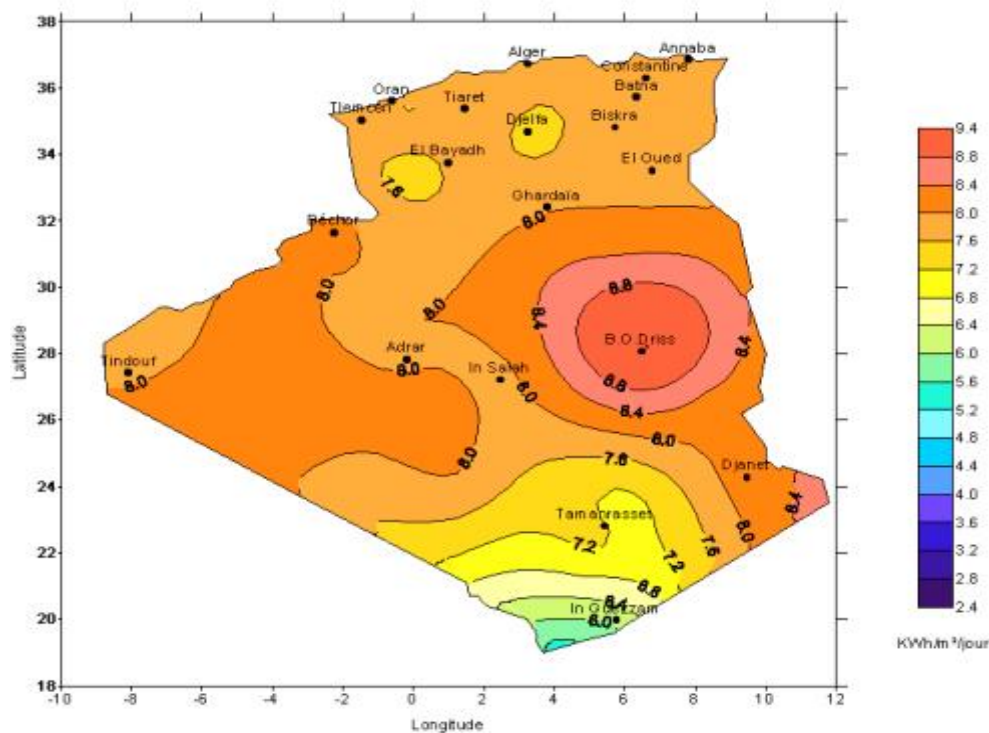
3.1. *Renewable energy resources and potential*

Solar

The solar map of Algeria has been elaborated and witnesses to the high solar potential of the country (see Figure 9).

The solar radiation in Algeria is estimated at over 5 billion TWh. Solar radiation falls between 5.6 kWh/m² and 7.2 kWh/m², corresponding to 1700kWh/m²/year in the North and 2600 kWh/m²/year in the South (see Table 8 for details). There is considerable potential in particular for desert areas where the density of the population is very low, the habitat rather scattered and recourse to traditional solutions relatively costly.

Figure 9 Daily solar radiation on a horizontal level in July (in kWh/m²/day)



Source: CDER, <http://www.cder.dz/EPE/cartesolaire.htm>

Table 8 Solar Potential in Algeria

	Coastal area	High plateaus	Sahara desert
Surface (%)	4	10	86
Average solar duration (hrs/yr)	2650	3000	3500
Energy received (kWh/m²/yr)	1700	1900	2650

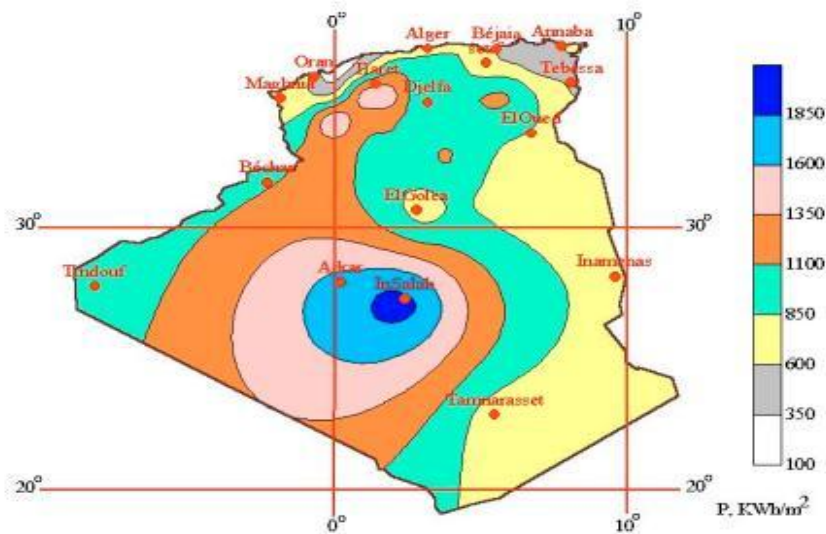
Source: Algerian Ministry of Energy and Mines - www.mem-algeria.org/enr/index.htm

Wind

Algeria is in the process of elaborating a detailed wind map atlas in order to establish areas with greatest wind potential. Some maps have already been elaborated¹⁴ and preliminary results suggest moderate wind regimes, varying between 2 and 6 m/s. Figure 10 illustrates the average annual recoverable wind power density.

¹⁴ For details see <http://www.cder.dz/EPE/cartesvent.htm>

Figure 10 *Average annual recoverable wind power density at 50 meters altitude
(in kWh/m²)*



Source: CDER, <http://www.cder.dz/EPE/cartesvent.htm>

Hydro

Hydro capacity is relatively limited. Even though global flows reach an estimated 65 billions m³, they are of little benefit to the country given the restrained rainfall days, concentration in limited areas, high evaporation and quick evacuation to the sea. However, feasibility studies on 21 dam watershed areas carried out by Tecsalt (selected by the local dams agency “Agence Nationale des Barrages”) testifies to some hydro potential.

Biomass

Biomass data for Algeria is rather scarce, but the current forest potential is evaluated at approximately 37 million toe (Mtoe), with a recoverable potential of about 10%. According to the General Forest Directorate (Direction Générale des Forêts), the wood potential is estimated at 360,000 m³/year for firewood and 3,000 tons/year of charcoal.

There also exists an energy potential in urban and agricultural wastes, of which about 5 million tons not being recycled. This potential represents a deposit of about 1.3 Mtoe/year.

Geothermal

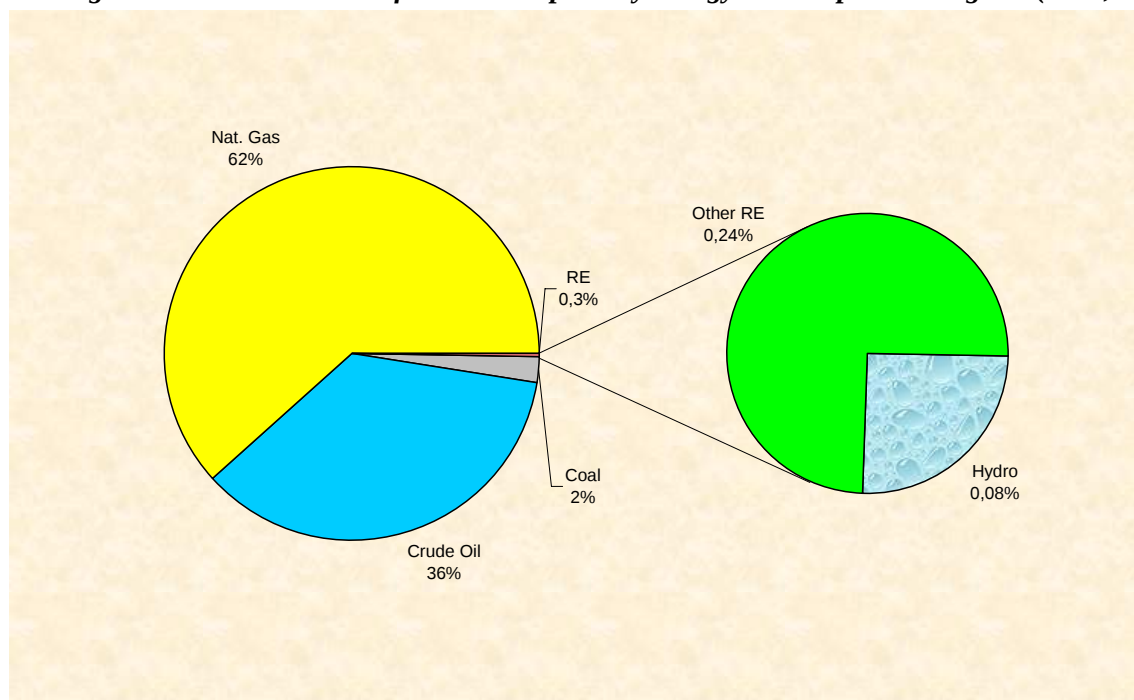
A preliminary geothermal chart has been established. Over 200 hot springs have been recorded in the Northern part of the country, a third of which with temperature exceeding 45°C. Springs with temperatures reaching 118°C exist in the Biskra region (South).

3.2. Current renewable energy situation

Contribution of RE to the energy balance

Dominated by fossil fuels, RE sources in Algeria accounted for about 0.1 Mtoe in 2005. Figure 11 illustrates that the share of RE remains marginal, representing about 0.3% of Total Primary Energy Supply (TPES). This includes basically biomass and hydro.

Figure 11 The share of RE in total primary energy consumption in Algeria (2005, %)



Source: OME based on questionnaires to member companies.

Concerning **solar water heaters** (SWH), Algerian installed capacity is only about 1000 m², but an in-depth study carried out by APRUE suggests that the potential in region which are neither connected to gas or electricity networks is about 2 million m² for the high priority zone alone (that is, not connected to any conventional energy network). But as is well known from experiences in other countries, the development of this sector is closely linked to the introduction of subsidies.

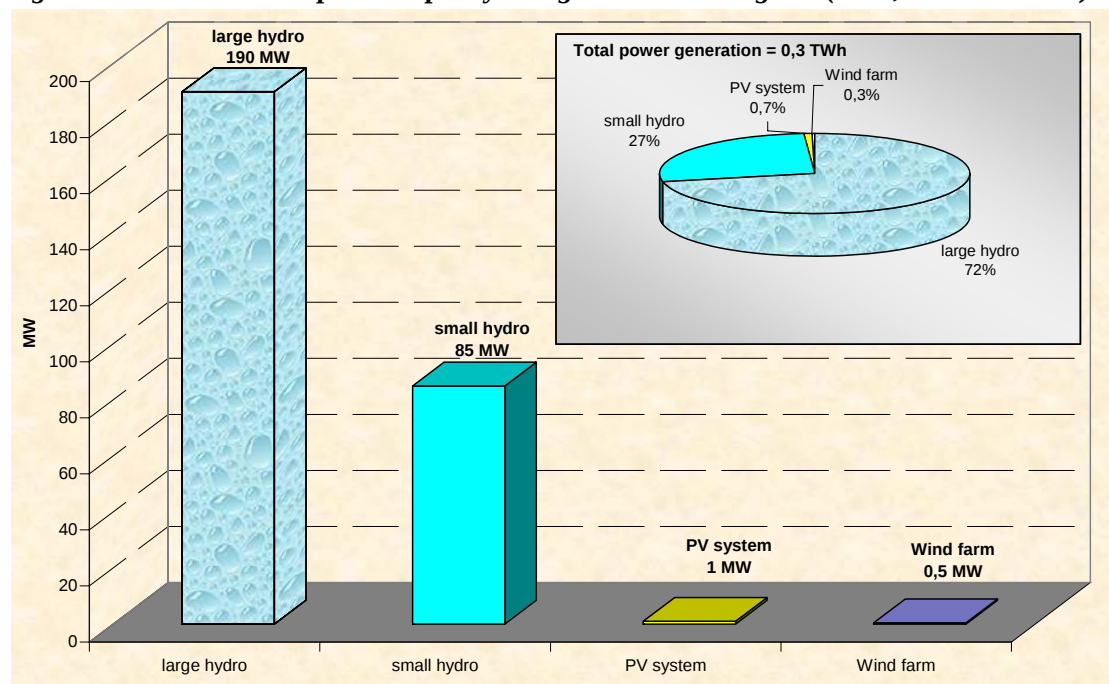
RE-based power capacity and generation

In 2005, total RE-based power capacity reached 276 MW, almost exclusively dominated by **hydro** resources. About 1 MW of **PV** applications and a 0.5 MW **wind** demonstration farm account for the rest of RE-based power capacity.

Total **small hydro** capacity amounts to 85 MW while **large hydro** (which includes 3 projects) represents a little over 200 MW (see Table 9 and Figure 12).

Total RE-based power generation amounted to 0.3 TWh in 2005 (about 0.9% of total power generation), most of it being generated by large hydro (see Figure 12).

Figure 12 RE-based power capacity and generation in Algeria (2005, MW and TWh)



Source: OME based on questionnaires to member companies.

Table 9 Hydro power capacity in Algeria by December 2005 (in MW)

Small hydro		Large hydro	
Name	Capacity	Name	Capacity
Ahzerouftis	5.0	Darguinah	66
Beni Behdel	3.3	Ighil Emda	24
Bou Hanifia	6.0	Mansouriah	100
Ghouriet	4.2	Sub-total	206
Ghrib	7.0		
Hamiz	1.64		
Ighzer n'chebel	2.7		
Illiten	8.0		
Oued Fodda	15		
Souk El Djemaa	9.0		
Tessala	2.4		
Tizi Meden	4.5		
Erraguene	16		
Sub-total	85		
TOTAL		275	

Source: Sonelgaz, direct communication.

Concerning **PV systems**, the government has financed a decentralized electrification program carried out in the 1990s by Sonelgaz. Thus twenty villages in the isolated sites of the Great South (Tamanrasset, Illizi, Tindouf and Adrar regions) were electrified with solar energy, representing about 900 households (see Figure 13). The PV installations have a unit capacity of 1.5, 3 and 6 kW_p to respectively supply 3, 6 and 12 households (consumption per household in the order of 1.5 kWh/day to 2 kWh/day). The power integrating the installations of rural electrification of the twenty villages is around 500 kW_p. The relays of telecommunication add up a power of 350 kW_p. The remainder is divided between water pumping with 59 kW_p, and the street lighting and domestic with 62 kW_p. Total installed PV capacity is about 1 MW_p.

A socio-economic study (using a participatory approach)¹⁵ has been carried out to evaluate the impact of the program. The results are conclusive with about three/fourth of the beneficiaries suggesting that the introduction of energy services has either totally or partially changed their lives. This development has even introduced new activities (for e.g. schools, health centres and some economic activities such as sewing). Concerning the environmental impact, the program has avoided the emission¹⁶ of 1400 tones of CO₂.

Figure 13 Rural electrification of the 20 villages of the South



Source: S. Guezane, Sonelgaz. Conference on the role of Renewable Energy, Algiers, June 7-8, 2005.

A second rural solar electrification program for 16 villages is being implemented, supplying an additional 600 households with electricity in Adrar, Illizi and Tamanrasset in the South.

¹⁵ The study was carried out by the Research Centre Applied to Economic Development (CREAD), see website: <http://www.cread.edu.dz/>

¹⁶ This is based on the program's cumulated power consumption to May 2005 of 1.57 GWh.

3.3. Institutional and legislative framework

Main actors

The interest for the development of RE sources in Algeria started with the creation of specialized agencies such as the solar energy institute as soon as 1962 to promote research and development in this field. In 1981, this entity was transformed into the research centre for new energies to finally espouse its current structure as the Centre for the Development of RE Sources (**CDER**) was created in 1988, financed by the government, Sonatrach and Sonelgaz. The centre is in charge of elaborating the research and development programs of solar, wind, geothermal and biomass sources. Since 1998, further efforts have focused on research in the framework of the *Five-year Orientation and Program on scientific research and technological development* (Law 98-11).

Concerning energy efficiency, one of the most active members is the Agency for the Promotion of the Rational Use of Energy (**APRUE**) whose objectives are energy conservation and the reduction of the impact of the energy system on the environment.

As already mentioned, **Sonelgaz** (the national electricity and gas distribution company) has together with the Ministry of Energy and Mines developed the PV program for 20 villages in isolated areas of the desert for a total investment of DA 800 million. Currently, there are plans to pursue a new similar program.

More recently (July 2002), the creation of **NEAL** suggests renewed interest in the field of RES. NEAL is a public-private company associating **Sonatrach** (45 percent), **Sonelgaz** (45%) and the private partner **SIM**¹⁷ (10%). The agency is to identify and implement projects related to the promotion and development of new and RE sources. Its main objectives include the development of solar and wind electricity generation, the promotion of solar water heaters and hybrid power installations (PV-wind-diesel-natural gas), the promotion of clean energy sources (LPG) and the establishment of a research pole on solar energy together with existing research centres.

NEAL is a member of SolarPACES, program for the promotion of solar energy and chemical energy systems of the International Energy Agency (IEA). This fits Algeria's commitment to increase the share of solar energy in power generation in the future. Algeria also wishes to supply electricity from solar thermal power plants to the European Union.

NEAL's current project portfolio includes an initial project for a 150 MW solar thermal plant in Hassi R'Mel already in construction¹⁸ and a 10 MW wind project to be developed as a CDM project. The ambitious objective of increasing the share of solar in the power mix to 5% has been announced by the government (see below section on priorities and targets).

Sonatrach (Health, Security and Environment) has recently also been involved in energy efficiency projects through a World Bank GGFR¹⁹ project aimed at identifying potential gas flaring reduction projects in the context of Kyoto's Clean Development Mechanism as well as building capacity in the field²⁰.

¹⁷ Semolina manufacturer.

¹⁸ The construction of the Solar Power Plant Project (SPPI) was launched in December 2006 by Abener (Spain) and will start operation in 2009. The financing is provided by Abener-Spain (66%), NEAL (20%) and BEA (14%).

¹⁹ GGFR is the Global Gas Flaring Reduction public private partnership.

²⁰ The OME was involved in this project as consultant together with Econ Analysis.

Some manufacturers such as **ENIE**²¹ are showing interest in the development of solar PV installations. According to the preliminary results of the market study the company carried out, the additional capacity needs in Algeria could be in the order of 2.5 and 3 MWp.

Regulatory and legislative framework

Figure 14 summarizes the general structure of the regulatory and legislative framework pertaining to RE and energy efficiency in Algeria.

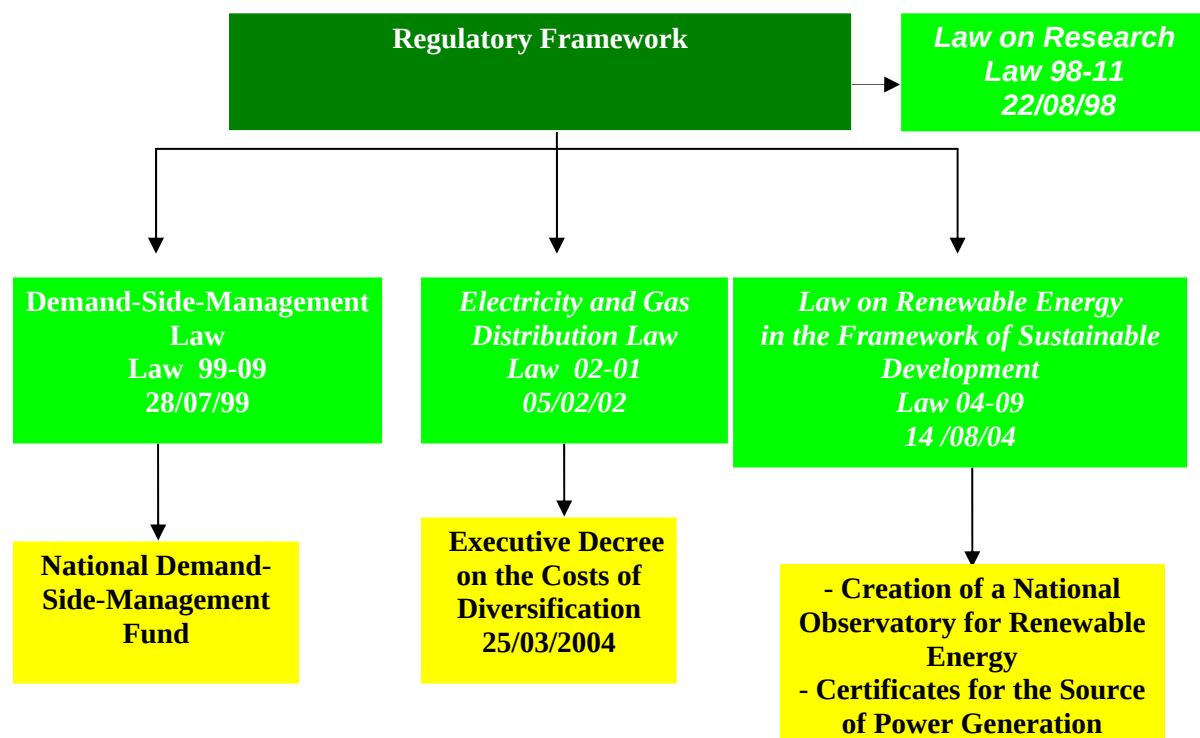
Law on Research

Impetus was first given to research and development through the *Five-year Orientation and Program on scientific research and technological development (Law on Research)*. The Law sets the Renewable Energy Program as a national priority program and aims to improve resources available for research and development (R&D) in the field.

Law on Demand-Side-Management

The promotion of RE was set within the larger framework for the promotion of rational energy use. In particular, the **law on Demand-Side-Management** (July 1999) provides the legal framework allowing for benefits to projects enhancing energy efficiency and promoting RE. In this context, the National Demand-Side-Management Fund supports such projects which can also benefit from financial aid, tax cuts and exemptions from custom duties. RE projects can also draw benefits from the legislation on investments in activities deemed priority projects²².

Figure 14 Summary of the regulatory and legislative framework



²¹ National enterprise for the electronic industries, see website : <http://www.enie-dz.com/index.htm>

²² Guide des Energies Renouvelables Algérie. Ministère des Mines et de l'Énergie.

Law on Electricity and Gas Distribution

In the latest **law on Electricity and Gas Distribution** (EGD) of February 2002, incentives are provided for electricity generated from RES and cogeneration. The law mentions preferential tariffs as well as a premium to cover part of the additional costs incurred from the production of RES as well as tax reductions. Article 26 of the Law pertaining to this issue is summarized in the textbox below.

Article 26

In the framework of national energy policy, the CREG (Electricity and Gas Regulatory Commission) can take organizational market measures in order to ensure the supply of a minimum quantity of electricity from RE or cogeneration systems at a minimum price.

The excess costs associated to these measures can be financed by the State or can be accounted for in the electricity and gas fund and be imputed on tariffs.

The quantities of energy supplied to the market and aimed at encouraging RE or cogeneration must go through a call for tender.

Law on Electricity and Gas Distribution (Informal translation)

Executive Decree on the Costs of Diversification

One should note, however, that terms defining benefits accruing to RE in the EGD law are generally broad and do not set specific conditions necessary for their implementation. This is the reason why the **Executive Decree on the Costs of Diversification** (March 2004) is of utmost importance.

In fact, the Decree defines the means of application of Article 26 of the EGD law. It sets clear targets and introduces several specific benefits for the promotion of RE and cogeneration projects. In general terms, the Decree aims for the protection of the environment and the sustainable development of energy supply through the increase in the share of RES.

According to the Decree, the transmission system operator or the holder of the distribution concession must purchase RE-based power generation; and in case of unfruitful calls for tender, the Regulatory Commission can set annual quotas for power generation from RE and ensure compliance to such obligations. Finally, the Decree establishes purchase conditions for electricity generated from RE such that a premium of 100 to 300% over the electricity price as established by the market operator is given to every kWh supplied to the network. The different premium allocated to the various renewable sources shows the objective of promoting RE. The premium allowances amount to the introduction of feed-in tariffs. Table 10 shows that the allowances decrease with the share of output (solar output for solar thermal plants and thermal output for cogeneration).

Table 10 Premium allowances for RE-based power generation

Source		Premium (% of electricity price)
- Solar PV		300
- Wind		300
- Solar Thermal:		
<i>Share of solar output</i>	$\geq 25\%$	200
	20-25%	180
	15-20%	160
	10-15%	140
	5-10%	100
	$<5\%$	0
- Waste		200
- Cogeneration: (power capacity should not exceed 50MW)		
<i>Share of thermal output</i>	$\geq 20\%$	160
	15-19%	120
	10-14%	80
	$<10\%$	0
- Hydro		100

Source: Executive Decree on the Costs of Diversification (March 2004)

Several Decrees of Application should be introduced which will relate (amongst others) to: i- the commercialization of green certificates; ii- the penalties power producers should incur for non-compliance to their production quotas based on RES; iii- the environmental measures that need to be respected.

Law on Renewable Energy

The law on Renewable Energy in the Framework of Sustainable Development (August 2004) constitutes a legal basis for statutory decrees aiming at enhancing the value of environmental benefits of RE.

The objectives of the law are to set concrete targets for the share of RE in the energy balance every five years; contribute to the international effort of limiting greenhouse gas emissions; the preservation of fossil fuels to ensure sustainable development; exploit local RE sources.

To achieve these objectives, the law plans to set up a national program (up to 2020) that includes a multi-annual evaluation of RE use compared to fossil fuels; to introduce real promotion measures based on providing certification of power generation sources and giving a legal setting for green certificates and certified emission reductions; to create a national observatory in charge of promoting RE (its structure and operation to be determined by regulatory means). Currently, the law is still awaiting the promulgation of decree applications.

4. Barriers, priorities and targets of renewable energies

4.1. *Barriers to renewable energy development*

Except for the common technical and economic barriers (which lead to a greater cost for the economic development of a country), some of the more specific barriers that apply to Algeria and many developing countries are of institutional nature. Some of the main aspects include:

- **Weak inter-sectoral coordination and communication.** The fields of RE and energy efficiency suffer from weak inter-sectoral coordination which not only tends to slow down the promotion of such projects, but also leads to the duplication of efforts and weakens human capital build up. Attaining broad stakeholder participation and reaching coordination among different stakeholders and various sectors of government are indispensable.
 - o *Among the different stakeholders.* The full integration of the different sectors (government, private sector, NGOs) may not be possible everywhere, but a minimum of collaboration is necessary and responsibilities of the various stakeholders must be clearly defined.
 - o *Among the various sectors of government.* Many ministries (Agriculture, Energy, Transportation, Environment, Foreign Affairs) have competence that can be used. Clear lines of authority, however, must be made.
- **Slow process in implementing Decrees of Application.** While several laws clearly provide the framework for a greater integration of RE in Algeria, it seems that the promulgation of the Decrees of Application takes time and prevents implementation of much needed measures for the promotion of such projects.
- **Human capital.** Continuity of personnel is essential. Rotation of staff prevents a long-term accumulation of experience and the process becomes too dependent on individual involvement, or lack thereof. Additional capacity building and awareness raising in certain aspects of the sector may also be needed.
- **Lack of knowledge networks.** While some associations have been created in the past few years to promote cooperation in similar field (for example, the ARCE²³ or APEQUE²⁴ associations), a lack of common platforms seem to also represent an obstacle. According to some researchers, knowledge is often not disseminated leading to duplication of efforts and slower capacity build up. According to the CDER, for example, the same type of R&D has been undertaken at different research centres without coordination. Capacity building seminars on an issue of interest to different stakeholders may only benefit some due to lack of information dissemination.

²³ ARCE is an association of researchers dealing with climate change issues. Its creation has been supported by the European Commission's program for the promotion of Algerian NGO's in the field of development and Sonatrach. The aim of ARCE is to strengthen the link between climate change and sustainable development while promoting a permanent dialogue between the actors in the field.

²⁴ APEQUE (Association pour la Promotion de l'Eco- Association pour la Promotion de l'Efficacité et la Qualité des Entreprises) was created to raise awareness of sustainable development and promote eco-efficiency among business leaders, governments and NGOs in Algeria. Apeque joined the WBCSD in 2000.

The briefly noted obstacles are common to most developing countries and generally institutional obstacles (by their very nature) take time to be overcome. However, this is exactly the reason why it is important to clearly identify them and initiate a process to solve them.

4.2. *Priorities and targets for renewable energies*

The Algerian government has set a target of 5% of power generation based on solar energy by 2010. The objective may seem ambitious but the first project being already implemented in this framework is the 150 MW hybrid solar-gas plant²⁵ in Hassi R'Mel. The construction of the Solar Power Plant Project (SPPI) was launched in December 2006 by Abener (Spain) and will be in operation in 2009. The financing is provided by Abener-Spain (66%), NEAL (20%) and BEA (14%).

The aim according to NEAL²⁶ is to develop reach about 400 MW solar based power capacity by 2010 for the domestic market, mostly based on hybrid solar-gas technology. The capacity should quickly increase both for the domestic and the export market to reach as much as 7500 MW capacity by 2020. The export part should be thought of more as a potential export capacity to the European market rather than an objective (see Table11).

Table11 *Projected solar-based capacity for domestic use and exports (2010-2020)*

	Domestic	Export	Total
2010	400	200	600
2015	1000	400	1400
2020	1500	6000	7500

Source: Hasni, T. 2005. "Renewable Energies in Algeria".

The advantage of using this hybrid technology is not only the use of the resource and the CO₂ emissions avoided, but also its contribution to the preservation of natural gas. NEAL's calculations suggest, for example, that 6000 MW would correspond to savings of about 12 billion m³ in natural gas.

NEAL has also in its portfolio a 10 MW wind project which should be developed in the near future.

5. Conclusions

For a country so richly endowed with hydrocarbon resources, Algeria stands out in that it has introduced laws and regulations aimed at promoting RE that are well in advance of countries that are relatively resource poor. Most striking is the introduction of the Executive Decree on the Costs of Diversification (March 2004) which introduces feed-in tariffs favouring power generation based on RE. This Decree provides a clear protection of the alternative sources of energy in an electricity market deemed to move toward greater opening (as set in the Electricity and Gas Distribution Law – February 2002) and which could easily hamper the development of the currently still more expensive alternative sources of energy.

²⁵ The power capacity based on solar energy is expected to be 25 MW.

²⁶ Information based on Mr T. Hasni's presentation "Renewable Energies in Algeria", US-Algerian Business Council, Houston, March 2005.

Algeria has also shown its engagement to devote resources (human and financial) to improving the local and global environment. Locally, efficiency measures have been introduced in an effort to curb energy demand and improve environmental conditions. Laws that have been promulgated clearly aim to promote alternative sources of energy not only to diversify the energy mix and take advantage of other resource endowment (solar in particular) but also to take a development path that is more sustainable. At the international level, Algeria has ratified the Kyoto Protocol and has shown commitment by introducing capacity building in the field of CDM as well as engaging in the process of promoting at least a few types of projects (NEAL's wind farm and the hybrid solar-gas power generation project and Sonatrach's gas flaring reduction projects). The Inter-ministerial Decree (early 2006) does promulgate the creation of the DNA within the Ministry of Environment – though there does not currently seem to be any indication of a concrete application.

As already noted, certain obstacles remain not the least of which being a sort institutional inertia. In the context of Kyoto's ratification, the difficulties of concretely setting up a functioning DNA illustrate this obstacle. Duplication of efforts are also common, though several actions aim at resolving this issue such as the creation of common platforms (associations, etc), the organization of seminars, capacity building and conferences related to the field of RE, energy efficiency and more generally to sustainable development issues.

These combined efforts together with some of the concrete objectives set by the government as translated into the promotion of some concrete projects in the field all seem to work in the right direction. In addition, high population growth and increased economic activity driving high energy demand (in particular electricity) may find their limits and ultimately give incentive to the promotion of a more sustainable consumption pattern.

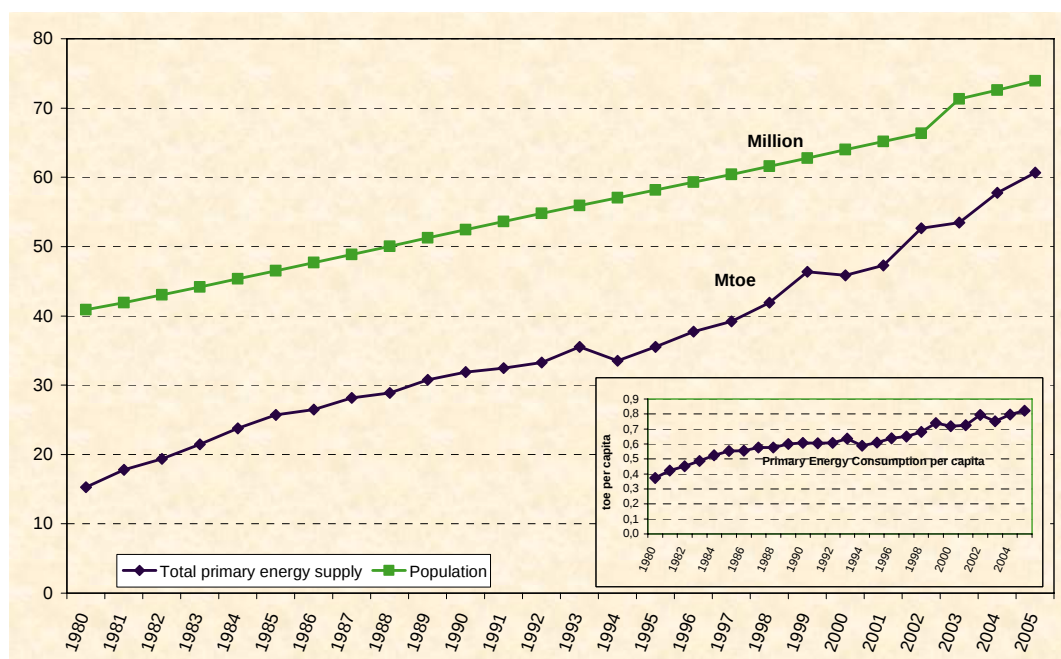
Chapter 2. Egypt

1. Energy Context

The energy sector plays a very important role in the economic development of Egypt. The country is indeed endowed with significant oil and natural gas resources and is currently an oil and liquefied natural gas (LNG) exporter (since January 2005 for the latter). However, due to increased energy and especially electricity demand growth, some projections call for Egypt to begin importing oil in the near future. To face this challenge, the government is encouraging increased exploration, better refinery recovery, and increasing the proportion of demand for natural gas. Egypt is hoping that exploration activity, particularly in new areas, will discover sufficient oil in the coming years to slow recent annual declines in output. As a result, there about 200 discoveries from July 1999 to July 2006, of which more than 70 were natural gas. Also, natural gas represents now about 50% of local hydrocarbon consumption compared to 12% in 1982.

Energy demand in Egypt has increased in recent years due to demographic growth, (population of 78.887 million in 2006, including 2.2 million Egyptian citizens abroad) improvement of standard of living, construction of new industrial zones and expansion of the commercial and residential sectors. An historical trend of Egypt's TPES and population is shown in Figure 15. It illustrates the high demographic growth and a rise in energy demand. Indeed, the Egyptian TPES increased about four times over the past two decades, from 15.3 Mtoe in 1980 to 60.7 Mtoe in 2005 (6% average annual growth over the period) In the same period, energy consumption per capita increased from 0.37 toe to 0.82 toe (3.2% average annual growth). In 2006, TPES was 73.83 Mtoe (70.9 Mtoe from Oil, Crude oil, Condensate and LPG; 2.78 Mtoe from Hydro-power; 0.12 Mtoe from RE; 0.03 Mtoe from Coal).

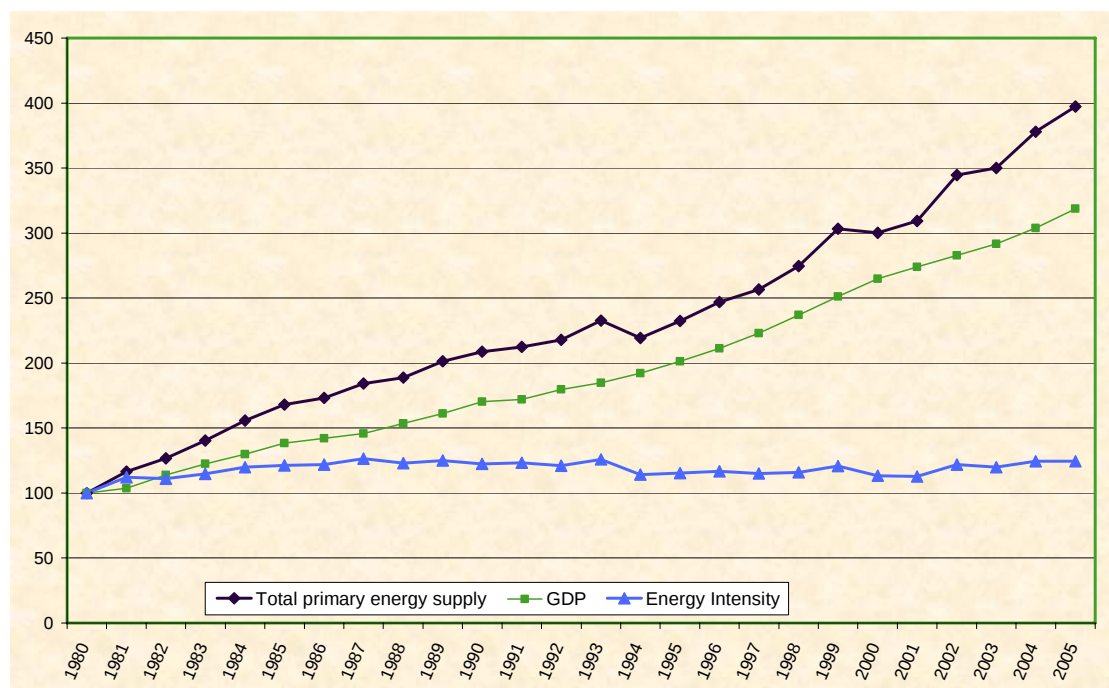
Figure 15 Egyptian TPES (total and per capita) and population 1980-2005



Source: OME

Figure 16 illustrates the trends for the TPES, GDP (constant 2000 US\$) and energy intensity during the two last decades in Egypt (1980 = 100). It clearly shows that energy demand is growing much faster than GDP, indicating that economic growth in Egypt is more and more energy intensive. The energy intensity has increased from 0.4 toe/2000 US\$ in 1980 to 0.49 toe/2000 US\$ in 2005 (0.8% average annual growth over the period).and 0.49 toe/2000 US\$ in 2006. Egypt's energy intensity is comparable to that of other oil producing countries. This clearly indicates the existence of an important potential for energy efficiency in the Egyptian economy.

Figure 16 *Egyptian TPES, energy intensity and gross domestic product*



Source: OME and IEA database Egyptian Central Agency for Public Mobilization and Statistics

Egypt's energy intensity should fall as the country implements more energy efficiency and conservation programs. In 1997, USAID entered into a 20-year partnership with Egypt and created the Egyptian Environmental Policy Program (EEPP). With the help of USAID, Egypt has created a National Energy Efficiency Strategy that focused on three goals: (1) accelerating the use of natural gas rather than oil; (2) developing national energy efficiency codes and standards, and (3) promoting private investment in energy efficiency activities. The EEPP estimates that if Egypt can aggressively adopt energy efficient technologies, there could be an annual savings of about 1% of GDP and a more than 10% drop in annual CO₂ emissions by the end of the program.²⁷

The Egyptian government pays a great attention to the poor and their access to energy services. This is crystallised in the annual subsidy in the energy sector in favour of the poor to decrease the poverty levels and improve current standards of living. The government annually pays about 3 billion EGP²⁸ to subsidise “Putagas” (mix of butane and propane). It also spends from 2 to 3 billion EGP to subsidise diesel fuel in order to keep the cost of transportation as low as possible. Gas is also subsidised in industry and households in order to reduce the costs of products for the poor. In addition, power plants also purchase subsidised gas in order to

²⁷ See Egypt: Environmental Issues at <http://www.eia.doe.gov/emeu/cabs/egypenv.html>

²⁸ EGP: Egyptian Pound (Egyptian national currency). As of 30 June, 100 EGP = 14.5 €.

keep electricity rates at low levels. All these subsidies while facilitating access of poor to energy services, of course worsen the situation of RE competitiveness vis-à-vis conventional energies.

Moreover, the electricity sector enjoys cross-subsidies in favour of the poor. The low levels of energy consumption in a range of 100 kW are subsidised and reach 6 piasters whereas households with high levels of electricity consumption pay a higher cost, reaching 30 piasters for consumption over 10,000 kWh. Also, commercial enterprises pay about a maximum of 45 piasters high consumption levels, part of which is used to subsidise the poor. With respect to industry, the cost is 18 piasters for low voltage consumption and 11.3 piasters for high voltage.

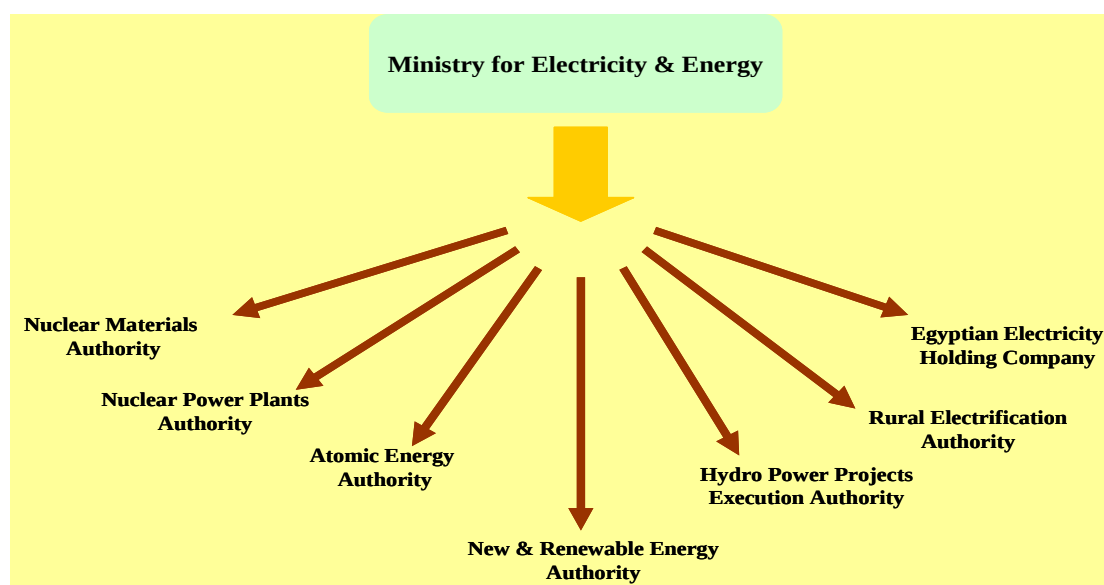
Since these prices have been frozen for the last ten years, the profits of the distributing companies are diminishing due to inflation and wage increases. Currently, the average profits represent a very small percentage compared to capital investments. This will lead to difficulties when companies are privatised.²⁹

The following are the key Ministries responsible for decision-making in the energy sector:

- The **Ministry of Petroleum**, concerning exploration, production, refining, transportation and marketing of oil and natural gas.
- The Ministry of Electricity and Energy (**MEE**), concerning electricity generation transmission and distribution.
- The **Ministry of Transportation**, concerning energy-related aspects in transportation.
- The Ministry of State for Environmental Affairs (**MSEA**), concerning environmental issues.

Figure 17 illustrates the organisational chart of the Ministry of Electricity and Energy.

Figure 17 Organisational chart of the Ministry of Electricity & Energy



Source: EEHC annual report 2004

²⁹ See http://www.undp.org/eg/workshops/2002/Nov/Post_wssd/Documents/Energy/report.pdf

The following Central Organisations provide decision-making support:

- The Egyptian Environmental Affairs Agency (**EEAA**), covering execution of environmental protection activities under the supervision of MSEA.
- Organization for Energy Planning (**OEP**), covering integrated energy planning policy analysis, and energy efficiency under the supervision of MEE.
- The **Egyptian Electric Utilities and Consumer Protection Regulatory Agency**, established by Presidential Decree No. 339/2000. The Agency regulates and supervises all electricity generation, transmission, distribution and usage as well as ensures availability of supply to users at fair prices.
- The **Cabinet of Ministers** is the main venue of coordination. It operates through specific Ministerial committees and is responsible for pricing the petroleum products and electricity.³⁰

Energy planning and policy analysis are considered on two different levels. First, on the national level studies are conducted on alternative energy policies that encompass economic variables, options for energy resources and ways to achieve an energy supply/demand balance. Second, on the sector level studies analyse energy consumption patterns so that the proper policies can be set for achieving development goals.

Technical cooperation programmes are implemented through bi-lateral official development assistance and other forms of economic cooperation including programmes related to management of power generation, transmission, RE, mining and oil refinery technology as well as energy efficiency.

The Egyptian energy policy is set up by the Energy Council. The OEP participates in the preparation of energy plans and is in charge of energy conservation.

Energy policy gives priority to the promotion of natural gas, the substitution of gas for oil in electricity production and for vehicles. Also, the limits in oil and gas reserves, the valid expectation of higher future prices of imported energy, and high energy demand growth has necessarily increased awareness for energy efficiency improvement and the integration of RE. The Egyptian government has indeed started giving high priority to the promotion and development of new and renewable energy and the introduction of energy conservation measures. This policy is reflected in the relevant authorities' planning, which comprises rolling five-year plans and longer-term plans.

In the future, energy will continue to fuel Egypt's economic growth and development. The upward trend in oil prices and the country's liquefied natural gas exports have at least partly compensated for the decline in oil production. In addition, Egypt's strategic geographic position makes it a key transit corridor³¹.

³⁰ See UNDP at http://www.undp.org.eg/workshops/2002/Nov/Post_wssd/Documents/Energy/report.pdf

³¹ Detailed information on the energy situation in Egypt (as of May 2005) are available on <http://www.eia.doe.gov/emeu/cabs/egypt.html>

2. Environmental Context

Egypt is 97% desert and is therefore dependent on the Nile River for its existence. Only 5% of the land area in Egypt is actually occupied and less than 4% of the land is suitable for agriculture. Since such a small percentage of land is habitable, population densities in some areas along the Nile River are greater than 1,000 people per square kilometre.

The Nile River is the lifeblood of Egypt. The river is the main source of freshwater for household use and irrigation, a source of power from the hydroelectric facility at Aswan, and a means of transportation for people and goods.

Economic development has placed great stress on Egypt's environment. Population density, combined with long-postponed infrastructure investments, has severely overwhelmed water and wastewater services of urban areas creating numerous environmental hazards. Oil pollution and careless anchoring of boats have damaged coral reefs off the coast, as has pollution from urban and industrial sources and improper disposal of solid wastes. Rapid population growth is straining natural resources as agricultural land is being lost to urbanisation, desertification, and salination. The Nile and its tributaries are being contaminated with pollutants, chemicals, and heavy metals.

Although Egypt does not have an extensive history of environmental law, regulatory policy has gained momentum over the past few years. In 1994, Egypt passed Law 4 for the preservation of the environment. This law restructured the existing environmental ministry and created the Egyptian Environmental Affairs Agency (EEAA) to draft laws, create and enforce regulatory standards, establish near- and long-term plans for environmental management, coordinate local, regional and national environmental protection efforts, and regularly report on the state of Egypt's environment. The 1994 environmental protection law also established the Environmental Protection Fund, which completed its pilot year in 2000/20001. The fund dispersed five grants of more than \$50,000 each to projects focusing on solid waste management.³²

Also, as mentioned in the previous section, an Egyptian Environmental Policy Program is being implemented with support of USAID since 1997 for a 20-year period.

In 2005, the main emitters of GHG in Egypt are fuel combustion in the energy sector (22%), in industry (21%), and in the transport sector (18%). Other important contributors are agriculture (15%), small combustion (9%), non-combustion emissions in industry (9%), and waste (5%).³³ In total, energy-related emissions are responsible for 71% of the GHG emissions.

In the same year, petroleum accounts for 72% of carbon emissions in Egypt, natural gas 25%, and coal is responsible for 3%. The increasing reliance on natural gas should work to lower carbon emissions. Egypt's energy-related CO₂ emissions increased by 3.9% yearly during one decade, from 89 Mt in 1992 to 146 Mt in 2005, mostly due to increased energy consumption (Figure 18).

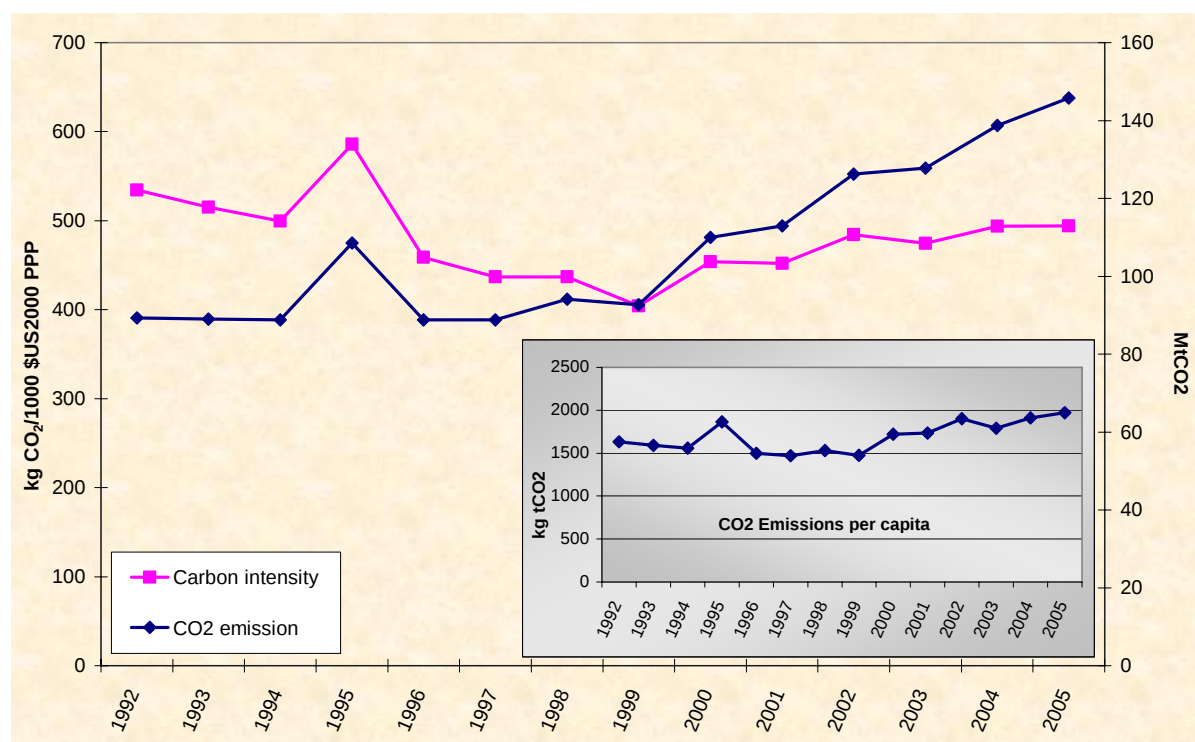
³² See Egypt; Environmental Issues at <http://www.eia.doe.gov/emeu/cabs/egypenv.html>

³³ See EEAA NSS Program: Egypt's strategy on CDM at http://www.cdmegypt.org/CDM/NSS_Summary.pdf

Egypt's CO₂ related-energy emissions per capita are also increasing, even though they are still significantly lower than in most developed countries. In 2005, Egypt emitted about 2 MtCO₂ per capita (1.6 in 1992) (Figure 18).

After a relative decrease in the 90's due to the efforts to develop natural gas in the country, the Egyptian carbon intensity is on an increasing trend. It has indeed increased by 23% over the period 1999-2005. The Egyptian economic development is thus more and more carbon intensive, which is not favourable to the sustainable development of the country.

Figure 18 Energy-related CO₂ emissions (1992-2005)



Source: OME

Egyptian emission levels have thus risen since 1990, the baseline year for the Kyoto Protocol of the United Nations Framework Convention on Climate Change, but as a non-annex I country, Egypt is not obligated to curtail carbon emissions. Egypt had nevertheless ratified the Kyoto Protocol on 12 January 2005 and is eligible for CDM projects.

The analysis of the future development of GHG emissions in Egypt indicates that they may reach more than three times 1990 levels by 2017; whereby the energy related emissions remain by far the major source for GHG emissions in the future. Energy emissions are expected to increase its share with the highest growth rate. This underlines the urgency of Egypt to use the CDM as an instrument to promote transfer of state-of-the-art technologies for energy related GHG emissions mitigation in the country.³⁴

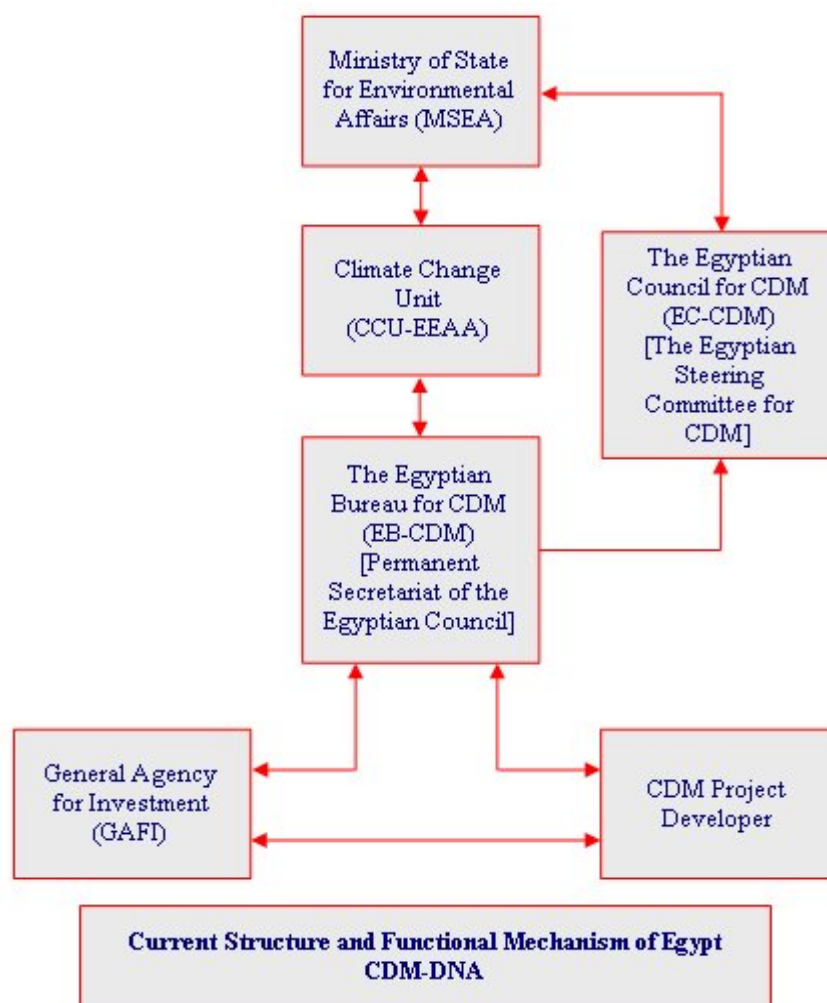
In the context of the activities linked to the CDM³⁵, Egypt is the second North African country (after Morocco) to set up a Designated National Authority (DNA) on 14 March 2005 (Ministerial Decree No. 42 on 14/3/2005). The DNA for CDM in Egypt is composed of the following dual-structured unit (Figure 19):

³⁴ See EEAA NSS Program: Egypt's strategy on CDM at http://www.cdmegypt.org/CDM/NSS_Summary.pdf

³⁵ For all the information on CDM in Egypt see <http://www.cdmegypt.org/>

- The Egyptian Council for CDM (EC-CDM) comprises 13 permanent members representing all relevant government departments, as well as private and associative sectors. At national level, the EC-CDM sets plans & policies and supervises the implementation of the whole CDM process in Egypt. It also suggests legislations and decisions to the government and official authorities. Internationally, the EC-CDM will be the official counterpart to the CDM Executive Board and will be the link agency with any potential international CDM stakeholder. A steering committee, emanating from the Council and consisting of five of its members, is delegated some expedited and intermediate responsibilities related to the process of implementation under the supervision of the EC-CDM. The EC-CDM meetings are held on a quarterly basis, but specific meetings can be convened, upon request from the Steering Committee, as required to react pro-actively to any relevant and urgent issue that might be crucial for the progress of the CDM activity in Egypt.
- The Egyptian Bureau for CDM (EB-CDM), which acts as the Permanent Secretariat of the EC-CDM, is operating at the CCU/EEAA within the Ministry of State for Environmental Affairs.

Figure 19 Current structure and functional mechanism of Egypt CDM-DNA



Source: www.cdmegypt.org

The participation of three financial institutions is an interesting feature of the Egyptian DNA. It meets every 3 months. A steering committee of 5 members (Ministry of State for Environmental Affairs, Ministry of Foreign Trade & Industry, Ministry of Electricity & Energy, Ministry of Agriculture & Land Reclamation, General Authority for Investment and Free Zones (GAFI) can convene additional meetings if necessary. To cover its costs, the government hopes for bilateral and multilateral donations and vaguely hints at "fees-for-services to be indexed on project CERs revenues.

The approval process is based on two steps. First, a "Project Profile" has to be submitted on which the secretariat will give a preliminary approval within 2 weeks. Then the project developers draft the PDD and submit it for final approval before submitting the PDD for validation.

The Egyptian sustainable development criteria for CDM projects in Egypt include the following aspects:

- Conformity to political and legal dispositions;
- Contribution to technology autonomy and sustainable use of natural resources;
- Social criteria (improvement of quality of life, alleviation of poverty, improvement of equity);
- Economic criteria (provision of financial returns to local entities, positive impact on balance of payment, transfer of new technology);
- Environmental criteria (mitigation of global climate change, reduction of GHG emissions, conservation of local resources).

The DNA has set up an excellent website³⁶ with information on Egypt's institutional CDM setup, the national CDM project approval process, and the Egyptian portfolio of currently more than 40 CDM projects of which 29 have been accepted/approved by the DNA (as of June 2007, with downloadable PINs and PDDs). The total annual CERs of the approved project is estimated at 6 MtCO₂e. These projects include 19 energy projects of which 7 relate to RE.

The RE projects concern 4 wind power plants (80, 85 and 2 * 120 MW) and 3 hydropower plants (13, 40 and 64 MW).

Egypt is thus eligible for CDM projects with an important potential. Many studies conducted concluded that the implementation of the CDM projects will promote many of the development plans of the Egyptian government, such as the National Energy Strategy, the development of natural gas and RE utilisation, and the plans in the transport, waste and forestry sectors. On the other hand, the existing subsidies on fuel and power, bureaucratic hurdles as well as custom duties and taxes limit to some extent the attractiveness and potential of the CDM in the country.

³⁶ See www.cdmegypt.org

3. Integration of renewable energy sources

Egypt³⁷ is on the way to develop its own "National Sustainable Development Strategy". Efforts are being coordinated through the Ministry of State for Environmental Affairs with all concerned stakeholders to draft the strategy. A ministerial committee has been established for this purpose headed by the Minister of State for Environmental Affairs and assisted by a technical group constituted of representatives of all concerned ministries. Energy is a major component of this anticipated national sustainable development strategy. The sustainability of energy calls for a sustainable long term vision for the energy supply/demand balance scenarios including maximizing the use of all available renewable resources, as well as setting quantitative targets and necessary mechanisms to insure the rational use of available resources. Also, minimizing the negative impact on the environment represents an integral part of energy sustainability.

The creation in late 2006 of the Supreme Council of Energy as well as the undergoing formulation of the National Sustainable Development Strategy in which energy represents one of its major components, will facilitate the coordination of all existing and future policies and orientations into a well defined integrated energy strategy that defines quantitative measurable targets for the enhancement of the wide spread use of both RE and the rational use of energy (RUE). As a matter of fact, RE has received more attention and growth due to the existence of a national organization (NREA) taking the responsibility of developing its activities. However, RUE which is not adopted by one single entity is very much less developed.

Egypt is endowed with a high potential of RE sources. In particular, it has abundant solar energy resources and a wealth of wind resources in certain locations. In addition, large quantities of agricultural wastes are produced annually from various agricultural activities, which could potentially be utilised in biomass energy production. This section describes the RE resources and potential, the current RE situation and the institutional/legislative framework of RE in Egypt.

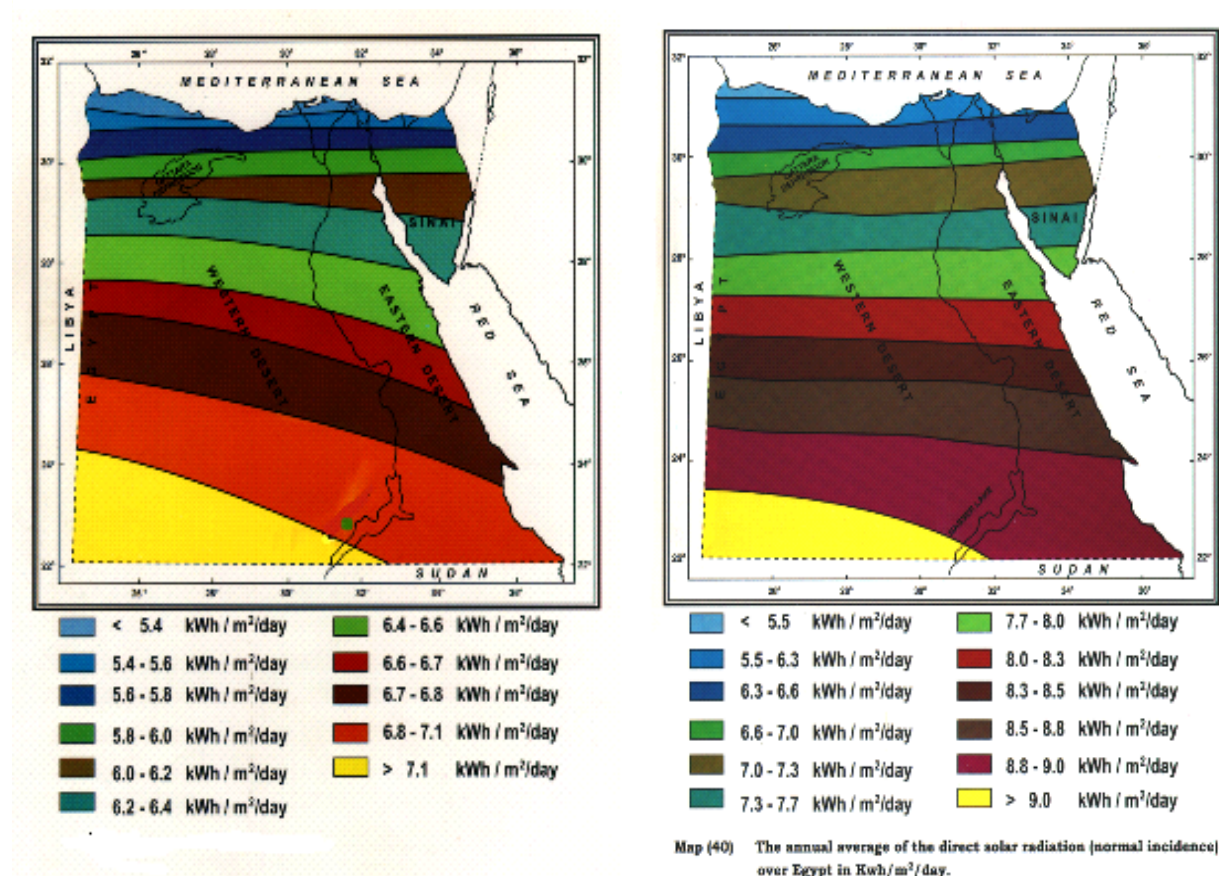
5.1. Renewable energy resources and potential

Solar

Egypt is located in the world's solar belt and has an excellent solar availability. As illustrated in Figure 21 the annual average global solar radiation over Egypt ranges from about 1900 kWh/m²/year on the Mediterranean coast to a more than 2600 kWh/m²/year in Upper Egypt. The direct normal solar radiation reaches (2000-3200) kwh/m²/year with low levels of cloudiness. About 90% of the country has an average global radiation greater than 2200 kWh/m²/year. The total sunshine hours ranges between 3200- 3600 hr/year (9 to 11 hours with few cloudy days all over the year).

³⁷ Based on Plan Bleu (2007) Regional Activity Centre, Gregory, R. Y. and A. T. Soliman. Energy Efficiency and Renewable Energy – National Study.

Figure 20 *Egypt Annual average of Global Solar Radiation and Annual average of Direct Solar Radiation*

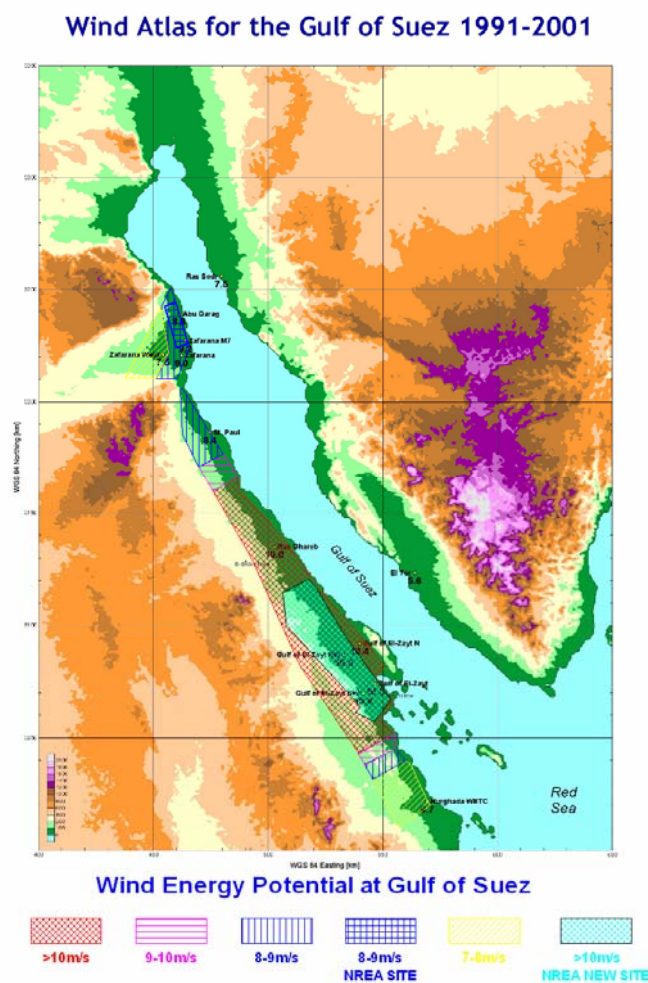


Source: NREA

Wind

Wind energy potential in Egypt is substantial, with high wind velocities on the Gulf of Suez north of the Red Sea Coast and the south western part of Egypt, East of Oweinat. A Wind Atlas for the Gulf of Suez was developed in cooperation with RISOE with the first issue in 1996. It included wind data over 1991-1995 for 4 sites (Abou Eldarag, Elzait Gulf, Hurgada), which are classified with high average wind speed (Figure 21). The results of analysing such data have encouraged the international financing institutions to cooperate with Egypt in order to implement large-scale grid connected wind farm projects. In March 2003, a detailed wind atlas of Gulf Suez area including accurate wind data over 1991-2001 for 13 sites, was issued with cooperation with Danish government, concluding that the region can host about 20,000 MW of wind farms. The Atlas also illustrated that the Gulf of Suez is classified with average wind speeds considered among the best world-wide.

Figure 21 Potential of wind energy in the Gulf of Suez



Source: NREA

Table 12 shows the average wind speed for different sites at Gulf Suez at 25 meter above ground level. The Atlas has been expanded, in cooperation with RISOE and the Egyptian Meteorology Authority, to cover the whole country. The collected data, over a period from 1998-2005 have been analysed in order to define the promising areas that can host wind regimes. The wind atlas for Egypt has thus been finalised by February 2006. Figure 22 illustrates wind forecasts by Windfinder³⁸ as of June 15, 2007.

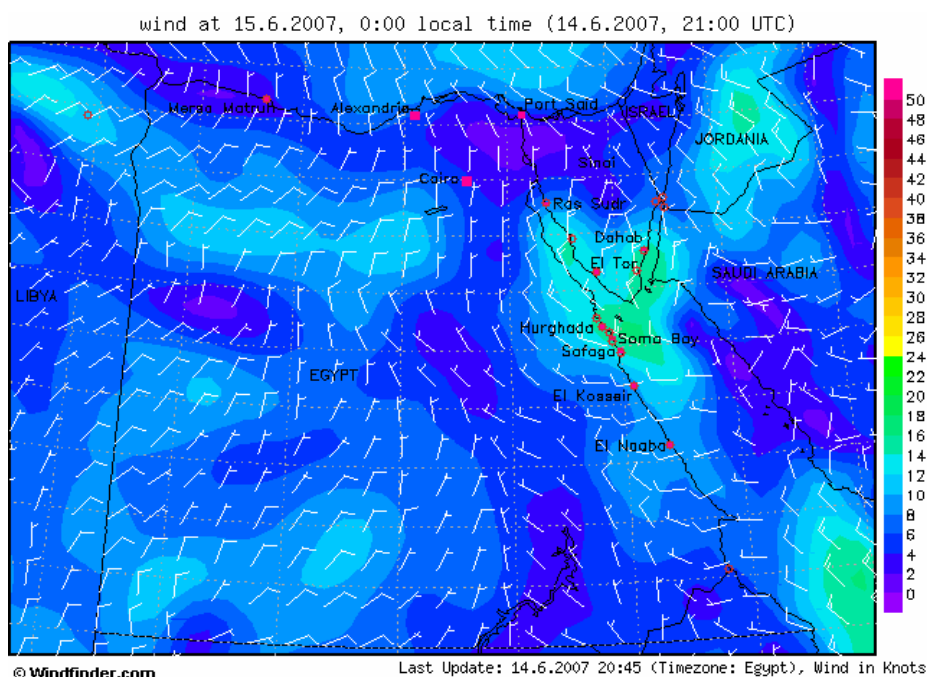
³⁸ www.windfinder.com

Table 12 Average wind speeds in Egypt

Region	Av. Wind Speed (m/s)
Ras Sedr	7.5
Abu Aldarage	8.8
Zafarana (north)	9.2
Zafarana	9.0
Zafarana (west)	7.5
St. Paul	8.4
Ras Ghareb	10.0
El Tour	5.6
Gulf of El Zayt (north)	10.4
Gulf of El Zayt (north-west)	10.5
Gulf of El Zayt	10.3
Gulf of El Zayt (south-west)	10.8
Hurghada	6.7

Source: NREA

Figure 22 Wind forecasts in Egypt (as of 15 June 2007)



Biomass

Total waste resource potential is around 47 million ton per year (equivalent to 17 Mtoe/yr), about 46% of which can be used for energy purposes (7.8 Mtoe/yr). Currently, 5 Mtoe/year contribute to primary energy consumption. Traditionally, plant residues have held an important share in non-commercial energy consumption, but data shows (Table 13) that the other types of waste could provide an important additional energy potential.

Table 13 Biomass potential resources (available and used quantities)

Kind of wastes	Total Potential (TP)		Total available for energy		Total used as energy	
	Mt (dm)/yr	Mtoe/yr	% to TP	Mtoe/yr	% to TP	Mtoe/yr
Agro. Residues: plant Animal	23	9.2	46	4.232	41	3.772*
	7.6	2.66	36	0.95	15	0.40
Municipal	6.6	2.38	36	0.59	5	0.08
Sewage	4.3	0.86	56	0.48	10	0.09**
Industrial	5.2	2.5	60	1.5	34	0.85
TOTAL	46.7	16.87	46.3	7.752	29.6	5.192

Source: NREA

* 65% is the sugar cane - bagass used in the paper factories.

** A huge biogas plant of 220000 m³ digester volume has a 18 MW electric power generation plant is under initial starting in the El-Gabal El-Asfer sewage treatment plant for Cairo.

Small hydro

Hydroelectric power is an important source of energy in Egypt--during the 1980s, the Aswan High Dam on the Nile River provided half of Egypt's electricity. Its contribution has fallen while energy demand has increased, but over the past ten years hydropower still contributed about 20% of the total electricity generated in the country. At present, it represents 12% of the total electricity generation.

Hydro capacity is important with 2,783 MW and primarily located near Aswan in Upper Egypt. However, all installations have a capacity greater than 10 MW except Nag Hamadi (4.5 MW) and El Lahoun Fayoum (0.8 MW). The terrain and topography in Egypt allows for limited opportunities for small hydropower projects. At the same time, average annual precipitation levels in Egypt are extremely low (often reaching zero), which makes it difficult to use micro dams. Table 14 presents the few potential sites where small dams could be built along with the estimated capacity. As shown, the total capacity for all possible small dams does not exceed 25 MW. Several studies have been carried out to assess the cost-effectiveness of these potential dams.³⁹ The 13 MW Damietta project is under construction and is expected to enter into operation by December 2010. Another 64 MW project (new Naga Hamadi Hydro power plant project) is under construction (excepted to start operation in May 2008). A third hydro power plant at New Assiut Barrage (32 MW) is under execution procedures to select project consultant and planned to be operational by 2014.

³⁹ S. Kamel, 2003, Baseline Survey of the renewable energy in Egypt, UNEP, 2003.

Table 14 Potential sites suitable for small hydropower generation

Site Location	Head (meters)	Discharge (m ³ /seconds)	Estimated Capacity to be Installed	Number of Units	Type of Units
Damietta Branch	4.4	280	13	2	Semi Kaplan Gear Siphon
Rosetta Branch	5.3	60	3.1	1	Kaplan w. Gear
Zefta	3.5	90	5.5	1	Semi Kaplan Gear Siphon
Dairout	5.1	60	3	1	Kaplan w. Gear
El Azab	5.6	15	0.71	2	Francis Pit Turbine
Tamiya	6	9	0.475	1	Kaplan Tube Turbine

Source: UNEP, 2004 & EEHC, 2005

The use of water wheels for small-scale power generation is also limited by the flatness of the terrain in the areas where water canals are. Table 15 presents the results of a survey conducted by a Danida funded mission in 1999⁴⁰. As shown, the total potential output capacity at the national level from these wheels if installed would be around 9.8 MW. It should be noted, however, that all the areas identified in both tables for small and medium hydropower projects are already covered by the grid.

Table 15 Potential sites for water wheel installation

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

Source: UNEP, 2004

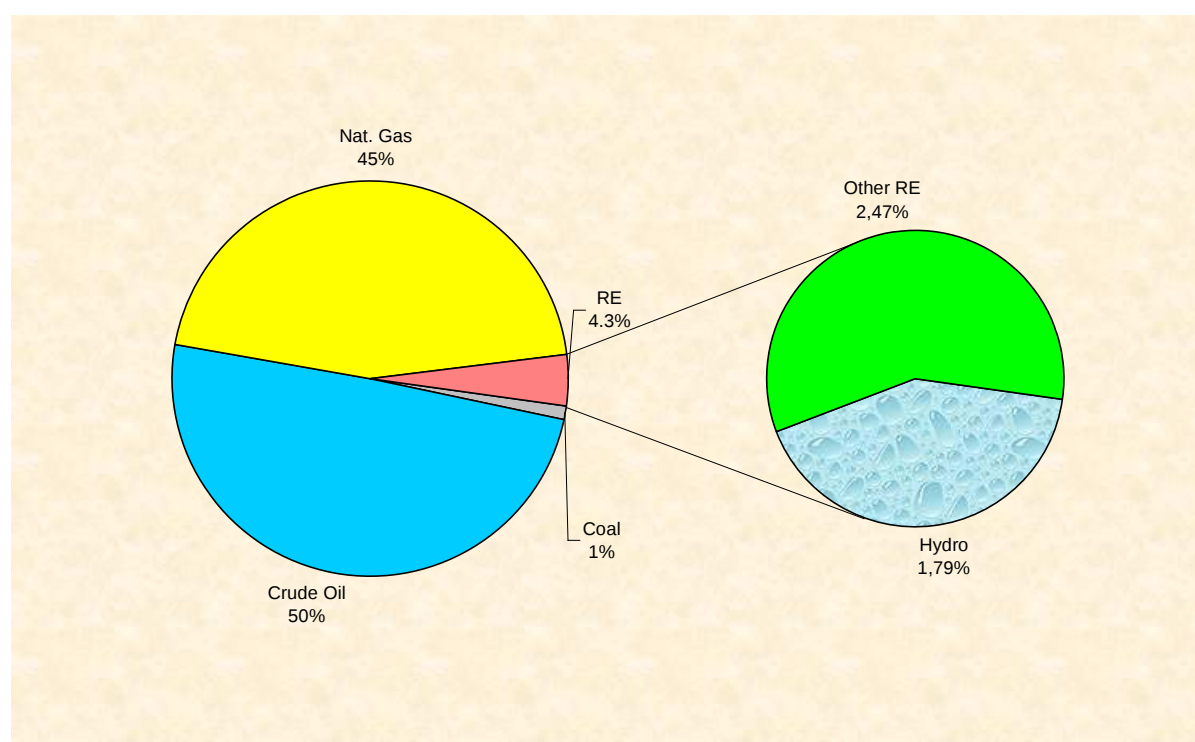
⁴⁰ See S. Kamel. Prospects for Renewable Energy Technologies in the Middle East and North Africa. UNEP RISOE April, 2004 at http://www.menarec.com/docs/Yemen_RET_UNEP-Background-Paper_16Apr2004_1_.pdf

5.2. Current renewable energy situation

Contribution of RE to the energy balance

Despite the high potential of RE resources Egypt is endowed with, these resources are currently not fully exploited. Indeed, RE sources represent 4.3% of TPES (biomass and large hydro mainly) which may seem relatively high, in comparison to other Southern and Eastern Mediterranean countries. However, excluding biomass and large hydro, RE sources represent less than 0.2% of TPES. Figure 23 illustrates the structure of TPES in Egypt in 2005.

Figure 23 The share of RE in total primary energy consumption in Egypt (2005)



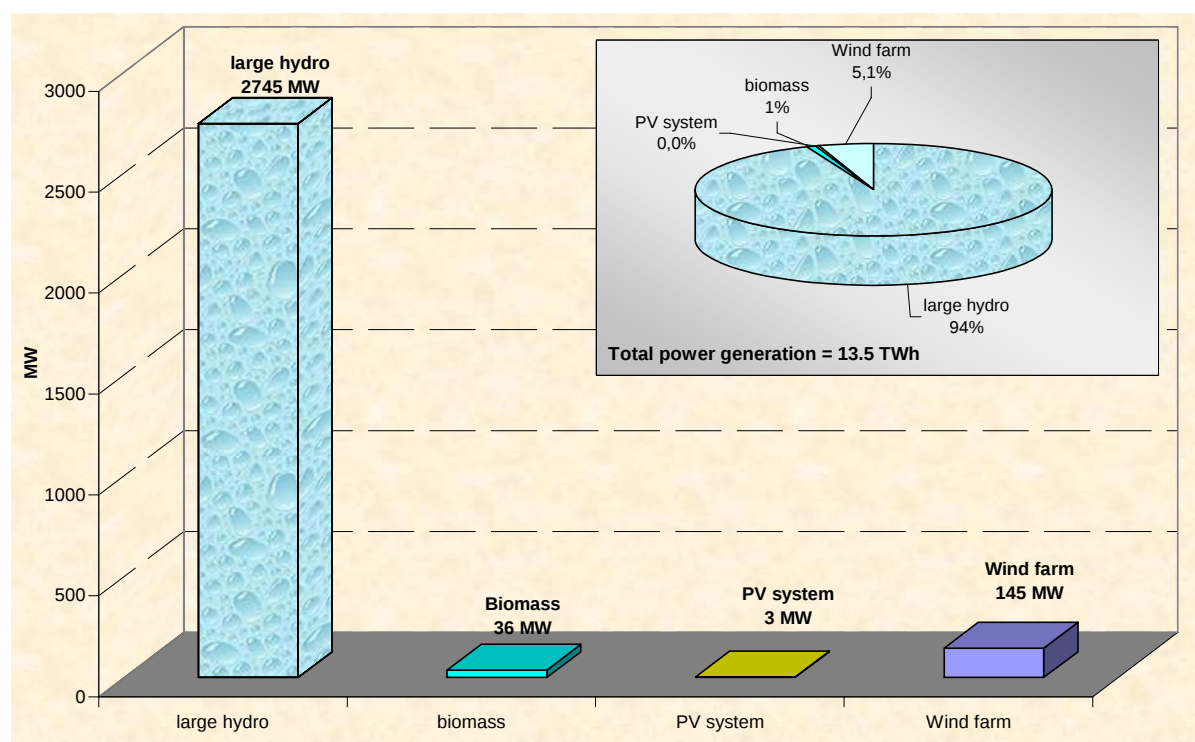
Source: OME based on questionnaires to NREA & EEHC

Contribution of RE to power installed capacity and generation

In 2005/2006, total RE-based power installed capacity reached 3,052 MW, almost 91% of which being large hydro. The rest is composed of 230 MW wind farms, 36 MW biomass power plant and 3 MW PV applications. This RE capacity represented 15% of total energy installed capacity (Figure 20).

The total RE-based power generation was 13.2 TWh, representing almost 13% of total power generation for the same year.

Figure 24 RE-based power capacity and generation in Egypt (2005)



Source: OME, based on questionnaires to NREA & EEHC

In the following, details are given regarding Egyptian RE situation by source.

Solar thermal

Solar Thermal⁴¹ is being developed in Egypt mainly for three applications: domestic solar water heating, solar industrial process heat and solar electricity generation systems.

In 1980, in order to introduce the technology to the Egyptian market, the Ministry of Electricity and Energy imported 1,000 domestic *solar water heaters* (DSWH) systems, using flat-plate collector technology. In the same year, the first private sector local manufacturing was implemented. Since then DSWH systems are manufactured locally.

Solar water heating is currently used in residential, commercial and tourist hotel buildings with varying degrees of success. More than 500,000 m² of solar collectors have been installed particularly in the new cities and tourist Villages resorts. About 200,000 families are using DSWH systems in Egypt. NREA estimates the current installed capacity to around 300 MW, while the potential capacity could easily exceed 1,000 MW provided the appropriate set of policy instruments and the government offers incentives. In fact, solar water heating could potentially become a substantial market in Egypt for RE technologies.

Tourist resorts and hotels are considered to be the main customer in this market, especially those located in the Red Sea and Egypt's North Coast. In early 1980s, the government enacted a law requiring all residential buildings built in the new satellite cities and urban centres to

⁴¹ For more detail see NREA, Implementation of Renewable Energy Technologies - Opportunities and Barriers, 2002 at <http://www.uneprisoe.org/RETs/EgyptCountryStudy.pdf>

have solar water heaters. However, the enforcement of this law was not diligently pursued by the local authorities in the new cities, which have led to gradual phasing out of the technology and a return to conventional electric water heaters. Added to this was the poor quality of solar water heating systems installed by many contractors who opted to comply with the law using cheap, low quality systems. The fact that there were no clear guidelines as to the minimum acceptable technical specifications for these systems has exacerbated the problem of malfunctioning systems. The result was unsatisfied system users, which gave solar water heaters poor reputation to what could have been a key energy saver in Egypt.

In 1992 NREA established the out-door solar thermal laboratory which is currently the main research, testing and certification facility for solar thermal applications in Egypt. More than nine local manufacturers are now working in the field. The annual production capacity is about 25,000 m² of solar collectors.

Solar water heating is of great importance in Egypt for energy efficiency purpose. It should also be attractive to the utilities since water heating is usually a major contributor to peak load demand and the power grid in Egypt currently suffers from blackouts during peak hours in summer. A major policy and regulatory intervention is needed in this sector in order for this technology to be deployed at a national scale. Different types of barriers are presently facing this technology and which will be presented later in the section on barriers to RE technologies. However, the government is considering sustainably boosting SWH deployment in Egypt.

As for *solar industrial process heat*, it represents a key issue in Egypt with many expected benefits. Indeed, the Industrial Sector is the highest consumption in the sectorial energy consumption in Egypt. About 50% of the total national primary energy consumption is used in industrial sector and about 60% of the industrial energy consumption is used in industrial process heat. About 20% - 30% of the industrial energy consumption is wasted because of low maintenance and inefficient processes. The development of solar industrial process heat would thus contribute to more energy efficiency in the country.

NREA built in 1990 and 1993 two solar industrial process heat systems in the food (Poultry) and textile (Misr-Helwane) industries with co-operation and financial support from USAID/Cairo. The two projects were integrated with waste heat recovery systems. The energy saving due to these projects amount to 1,800 toe per year and the emission reductions are estimated to 9,700 tCO₂ per year.

In 2002, NREA has implemented a new project for solar industrial process heat by utilising parabolic trough concentrating collectors, to produce and deliver saturated steam at a pressure of 8 bar and temperature of 175°C to the steam network of El-Nasr Pharmaceutical Company. The solar collectors area is 1900 m² to generate 1.3 tons per hour of steam as peak generation. The project is integrated with a heat recovery system and is financed by African Development Bank (ADB). The project also includes renewing the burners of the boiler, implementing condensate return systems and enhancing the thermal insulation of the steam network. The fuel saving related to the project is estimated to 1,120 toe per year and the emissions reductions to 3,570 tCO₂ per year. About 70% of the system was locally manufactured including the parabolic collectors, aluminum structures and the metallic joints, storage tanks, pipe networks, civil & electrical works while aluminum sheets for reflectors, absorber glass envelopes, tracking & control system components & pumps were imported. The components of the solar system were assembled and erected at the site.

As for *solar thermal power generation*, considerable research work has been done by NREA on the technological viability of this technology in Egypt and the potential for its adoption as a contributor to the installed generation capacity added annually. This has been initiated within the Intersudmed project, co-financed by the EC (4th Framework Programme) and coordinated by OME⁴². NREA concluded in this study that Integrated Solar Combined Cycle System (ISCCS) is an appropriate technology where parabolic solar troughs are used in conventional fossil-fuelled power plants. Ideal locations for this technology are areas with high solar radiation intensity, natural gas supply source, and proximity to the grid line.

Two pre-feasibility studies were performed, based on parabolic trough collectors and central tower receiver technologies through financial support of the EU and technical support of Spain. Egypt then submitted an official request to the GEF to support financing the first solar thermal power plant in Egypt.

In 1999, the World Bank conducted a study that looked at the comparative cost estimates of solar-thermal power in Egypt. Table 16 presents the results from the study conducted by the bank.

Table 16 *Projected Costs of Integrated Solar Thermal and Gas Power Generation*

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

Source: S. Kamel, UNEP, 2003

Based on this study, the World Bank is currently giving support to Egypt's first Integrated Solar Thermal Power Plant to be located in the North Coast (planned to be operative by 2010). NREA has indeed received positive response stating that GEF is available to finance through a grant of 50 Million US\$ to cover a substantial part of the incremental cost. The Bank views the project as a means towards increasing the share of RE in the power supply mix and to demonstrate the technology to local energy planners. JBIC will finance the balance of the plan, the total investment being estimated at about 150 Million US\$.

Solar energy contribution in the 150 MW power plant is 30 MW (Currently, there is a negotiation to reduce the solar energy contribution from 30 MW to 20 MW). The plant will be implemented under an IPP arrangement. It is expected that the levelized cost of energy (LCOE) from this plant will be at levels competitive with conventional combined-cycle plants depending on the terms of the financing.⁴³ The tender documents for solar portion are being evaluated. The tender documents for the combined cycle portion are being evaluated. It is anticipated to operate the project by 2009.

⁴² See www.ome.org

⁴³ S. Kamel, 2003. op. cited.

Solar photovoltaic

Photovoltaic power utilisation has been addressed within the Egyptian Ministry of Electricity and Energy (MEE) as early as 1979. Most PV⁴⁴ applications have been field tested and demonstrated by NREA to evaluate the performance under the prevailing local conditions, including: water pumping, desalination, refrigeration & ice making, village electrification, telecommunication, etc. Some PV Application have been already commercialised, such as lighting, water pumping, wireless communications, cooling and commercial advertisements on. In additions, consultancy services for lighting some traffic guide signs on the Desert High Ways by PV systems have been undertaken in cooperation with the Ministry of transportation. The capacity of PV projects currently in operation ranges between 5 – 5.25 MW.

The Egyptian government has an on-going rural electrification program through grid extension which has reached coverage of more than 98% of rural villages. Despite ambitious efforts there will be some remote isolated small communities and settlements that are far from the electric grid and consequently cannot be connected in the near future. As a result, there is room for applications based on PV systems for at least 121 remote villages/communities.

Wind energy

Encouraged by the considerable wind potential since the early 1980s, the country started the implementation of some pilot projects such as the first 400kW wind farm at Ras Gareb in the Red Sea area. The project was considered a good opportunity to create the experience in the field of planning, implementing, operating and maintaining wind farms. This successful experience encouraged the installation of another similar wind farm of 5.4 MW capacity at Hurgada in cooperation with Denmark and Germany. The plant has been connected to the grid and operated successfully since 1993, producing about 10 GWh/year. The farm consists of 42 wind turbines of different types of technologies, ranges (100 -300 KW). 50% of the components are locally manufactured. The energy savings due to the project are estimated at 2,200 toe per year and the corresponding CO₂ emission reductions are estimated at 5,400 tons per year.

In 1995, Egypt crossed the phase of limited experimental projects to the phase of grid connected large scale wind farms. An active programme within the MEE through NREA was introduced.⁴⁵

The greater commercial maturity of wind and the interest of bilateral donors have permitted a more rapid build up of experience in developing wind farms⁴⁶. As of December 2006, 230 MW have been installed in co-operation with Danish (60 MW), German (85 MW) and Spanish Governments (85 MW). Current wind capacity and electricity generation are presented in Table 17. As of the end of 2006 (230 MW installed capacity), the annual electricity generation of the projects amounts to 553 GWh per year, corresponding to 126,000 toe of energy saving and of 300,000 tCO₂ emission reduction. The average wind speed of the site is 8.3 meters per second⁴⁷. The capacity factor amounts 41% and the availability factor 98.5%⁴⁸.

⁴⁴ See for details <http://www.nrea.gov.eg/pv.htm>

⁴⁵ For details see http://www.nrea.gov.eg/wind_energy.htm

⁴⁶ See http://www.gefweb.org/Projects/Pipeline/Pipeline_7/Egypt_Private_Sector.pdf

⁴⁷ maximum wind speed is 10.7 m/s in June 2006 and minimum is 8.1 m/s in January 2006 at Zaafarana

⁴⁸ Technical performance indicators 2005-2006. Source : NREA Annual Report

Table 17 Wind energy capacity and power generation in Egypt

Wind farm project	Capacity (MW)	Year of operation	Power generation (TWh/yr)	Comments
Hurghada	5.4	1993	0.01	
Zafarana ¹ (1)	30	April 2001	0.11	1 st phase out of 60 MW
Zafarana ² (2)	33	May 2001	0.13	1 st phase out of 80 MW
Zafarana ¹ (3)	30	November 2003	0.12	2 nd phase
Zafarana ² (4)	47	June 2004	0.18	2 nd & 3 rd phases
Zafarana ³ (5)	85	September 2006	na	4 th phase

Source: NREA

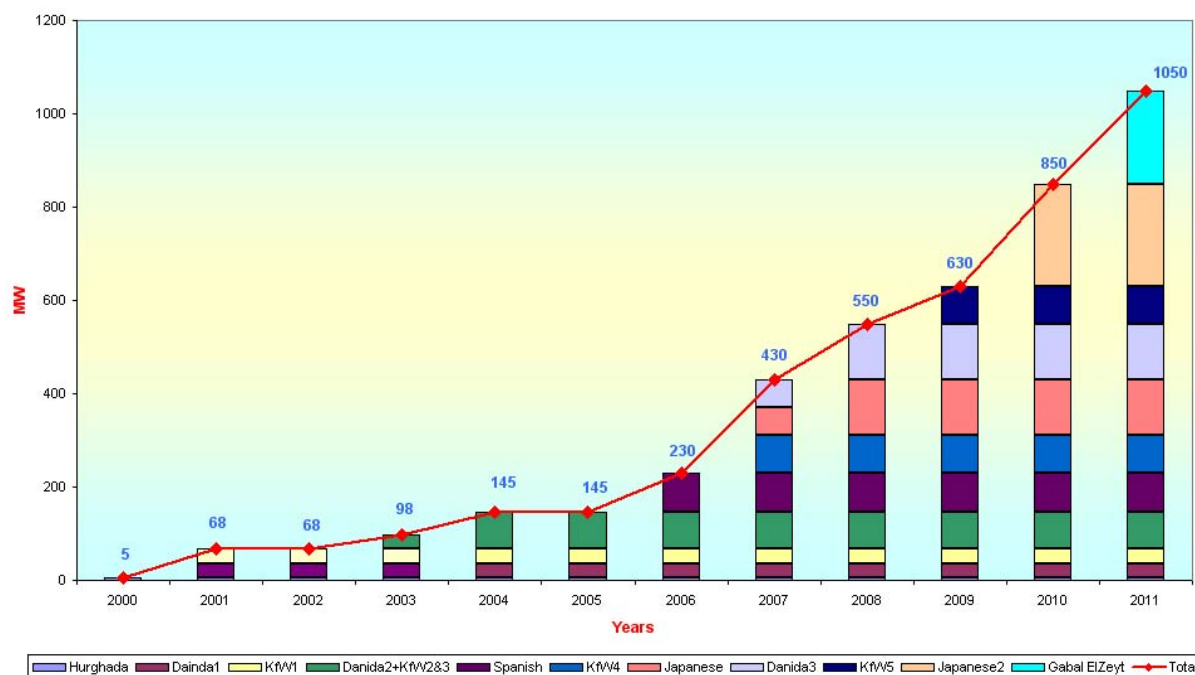
Note: 1) Project with DANIDA cooperation; 2) Project with German (KfW) cooperation; 2) Project with Spanish cooperation

The new projects consist in there wind power plants recently contracted and currently underway in Zafarana along the Gulf of Suez, that are in different stages of implementation as follows:

- An 80 MW installed capacity wind power plant projects in cooperation between NREA and kfw of Germany representing phase (4) of the joint cooperation, with the following financing scheme (expected project operation start date: April 2008):
 - A loan from kfw to NREA amounting 75.937 million Euro divided to 50% soft loan having and 50% commercial loan
 - A loan from National Investment Bank of Egypt (NIB) to NREA amounting 201.089 million Egyptian pounds (L.E.)
- A 120 MW installed capacity wind power plant in cooperation between NREA and JBIC of Japan with the following financing scheme (expected project operation start date: February 2009):
 - A soft loan from JBIC to NREA amounting 85.329 million Euros (equivalent to 13.141 billion Japanese Yen):
 - A loan from NIB of Egypt to NREA including: 16.5 million Euros and 391.49 million L.E.
- A 120 MW installed capacity wind power plant in cooperation between NREA and DANIDA of Denmark representing phase (3) of the joint cooperation, with the following financing scheme (expected project operation start date: 2010):
 - A mixed credit loan from DANIDA to NREA amounting 111 million Euro (equivalent to 825.3 million Danish Krone):
 - A loan from NIB of Egypt to NREA including 91.99 million L.E. (equivalent to 12.713 million Euros).

Figure below shows the installed wind power plants capacity present and planned distributed according to cooperating countries.

Figure 25 Wind energy in Egypt: situation and prospects



5.3. Institutional and legislative framework

Main actors

Egypt has an early start addressing renewable energies. The strategy for the promotion of RE sources was included in the early 1980s as an integral element of national energy planning. Between the mid-70s and mid-80s RE activities were undertaken by specialised department in existing authorities. These include the National Research Centre (NRC), universities, and other public organizations. The activities of these organizations range from exploratory research to the implementation of pilot and demonstration projects. The main impetus behind the development of RE has been the New and Renewable Energy Authority (NREA).

Indeed, in 1986, NREA was established and affiliated to the Ministry of Electricity and Energy (MEE) to provide the institutional framework for the RE strategy implementation targeting to introduce these technologies to Egypt on a commercial scale. NREA is also entrusted to coordinate efforts with national, regional and international entities for RE resources assessment; the development and introduction of new technologies; RE testing and certification; pilot and field testing projects implementation and evaluation; market and economic evaluation studies and technical and environmental feasibility studies.

The NREA Testing and Certification Centre, named EREDO⁴⁹, was established in 1996 in cooperation with the European Union and the Italian Government. EREDO includes a set of

⁴⁹ See Zannoun, Mahmoud Sami, World Energy Congress, 18th Congress in Buenos Aires. Egypt's renewable energy strategy, achievements and programs at: http://www.worldenergy.org/wec-geis/publications/default/tech_papers/18th_Congress/downloads/ds/ds15/ds15_4.pdf

indoor and outdoor testing facilities for testing and certifying Renewable Energy components and systems namely; solar thermal, photovoltaic and biomass. EREDO also includes a number of mobile and stationary testing facilities that can serve for energy audits and testing of equipment for environment activities. Beside the above, there is a group of testing facilities: aging laboratories, optical measurements laboratories and chemical laboratories. The center is entrusted to carry out tests on performance, reliability, durability as well as environmental impact of renewable Energy equipment, hence issue licensing certificates.

Tests performed at EREDO centre follow the Egyptian and international procedures and standards. Moreover, EREDO has fulfilled all the requirements of the International Standards Organization ISO 9001 and the auditing of the Quality Management System has been conducted by Germanischer Lloyd Certification Body.

NREA recently established an accredited laboratory for energy efficiency testing and certification. The centre includes indoor and outdoor testing facilities for solar thermal units, photovoltaic, biomass and energy conservation as well as resources assessment and environmental measurements facilities. This project has been established in cooperation with UNDP, and is a complementary component of the ongoing UNDP/GEF Energy Efficiency Improvement and Greenhouse Gas Reduction Project.

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

The main method these companies operate is through bidding for tenders issued by various companies and government entities. There are some cases where local private investors participated in funding some of these companies but no specific data on the size and conditions of this type of equity financing is available.⁵⁰

Regulatory and legislative framework

The government supports the deployment of RE technologies in general. However, yet, there are no specific commercial programs that the government is currently implementing and which aim at facilitating commercial deployment of RE technologies. The majority of existing RE programs with commercial orientation is donor-related.

There is currently no legislation specifically promoting the use of RE, and almost no policy instruments or regulations currently set to promote the adoption of clean energy technologies. However, the government has been committed over the years to allocate a budget for NREA and its R&D work in the various RE technologies, specifically wind, PV, biomass, and solar thermal technologies.

Purchase conditions for existing projects follow individually negotiated terms. The energy generated from wind farms projects, for example, is sold to the transmission company through Power Purchase Agreements (PPA) at a tariff with a premium of 0.6 piasters (the base tariff is 12 piasters) and a 5% yearly increase.

⁵⁰ S. Kamel, 2003, op. cited.

Noteworthy is the fact that in June, 2004, the Minister of Electricity and Energy, and the Minister of petroleum have mutually agreed to establish the Renewable Energy Fund for financing part of the incremental cost of wind energy projects from revenues difference between international price of natural gas, saved hence exported due to use of RE, and local subsidized prices. The Fund allows for a kWh premium to support RE of maximum 2 piaster/KWh.

Another RE technology the government supports is solar water heating. The purpose of the 1986 law enacted in this regard was to impose on all new apartment buildings built in the new urban cities outside of main cities to use solar water heating systems. However, as underlined in the previous section, the results are not successful. Indeed, urban developers and contractors complied with the new law for some years but gradually stopped abiding by this law due to two main reasons. First, adequate enforcement of the law by the government was not sustained, and second, tens of solar water heating systems of poor quality were procured and installed. The government is very interested in developing the market in a sustainable manner.

4. Barriers, priorities and targets of renewable energies

4.1. Barriers to renewable energy development

Besides the barriers highlighted in the regional overview, the followings are in addition specific to Egypt:⁵¹

Financial: The economics of some RE technologies (e.g. PV water pumping and PV home systems) are in an unfavourable competitive position due to large energy subsidies in the market, specifically diesel fuel subsidy (approximately 65%) and electricity subsidies. In addition, high import tariffs on some components of RE technologies (e.g. 50% import tariff on batteries for PV systems, and 30% on integrated PV systems, and 10% import tariff on PV cells). In addition, low levels of rural dwellers income is an important barrier for decentralised RE development (such as PV).

Institutional: First, the national economic development plan does not incorporate RE as a target sector that should be given priority as a means for achieving savings in the national budget and improved environmental conditions. This is partially attributed to large discoveries of natural gas which has shifted the attention from RE as a possible contributor to energy supplies in the country. Second, NREA does not seem to be directly involved with local energy planners in the evaluation of technology options for off-grid power supply systems as its role seems to be confined to R&D work rather than technology deployment. Third, there are no financial/non-financial incentives or command & control regulations that would increase the adoption of RE technologies. Fourth, as for wind, the procedures of land registration for wind farms are rather slow; and there a lack of support program for the private sector to be involved in the establishment large-scale wind farm.

Regulatory: For grid-connected wind, and as mentioned earlier, one barrier is a modification recently made to the BOOT laws in Egypt. The amendment stipulates that in the Power Purchase Agreement (PPA), the government will buy the power from the IPP in local currency and not in foreign currency as was done before. The implications are that foreign

⁵¹ Based on S. Kamel 2003 and 2004 and direct contact with R. Gregory.

investors interested in becoming an IPP in a grid-connected wind project will not be interested in such offer given the fact that all project financing will be done in foreign currency and probably from a foreign bank. However, this amendment is quite recent and the situation should be monitored as to the impact of this regulatory change on potential IPPs in the wind energy sector.

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

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

Environmental barriers: migratory birds may prevent different wind power projects to be established in windy sites due to the fact that site lies in the way of these birds. However careful selection of wind farm sites should reduce this problem to minimum.

Risks related to site works: some windy sites in Egypt are contain some mines (residuals of Wars), that could hinder the exploitation of wind farms. However, mine clearing is always performed before implementation of every project thus should not represent a serious problem.

4.2. Priorities and targets for renewable energies

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

- Grid-connected large scale wind.
- Solar water heating.
- Solar-thermal power.
- Small & Medium wind for off-grid water pumping.
- Wind-diesel hybrids for off-grid pumping and electrification.
- PV for telecommunications.
- PV for off-grid ice making.
- PV for home systems.

Adapted institutional and regulatory framework, along with tailor-made finance support mechanisms would contribute to a faster deployment of the above technologies and in some cases will create new markets for the technologies with no existing market.

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

As for targets, the Government of Egypt has maintained within its national energy strategy a target of meeting 3% of its electric energy demand from renewable by the year 2010, mainly solar and wind, which includes about 850 MW of wind farms installed capacity and 150 MW Solar Combined Cycles Power Station. Currently an area of about 700 km² is being allocated at Gulf of EL-Zayt about 70 km north of Hurghada, for new wind farms. The new site is classified with excellent wind speed that reaches to 10.5 m/s and can host about 3,000 MW wind power plants⁵².

Planned wind capacity and electricity generation are presented in Table 18. If projects are implemented according to plans, annual power generation can be increased to 2.4 billion kWh (equivalent to fuel saving of 0.55 million toe/year) by year 2012. Egypt also, plans a dramatic expansion of its installed wind capacity until 2020 (about 3,000 MW).

Table 18 Future wind projects plan up to 2022

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Added power (MW)	85 (1)	80 (2)	120 (3)	120 (4)	220 (3) + 80 (2)	200	200	200	200
Total power (MW)	230	310	430	550	850	1050	1250	1450	1650

(1) with Spain, (2) with Germany, (3) with Japan, (4) with Denmark

Year	2015	2016	2017	2018	2019	2020	2021	2022
Added power (MW)	200	200	200	200	200	200	200	200
Total power (MW)	1850	2050	2250	2450	2650	2850	3050	3250

Source: NREA, 2006

In addition, other important contributions including domestic solar water heating, PV utilization and biomass are also anticipated. According to the MED 2010 study, from the remaining non-electrified villages, 121 small remote rural communities with a total of 4,500 houses found a best fit for photovoltaic PV electrification. These villages are characterized by low power demand, constant load, dispersed nature of houses, beyond the economical extension of the utility and are not included in the future plan for electrification from the national grid. The structure of those communities in many cases includes 20 houses each, 8 persons per family, low power demand (700-800 Wh/day), constant load, and dispersed nature of houses and far from the utility grid. Individual PV household's kit capable of supplying around 700 Wh/day could be an appropriate solution⁵³.

⁵² NREA, Annual report 2005.

⁵³ NREA. Report for PV studies for Egypt. Med 2010.

An agreement between NREA and IMET (Italy) has been signed to electrify two remote villages in Matrouh Governorate through grant element of an amount of 400,000 euro. The Tender Document has been prepared and ready to be published in January 2007. It is planned to finalize the construction of the project in October 2007.

Egypt's objective is also to reach 14% of Egyptian electricity demand with RE (7% hydro, 7% wind and solar) in 2020⁵⁴.

5. Conclusions

Egypt faces high growth in energy with obvious consequences on climate change and on sustainable development of the country. At the same time, great effort is still needed in order to give access to energy services to the whole population.

In this context, energy efficiency and RE have been recognised as pillars of the energy strategy of the country. However, realisations are rather modest at present and most of them have been undertaken within bilateral or multilateral cooperation projects and relief on grants.

As for electricity, Egypt has witnessed a radical change over the past 25 years. From an abundant supply of cheap water power, it is in a situation where almost 80% of electricity consumption is covered by thermal power plants using oil and natural gas as energy sources. At the same time the demand for electricity is expected to rise by about 5% per year. An adequate supply of electricity is a prerequisite for the development of Egypt's productive capacity and for the promotion of economic growth which will contribute to improving the living conditions of the poor. Because of the high potential of RE sources Egypt is endowed with and the benefits of related technologies, RE should be largely integrated in the electricity mix.

Even though the Egyptian government set in place clear objectives to develop renewables, it has not yet defined an adapted institutional and regulatory framework supporting the realisation of the objectives. This is the first priority and main condition for a sustainable development of the RE sector in the country. Bilateral and international cooperation are still needed and may facilitate and accelerate achieving these objectives.

As a non-Annex I country eligible to the CDM, there are also some positive signals indicating that the RE sector in Egypt may benefit from this financial mechanism. Some projects are in the pipe already, but the CDM can not be perceived as a panacea. It can only provide an additional option. The same applies to innovative financing schemes such as tradable green certificates.

⁵⁴ This has been included in the International Action Programme of the International Conference for Renewable Energies, Bonn 2004.

Chapter 3. Libya

1. Energy Context

The energy sector plays a vital role in the economic development of Libya. The country is indeed endowed with high hydrocarbons resources and is an important oil exporter, particularly to Europe (more than 90% of Libya's exports). Oil export revenues are extremely important to the economic development of the country as they constitute 80% of its GDP⁵⁵ and represent the major hard currency earnings of the country (more than 95%). Libya's budget is thus highly vulnerable to fluctuations in oil prices.

However, substantial hydrocarbon resources may be discovered in the near future as only 25% of the country has been explored for oil and gas. Analysts expect up to 100 billion barrels to be found. Libyan crude oil is particularly attractive due to its extremely high quality (very low sulphur content) not easily found elsewhere.

Libyan energy strategy is looking to expand natural gas production with the purpose of exporting the energy particularly to Europe and increase its use domestically to free up more oil for export. In October 2004, the Greenstream Pipeline across the Mediterranean to Italy has been inaugurated. This pipeline allows exporting some 8 bcm per year.

As for electricity, the Libyan total installed capacity for power generation amounts 5.5125 GW (35% ST Gas, 65% gas) with peak load around 3.9 GW. The national electricity demand is growing rapidly (around 6%-8% annually), leading to several blackouts especially in the summer. In order to prevent such situation and to satisfy the growing electricity consumption, Libya's state-owned General Electricity Company (GECOL) has plans to build several new power plants, mainly combined cycle and steam cycle power plants. GECOL is also looking for RE as an option for electricity generation. However, because of low and subsidised electricity prices (around 0.02 LYD⁵⁶ per kWh) and high share of uncovered power bills, GECOL is facing some financing problems to implement its development plans.

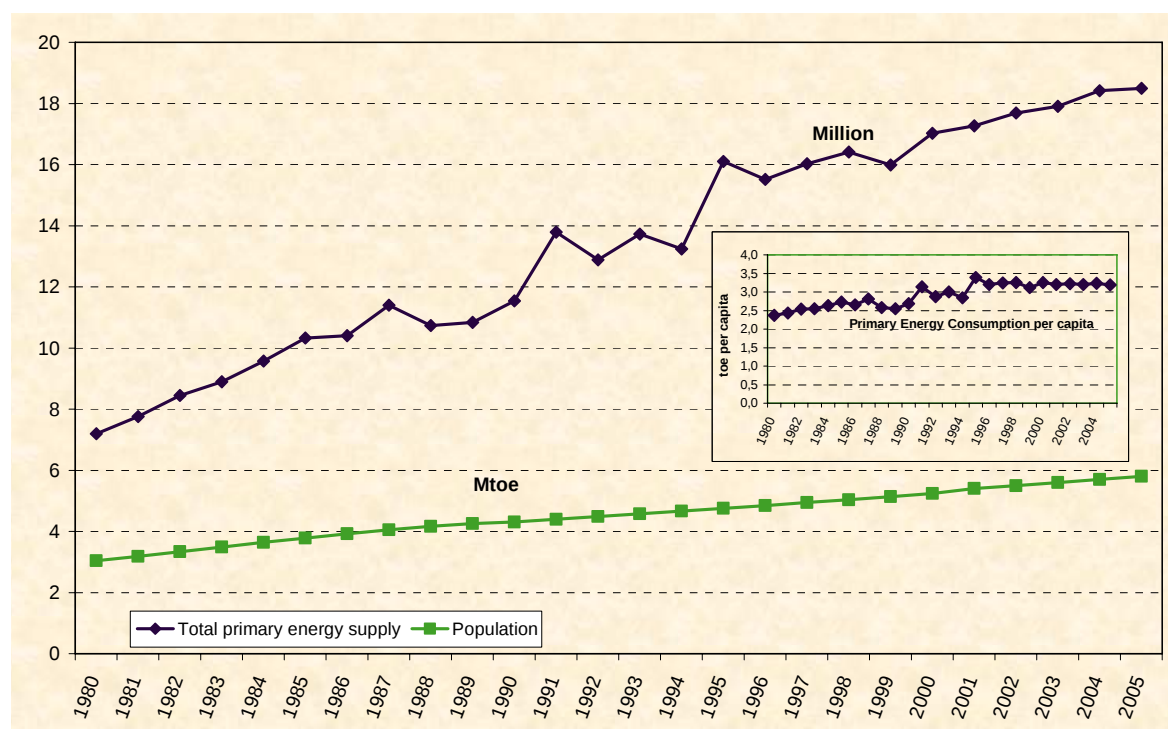
Clear signs are showing that Libya attempts to introduce economic reforms and reduce the role of the state in the economic sphere. Recently, the government announced its intention to remove \$5 billion worth of subsidies (in energy and basic food) in an effort to liberalize certain sectors of the economy. Progress in implementing these measures is tangible and the government has introduced compensation measures to prevent a fall in the standards of living of low income Libyans.

As illustrated in Figure 26, TPES in Libya has increased very rapidly in recent years. This is attributed to population growth but is mostly due to the rapid growth of the oil sector and its influence on the economic and social development of the country, especially during the seventies and early eighties. Indeed, the Libyan TPES increased from 7.2 Mtoe in 1980 to 18.5 Mtoe in 2005 (7.5% average annual growth). In the same period, energy consumption per capita increased from 2.36 toe to 3.19 toe (2.4% average annual growth).

⁵⁵ "In part due to higher oil export revenues, Libya experienced strong economic growth during 2004 and 2005, with real gross domestic product (GDP) growth of about 6.7% and 6.5%, respectively. For 2006, real GDP is expected to grow 6.7%". (source: <http://www.eia.doe.gov/emeu/cabs/libya.html>)

⁵⁶ LYD = Libyan Dinars (national currency). As of 9 December 2006, 10 LYD = 5.9 €

Figure 26 *Libyan TPES (total and per capita) and population (1980-2005)*



Source: OME

Figure 27 illustrates the trends for TPES, GDP (US \$ 2000) and energy intensity during the three last decades in Libya (1980 = 100). It clearly shows that TPES is growing much faster than GDP, leading to a more and more energy intensive economic development of Libya (except for the three last years). The energy intensity has more than doubled in comparison to its levels in 1980, and increase from 20 koe/1000 US\$ 2000 in 1980 to 48 toe/1000 US\$ 2000 in 2005 (7% average annual growth). Libya's energy intensity is the highest in the region (more than six times in comparison to Morocco and three times in comparison to Egypt for example).

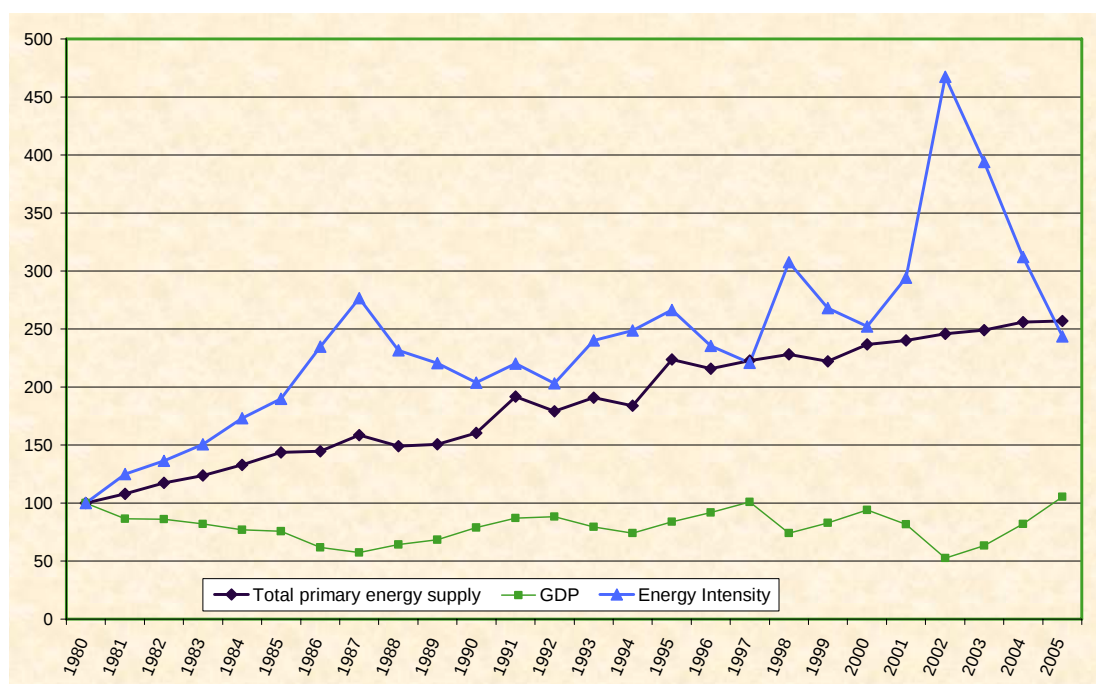
The analysis of the present energy situation in Libya clearly indicates an important potential for a decrease in energy intensity. But this would be possible only if the country implements ambitious energy efficiency and conservation programs.

Even if there are signals towards developing RE in the country, energy efficiency is basically absent from the energy policy and goals of the country. Addressing both aspects together would lead to better use and diversification of energy sources along with and important decrease of greenhouse gas energy related emissions, thereby promoting sustainable development in the country.

Several studies have analysed the potential impact of improved energy use efficiency on the future energy demand in Libya. One of them was carried out under the auspices of the Libyan National Energy Committee on the impact of economic growth and energy conservation on future energy demand by 2020. The study indicated a potential for energy savings of around 25% in addition to substantial financial savings⁵⁷.

⁵⁷ More details on the study and its result are available on www.worldenergy.org/wec-geis/publications/default/tech_papers/17th_congress/1_1_07.asp

Figure 27 *Libyan TPES, energy intensity and gross domestic product*



Source: OME

2. Environmental Context

In Libya, more than 90% of the country is desert or semi desert. The major environmental issues Libya faces relate, therefore, to desertification and the very limited natural fresh water resources available. In this regard, the Great Manmade River Project is being built to bring water from large aquifers under the Sahara to coastal cities.

Libya is a party to Conventions on Desertification, Marine Dumping, Nuclear Test Ban and Ozone Layer Protection. It has signed, but not ratified Biodiversity, Climate Change and Law of the Sea. It is a Non-Annex I country under the United Nations Framework Convention on Climate Change (ratified June 14th, 1999) and has ratified the Kyoto Protocol on August 2006. Thus, Libya is becoming eligible to the CDM.

The main emitters of CO₂ in 2002 in Libya are fuel combustion in the power generation sector (30%), in the transport sector (17%) and in industry (8%). Other sectors represent 43%. In total, energy-related emissions are responsible for almost 100% of CO₂ emissions in the country⁵⁸.

According to IEA-DOE sources⁵⁹, in 2002 petroleum accounts for more than 69% of carbon emissions in Libya and natural gas is responsible for around 31%. The increasing reliance on natural gas should work to lower carbon emissions. Libya's energy-related CO₂ emissions increased by about 20% in one decade, from less than 30 Mt in 1992 to around 47 Mt in 2005 (3.5% average annual growth), mostly due to increased energy supply (Figure 28).

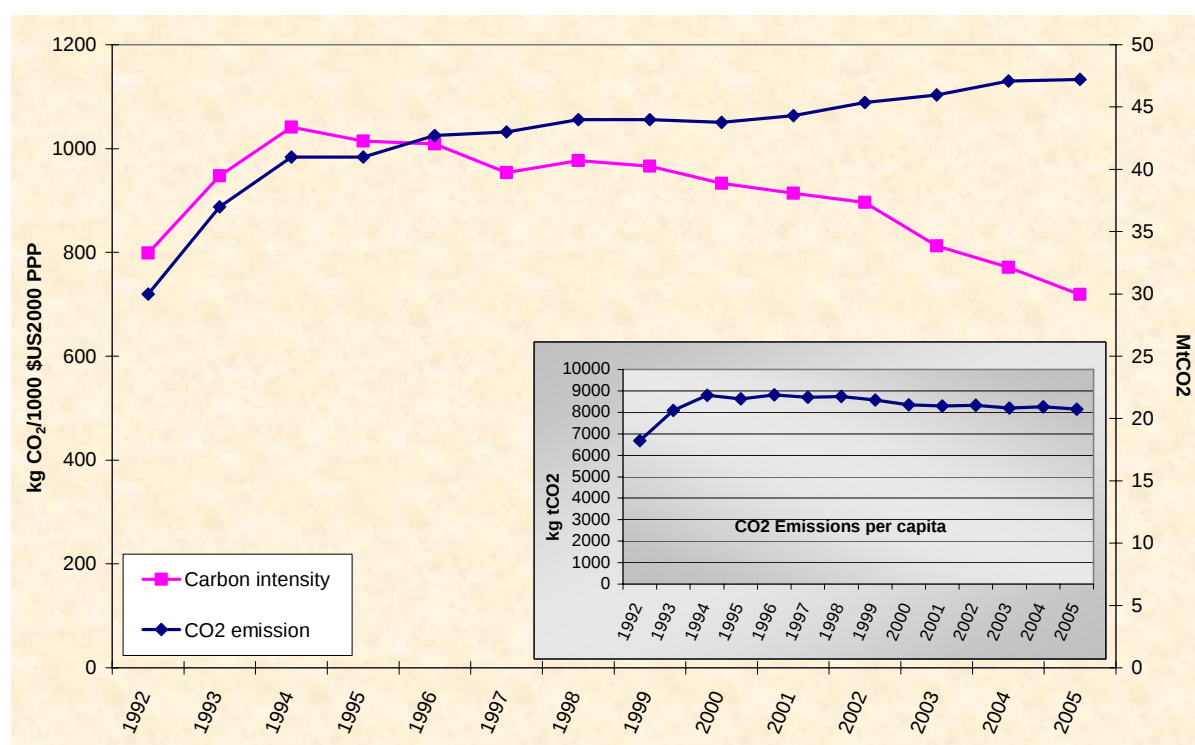
⁵⁸ Ibrahim M. Saleh Ibrahim, 2004

⁵⁹ IEA-DOE The Arab Maghreb Union, June 2005.

Libya's CO₂ emissions per capita are also increasing, even though they are still significantly lower than in most developed countries. In 2005, Libya emitted 8.2 ktCO₂ per capita, corresponding to an average annual growth of 1.7% over the period 1992-2005 (Figure 28).

Carbon intensity nevertheless is on a relative decreasing trend and is almost at its level of 1992. Libyan CO₂ emission's levels are thus increasing rapidly since 1990, the baseline year for the Kyoto Protocol of the United Nations Framework Convention on Climate Change. But as a non-annex I country, Libya is not obligated to curtail carbon emissions. As mentioned earlier, Libya is being eligible for CDM projects and reducing carbon emissions in Libya could be easily reached through energy efficiency measures and the promotion of clean technologies. Libya has thus a significant potential for “high quality” CDM projects, RE projects being one category.

Figure 28 **Energy-related carbon emissions (1992-2005)**



Source: OME

3. Integration of RE sources

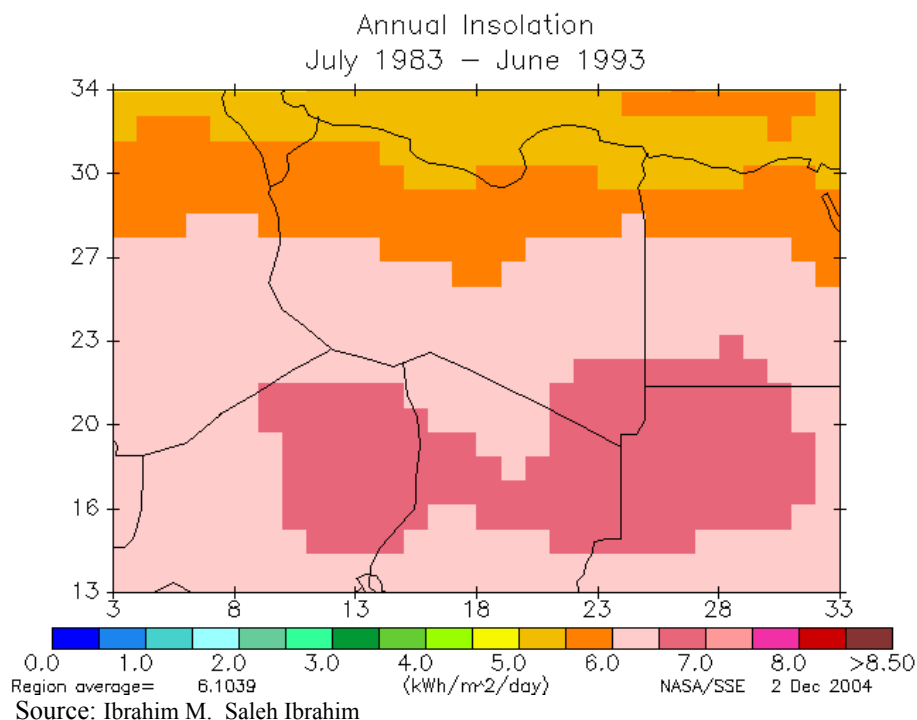
Libya's use of RE is relatively limited and mainly concentrated in rural electrification, telecommunication stations and in cathodic protection. A new restructuring plan predicts the increased use of RE, which should account for 20 per cent of electricity production by 2020. Investments of about 200 million euros are to be devoted to RE in the coming five years.

The country is endowed with a high potential in RE sources. In particular, the country has abundant solar energy resources and substantial wind resources in certain locations. This section describes the RE resources and potential, the current RE situation and the institutional/legislative framework in Libya. Emphasis will be given to solar and wind resources for which data are readily available. Biomass is also used in Libya. However, data were not available.

3.1. Renewable energy resources and potential

The daily average solar radiation on a horizontal plane is 7.1 kWh/m²/day based on an average of 8 hours of sunshine per day in the coastal region and 8.1 kWh/m²/day based on an average of 11 hours of sunshine per day in the southern regions. These reasons encouraged the use of PV systems in remote areas wherever it is needed. It should be noted that the average temperature is relatively high in the summer which might be one of the drawbacks in the storage element of the PV system. Figure 29 illustrates the solar radiation in Libya over the period 1983-1993. The production of a detailed solar atlas is one of the objectives of GECOL in relation with its RE policy.

Figure 29 Libyan radiation 1983-1993

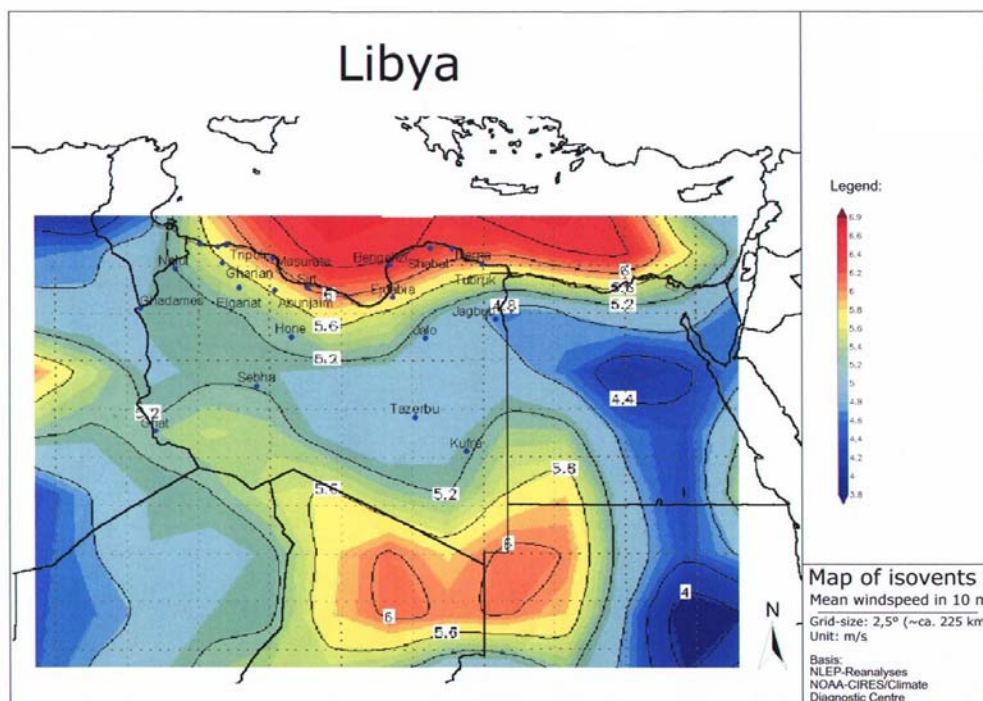


Wind

Wind energy potential in Libya is substantial, with high wind velocities especially on the coastal region. A first Wind Atlas for the Coastal Regions of Libya was developed by Yousef M.A. Kalifa⁶⁰ (CSES) in 1998. The WASP model (method of the European Windatlas) has been applied to compute wind statistics at 9 different coastal locations. At 50 m a.g.l. Kalifa predicts average wind speeds of 4.7-9.1 m/s at the West Coast, 5.4-8.9 m/s at the Central Coast and 5.6-10.4 m/s at the East Coast.

Also, the WorldWindAtlas based on the NCAR/NCEP-data and its resolution of 2.5 degrees contains 6h-data records for wind speed and wind direction for 50 years in total. Two heights, 50m and geostrophic height (500m), are available. The wind speeds for a 10 years period (1992-2001) and the coastal area for Libya are shown below (Figure 30). The figure illustrates very good correlations with wind measurements in Libya (Generation of long term values).

Figure 30 Potential of wind energy in Libya



Source: Ibrahim M. Saleh Ibrahim

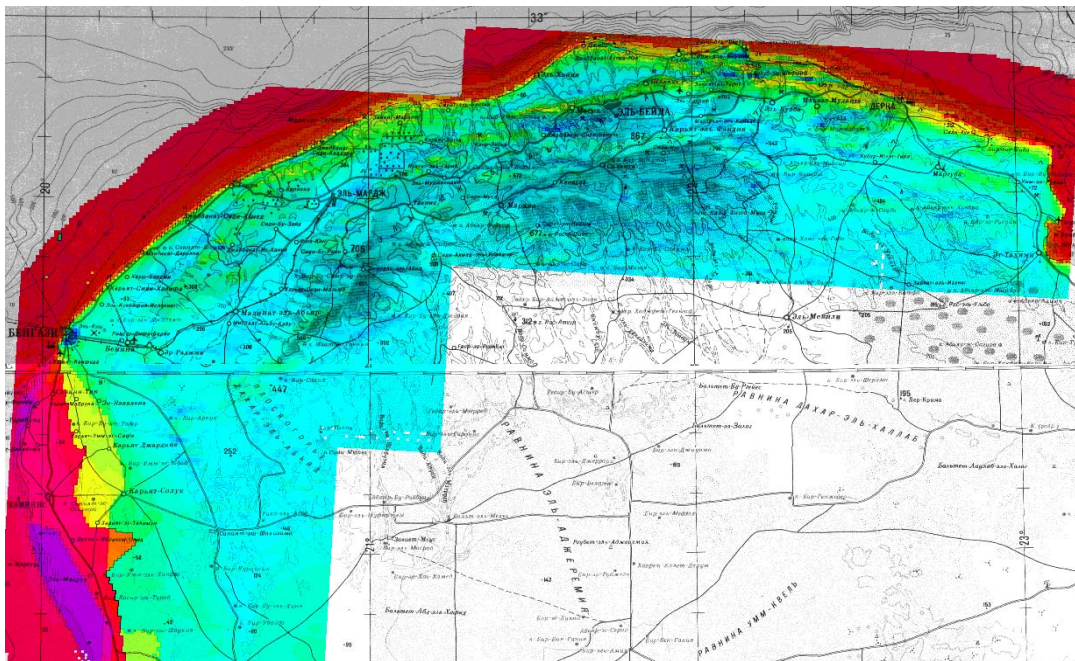
More recently and in view of the first large-scale wind power plant project in Libya, a detailed wind energy resource map for the entire coastal region of the country has been produced by the German CUBE Engineering. More than 40 single locations (proposed wind farm and reference sites) were initially inspected by the CUBE staff and GECOL. 24 sites were identified as interesting sites for wind power projects. Evaluation Matrices were specifically designed for this project to describe each individual site and determine the most suited locations.

Basis data has been obtained from the World Digital Elevation Model (GTOPO30) and Topographical Maps. 3 areas have been identified: West Coast (Tripoli), Central Coast (Sirt) and East Coast (Benghazi). With a resolution of 1 km² the PCs have been operated the WAsP

⁶⁰ The Wind Atlas was developed by Yousef M.A. Kalifa for his Master of Science dissertation

calculation several days. Wind resource maps for scale of 1/2,500,000 have been created for two heights (10/50m). Figure 31 illustrates the regional distribution of wind resources in the region.

Figure 31 *Regional distribution of wind resources*



Source: Dr Ekhlal, Gecol, OME RESDC meeting, Rome 2004

The average wind speed in coastal region reaches 8 m/s, which illustrates the high potential of wind, Libya is endowed with. The production of a national wind atlas is another one of the objectives of GECOL in relation with its RE policy.

3.2. Current renewable energy situation

Contribution of RE to the energy balance and to power installed capacity generation

Despite the high potential of RE resources Libya is endowed with, these resources are almost unexploited currently, except biomass (consumption estimated at 146,000 koe in 2003⁶¹) and some PV systems for rural electrification and telecommunication, with total installed capacity not exceeding 1 MW. RE in TPES is negligible and so is RES-based power generation. The following section analyzes the present Libyan RE situation by source.

⁶¹ IEA database.

Solar thermal

As mentioned earlier, Libya is endowed with significant solar resources. However, its contribution to the country's energy balance is marginal given the important oil and gas reserves.

Solar thermal use in Libya is mainly limited to one kind of applications, the domestic Solar Water heating (SWH) systems, with few successful results. Even though the information gathered is old (1996), it seems that the situation has not changed much (direct communication)⁶².

Some 8,000 SWH systems exist in different parts of the country (200 litres/3m² and 200 litres/5m²) all imported from Greece. The first programme was initiated by the government and a contractor undertook to deliver the work on a turn-key basis.

Another Governmental Project was implemented in the early 1980's in the city of Marge, 100 km east of Benghazi, with 2000 units of 160 litres/2m² open loop, imported from Cyprus. In 1983, 35 units of 200 litres/3m² open loop were imported from Japan - "Hitachi" and installed within an "Evaluation Project" in the southern part of the country. In 1993, a local manufacturer under the brand name "Shams" has signed a contract with a manufacturer from Jordan for 3000 units of 100 litres/1.4m² open loop. The company which assembled them is government-owned and does not deal with the production of solar systems, but it is a steel construction and spare parts company. A part of its activities in 1993 was the assembly of those 3000 small solar SWH units, as a trial operation.

For the years 1994 to 1996, a large Integrated Project for the demonstration, field test and transfer of SWH technology was developed with a budget of 350.000 Libyan Dinars. This project has been initiated by the Centre for Solar Energy Studies (CSES), which is headed by the National Energy Committee of Libya, part of the Ministry of Energy. The main results of this project were:

- The CSES performed the evaluation, quality control and testing of 300 imported SWH according to local operational and meteorological conditions.
- Carrying on a market and marketing study for the uses of low temperature SWH systems and proposing relevant incentives to facilitate their wide-spread use.
- Establishing related national standards and testing procedures.
- Creating public awareness in the field.

The installation of approximately 300 solar SHW systems from 5 different manufacturers (FOCO, SOLE, BATEC, GIORDANO and an Egyptian firm), with different designs, features, capacity and materials, was implemented. CSES organised a «SOLAR WEEK» exhibition, open to the public. A number of 200 interested families have been chosen to participate in the above mentioned project as users.

As described above, the only solar market existing so far in Libya is SWH systems, either as evaluation projects or as governmental projects at tenement houses. Currently, almost no local mass produced solar systems are offered on the local market. The only exceptions are:

⁶² GECOL, CSES

- A public sector pilot project to assemble 3000 units of 100 lit of solar SHW systems (the already mentioned "SHAMS") and,
- A PV module encapsulation line.

Currently, the only potential projects for solar resources are through the government. Import duties -for private use- are 30%. However, some industries supporting solar system manufacturing do exist in Libya, including of glass, steel and plastics industries. The required manufacturing processes to transform such semi-finished products into functioning solar systems exist in Libya. There is a number of well equipped plants and workshops, e.g. the National Company of Metal Works in Tripoli Misurata, the Central Workshops in Tripoli and Benghazi and the plants of the Engineering Industries Authority, as well as a large number of smaller private workshops.

In the future and for energy efficiency purposes, Libya and GECOL in particular is very concerned about the development of a massive and sustainable SWH market. The development of this market is one of the priorities in the field of energy efficiency and RE development mentioned by the top managers of GECOL.

Solar Photovoltaic

Several photovoltaic (PV) systems with a total capacity of about 600 kWp have been installed in Libya since 1976. The main PV application today concerns telecommunication and electrification of remote areas. Because of its important solar resources, Libya is also looking to test PV power plants connected to the grid. A potential for decentralised rural PV electrification also exist for some 63000 people that cannot be connected to the grid (dispersed population). About 920 systems totalling 1865 kWp have been installed (direct communication).

Experience with PV systems for the telecommunication network⁶³

The use of PV systems first started in the Libyan communication network as a pilot project in 1980 where ten small repeater stations were put into work. The use of the PV systems proved to be suitable for this type of application, the stations which are running with PV systems did not stop due to lack of fuel or maintenance problems, and the stations are still running. Table12 summarises the operating technical experience gained from the pilot stations running with diesel in comparison with stations running with solar in the last 25 years of work.

Table 19 Technical comparison between stations running on diesel and on solar

Diesel generators	PV Solar generators
Need special machines for installation or replacement	No need for special machines
Experience more theft cases in fuel and spare parts	No theft problems
More communication stops due to power failure	No power failure
Need qualified personal for maintenance	Experience no maintenance
Need spare parts	No spare parts ever used
Stops due to fuel theft	No fuel
Stops due to fuel run out	No need for fuel
Rate of stops is 1.5 days per month per link	No power failure

Source : Ibrahim M. Saleh Ibrahim

⁶³ Details on the Libyan experience with PV systems for telecommunications network are based on a report prepared by Dr Ibrahim Saleh Ibrahim (El-Fateh University, Libya) on which this section is based.

The following remarks have in addition been drawn by Dr Ibrahim from the past experience:

- No spare parts have been ever used for four PV systems which were installed 25 years ago.
- No spare parts have been ever used for the 16 PV systems which were installed six years ago.
- No communication failure has been registered for the systems.
- No running cost for the PV systems and the only cost is for the routine visits.
- Batteries have been changed only once after about ten years from installation.
- Change of module glass colour has been noticed; this is due to high temperature and ultraviolet.
- Degradation in the power generated by the module has been recorded in the last year in old systems.
- Life time of the open type batteries was found almost the same as of the closed type in spite of the high temperature environment.
- The watering of the open type batteries made it one of the obstacles in maintaining the open type batteries in good conditions.
- The remote monitoring of the solar system will ease a lot of problems.
- Vandalism in the PV systems consists of breaking the modules either by direct hit by stones or going after birds.
- The component of the PV systems has to be adapted to the local environment of the installation. In one of the cases mice caused the failure of the PV systems as it ate the battery sensor wire.
- Unskilled personal dealing with PV stations may cause for the system to stop.
- Lack of knowledge: people in developing countries should be made aware of the PV systems by increasing their understanding and appreciation of this technology.
- Data acquisition is very helpful in diagnosing the system performance.

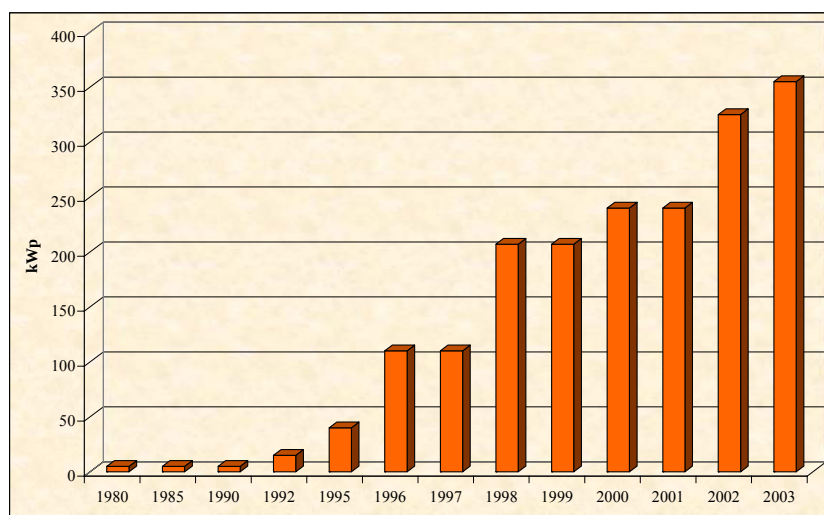
The excellent performance of the pilot PV project dictate the use of PV solar energy instead of diesel generators, but the implementation of PV systems was delayed until 1996 due to the following reasons:

- High initial cost of PV solar systems in the early eighties.
- No technical labour has been trained in the period of the pilot stations.
- The old communication network was an analogue network, which needs more power.
- The insistence of using air conditioning powered by PV solar energy.
- No study has been conducted on the pilot stations since the PV solar generator was installed in 1995.

The outcome of the pilot project convinced the GPTC (General post and Telecommunication of Libya) to plan using PV systems as power supply rather than diesel generators. The GPTC set up a plan to change all repeater stations running with diesel generators to PV solar

generator, seventy stations of medium size (about 15 kWh/day) have been installed up to now. The first stage started with 26 PV systems, these systems were constructed by the end of 1997. The second stage for 26 PV systems was constructed by the beginning of 2002. Another seven stations were designed from the beginning to run with PV systems. The total installed PV peak power installed by the end of 2003 was around 350 kWp, reaching 690 kWp in 2007 (120 systems). Figure 32, shows the accumulated installed PV systems in the communication networks in the period 1980-2003.

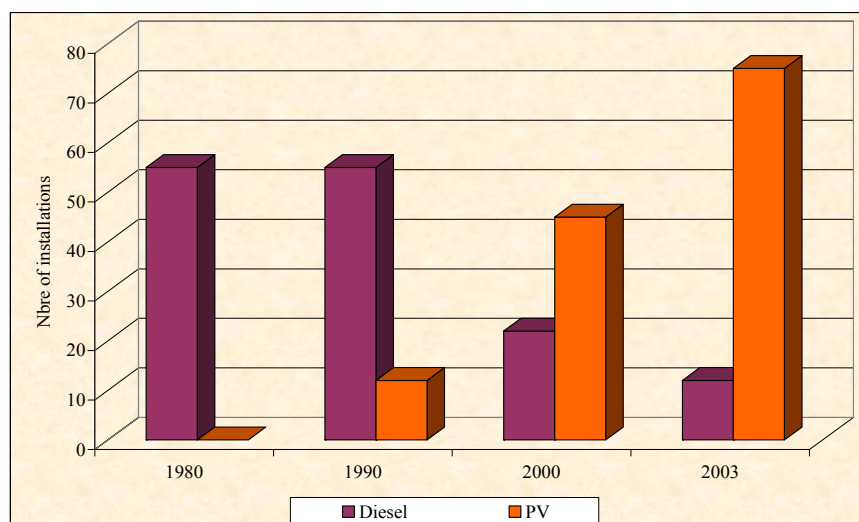
Figure 32 *The accumulated installed PV peak power in the period 1980-2003*



Source: Ibrahim M. Saleh Ibrahim

It was the success of the PV systems technically and economically that drove the change of all possible diesel stations to PV stations. The total number of stations running with PV in the field of communications is 75 stations. The increase in the number of PV stations accompanies a decrease in the number of stations running on diesel. Figure 32, shows this trend in the Libyan communication networks.

Figure 33 *Number of PV and diesel stations in the communication network*



Source: Ibrahim M. Saleh Ibrahim

Based on the data gathered on the performance of PV systems in the local environment, the technology has proved to be highly reliable and cost effective. As a result, GPTC plans were prepared to expand the use of PV generators in all remote and isolated communication station of a medium size.

PV for rural electrification and water pumping

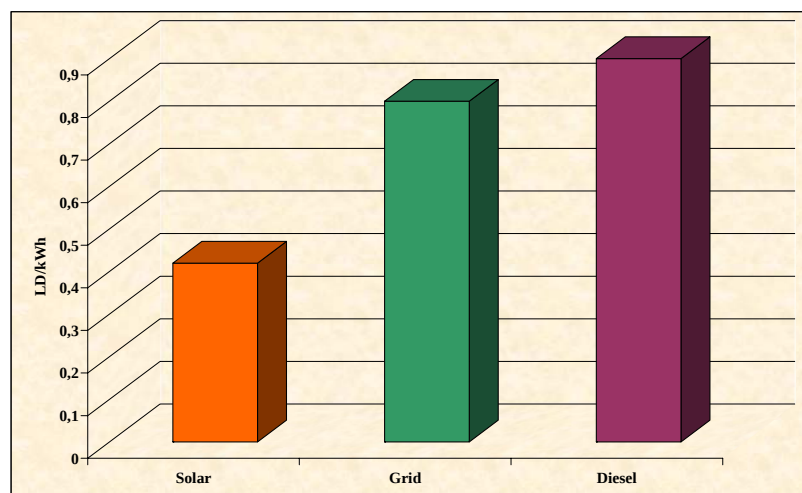
A project for rural electrification is now under way in Libya. It involves the electrification of 5 villages, 120 scattered isolated houses, and thirty water pumping systems, using PV systems.

Many Libyan villages and remote areas are located far away from the electricity networks. Economically these areas cannot be connected to the grid, owing to its small population, and the small amount of energy required. In the past these facts called for the use of diesel generators as a source of power supply. Libya engaged in the use of diesel generators to electrify some of the villages in the seventies and eighties, though in some other areas diesel generators could not be used as it was not easy to either reach them or regularly transport the fuel. These reasons opened the opportunity to look into some other sources like RE.

The main study carried out to convince GECOL to use PV systems involved the village of Mrrair-Gabis. It was selected for its lack of access to electricity and for its location (about 250 km west of the large urban centre of Benghazi and 50 km away from the nearest city Gdabia). The climate in this region is Mediterranean; the ambient temperature ranges between - 5°C and 45°C. The population is composed by 29 families totalling 250 inhabitants scattered in an area of about 15 km². This population lives either in houses or huts and there is a school for students from the first to the ninth grad. The main activity of this village is livestock pasturing and agricultural. Three options for access to electricity have been studied: electricity grid, diesel generation and decentralised PV generation.

The results of the study indicated that PV is the least cost option for access to electricity in the village (Figure 34).

Figure 34 Access to electricity: Cost per kWh for the three options



Source: Ibrahim M. Saleh Ibrahim, M. Ali Ekhlal

The Libyan national plan to electrify rural areas consists of electrifying scattered houses, villages, and water pumping. The PV supply systems for five villages, was introduced as part of the 2002 projects concerning the electrification of remote areas and 30 water pumping PV projects. The project will be implemented by GECOL and the Centre for Solar Energy Studies (CSES).

The installation of photovoltaic systems started mid-2003. The total number of systems to be installed by GECOL is 370 with total capacity of 310 kWp, while that which will be installed by Centre of Solar Energy Studies (CSES) is 150 systems with a total power of 116 KWp.

According to Dr Ibrahim and Dr Ekhlal, the lessons learned from the Libyan experience (installations in the year 2003) in the field of PV for decentralised rural electrification are the following:

- People in the villages in spite of being not used to the technology are dealing with the systems with care.
- None of the systems went over Batteries discharge.
- No system failure recorded.
- The average production energy for systems of 1.2 kWp is 6 kWh/day.
- The a.c option of electricity was the best choice.
- The closed type batteries option was the best choice for the rural areas people.
- People in remote areas are increasingly asking for PV systems.
- People in the villages started to organize night gatherings.
- People started to watch TV and use refrigerator.
- The PV systems performance at the local environment proved to be highly reliable and cost competitive.
- All systems have been installed by local engineering and technicians.
- Children should be aware of the PV systems through their schools.
- Repeated visits should be done to ensure the correct use of the PV systems.

PV for power generation

As mentioned earlier, Libya is also interested in testing PV power generation connected to the grid. In this context, a pilot 1 MW project should be developed. The consulting company IT Power has been selected to perform the pre-feasibility study of the project. The site has been selected and the terms of reference for the project implementation prepared.

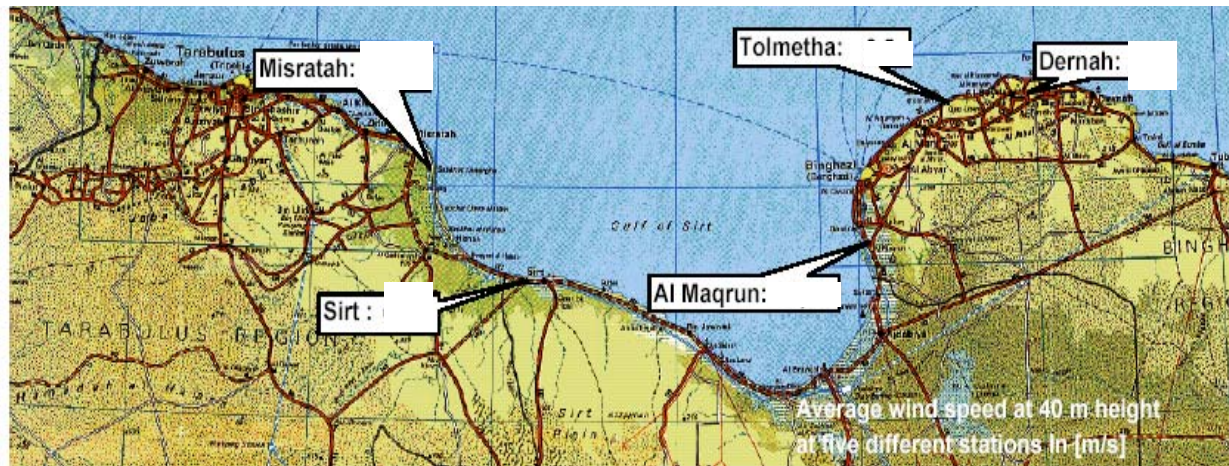
Wind energy

Wind mills for small applications have been used for many years in Libya. More recently, GECOL decided to test large scale integration of wind energy in its power generation system. In this context, a first 25 MW power plant will be implemented. The project's objective is to install a pilot wind farm up to 25 MW-capacity, if at least one of the selected candidate sites proves to be an option for a technically and economically feasible wind operation. The technical knowledge transfer from Germany and Denmark to Libya plays a vital role throughout the entire project.

In March 2004 phase 1 of the project has been finalised with the presentation of the feasibility study, in which five candidate sites had been intensively investigated on all technical and economic relevant aspects for such project. The sites are Misratah, Sirt, Al Maqrun, Tolmetha and Dernah (Figure 35).

The results of wind measurements in the 5 sites confirmed the large wind resources available in the region (average 6 to 8 m/s). The site selected for the project is Dernah in the North of Libya. The site is the most suitable due to its excellent wind and site conditions. 25 MW of installed capacity is the recommended size for the first building phase. An extension capacity of 100 to 150 MW is given. The 25 MW project is under negotiation and is to be implemented by GECOL

Figure 35 Location of candidates sites for the first wind farm in Libya



Source: GECOL

PV - wind Hybrid projects for water desalination

Libya is also interested in the development water desalination projects and using RE for that purpose. The General Electricity Company of Libya GECOL is indeed planning to install an experimental plant for Sea Water Reverse Osmosis (RO) desalination powered from RE Sources on Libya's coast on the Mediterranean. The nominal production of the plant will be around 300 m³/day to supply a village with drinking water. Both wind energy conversion (250 kW) and PV power generation (50 kW) will be integrated into a grid-connected power supply for a RO desalination plant with power recovery. The site of Ras Ejdir has been selected for the plant location. Following an international call for tender, a national company has been selected to implement the project.

3.3. *Institutional and legislative framework*

Main actors

Because of its high hydrocarbon resources and relatively high access of the population to the grid, energy efficiency and RE have not been considered as a pillar in the national energy policy of Libya.

The main actors involved in RE in Libya are:

- The Ministry for Energy: the Ministry is under the umbrella of the General People's Conference, the highest political organ in the country.
- The centre for RE and water desalination that includes also the Centre for Solar energy studies (CSES). The latter carries out studies and research programmes in the field of solar energy and proposes plans for the wider use of solar energy and promotes a better understanding of this vital field.
- GECOL, the national electricity company (under the Ministry for Energy) which is more and more interested in RE for energy efficiency purposes (SWH) and the exploitation of RE sources (remote areas and also large scale integration of RE to the grid).
- The General post and telecommunication company that has a solar division.

The International Energy Foundation also plays an important role in providing information and raising awareness through the realisation and dissemination of studies and documents on RE, organisation of national events and participation to international ones.

Regulatory and legislative framework

At the time of writing, there is no regulatory and legislative framework for RE in Libya. However, the government should be taking a decision soon regarding these issues. Indeed, the Libyan government has recently decided to give impetus to RE in the country. For that purpose, a Renewable Energy Committee was set up with participation of representatives from the main stakeholders i.e. the Ministry for Energy (Head of the Committee), GECOL, CSES, and universities. The Committee reviewed the RE situation in the country and the international experience in the field. The final objective would be to propose/decide on the institutional framework to put in place in order to promote sustainable development of RE in the country. According to information received from direct contacts, energy efficiency is not considered.

4. Barriers, priorities and targets of renewable energies

4.1. Barriers to renewable energy development

Besides the barriers highlighted in the regional overview, the followings are in addition specific to Libya:

Institutional and regulatory: Libya lacks an adapted and stable institutional and regulatory framework for RE and also for energy efficiency. This is going to be changed in a coming future.

Competing resources: As for the other hydrocarbon producing countries in the region, large resources and discoveries in recent years continue to strategically shift the government's attention away from developing the RE sector and markets. Abundant conventional resources and absence for environmental constraints are major barriers for RE to be taken seriously into consideration.

Awareness and information: Lack of awareness and information about RE technologies among policy makers, energy planners, and potential users of the technology.

Human resource: There is a great need for capacity building programmes in the field of RE in the country and for different actors (decision makers, consultants, companies ...).

4.2. Priorities and targets for renewable energies

In the immediate to the short term, the following technologies are of great importance to Libya and could be supported through new and innovative financing support mechanism(s), such as MEDREP ones:

- Solar water heating.
- Grid-connected large scale wind.
- PV for remote areas and buildings.
- PV power plants connected to the grid.
- Small & Medium wind for off-grid water pumping.
- RE hybrids for off-grid water pumping and electrification.
- Solar - wind hybrid projects for water desalination.
- PV for telecommunications.
- Solar-thermal power.

Adapted institutional and regulatory framework, along with tailor-made finance support mechanisms is however the main urgent issue to deal with by the Libyan government. It would contribute to a faster deployment of the above technologies.

Many RE projects are foreseen. GECOL's master plan allocates 200 MW to be generated by wind plants. Several solar projects will also be undertaken. Libya's objective is also to reach

6% of Libya Electricity Demand with RE in 2020. In addition, it would be important the energy efficiency also be included as a pillar of the national energy policy.

5. Conclusions

Although an important exporting countries and aware that supplies of oil and gas are limited in the long term, Libya intends to make more extensive the use of RE sources in the future.

Particular attention is given to solar thermal (SWH) and RE-based power generation. Libya intends to experience different technologies (wind, PV connected to the grid), hybrid for water desalination and to build a strong RE market on the basis of the results to be obtained from the pilot projects.

The first priority and main condition for a sustainable development of the RE sector in the country is to define an adapted and stable institutional and regulatory framework for RE and energy efficiency. Low energy prices and important subsidies constitute one of the major barriers to the efficient use of energy in the country.

Libya is hoping to reduce its dependency on oil as the country's sole source of income and to increase investment in agriculture, tourism, fisheries, mining, and natural gas. RE integration in the Libyan economy can play an important role helping achieve these objectives.

Chapter 4. Morocco

1. Energy Context

Morocco is highly dependent on imports of fossil fuels to satisfy its energy needs (in 200, more than 95% of energy was imported). Currently, the country produces small volumes of natural gas, oil and coal, but domestic output is far from sufficient to satisfy the country's energy demand. As such, Morocco is the largest energy importer in North Africa. It is a transit country for Algerian gas sold to Spain and also exports electricity to Spain. The country is looking to increase its trade in energy.

The national authorities face pressing energy-related problems, especially in rural areas and for the main following reasons:

- Low access to electricity for rural populations; important efforts are being made: according to ONE the rural electrification rate reached 81% percent by the end of 2005 (18% by the end of 1995).
- The burning of fuelwood supplies is close to 25% of TPES; such a level of use is not sustainable and causes progressive deforestation, with all the consequences on the environment.
- There is a great need to increase water supply to counter the effects of the severe droughts that have plagued the country for the past 12 years or so.

Apart from the direct impact of fossil fuels on the environment, energy imports in Morocco represent a yearly bill of 1 to 1.5 billion \$. However, high oil prices in 2005 increased import costs to approximately \$2 billion for the year. At the same time, Morocco's wind and solar potential is among the most important in the world.

In an effort to reduce oil prices due to supply shortages, the Moroccan government announced in February 2003 that foreign companies could import oil without having to pay import tariffs. In March 2000, Morocco modified its hydrocarbons law in order to among others offer a 10-year tax break to offshore oil production firms and to reduce the government's stake in future oil concessions (to a maximum of 25%). In addition, because of the budgetary constraints of the State and the fast increase of oil prices on the international market, Morocco applied the system of indexing prices of the petroleum products on the international prices. This system came into effect in August 2006, after its suspension since the year 2000. This measure is based on two important considerations: provision of the national market and balance in the budget of the equalization fund. The entire energy sector is due to be liberalised by 2007.⁶⁴

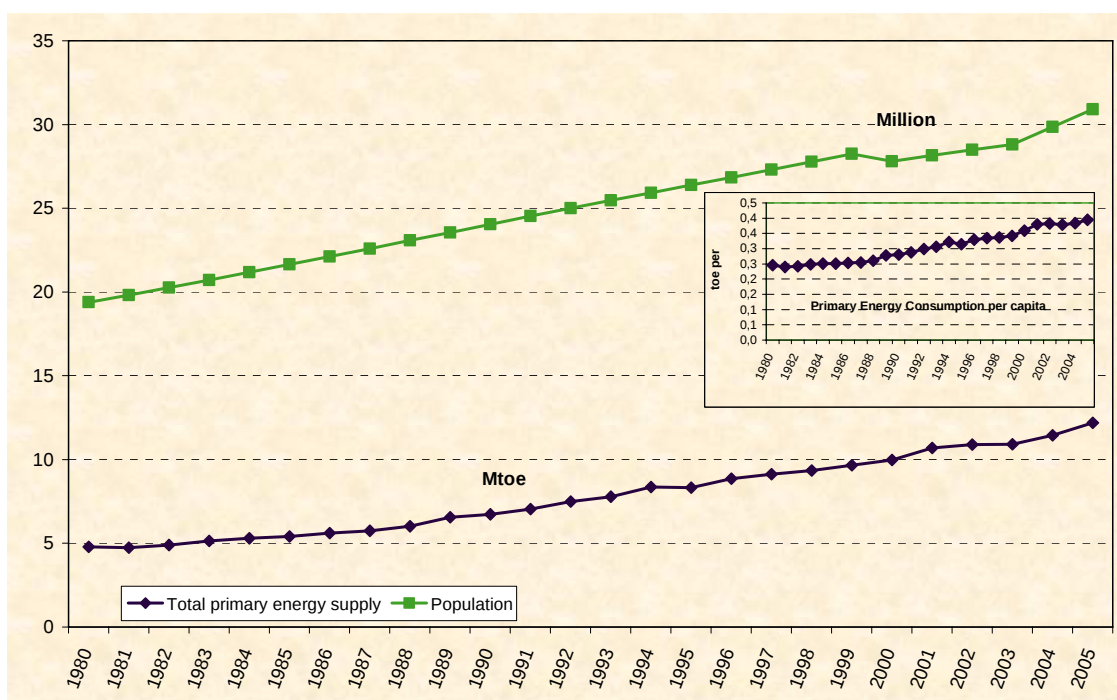
As far as electricity is concerned, the vast majority of Morocco's electricity is generated by thermal power plants that burn imported oil and coal⁶⁵.

⁶⁴ For more detail see EIA/DOE: The Arab Maghreb Union, April 2006 at: <http://www.eia.doe.gov/emeu/cabs/maghreb.html#MOR>.

⁶⁵ All of the oil is imported, and most of the coal comes from South Africa (the United States and Columbia are also key suppliers). Morocco produces a small and declining amount of coal from a mine at Jerada.

As illustrated in Figure 36, energy demand in Morocco has increased very rapidly in recent years mainly due to demographic growth, the improvement of standards of living and the expansion of industrial, commercial and residential sector. Indeed, total primary energy supply has increased by an average annual growth of 6% over the past two last decades, from 5 Mtoe in 1980 to 12 Mtoe in 2005. In the same period, energy consumption per capita increased from 248 koe to 395 koe (3.2% average annual increase).

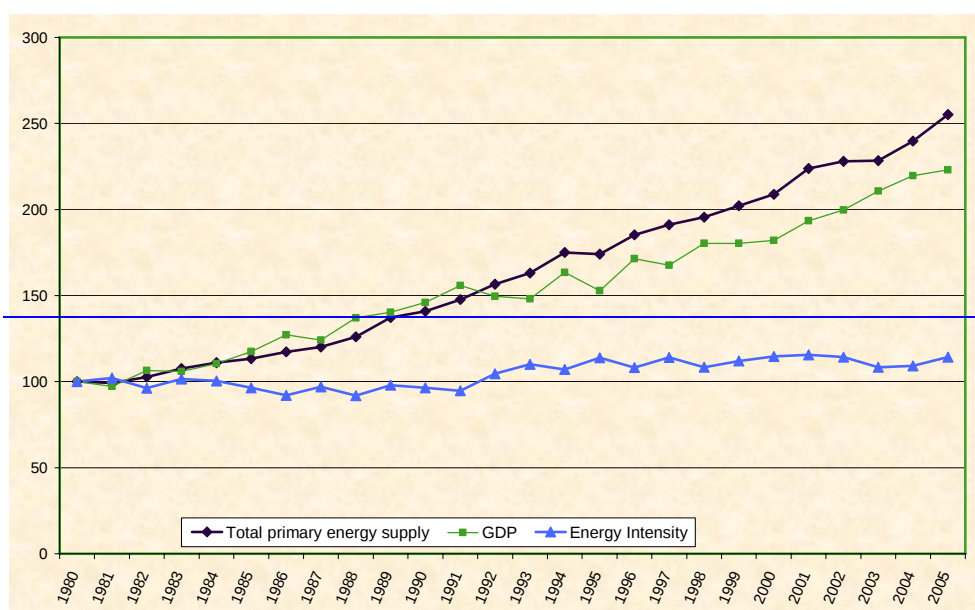
Figure 36 *TPES (total and per capita) and population in Morocco 1980-2005*



Source: OME and IEA database

Figure 37 illustrates the trends for the TPES, GDP (US \$ 2000) and energy intensity during the three last decades in Morocco (1980 = 100%). It clearly shows that TPES is growing much faster than the GDP, indicating that economic development in Morocco is increasingly energy intensive. The energy intensity is up by more than 15% compared to its 1980-level and has increased from 260 koe/1000 US \$ 2000 in 1980 to 300 toe/1000 US \$ 2000 in 2005 (1% yearly increase). While Morocco's energy intensity is relatively high in comparison to Western Europe, it is the lowest in the North African region. However, it is important to underline that non-commercial biomass consumption is not considered here, though biomass represents over 24% of TPES in the country. Taking biomass into consideration would considerably increase the energy intensity of Morocco.

Figure 37 *TPES, energy intensity and gross domestic product in Morocco*



Source: OME

Moroccan energy intensity should fall as the country implements energy efficiency and conservation programs. There is clearly an important potential for a decrease in energy intensity may be reduced, along with the greenhouse gas energy related emissions. The government is very aware about the benefits of promoting renewable, clean and efficient technologies in Morocco together with demand side management measures, especially in the present context of high oil prices and rise in environmental concerns. In this context, energy policy of the country is looking for a sustainable energy development though such elements as the following:

- The Gas Development Plan sets out to improve connections between Morocco's various gas networks. There are plans to diversify supplies with the creation of an LPG network. A gas code is being drawn up.
- The Renewable Energy Development Centre (CDER) continues to promote the technological development of RE sources in Morocco.
- With regard to the internal refined oil products market, Morocco is planning to re-orient its production of hazardous heavy fuels towards the processing of light oil products.
- With its pricing structure for industrial users of electricity, Morocco wants to step into line with EU pricing. Morocco has signed the Memorandum of Understanding concerning the Maghreb electricity market and the integration of that market into the EU internal market which was developed in the Euro-Med energy forum (Rome, December 2003). In signing the Memorandum, Morocco committed itself to gradual integration into the internal energy market.⁶⁶
- After investing substantial resources in research and development as well as demonstration and pilot projects, national planning of electricity infrastructure and electrification programs are taking into account RES as a serious solution in their evaluation of energy options, in particular PV systems in the context of rural electrification programs.

⁶⁶ EU Commission staff working Paper, European Neighbourhood Policy. Country Report: Morocco, May 2004. See for more detail at http://europa.eu.int/comm/world/enp/pdf/country/Morocco_%2011_May_EN.pdf

Institutionally, the Ministry of Energy and Mines coordinates the activities of the energy sector. This ministry's Department of Energy is responsible for drafting and implementing sector policy, especially as concerns planning, regulation, control and energy cooperation.

The Ministry of Equipment is responsible for design and construction of hydraulic facilities used for generating hydroelectricity. The Ministry of Territorial Development, Water and the Environment, acting through the various area water boards, coordinates all activities related to the use of water for electricity production. The Ministry of the Interior, acting through its Department of Concessionary Companies and Services has supervisory authority over electricity distribution utilities and other entities placed under concession. The Minister Delegate to the Prime Minister in charge of Economic and General Affairs chairs the inter-ministerial billing commission and is involved in the regulation of rates. The Minister of Finance coordinates the sector's economic and financial planning actions.

The organisation of the sector is characterised by the sharing of responsibilities between public and private corporations. The public corporations are the National Mines and Hydrocarbons Authority (a merger of the National Oil Exploration Authority (ONAREP) and the Mining Research and Participation Bureau (BPRM), the National Electricity Authority (ONE), the Renewable Energies Development Centre (CDER) and water and electricity distribution utilities. The major private corporations are the Moroccan Refining Company (SAMIR), the Maghreb-Europe Gas Pipeline Management Company (METRAGAZ), petroleum product distribution companies and electric power generation companies: Jorf Lasfar Energy Company (JLEC), Tahaddart Electricity Company (EET), Detroit Wind Energy Company (CED) and water and electricity distribution companies placed under concession (LYDEC in Casablanca, REDAL in Rabat-Salé, and AMENDIS in Tangiers-Tétouan).

Over the last ten years, the institutional framework of the energy sector has evolved considerably under a reform process that is essentially geared towards gradual liberalisation and opening of the sector to national and foreign private investments in order to ease the heavy financial obligations weighing on the State budget. The main outcomes of these reforms are the concessioning of four national water and electricity distribution utilities (Casablanca, Rabat-Salé, Tangiers and Tétouan) to private companies, the privatization of petroleum product distribution companies, the privatization of oil refineries, the construction of the Maghreb-Europe Gas Pipeline (GME), electric interconnection with Spain, conclusion of concession contracts for electric power production, the Global Rural Electrification Program (PERG) with a decentralized component using renewable energies, tariff reforms for petroleum products and electricity, and revision of the petroleum exploration code to make it more attractive to investors.

The main Government policy guidelines for the sector focus on: (i) ensuring regular supply in order to guarantee availability of energy products; (ii) obtaining more reasonable energy costs in order to boost the production sector; (iii) generalising access to energy; (iv) protecting the environment; (v) ensuring control and safety through the development of clean energy technologies, the upgrading of product specifications and energy equipment standards as well as the enhancement of safety for facilities and persons; (vi) developing observation and long-term planning in the energy sector through improvement of the information system, forecasting of medium- and long-term sector trends as well as skills development, and (vii) liberalising markets, restructuring energy sub-sectors and repositioning the ONE in an increasingly competitive environment.

The following measures were taken to implement this policy:

- Sector liberalization through privatization of petroleum product distribution activities and oil refining companies, liberalization of petroleum imports and adjustment of their sales prices to those of Rotterdam, and opening of the electricity production sector to private operators.
- Diversification of the energy products consumed and of supply markets notably through recourse to imported coal, introduction and development of the use of natural gas for electricity production and for household needs, made possible by the construction of the Maghreb-Europe Gas Pipeline (GME).
- Introduction of an attractive new petroleum code and a tariff policy aimed at enhancing the competitiveness of the national industry.
- Promotion of RE in order to reduce the country's dependence on foreign energy sources.
- Finalization of the plan to gradually liberalize the electricity sub-sector by instituting a free market for eligible consumers (e.g. industries) and a regulated market for distribution of electricity (residential and tertiary) through a utility.
- Implementation of the rural electrification program, promotion of programs on rational and efficient energy use and enhancement of the energy system's efficiency; and
- Reinforcement of electricity interconnections to guarantee regular supply and satisfy the country's demand for electricity."⁶⁷

An energy monitoring centre is envisaged to support the development of such a policy.

2. Environmental Context

Morocco faces various environmental problems, including several arising from natural hazards: land degradation/desertification (soil erosion resulting from farming of marginal areas, overgrazing, and destruction of vegetation); water supplies contaminated by raw sewage; oil pollution of coastal waters. The main difficulties arise from Morocco's dependency on water and the economy's vulnerability to climate change. As energy demand is growing rapidly and rural areas still poorly served with energy services, it is expected that GHG emissions increase substantially. In addition, the country suffers from oil pollution of its coastal waters.

In this context, Morocco has clearly declared its willingness to pursue Sustainable Development for two decades. This was translated into concrete action, with the creation of a ministerial department for the environment in 1992 and the implementation of a process that has fully integrated environment protection concerns in the social, political and economic plans.

Today, Morocco has a better understanding of the environmental problems. A national environment strategy has been developed and a well-founded environmental regulation exists. However, Morocco is still facing challenging environmental problems, some of which would

⁶⁷ AfDB Report on The Ain Beni Mathar Solar Thermal Power Station Project: Appraisal report, September 2004. Detail at: http://www.afdb.org/pls/portal/docs/PAGE/ADB_ADMIN_PG/DOCUMENTS/OPERATIONSINFORMATION/MAR-OC-ABD_BD_WP_2005_05_E.PDF

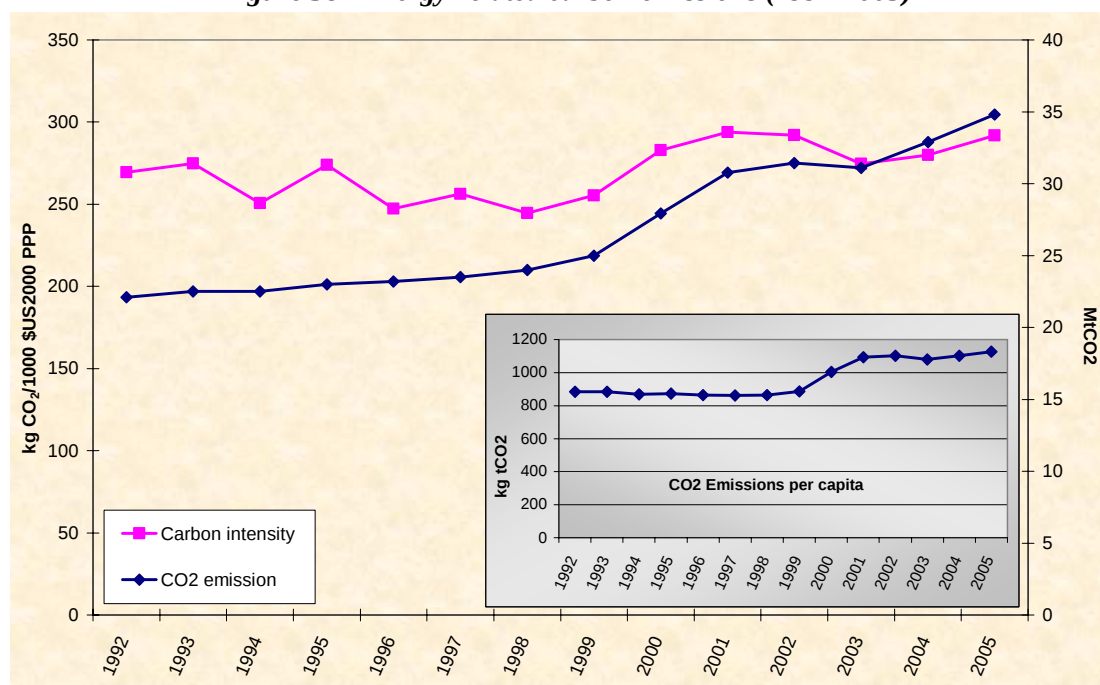
require appropriate solutions, in order to achieve the national strategy and assure the population with a healthy and acceptable life.⁶⁸

In 2005, the main emitters of GHG in Morocco are fuel combustion in the energy sector (35%), in manufacturing and construction industry (18%), in the transport sector (7%) and in the residential sector (11%). Other sectors represent 29% of total emissions.

According to EIA-DOE⁶⁹ sources, petroleum accounts for about 72% of carbon emissions in Morocco, natural gas 5%, coal 20%, hydroelectricity for 2% and net electricity imports 1%. The increasing reliance on RE and natural gas foreseen by the Moroccan government should work to lower carbon emissions.

Energy-related CO₂ emissions in Morocco increased by about 46% in one decade, from less than 18 Mt in 1990 to around 35 Mt in 2005 (4.5% annual average growth), mostly due to increased energy consumption. CO₂ emissions per capita are also increasing, even though they are the lowest than in the North African region. In 2005, Morocco emitted 1.1 tCO₂ per capita (representing an annual average growth rate of 2.6% over the period 1990 - 2005). As illustrated in the Figure 38, CO₂ emission levels are increasing rapidly since 1990, the baseline year for the Kyoto Protocol of the United Nations Framework Convention on Climate Change. It is important to remind that this situation is heavily due to the low access to energy of rural populations and the high share of non-commercial biomass in energy consumption (not taken into consideration in the calculations). One can easily conclude that carbon emissions will continue on their trend or even grow more rapidly, as the population gets access to energy services. As a non-annex I country, however, Morocco is not obligated to curtail its carbon emissions.

Figure 38 Energy-related carbon emissions (1992-2005)



Source: OME

⁶⁸ See detail at: http://www.mdpmaroc.com/English/cdm_nationalstrategy.html

⁶⁹ IEA-DOE The Arab Maghreb Union, June 2005.

In order to participate, consolidate and reinforce the national Sustainable Development policy, Morocco has, fully been engaged in the world effort for GHG emission reduction from the early stages on. It has ratified the Kyoto Protocol (KP) in 2002 and has engaged much effort during the Seventh Conference of Parties (Marrakech 2001) to ensure that the application text and flexibility mechanisms relating to the KP be adopted.

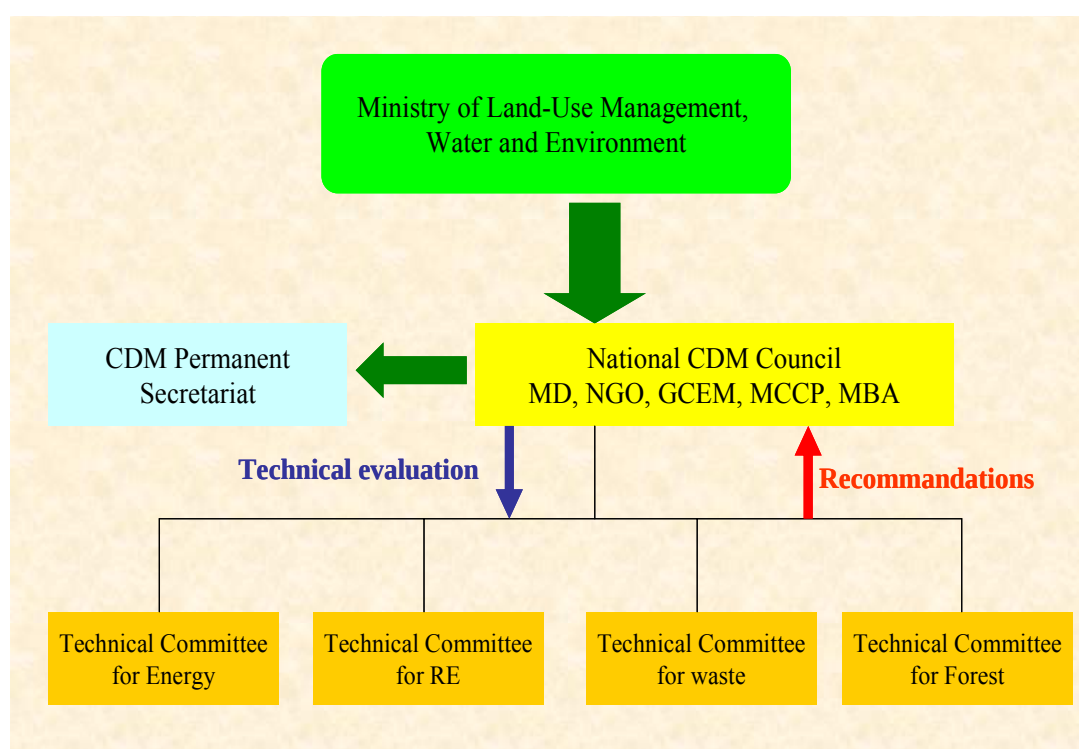
Morocco was also the first country in the North African region to assign a Designated National Authority (DNA), through ministerial order (September, 2002), at the Ministry of Land-Use Management, Water and the Environment (MATEE). The DNA for CDM in Morocco is composed of the following dual-structured unit Figure 39 illustrates the CDM's National Institutional Arrangement in Morocco):

- A *CDM National Council (CDM NC)* that is composed of about twenty high level representatives representing all relevant government departments, as well as associative sector and NGOs. At national level, the council has the following missions:
- the review and assessment of projects submitted to the CDM Designated National Authority by the economic operators for financing within the CDM framework;
- the recommendation of the council to be considered as the justified decision emanating from the CDM DNA;
- the approval of sustainable development criteria and of the modalities to putting them into operation;
- the approval of guidelines and manuals, for the evaluation CDM verification and monitoring CDM projects;
- the encouragement of competent entities to be engaged in highly technical CDM activities:
- Capacity Building, Consulting, and Research and Development activities to the benefit of economic operators; and
- the establishment of an annual report on the activities of CDM Morocco.
- A *Permanent Secretariat of the National Council (CDM PS)* operating at the Climate Change Service/Directorate of Partnership, Communication and Cooperation/MATEE.

At the starting of the process, the CDM DNA functioning budget is largely secured by the MATEE. In the future, the CDM PS will do its best to sustain the DNA through a combination of bilateral and multilateral donations or any other funding sources.

The CDM Designated National Authority has several commitments, of which the key ones are to establish an efficient and transparent CDM national project approval procedure, to evaluate the projects that have been submitted to the authority and to verify, in particular their conformity to the national Sustainable Development criteria, to establish the project approval decision and to authorise the sale or exportation of CERs (Certified Emission Reduction Units).

Figure 39 CDM's National Institutional Arrangement in Morocco



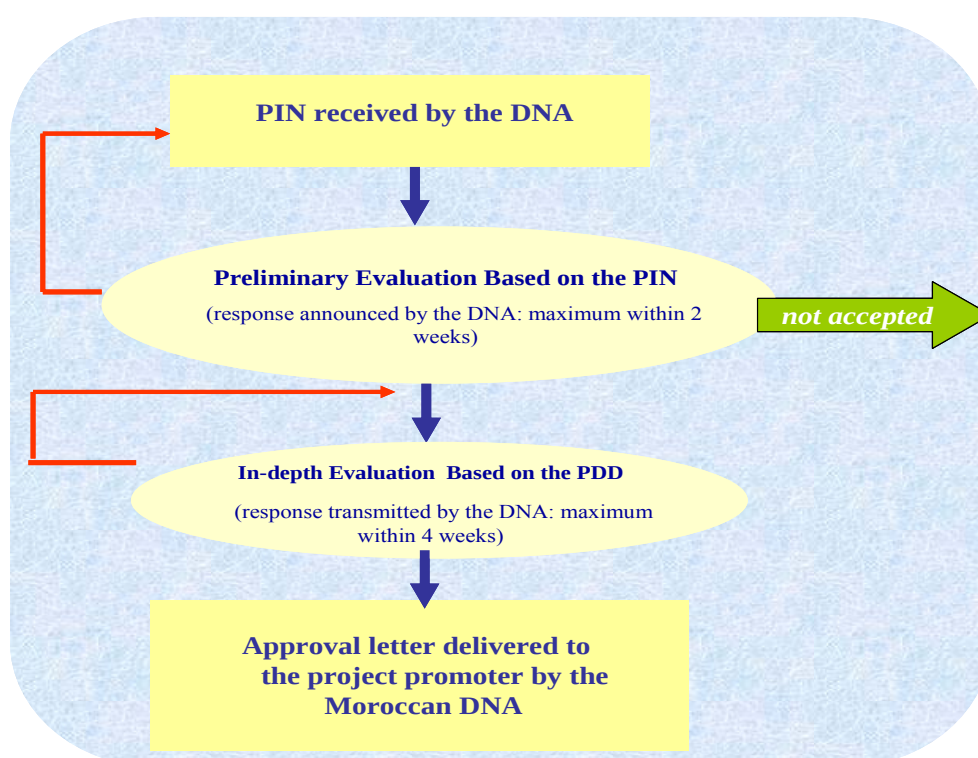
Source: CD4CDM Djerba Seminar, September 2004

In order to ensure an efficient functioning of the CDM Designated National Authority and be in position to attract investors, the Moroccan government has implemented a standard procedure for CDM DNA to assess and approve CDM projects proposals. This procedure is done in two stages: a preliminary project evaluation then a thorough evaluation.

The preliminary evaluation lasts no more than 2 weeks. It examines the Project idea Note submitted by the project promoter. The In-depth Evaluation lasts no more than 4 weeks. At this stage, the CDM DNA reviews the Project Design Document (PDD) submitted by the project promoter. The final objective is to check that the project fulfils the three following conditions: it leads to real and measurable GHG reductions; it conforms to the national SD criteria; and it has no external negative effects. Figure 40 illustrates these Procedures.

The DNA also sets up an excellent website with information on all features related to CDM in Morocco, the national CDM project evaluation and approval process, the CDM Morocco strategy, contacts for potential investors and the projects portfolio of currently 25 CDM projects.

Figure 40 Approval and Evaluation Procedures for CDM projects in Morocco



Source: http://www.mdpmaroc.com/English/projet_evaluation.html

25 projects have been approved by the DNA in 2003-2005: 3 registered projects, 3 projects under validation, 1 project with PDD approved by the DNA and 18 PIN's approval. Most of the projects are RE projects and mainly wind (6 projects totalling 380 MW to be installed). The portfolio clearly indicates the important place the Moroccan government is giving to RE (wind, PV and hydro mainly) and also to energy efficiency.

Morocco already signed Cooperation Agreements for promoting the Clean Development Mechanism (CDM) with France, Austria, Italy and Japan (Japan Bank for International Cooperation). The Cooperation Agreements are aimed at promoting CDM projects in Morocco, with financing provided by the partner Annex I countries and supporting their firms for acquiring emissions credits (Certified Emissions Reductions (CERs) accrued from such projects.

It is also worthwhile to briefly note Morocco's sustainable development criteria. This is very important issue as one of the major criteria for eligibility of CDM project relates to sustainability and how the project addresses the sustainable development concerns of the host country. Indeed a list of criteria and indicators has been used to assess project eligibility to CDM, in conformity with the national Sustainable Development policy. These are:

- The project must be integrated into morocco's main objectives and be a part of the defined priorities in the National Sustainable Development Strategy.
- The project must conform to current country laws and in particular the ones related to the environment and its preservation. It is particularly essential that an environmental impact study be realized in conformity with the national regulations on environmental impact studies.

- The project must use clean and confirmed technologies and avoid any out-dated technologies.

The potential CDM projects have to also demonstrate/assess their contribution to the following criteria:

- Mitigation of global Climate Change.
- Sustainability of the local environment.
- Creation of employment.
- Durability of balance of payments.
- Positive contribution to the macro-economic plan.
- Effect on costs.
- Technology autonomy.
- Sustainable use of natural resources.

3. Integration of renewable energy sources

In a country where energy resources are largely depending of oil imports, the recent increases in oil prices is heavily affecting the Moroccan government's budget as well as the economic growth. Thanks to its strategic location, Morocco's geographical situation offers a variety of renewable energy sources that the government is committed to optimize in order to increase its contribution to the energy mix from 4% to 10% in 2012.

Morocco aims to become a regional hub for electricity transfers, thanks to its program of interconnection with Spain and Algeria. As the required investments in these projects are usually higher than the conventional hydrocarbon resources, the government opted for the BOT concession mode. Morocco represents considerable opportunities for companies in equipment, technology and services related to RE development.

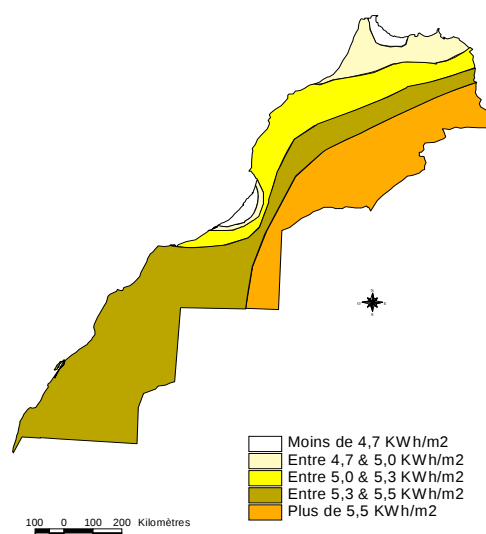
Morocco has one of the greatest endowments of solar energy resources in the world. It is also endowed with important wind resources. This section describes the RE resources and potential, the current RE situation and the institutional/legislative framework in the country.

3.1. *Renewable energy resources and potential*

Solar

Morocco has a significant solar potential. The annual average solar radiation over the country ranges from about 2800 hours to 3400 hours, respectively in the northern and southern parts of the country. Solar radiation reaches between 4.7 and 5.6 kWh/day (horizontal plan).

Figure 41 Solar Atlas in Morocco



Source: CDER

Wind

To evaluate wind potential in Morocco, an important measurement program was launched since 1991. The objective of this program is to determine windy areas and to evaluate their potential. The first phase of the program (1991-1994) concerned the evaluation the potential of the Moroccan Atlantic coast (about 3500 km). The second one (1995-2000) concerned the north east of Morocco and the south regions. The activities were carried out between 1991 and 2000 within the framework of the GTZ TERNA Wind Energy Programme⁷⁰. The third phase (2001-2010) is ongoing and concerns the Atlas and Rif mountains. Wind data gathered until now are being updated yearly in a document titled “Moroccan Atlas of wind Energy”.

The wind cartography of Morocco was launched in March 2002 by CDER. The objective of this work is to establish a detailed geographic info system for wind in Morocco. Also, the Sahara Wind Project has also conducted wind surveys and investigated the possibility of erecting a high-voltage power transmission line between Morocco and Western Europe⁷¹.

Wind energy potential is estimated at 6,000MW capacity (global power capacity of 5,000 MW), notably in the areas around Tangiers-Tétouan where wind velocity ranges between 8 and 11m/s. The evaluations for the Tétouan region near Tangiers showed locations with mean wind velocities of 11.5 m/s, thus placing them among the best locations in the world. This potential would translate into a power production of 17,000GWh/year⁷². Figure 42 presents the wind atlas in Morocco and Figure 43 illustrates wind forecasts by Windfinder⁷³ for the 15 June 2007.

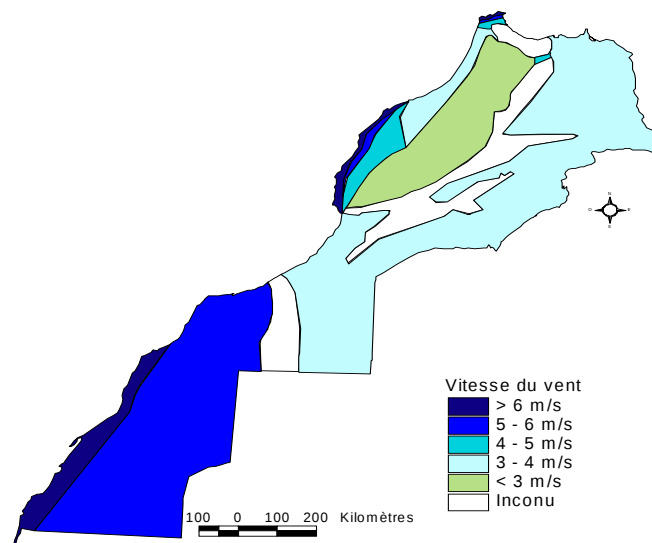
⁷⁰ See www.gtz.de/wind

⁷¹ for more information, see www.saharawind.com

⁷² Med 2010. Final Publishable Report.

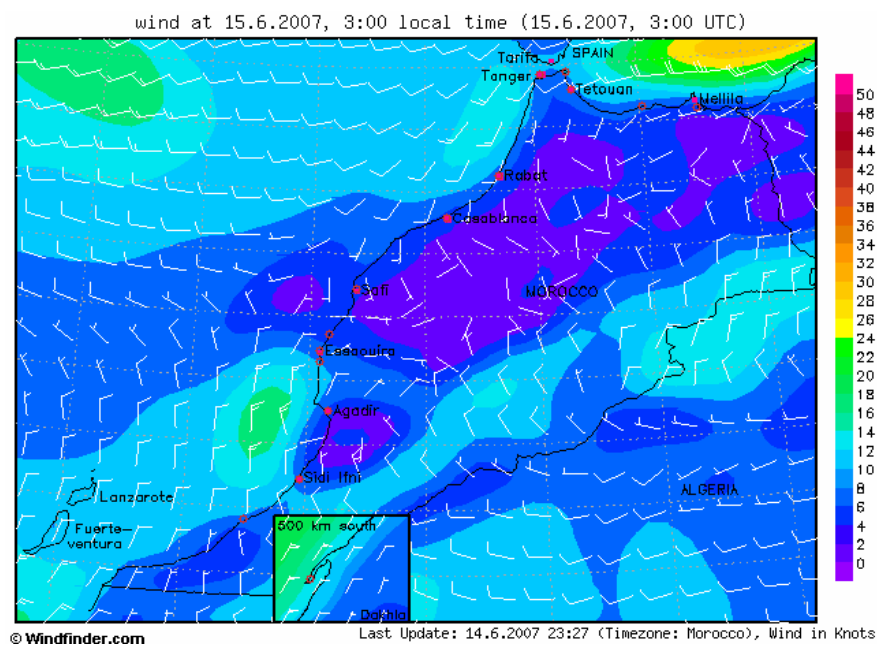
⁷³ www.windfinder.com

Figure 42 Wind Atlas in Morocco



Source: CDER

Figure 43 Wind forecasts in Morocco (as for 15 June 2007)



Hydropower

Morocco's technically exploitable hydroelectric power potential is estimated at 2,500 MW. It is most notably in the category of small hydro that Morocco has large potential. According to the "Strategic National Plan for the Development of RES", the country possesses a significant potential for mini-hydro systems of over 200 sites which the government intends to exploit.

Biogas

According to CDER, urban domestic wastes (estimated at 8000 tons per day) constitute important potential reserves of organic recyclable and biodegradable matter. A potential production of 584 million m³ of biogas per year is achievable (that is, 299.52 toe per year). Potential of biogas production from sewage water is estimated at 92 million m³ per year (47.2 toe /year) while that from animal waste at 320 million m³/year (165 toe/year).

Geothermal Energy

Morocco's geothermal potential is still largely unexplored. The country's geothermal resources are confined to the north-eastern region and parts of the Sahara. The resources are relatively minor in magnitude but, according to the International Geothermal Association (IGA), could be used for heating purposes.

Biomass

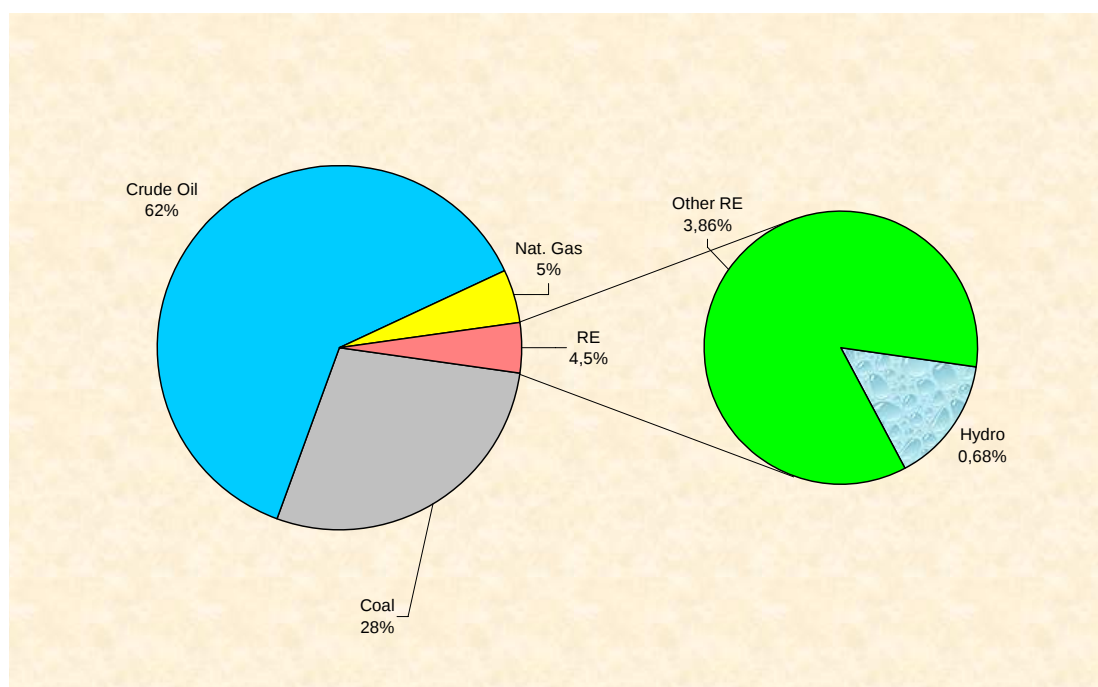
Nearly one third of Morocco's total energy requirement is met by biomass, mostly by traditional means, i.e. the use of biomass in the form of fuel wood or charcoal for heating and cooking purposes. Morocco has approximately 5 million hectares of forested area. The country's rapid consumption of wood as a source of energy (about 11 million tons annually) is not indefinitely sustainable. Indeed, the country is losing more than 30,000 hectares of forest each year. The Government of Morocco is therefore promoting the introduction of technologies for the efficient use of fuel wood and for its substitution by other energy sources.

3.2. Current renewable energy situation

Contribution of RE to the energy balance

All of the Northern African countries, Morocco is the country that has done the most to develop its RE sources for access of its population to energy. Indeed, RE sources represent 25% of TPES (when including non-commercial biomass) which is very high in comparison to other countries in the region. However, excluding non-commercial biomass and large hydro, RE sources represent 4% of TPES. Figure 44 illustrates the structure of TPES in Morocco in 2003.

Figure 44 Share of RE in total primary energy consumption in Morocco (2005)



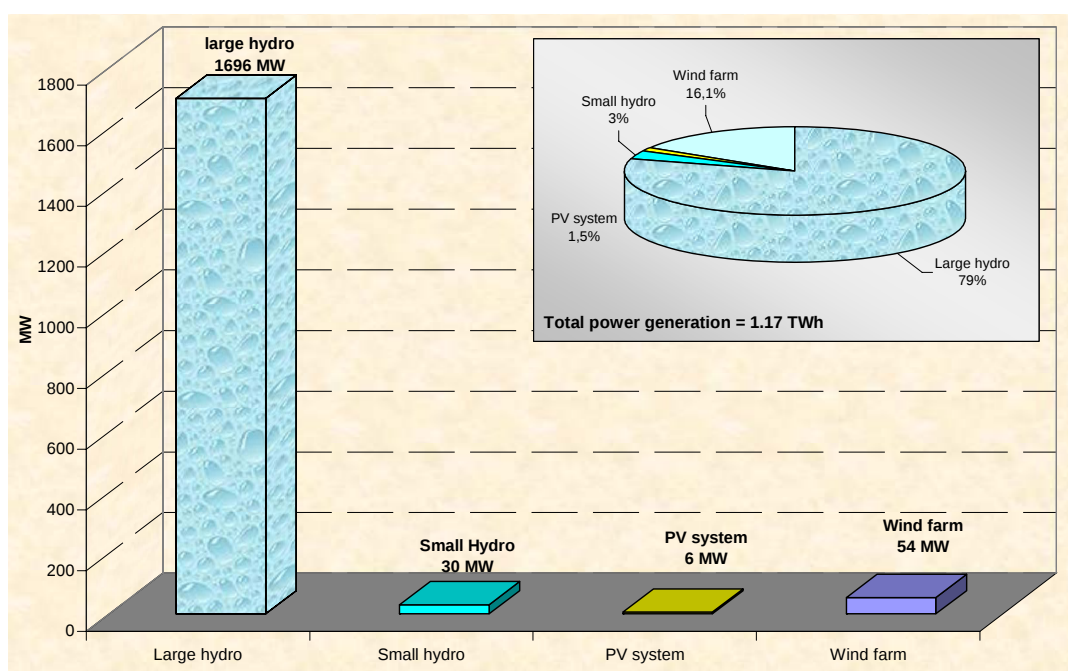
Source: OME based on questionnaires to CDER

Contribution of RE to power installed capacity and generation

In 2005, total RE-based power installed capacity reached 2,929 MW, more than 93.7% of which being large hydro. The rest is composed by 30 MW small hydro (1.2%), 54 MW wind farms (5%), and 6 MW PV applications (0.1%). This RE capacity represented 17.5% of total power installed capacity (Figure 45). The total RE-based power generation was 1.17 TWh in 2006, representing around 5% of total power generation for the same year.

It should be noted that a new 60 MW wind farm in Essaouira built by Gamesa (Spain) was inaugurated in April 2007. This brings total wind capacity in Morocco to 114 MW. Several other renewable energy projects in the CDM pipeline should bring up the share of RES in the coming years.

Figure 45 RE-based power capacity and generation in Morocco (2005)



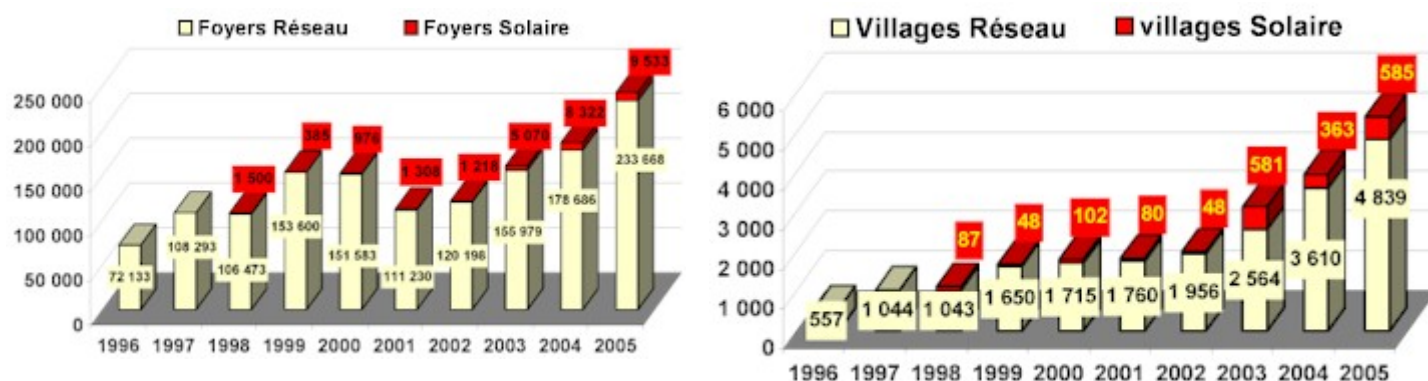
Source: OME, based on questionnaires to CDER

In the following, details are given regarding Moroccan RE situation by source.

Solar

PV systems

Solar PV systems have been introduced since the late 1980s in the context of rural electrification and water pumping programs. In fact, in the context of the PERG (Rural Electrification Global Plan launched by 1996), the ONE (Office National d'Electricité/ National Electricity Company) had chosen to use the country's solar potential to electrify villages where the connection to the grid was prohibitively expensive. Several programs have contributed to the PV electrification in Morocco. By the end of 2005, around 29312 households have had access to electricity thanks to PV systems. Total current installed PV capacity is evaluated at 7 MW⁷⁴:

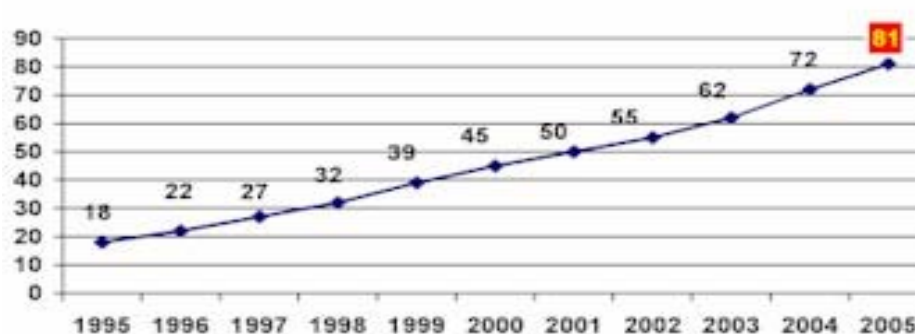


⁷⁴ Based on OME Study Medsupply June 2003, Chapter 4.1. Renewable Energy Sources in selected Southern and Eastern Mediterranean Countries: Status, Prospects, Barriers and Opportunities and update information from CDER and ONE.

- SAER was implemented in collaboration with the German Agency for Technical Cooperation (GTZ) was initiated in the province of Kénitra (1989-1992). It was the detonator of PV solar Kits demand for lighting and TV in rural area. The originality of the approach allowed the equipment of more than 400 households and the implementation of projects beneficiary associations. Thanks to flexible credit and repayment systems, managers achieved a financial flow allowing them to equip other households.
- PPER was implemented in collaboration with French co-operation (1990-1994). The PPER provided for the equipment, by RE in general and solar PV in particular, of 240 villages of three provinces: Azilal, Errachidia and Safi. The specificity of each province concerned makes this realization a project representative of the Moroccan rural context. The program equipped a total of 15,000 households. This was achieved with technical solutions based on RES: individual solar (Kits), collective solar (house of batteries refill) and micro-network (power generating units and MCH).
- VILLAGE POWER Programme: carried out within the framework of the Morocco-Spanish co-operation, this project concerned the equipment of 500 households. The adopted approach for this project is the traditional approach. The equipment was provided in the form of donation; Installation, and maintenance costs are in the charge of users.
- The Global Rural Electrification Program⁷⁵ (PERG): based on the experience of the previous programs, the national PERG was launched in 1996 to electrify rural households for whom connection to the grid fell below 10,000 Dh. The use of individual PV kits was selected for villages where population is low and scattered, with the objective of electrifying 150,000 rural households and to reach a total electrification rate of 98% by 2007. By the end of 2005, 22632 villages were supplied with electricity since the inception of PERG in 1996 giving access to 1.42 millions households. In 2005, the PERG recorded 4,839 villages connected to the grid and 585 villages equipped with PV systems, corresponding to access of electricity of 243,201 households (of which 9532 with PV systems and the rest with connections to the network). The rural electrification rate thus raised from 18% in 1995 to 81% by late 2005 (Figure 46). For 2006, ONE intends to bring this rate to 89%. More recently, the ONE and the European Investment Bank (EIB) signed on 14 December a further loan for rural electrification. The 20-year loan, worth 170 M€ (222 MUS\$), falls within the fourth section of the utility's *Programme d'Electrification Rurale Globale (PERG/phase 2)*. According to ONE, the money will help it electrify 2,596 villages across 51 provinces and benefit more than 708,000 people. The project includes the installation of pre-payment meters in over a million homes throughout Morocco, as well as a regional electrical network control system and a new power transmission line study. According to ONE, the pre-payment meters (increasingly popular across Africa) will enable customers to match their power consumption with their income.
- PER/private sector (2001-2005): Within the framework of the efforts made by ONE in the field of decentralized rural electrification, a strategy based on an effective partnership with the private sector, the communes and villages associations was adopted. This approach is in conformity with the approach of the PERG which is based on the participation not only in the financial aspects but also in the implementation process.

⁷⁵ Programme d'électrification rurale globale (PERG).

Figure 46 *Trend in the electrification rate in Morocco (1995-2005)*



Source: ONE

Solar thermal

Solar water heaters

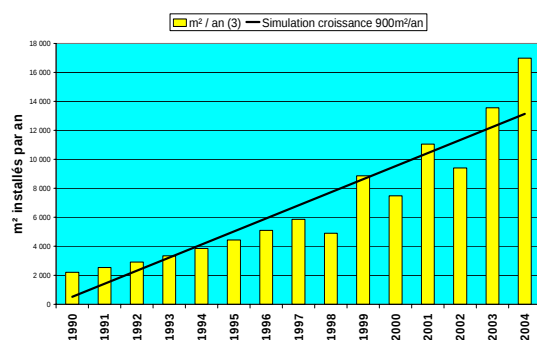
A national solar water heater (SWH) programme called PROMASOL was launched in November 2000 which intervenes at different levels to improve product quality and encourage the use of SWHs. The global objective of this program is to increase the actual installed capacity (60,000 m²) to about 400,000 m².

In addition to some supporting actions concerning the restructuring of the private sector, the equipments quality control and the training of a skilled personnel, PROMASOL is a development project that aims at promoting the use of RE in Morocco by implementing appropriate financial mechanisms especially, the development of a local market for solar water heating systems. Three financial support mechanisms have been implemented. The first one, ICP (Insurance commercial partnership) promotes the diffusion of SWH in the Moroccan market by supporting partnerships between SWH suppliers (either manufacturers or importers) and distributors. The second one SSE (Subsidizing solar equipment) aims to bring a financial support for the implementation of an industrial investment relating to the manufacturing of SWH. The third one is the leasing. It is a financing operation under a particular leasing form between the financial backer (equipment owner) and the lease holder (end-user). The leaseholder can get the option of owning the equipment by the end of the contract. Its main objectives are:

- To make Moroccan leasing agencies interested in RE markets.
- To orient NGO's to micro-leasing instead of micro-finance in the different RE markets;
- To encourage the business leasing to manufacturers/distributors of SWH.
- To set up a professional financial instrument that would allow CDER to continue and advance its experience in developing the field of RE.

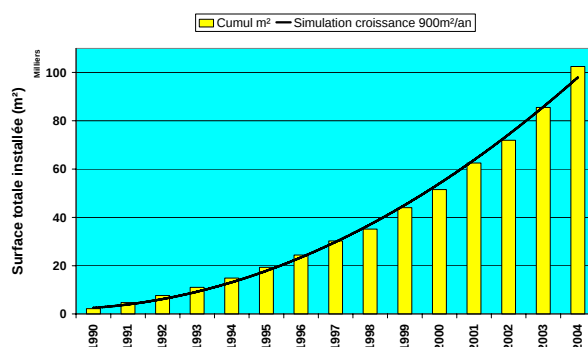
In addition, in the framework of MEDREP and with the involvement of the Office National de l'Electricité (ONE) and the United Nations Environment Programme, Division of Technology, Industry and Economics (UNEP/DTIE), financial tools for Solar Water Heating are being further developed, with specific regard to a loan facility developed for the Hotel sector. The facility is intended to help local financial institutions build SWH loan and leasing portfolios by subsidizing the interest rate for these loans, using ONE as a channel for recovering the monthly payments through the customer's utility bill. Figure 47 and Figure 48 illustrate respectively the annual and cumulative installed capacity of SWH in Morocco.

Figure 47 SWH annual installed capacity in Morocco



Source: A. Bennouna, 2006

Figure 48 SWH cumulative installed capacity in Morocco



Solar thermal plants

Morocco has considered the installation of solar thermal plants. A potential project to build a 50 MW solar power plant in the south at Ouarzazate Province has been postponed, while a hybrid solar thermal (10% solar) plant at Ain Beni Mathar (South of Oujda), initially conceived for a capacity of 250 MW, has been carried to 472 MW in order to meet strong growth in domestic electricity demand and optimize the growth of natural gas transiting the country (ie, royalties from the Maghreb-Europe gas pipeline) which should feed this project. The completion of the power plant project is planned for 2009 and should consist of a unit based on solar energy (solar field will cover a surface of approximately 200,000 m²) and a combined cycle unit.

According to an international call for tender process, ONE (Office National de l'Electricité) entrusted the realization of this project to the Spanish company ABENGOA. The Financing of this project will be ensured by the African Bank of Development, the contribution of the GEF as well as other sources of financing, a complement being ensured by the own capital stocks of the ONE.

ONE and the World Bank, acting as agency of execution of the Global Environment Facility (GEF), signed on April 20th, 2007 in Rabat in the headquarter of this institution, a \$43,2 million financing by donation agreement from the GEF intended for the partial financing of the project.

The project⁷⁶ seeks to extend electric power generation facilities and develop renewable forms of energy. The specific objectives are to contribute to ensuring steady supply of electricity to the country, diversifying energy sources and reducing greenhouse gas emissions.

The project is in line with the ONE low cost equipment plan to match supply with demand for energy by 2009. It will help to: (i) promote RE and diversify energy resources for the generation of electricity in Morocco; (ii) master solar thermal technology with the aim of reducing the cost of a kWh in the medium and long terms; (iii) reduce greenhouse gas emissions through the use of solar energy and natural gas; and (iv) enable the ONE to save on the cost of fuel used to generate electricity in its thermal power stations.

This project contributes to poverty reduction, through its connection to the national grid, guaranteeing steady electricity supply to urban centres, urban-rural fringes and rural areas

⁷⁶ Project information based on AfDB Report on The Ain Beni Mathar Solar Thermal Power Station Project: Appraisal report, September 2004, *op. cited*.

thus facilitating access to electricity for hitherto marginalized social classes and reducing the gap between some areas.

Wind

In 2005, 188 000 MWh electricity has been generated two wind farms in operation (totalling 54 MW) in the north of the country, representing 1% of total electricity demand in Morocco; these are (see table 20).

Table 20 *Wind farm installed capacity in Morocco at the end of 2005 (in MW)*

	Capacity/production	Commissioning date
Existing		
Koudia Al Baïda	50 MW (200 GWh/year)	August 2000
Abdelkhalek Torres	3.5 MW (15 GWh/year)	October 2000
TOTAL	53.5 MW (215 GWh/year)	

Source: ONE

- The Abdelkhaled Torres wind farm: 3.5 MW-capacity, initiated by ONE as a first pilot project. It was erected at the Al Koudia Al Baïda site (Tlat Taghramt in Tétouan Province, 40 km east of Tangier) in late 2000 at a cost of approximately 6 million euros. The Kreditanstalt für Wiederaufbau (KfW) provided a low-interest loan of 4.35 million euros for this scheme with German turbine technology (Enercon). The wind farm is being operated by ONE.
- The Koudia Al Baida Wind farm (50 MW-capacity): it is located on Morocco's northern coast, in the tip of Africa, across the Strait of Gibraltar 20 kilometers away from Europe's Spanish peninsula (next to the city of Tetouan). It was commissioned in August 2000 with the help of a 24.4 million euros loan from the European Investment Bank. The cost of generating the electricity was calculated at 0.40 to 0.60 DH⁷⁷/kWh (3.7 to 5.5 € cents/kWh). 84 wind turbines from Vestas, each rated at 600 kW, were erected by Compagnie Eolienne de Détroit (CED) for approximately 45.7 million euros. This scheme is a purely private project based on a BOT contract with ONE, to the ownership of which the wind farm will be transferred after 20 years.

The wind generated electricity is currently being produced by some 90 Wind Turbines of the 600 kW range. If this production was to be supplied by a Coal fired power plant, some 230000 Tons of Carbon Dioxide would have been released in the atmosphere. To sequesterate this amount of carbon, the planting of over 12 million trees would have been necessary⁷⁸. As for the natural habitat, large corridors have been provided for migratory birds to pass through. Statistical surveys have now revealed that the impact of the wind turbines on the local environment has been negligible.

⁷⁷ DH: Dirhams (national currency). As for 30 June 2005, 100 DH = 9.15 €

⁷⁸ CDER, 2004

Table 21 Wind farm installed capacity in Morocco (in MW)

	Capacity /production	Commissioning date
Existing		
Koudia Al Baïda (Tetouan)	50 MW (200 GWh/yr)	August 2000
Abdelkhalek Torres (Tetouan)	3.5 MW (15 GWh/yr)	October 2000
Sidi Kaouki (Essaouira)	0,05M MW	2000
Moulay Bouzerktoume	0,015 MW	2000
Ouassen	0,007 MW	2000
Lamdint/Taroudant	0,06 MW	2002
Essaouira (Amogdoul)	60 MW (200 GWh/yr)	April 2007
TOTAL	113 MW	

Source: ONE

- The Essaouira Wind farm 'Amogdoul': ONE proceeded on Friday, April 13th, 2007 to the inauguration of the Wind Park "Amogdoul". The wind farm is situated on Cap Sim, at 15 km in the South of Essaouira city. It consists of 71 generators with 60 MW total capacity and an average annual productivity of 200 GWh, the "Amogdoul" wind farm will allow the reinforcement of the production means of wind origin and the interconnection network of the Essaouira region. The Park was achieved within 18 months. Its realization by the company Gamesa was entrusted following an international call to competition. This project benefited from a financing of the German bank KfW. It integrates the framework of the Clean Development Mechanism (MDP), according to the policy of greenhouse gas emissions reduction. On the environmental level, this project will allow a saving of 48000 tons of fuel, thereby contributing to a reduction of greenhouse gas emission of 156 000 t of CO₂ per year.

Many projects have been launched by the ONE to be commissioned by 2007 and 2008. In addition to the completed 60 MW Essaouira wind farm, there are plans for a 140 MW (Tangiers) and 60 MW (Tarfaya) wind farms. Also, another 100 MW project in Taza is under study (see Table 22). It should be noted that the ONE has launched a vast program of wind farms "Initiative 1000 MW". Morocco, thus, confirms its ambition to reach the objective of 12% of renewable energies in its energy balance before 2012.

Table 22 Most recent wind farm developments

Location	Status	Cap (MW)	Start-up	Company
Essaouira	completed	60	Apr. 2007	by Gamesa (Spain)
Tanger	project	140	under way	
Tarfaya	project	60	under tendering	
Taza	project	100	under study	

Decentralised exploitation of wind energy

To some extent, wind energy is also being exploited for the purposes of distributed rural electrification. For example, a pair of 25 kW wind energy conversion systems and a 15 kW unit were recently installed in the province of Essaouira. Together, those systems are supposed to generate enough electricity for 123 households. According to CDER, Morocco presently has some 300 off-grid wind power plants and roughly 5,000 wind-driven pumps. In addition, technical-economic studies for decentralised wind power projects have been finalised by the ONE and relate to 9 villages located in Essaouira and Agadir Ida Outanane.

Wind energy is also being exploited for water desalination purposes. In this respect, with support from IMET, CDER and ONEP are undertaking a pilot project located near Akfennir village. The volume of desalinated water amounts to 314,000 m³/year (860m³/day). The total cost of the project is 4.1 M€. The project is expected to be operational by July 2008.

Hydropower

Total hydro capacity amounted to 1,729 MW in 2005. Small hydro total capacity reached 30 MW. This park is relatively old, pointing to the fact that few projects have been realised in recent years.

Morocco is also interested in developing decentralised small hydropower projects for isolated areas. Two recent projects (Askaw and Oum Rbaï) have been realised in 2002 and 2004, respectively:

- The Askaw power plant has a total installed capacity of 200 kW and is supplying 30 villages, representing 593 households.
- The Oum-Rbaï power plant has a total installed capacity of 220 kW and is supplying 18 villages, representing 556 households and administrative buildings

The ONE launched 2 important projects for the hydropower sector development:

1. *Remote management and rehabilitation of hydroelectric power plants*: the purpose of this project is remote management of all the hydroelectric plants of the Office from two management centers, one in Fez, another in Afourer and one sub-center in at the Al Massira plant. This will enable an economic gain via the reduction of running costs and increasing performance. The project consists of renovating and modernizing the equipment, making automatic control of units, auxiliaries and plants, provide remote transmission of data to the remote management centers and the establishment of a security system (date of commissioning: 2006).
2. *Hydro electrical complex of Tanafnit El Borj (40 MW – 932 M dhs)*: The investment for the development of this hydroelectric complex is funded by the KFW. Located in the province of Khenifra, this complex includes two hydroelectric installations : hydroelectric installation of Tanafnit (located 30 km to the northeast of the city of Khenifra, this installation benefits from substantial natural regularization thanks to the sources of river Oum Errabia which feeds into it with particularly regular minimum flows. With an installed power of 2 x 9 MW, the Tanafnit system consists of putting through a turbine of the flows of this source and restitution them just upstream of the hydroelectric facility of El Borj.) and hydroelectric installation of El Borj Located just downstream of the restitution of the Tanafnit project and 12 km from the city of Khenifra, the El Borj installation putting through a turbine the water flows of Oum Er

Rbia, modulated by the Tanafnit hydroelectric facility and restituting the same upstream of the junction of the river Amassine. The installed power of the El Borj facility is of 2 x 11 MW (date of commissioning: 2008).

Biomass

Woodfuel

Biomass consumption accounts for an important share of Moroccan energy consumption (34%), representing a major deforestation problem (30,000 hectares annually). It is estimated that about 50% of the population using fuelwood collects it from neighbouring forests (in the vicinity of 10 km) while the other 50% buys the wood for about 0.8 Dh/kg with an average monthly consumption of about 50 kg/household.

In order to improve the use of fuelwood, programmes have focus on fuel switching and energy efficiency. These include⁷⁹:

- Dissemination of small agricultural Bio-Digestors for producing Biogaz. Since the 1983 more than 350 units were installed in different regions of country for example, a CDER/GTZ cooperation program introduced more than 100 Biogaz digestors in the pilot region of Souss Massa to encourage this technique and reduce thermal deforestation.
- Dissemination of fuel wood saving stoves for cooking and heating in rural zones and encouragement to consume gas. For example, a CDER/GTZ cooperation program in the late 1990s introduced cooking stoves to 6,000 rural households to reduce thermal losses and deforestation.
- Promoting the use of wood energy-saving technologies for urban and rural hammams, through training, supervision, awareness-raising, informative and incentive measures to save neighbouring forests. The new technologies can reach a 78% efficiency rate.

In Mars 2003, a contract was signed between the Moroccan Ministry of Energy and Mines and the Agence Française de Développement and the Fonds Français pour l'Environnement Mondial (AFD/FFEM) and the Forest Department of Morocco concerning the implementation of a national program for wood saving in rural and urban areas

The main objective of this program for which CDER was nominated as the Executive Agency is to develop, promote and disseminate hundreds of improved systems (cooking stoves and boilers for urban hammams).

Waste

A pilot biogas station using sewage waters in Agadir to produce methane have been installed in collaboration with GTZ⁸⁰. Other projects are under study.

⁷⁹ Mohamed Berdai, 2004.

⁸⁰ CDM in the framework of RES, Gesellschaft für Technische Zusammenarbeit (GTZ) .

3.3. Institutional and legislative framework

Main actors

Centre de Développement des Energies Renouvelables (CDER)

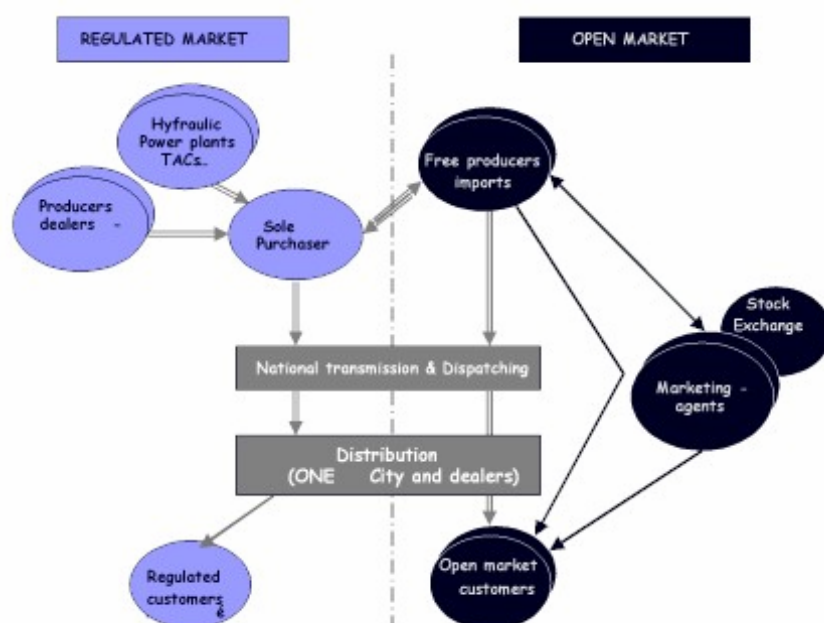
The creation of the Centre for the Development of RES (CDER) in 1982 was a milestone in the integration of RES in national policy. The CDER is in charge of RES-based decentralised rural electrification, independent power production (wind, PV and thermal), energy saving, resource assessments and firewood demand management.

Office National de l'Electricité (ONE)

Morocco's electrical sector has traditionally been the responsibility of the state-owned Office national de l'Electricité. ONE was reorganised in 1995, after which it regained profitability. Power shortages and a desire to control public spending have led the Moroccan government to make more use of the private sector to meet the country's power needs. The increasing commonness of these arrangements is expected to cause the state's share of electricity generation to decline to 40% by 2020. Part of the electricity sector is expected to be liberalized by 2005, though ONE has said there will be two systems, one regulated and one free. ONE will continue to be solely responsible for distribution and transmission.

As for the electricity sector, the future organization of the sector, next to the regulated market, will include an open electricity market. Figure 49 illustrates the projected sector organisation.

Figure 49 Projected sector organisation



Source: ONE

In the field of RE sources, ONE is most active in the areas of hydropower (owning all hydroelectric power plants) and wind energy (one 3.5 MW wind farm). The construction of new hydropower plants and wind farms is planned. ONE is also responsible for the supply of approximately 50% of all electricity produced in Morocco. Local power providers supply the other half.

Compagnie Eolienne de Détroit (CED)

Compagnie Eolienne de Détroit (CED) owns and operates a 50MW wind farm. CED is owned by Electricité de France (EDF, 49%), Paribas Merchant Bank (35.5%) and Germa Consulting (the initiator of the project; 15.5%).

Morocco has a number of small-and medium-size enterprises populating the solar energy sector. According to the Moroccan solar industry's association (Association Marocaine des Industries Solaires, AMISOL), some 20 companies assemble simple PV systems from bought-in imported components. There are also several companies that import complete solar systems and sell them on the Moroccan market.

Solar enterprises

The leading solar enterprise in Morocco is Afrisol SA. Established in 1987, Afrisol sells American-made Solarex solar energy systems. Since 1998 Afrisol has been operating in the Maghreb/West Africa region and other African countries as Solarex's master distributor.

Afrisol is implementing a solar project with a financial volume of US\$1,000,000 for the Photovoltaic Market Transformation Initiative (PVMTI). Afrisol is also planning to build a factory for solar modules in the vicinity of Tangier sometime within the next few years. Other major solar enterprises in Morocco include SunLight Power Maroc (SPM), Noor Web (also involved in PVMTI) and Total Energie Maroc.

Maisons de l'Energie

The Government of Morocco recently began promoting the establishment of 'Maisons de l'Energie et de l'Environnement'. These 'Houses' are small, rural enterprises that help local residents plan their own energy supplies.

CDER and the United Nations Development Programme (UNDP) provide technical and financial assistance in the setting up of these enterprises. Some 200 such enterprises had been established.

Regulatory and legislative framework

Morocco, through to two promulgated laws (1994 and 1996) has substantially reduced (to 2.5%) its import duties on certain components for use in harnessing RE sources. No other tax incentives or remissions are planned for the time being.

As regards normalisation, a technical Committee for Normalisation has been set up by the Energy Direction. It concentrates on norms and technical specifications of solar water heating systems and PV systems.

Capacity building activities for managers and technicians and the R&D in the field of RE are ensured by the CDER, but especially by universities (Schools of engineers, Schools for Technology and Institutes for Applied Technology, Faculty of Science). These activities miss however coordination and of orientation in direction of the market's needs. Also, the CDER plays the role of information centre. But other governmental institutions such as CIEDE or NGO's such as GERERE ensure a similar role.

As already mentioned, policy promoting RE development in Morocco is defined by the Moroccan Ministry for Energy and Mines. In 2001, the government defined the energy policy guidelines for the promotion of RE sources in Morocco in the National Strategy Plan for the Development of Renewable Energy Sources⁸¹. The general objective is to increase the consumption of RES so as to diminish energy import dependency from the current 97 to 80%, thereby promoting the use of indigenous resources, completing the electrification of rural areas, creating new jobs, and lowering the country's CO₂ emissions. More specifically, the plan sets broad guidelines that should be conducive to the promotion of RES and aims to introduce the following measures:

- The establishment of a global guarantee investment fund related to clean energy sources.
- The increase in funds provided to the CDER.
- The elaboration of an incentive structure promoting the use of RES (specifically through tax reduction or exemption).
- The introduction of a favourable tariff structure for electricity produced from RES.
- The encouragement of private investment.
- Drawing up a framework appropriate for the development of cogeneration and independent power production from wind resources.

Among measures supporting the realisation of the government objectives, the CDER proposes more specifically, the implementation of incentives to the creation of energy service companies (ESCOs), tax provisions and government support to promote distributed generation. However, this is not yet taken into consideration.

As already mentioned, another important aspect to underline relates to the Government's plan to further liberalise the energy sector and in particular the electricity market in the years to come. In this context, ONE is to be unbundled into independent enterprises responsible for the generation, transmission and distribution of electricity.

Generally, the major obstacle to further development of RE relates to the fact that Morocco still lacks a strong and adapted institutional framework in its favour such as a power feed in law, for example. As in most Southern Mediterranean countries, Morocco does not have a regulatory framework prescribing a legal obligation to purchase and pay for electricity generated from RE sources. The prices for electricity from privately operated power plants (for example from the Al Koudia wind farm) are negotiated between ONE and the respective operator as ONE's contract partner. In such contracts, ONE pledges to purchase all electricity produced by the power plant in question.

4. Barriers, priorities and targets of renewable energies

4.1. Barriers to renewable energy development

Besides the barriers highlighted in the regional overview, the followings are in addition specific to Morocco:

Taxation: the operators complain that the VAT paid on solar equipment statement is 20%, whereas conventional electricity is taxed only to 7%.

Financial: financial barriers are very important and numerous. In addition to the fact that economics of RE technologies most often suffer from an unfavourable competitive position due to large energy subsidies in the market, barriers include in particular the lack of:

- Direct financial incentive for both users and investors in RE;
- Preferential and attractive interest rate allocated to the grants for the purchase of RE equipments. The interest rates used are the common interest rate allocated for consumer credits;
- The lack of a specific line of financing is an important obstacle, in particular for the urban SWH market. There is no guarantee fund for investors.

Institutional: these barriers include in particular:

- National energy planning does not really take into account of the potential for RE.
- The certification and the quality control of the products and services provided to the users are not assured. The CDER is not requested to test the equipment, whereas it is equipped to ensure this mission.
- The awareness raise of decision makers and dissemination of information to operators and users are insufficient.
- Absence in universities and professional training centres of specific courses on RE training of technicians and managers which the market needs.

4.2. Priorities and targets for renewable energies

In November 2006, the Moroccan government launched a national debate on energy in the country following which a National Plan for the Development of Renewable Energy and Energy Efficiency (NPDREEE) has been adopted for the period 2007-2012. The objectives set up by the NPDREEE are to reach by 2012 a contribution of RE up to 10% of the TPES and 20% of the electricity generation. Figure 11 illustrates the related structure of the TPES in the country by 2012.

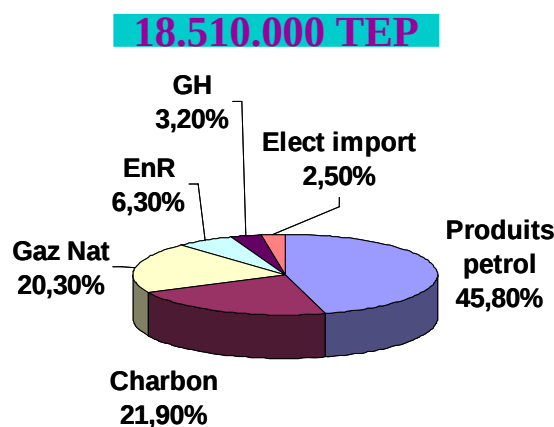
- **Electrification program:** implementation of the wind program (50 MW operational, 280 MW to be launched shortly -potential CDM projects- and 350 MW in preparation), construction of a combined cycle solar thermal power plant (solar fraction: 30 MW, scheduled for 2008), expanding the use of biomass to an order of 50 MW and promoting cogeneration. The perspective of the Moroccan energy strategy is to produce in 2012, 20% of electricity consumption from RE with a large contribution of wind farms by implementing about 1000 MW in windy sites.

- **Decentralised rural electrification program:** Continuation of the decentralised rural electrification (DRE) component of the PERG (150,000 households). In total, the potential market for the next 5 years is estimated at 10 MW PV for decentralised rural electrification. It is expected that the potential demand for PV systems will be satisfied by mobilising private service operators who will operate on a “fee for service” basis on behalf of the ONE. The service providers are required to provide maintenance for 10 years though the users will pay for it (US \$5-10 per month and per family).

The growth in PV systems is expected to increase for the following two reasons:

- The important efforts introduced in promoting RES (and mostly solar). In fact, many arrangements have been taken by the government to encourage and to promote the wide use of this technology (tax and duties deduction, establishment of credit structures, etc). For example, households can receive a subsidy of 4500DH.
 - The increase in international investment in the sector through cooperation schemes, such as with German Kreditanstalt für Wiederaufbau (KfW) and the EU.
- **Energy efficiency:** program for improvement of energy consumption in the residential sector (PROMASOL Program aiming at the installation of 400,000 m² of SWH), the industry sector (an annual saving of 360,000 Mtoe), the commercial sector (a saving of 150,000 Mtoe) and the transport sector, and programs for improvement of the energy efficiency of the furnaces and hammams (3000 units), furnaces of potters (400 units) and improved hearths (1,000,000 units).
 - **Energy house:** creation of 1000 energy services micro-companies for rural populations.

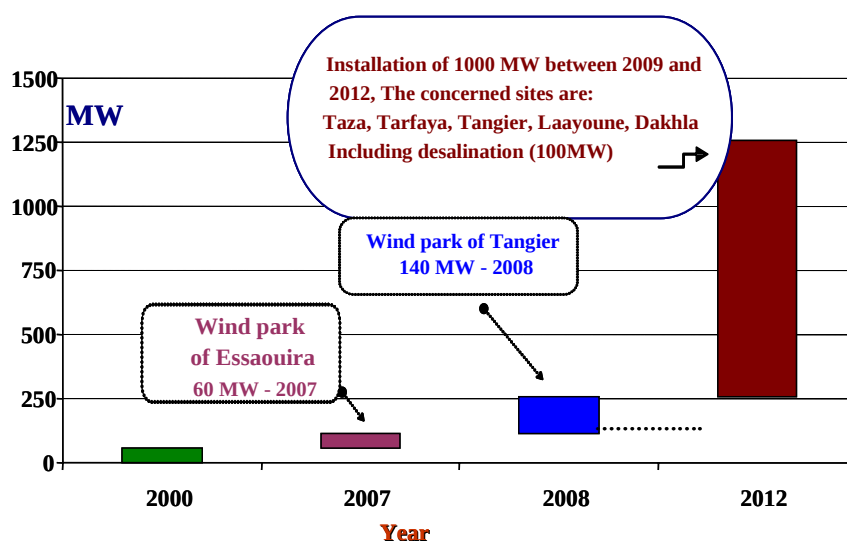
Figure 50 TPES in Morocco by 2012 (NPDREEE)



Source : CDER

As for wind energy, the NPDREEE objectives are to reach 1,000 MW installed capacity by 2012. 14 sites have already been identified by CDER and ONE (Figure 51). Projects will be realised most likely as IPPs. A specific fund for financing RE projects will be established with participation of EIB, KfW and World Bank

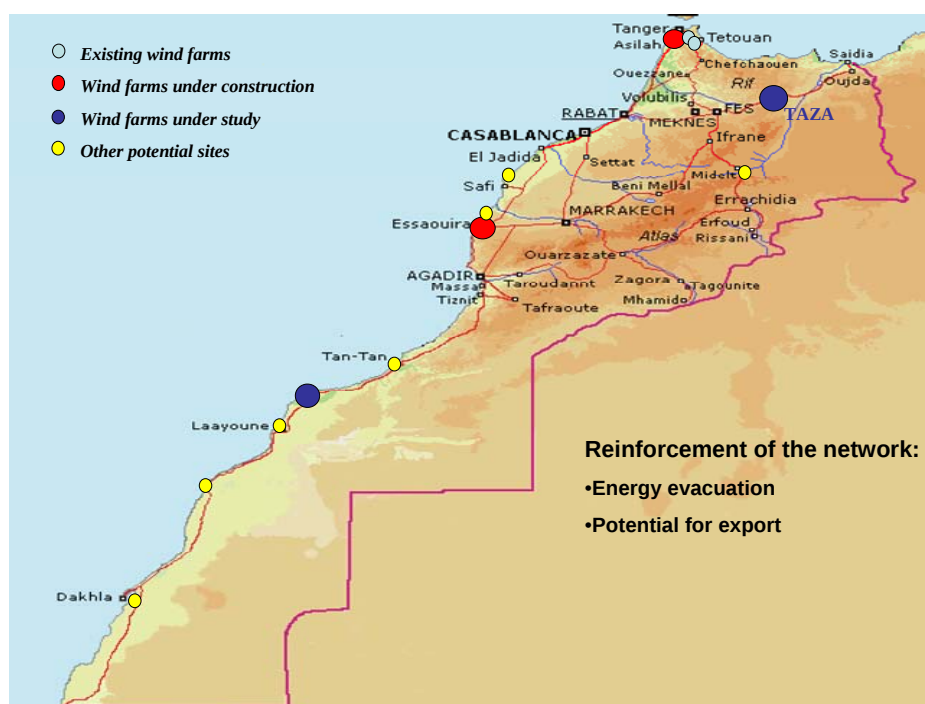
Figure 51 Wind power prospects in Morocco by 2012



Source: CDER, 2006

Two projects have been launched by the ONE to be commissioned by 2006 and 2007. These are respectively the 60 MW Essaouira wind farm and the 140 MW Tangiers wind farm. Another project (100 MW) in Taza is under study (Figure 52).

Figure 52 Wind sites in Morocco



Source: ONE

5. Conclusions

Compared to other SMCs, Morocco has done the most to develop RE sources, especially for electricity generation. This is at least in part due to its energy situation. Thanks to the high RE (solar, wind, hydro) and energy saving potential, transformation of the energy sector in the country has already started and will continue through restructuring programs.

In the years to come, Morocco intends to capitalise and consolidate the efforts made during the past two decades in the field of RE and significantly increase the contribution of RE in achieving the following objectives: security of supply, greater access to energy services, reinforcement of the competitiveness of the productive sector, protection of the environment, thereby promoting sustainable development of the country. With the adoption of National Plan for the Development of Renewable Energy and Energy Efficiency, continued political support for the dissemination of these technologies in Morocco can be expected in the years to come.

The recourse to national and international private investments, allowing the country to support its Sustainable Development orientation, turns out to be essential. In this context, Morocco considers that the CDM would offer a critical and strategic contribution in promoting clean technology transfer and environmental improvement and has undertaken the necessary and adapted actions (eligibility, capacity building, dissemination of the information) in order to fully exploit this opportunity.

The CDM intervention in Morocco can put a special emphasis on areas with promising potential for improving socio-economic and environment situation, such as RE development, energy efficiency development. The portfolio of potential projects identified focuses on RE and energy efficiency projects. However, it is important that the efforts of the government be strengthened by the implementation of an adapted and strong institutional and regulatory framework. This will facilitate the market really develop and the country to take profit from innovative mechanisms such as the CDM or the green certificates; these latter can only support and help developing the sector and do not constitute the only solution to its sustainable development.

In the other hand, the concretization of the objectives traced within the framework of a national plan of development of EnR is however subordinated to a certain number of relatively important measurements and which must be taken into account. It acts in particular:

- Development and the setting of specific regulations and incentives specific to ER and the EE,
- The systematic integration of renewable energies and the energy efficiency in the sectorial development programs,
- Reinforcement of the capacities and the tools of intervention of the CDER so that it can fully play its part of promoter and organizer of this ambitious project.
- The implication, the mobilization and reinforcement of the Moroccan private sector so that it can play an important part in the achievement of the strategic objectives.

Chapter 5. Tunisia

1. Energy Context

Tunisia is a medium income country with a satisfactory economic growth and constantly improving social conditions. Since the late 80's, the annual average GDP growth rate has been around 5%. At the same time, the poverty rate has decreased in 2000 to reach 4.2% compared to 40% in the 60's.

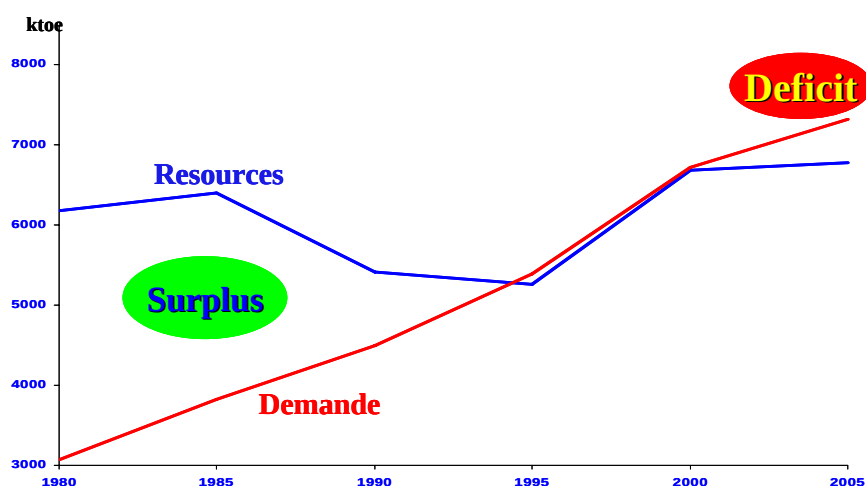
Sustainable energy is one of the main priorities of the Tunisian authorities. Energy efficiency and RE constitute top priorities of the national energy policy, especially in the present context of high oil prices.

Until the middle of the 80s, Tunisia enjoyed a favourable energy situation characterised by a surplus in the energy balance. As such, the energy sector played during this period a key role in financing the economic growth of the country, representing in 1980 approximately 13% of national GDP and 16% of national exports.

Since the late Eighties, however, the situation started deteriorating under the join effect of two major factors: the stagnation of national hydrocarbon resources and the rapid increase in energy demand, as induced by economic and social growth.

In fact, the energy balance moved from a surplus situation of approximately 3 Mtoe in the beginning of the Eighties to a deficit situation starting in 2000. The contribution of the energy sector to economic growth has been decreasing since 1986. Currently, the energy sector accounts for approximately 5% of GDP of the country and less than 7% of national exports. The government subsidies for the energy sector rose from 200 Mdt in 2003 to 1,500 Mdt in 2005. This is due to energy subsidies but also the increase of oil prices, imports of oil products and energy demand. The figure hereafter summarises the trend of the energy balance during the two last decades.

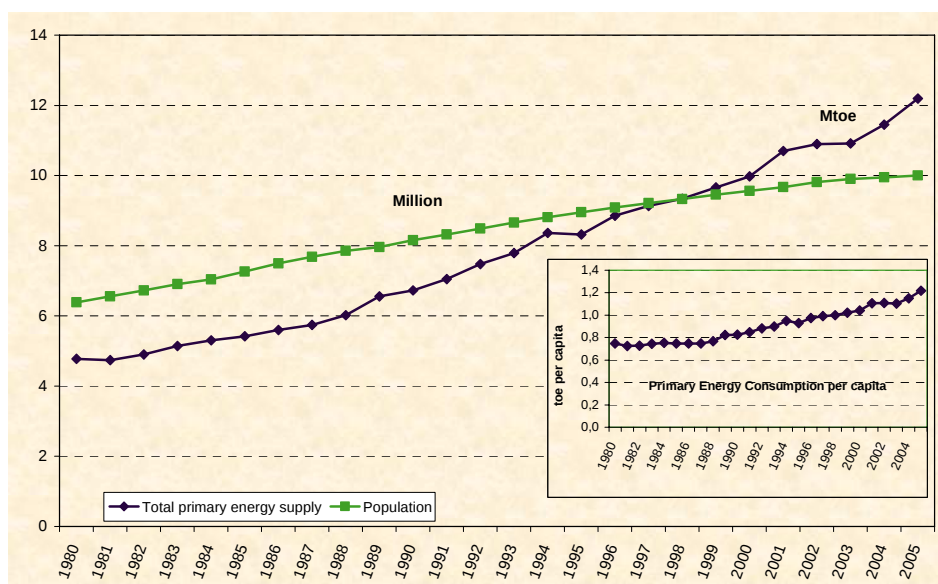
Figure 53 *Tunisian Energy resources and demand - trends*



Source: ANME, 2006

As illustrated in Figure 54, TPES in Tunisia has increased very rapidly in recent years mainly due to the rapid socio-economic development of the country, the improvement of the standard of living and population growth. Indeed, TPES more than doubled over the past two last decades, from 3.7 Mtoe in 1980 to 9 Mtoe in 2005 (6% annual increase). In the same period, energy consumption per capita more than doubled, increasing from 0.75 to 1.22 koe (3.3% annual increase). The structure of the final energy demand as of 2005 is the following: 26% residential and commercial sector, 7% agriculture sector, 36% industrial sector, 31% transportation sector⁸². As of 2006, 99.6% of the population had access to electricity.

Figure 54 *TPES and population in Tunisia 1980-2005*

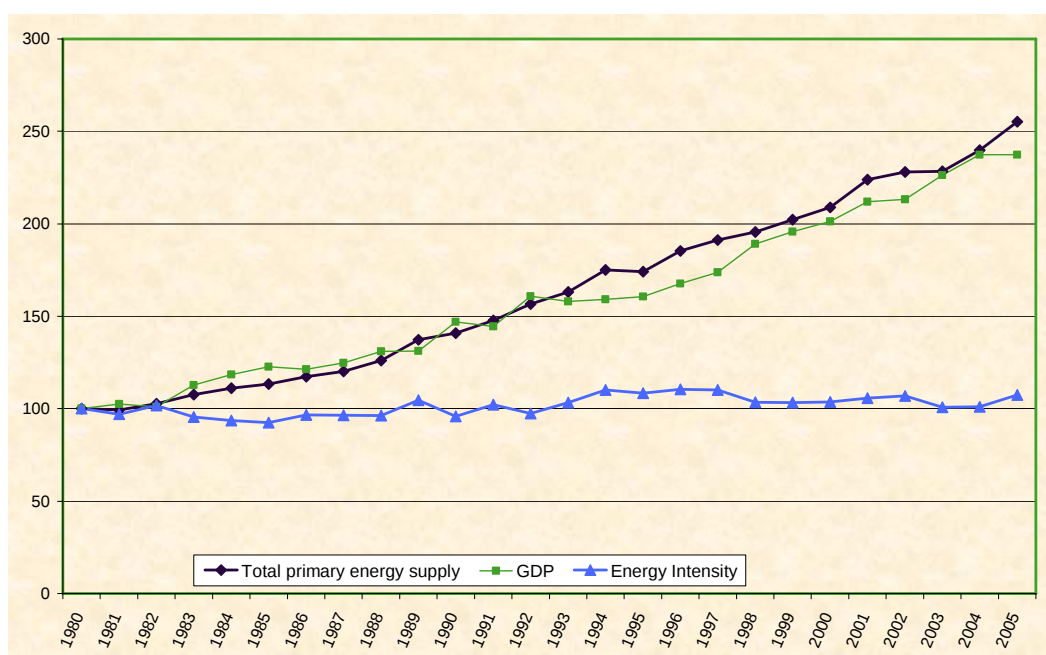


Source: OME

⁸² ANME, 2004

Figure 55 illustrates the trends for TPES, GDP and energy intensity during the two last decades in Tunisia (1980 = 100). It clearly illustrates the benefits of the voluntary energy efficiency policy set up by the government since the early 80's. Tunisia is the only country that has succeeded in stabilising and even decreasing its energy intensity. The figure also illustrates that since 1992, a phase of decoupling between GDP growth and energy demand growth has started as it is the case in industrialised countries. Until 1992, energy demand increased almost at the same level as GDP. Over the period 1980-2002, they have increased with an average annual growth respectively of 6.4 and 6.1%, while the energy intensity was relatively stable until 2004, but registered an important increase in 2005. Over the whole period, the Tunisian energy intensity increased by 0.5% annually. Tunisia has the lowest energy intensity of the region. Nevertheless, there is still great potential for energy savings which the government strongly wants to pursue.

Figure 55 *TPES, energy intensity and gross domestic product in Tunisia*



Source: OME

In order to address the Tunisian energy situation, national authorities (especially the Ministry for Industry, Energy, and small and medium enterprises) have committed to an energy policy that is compatible with sustainable development. Its main components include:

- Intensification and reinforcement of the efforts made for the development of the country's hydrocarbon resources (the Hydrocarbons Code). This allowed the discovery and exploitation of new reserves allowing the compensation of the old layer's decline.
- Providing energy supply at lower cost such as to facilitate access to energy to the whole population.
- Adoption of a voluntary sustainable energy strategy.

In an effort to improve the increasing deficit in the energy balance, public authorities also set a National Energy Efficiency and Renewable Energies Commission in October 2000. Its missions specifically included drawing up a national programme aimed at rationalising energy consumption and promoting renewable energies. This programme comprises two types of

actions: a set of priority actions to be undertaken in the very short-term, and a set of actions to be undertaken within a medium-term programme.

The short-term programme relies on some twenty presidential decisions announced in May 2001, which attests to the government's determination to fully engage in favour of the rational use of energy and the development of renewable energies. These decisions have related to:

- Enhancing awareness-raising and information.
- Setting out the appropriate legal framework to encourage the private sector to invest in the field of energy efficiency.
- Involving the public sector in making profitable use of the energy efficiency potential.
- Mobilising the financial resources necessary to the development of the sector.
- Building local capacities and providing support to research and development programmes.

As for the medium-term programme, its objectives include:

- Large-scale dissemination of solar water heaters.
- Optimisation of rural electrification based on photovoltaic systems.
- Development of wind energy for electric power generation.

In order to ensure a consistent and sustainable energy policy, Tunisia undertook to conduct a strategic study on the development of renewable energies. This study, which was completed in April 2004, draws up an Action Plan for developing the whole range of sectors up to 2011 and sets out strategic options for each sector for the next three decades.

More recently, a Ministerial Council chaired by the President in November 2006, stressed the need among others to strengthen energy conservation programmes and renewable energy development and mainly SWH and wind energy.

2. Environmental Context

Most of Tunisia's environmental problems are a result of population pressures. Specifically, overgrazing, the usage of arable land for agricultural development, over-use of water for irrigation and an increasing population base, together have contributed to a host of environmental challenges. In addition, the contamination of already-scarce water supplies as a result of inadequate sewage treatment facilities results in both water pollution and health consequences. Key current environmental issues also include limited natural fresh water resources, deforestation, soil erosion and desertification.

The protection of the environment in Tunisia represents a national priority in matter of economic and social development. Tunisia has committed itself fully with regard to environment protection since the 1980s. In this regard, the Tunisian government has implemented policies and programs to conserve and manage the country's resources, and its landscape in particular. The government is also examining ameliorated waste treatment systems, as well as the application of ecological consciousness for the public at large.

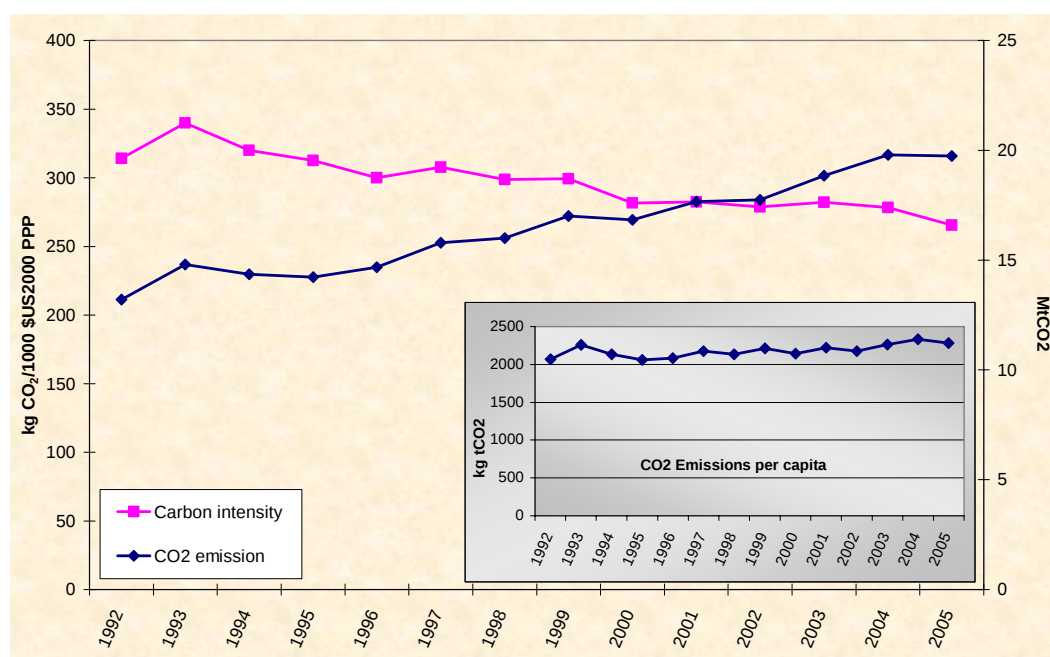
For purposes of implementing its environment protection policy, the government acts through the Ministry for Environment and Sustainable Development, as well as via several specialised institutions. Tunisia has also undertaken considerable effort toward the integration of

sustainable development in the sector-based economic policies. In this regard, it ratified the United Nations Framework Convention on Climate Change (UNFCCC) in July 1993 and the Kyoto Protocol in June 2002. It has also recently set up its DNA and is thus eligible for hosting CDM projects. Several projects are in the pipe and include RE ones.

Also, among the several activities undertaken in the field of climate change, an inventory of GHG emissions related to the energy sector for the year 2000 has been realised. The results indicate 20.8 Mte-CO₂ of anthropic emissions, representing an average annual growth of 5.3% compared to 1994. In 2005, GHG emissions per person reached 2.28 tCO₂ for energy needs (in comparison with 2 tCO₂ in 1992) (

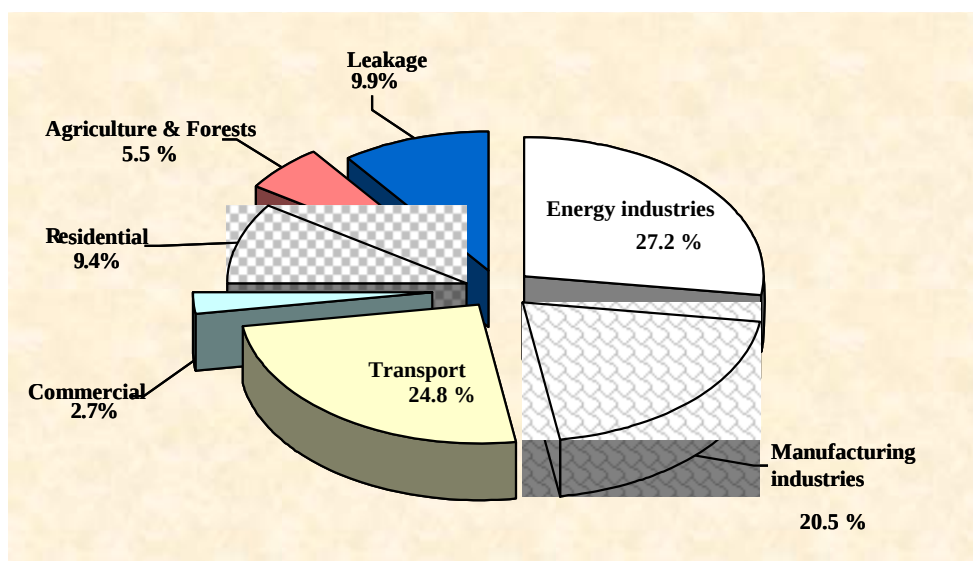
Figure 56). The figure also shows that the energy-related carbon intensity is on a decreasing trend. The carbon intensity indeed decreased by about 1.1% per year over the period 1992-2005. This is mainly due to the development of natural gas use in the country. As illustrated in Figure 57 for the year 2000, Energy industries (power production, refining), transport and the manufacturing industry are the most polluting sectors in terms of GHG emissions (more than 93% of total emissions).

Figure 56 **Energy-related carbon emissions (1992-2005)**



Source: OME

Figure 57 Structure of the energy related GHG emissions for the year 2000



Source: ANME

Tunisian CO₂ emission's levels are thus increasing rapidly since 1990, the baseline year for the Kyoto Protocol of the United Nations Framework Convention on Climate Change. As a non-annex I country, Tunisia is not obligated to curtail carbon emissions. However, the country is looking to use the CDM as a means for supporting sustainable development and partly remove the financial barriers clean technology projects (for e.g., RE) are facing.

In this context, institutional actors have engaged much effort in the last few years to disseminate information and raise awareness of different stakeholders regarding CDM. In fact, several seminars, workshops and capacity building activities have been organized for this purpose. Currently, the Tunisian DNA is operational and many national consultants work on the CDM. Nevertheless, a lack of dissemination of information has failed to attract potential investors, such as a specific website. An excellent website including information on climate change⁸³ in Tunisia disseminating information on this subject does exist, but it is not exclusively related to CDM issues. It is not easy to have information on the DNA, on its structure, functioning, contacts, etc. as it is the case in Morocco or in Egypt, for example.

In spite of its relatively low level of emissions (less than 2.3 tons equivalent CO₂/inh), Tunisia has an important potential to decrease emissions that could be promoted, among others, through the CDM contribute to sustainable development. A portfolio of projects eligible for the CDM has been set out highlighting the importance of RE as a strategic option for GHG reductions. Two projects have already been registered and several others are under development; these concern mainly RE projects, landfill and gas flaring. The implementation of these programmes should enable Tunisia to take part in international initiatives to combat climate change and contribute to sustainable development of the country.

⁸³ www.changementsclimatiques.com

3. Integration of renewable energy sources

Tunisia is endowed with substantial potential of RE sources. In particular, the country has abundant solar and wind energy resources. This section describes the RE resources and potential, the current RE situation and the institutional/legislative framework in Tunisia.

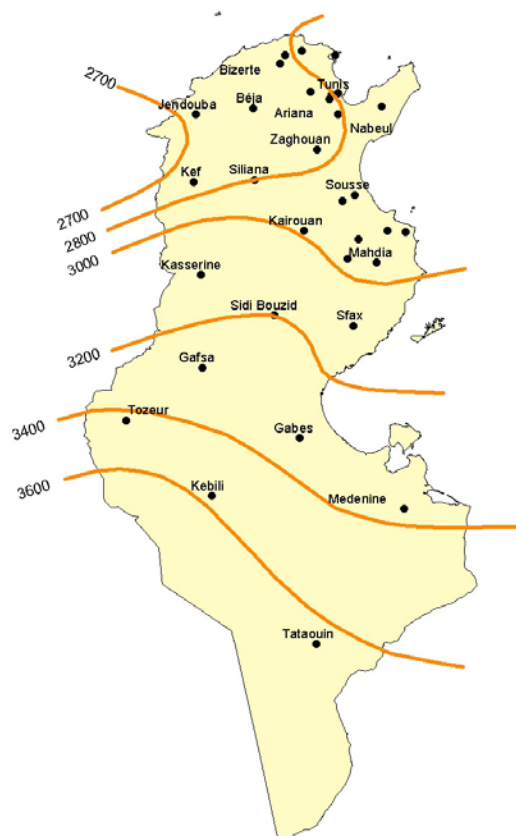
4.1. Renewable energy resources and potential

Solar

Tunisia has good conditions of sunning which are characterised by the following:

- The average irradiated energy in the country is 2,000 kWh/m² year. The irradiation per day, on an annual average, varies between 4.1 and 5.2 kWh/m² day. The number of hours of sunshine is 2,700 - 3,600 hours per year.
- Yearly, the index of insolation varies between 64% and 75%. Monthly, this index varies between 47% and 89%.
- The temperatures are relatively high. The monthly average exceeds 9°C in general.

Figure 58 Yearly number of hours of sunshine in Tunisia



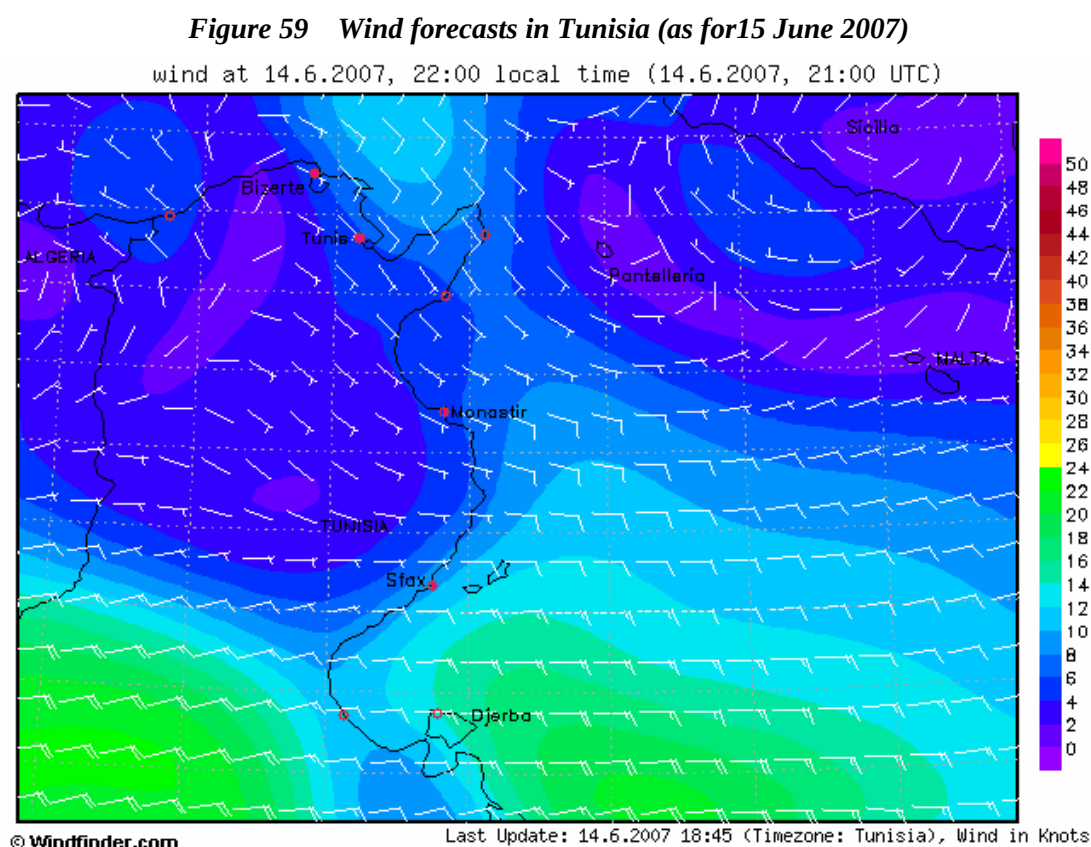
Source: ANME

Wind

A wind atlas is being realised in the framework of bilateral cooperation with Spain (RE Institute of Navarra). Several sites have already been identified and instrumented indicating an interesting potential.

According to ANME, the “On Shore” wind potential in Tunisia is estimated, referring to preliminary studies (not based on real wind data), to 1,000 MW with an average producible energy about 3 MWh per year and by kW installed.

Summary studies were carried out on fifteen sites. Among them, five are located in the north and the North-East and were the subject of evaluation studies. These studies (not based on real wind data) showed the existence of a potential of about 300 MW with annual average wind velocities between 7 and 10 m/s. However, a study conducted by CESI on behalf of STEG concluded that no more than 205 MW (35% load factor and 5% contribution to power generation) of wind power capacity can be absorbed to the Tunisian electricity network during the period 2007 – 2011. Figure 59 illustrates wind forecasts by Windfinder⁸⁴ for June 15, 2007.



⁸⁴ www.windfinder.com

Biomass

Biogas

The energy valorisation potential of solid wastes in Tunisia is quite important. Organic wastes annually produced in Tunisia are estimated at more than 30 millions tons.

Wood energy

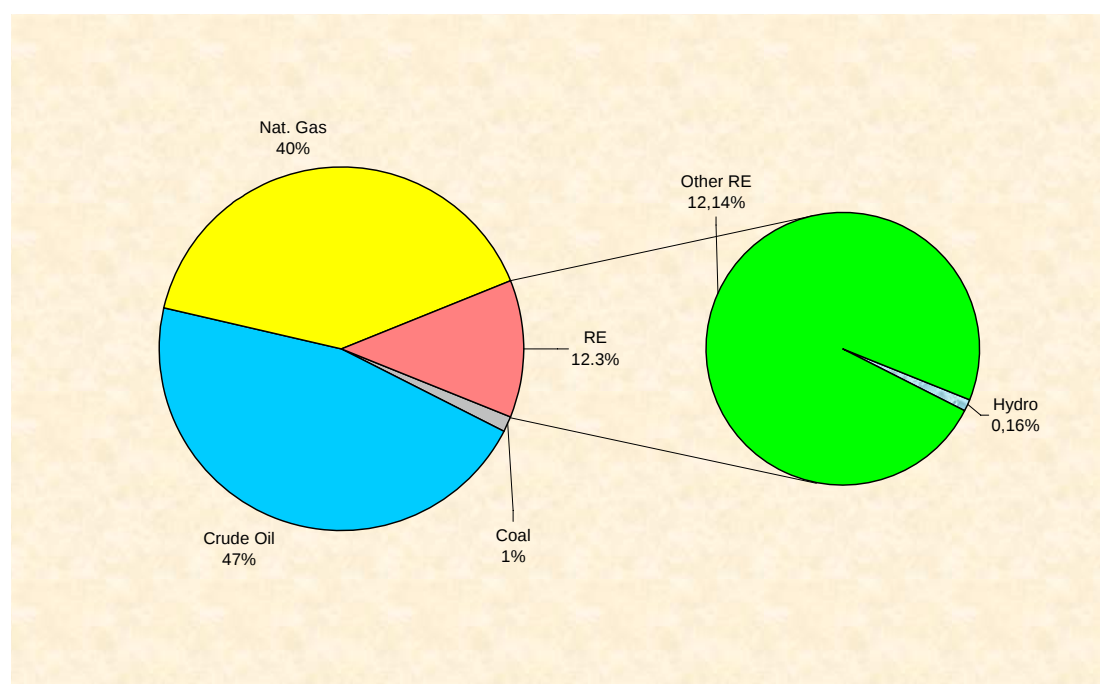
The wood energy assessment is overall slightly overdrawn, but with significant regional disparities. The demand for wood energy comes primarily from the residential sector which accounts for 98% of national consumption. The cooking of the bread in the traditional furnaces (*Tabouna*) constitutes approximately half of the consumption of the residential sector.

4.2. Current renewable energy situation

Contribution of RE to the energy balance

Despite the important potential of RE Tunisia is endowed with and the willingness to promote them, these resources are not fully exploited at present. Indeed, RE sources represent 12% of TPES consumption (biomass mainly) which may seem relatively high, in comparison to other Southern and Eastern Mediterranean countries. However, excluding biomass and large hydro, RE sources represent only 1% of TPES. Figure 60 illustrates the structure of TPE in Tunisia in 2005.

Figure 60 Share of RE in TPES in Tunisia (2005)



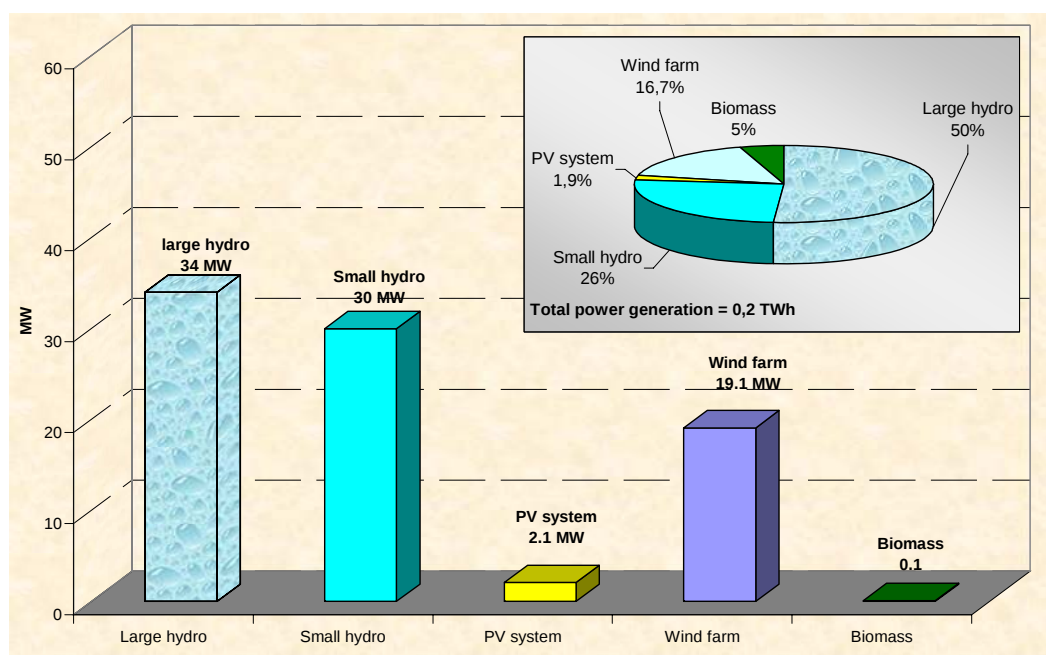
Source: OME based on questionnaires to ANME & STEG

Contribution of RE to power installed capacity and generation

In 2005, total RE-based power installed capacity reached 85 MW, almost 74% of which being hydro (39% large hydro and 35% small hydro). The rest was composed of 20 MW wind power plant, 0.1 MW biomass power plant and 2 MW PV applications (Figure 61). This RE capacity represented less than 3% of total electricity installed capacity.

The total RE-based power generation was 0.22 TWh, representing almost 1.7% of total power generation for the same year.

Figure 61 RE-based power capacity and generation in Tunisia (2003)



Source: OME, based on questionnaires to ANME & STEG

In the following, details are given regarding Tunisian RE situation by technology. The development of RE relates in particular to four major energy sectors: photovoltaic, solar thermal (solar water-heaters), wind and biogas.

Solar

PV systems

The development of the photovoltaic market in Tunisia is closely connected with the electrification of isolated and sparsely populated rural zones. Technically speaking, this electrification is usually made by means of individual 100 Wc individual photovoltaic systems. From an institutional point of view, this electrification is based on a public approach via national programmes financed by the State and implemented by ANME.

According to the current state of development, over 12,000 households and about 200 schools have been electrified. Besides these electrification programmes, some 70 solar water pumping installations have been constructed, mainly in southern Tunisia where there is a good number of surface wells and a need for drinking water. Other applications in professional activities have been used, such as in telecommunications and in beaconing. Projects for PV desalination

are also being implemented. In sum, the total energy installed, including all uses, is estimated at 1.4 MW of which about 1.2 MW for electrification.

Tunisia has adopted a project to be undertaken by 2007 and that concern PV electrification of 1200 households in 14 governorates. An ongoing project, in cooperation with JBIC (Japan), concerns the decentralised PV rural electrification and water supply within PV. The total cost of the project is estimated at 23.6 MTD. The project targets the electrification of 500 households in the North-West region and 63 water PV pumping and/or desalination projects.

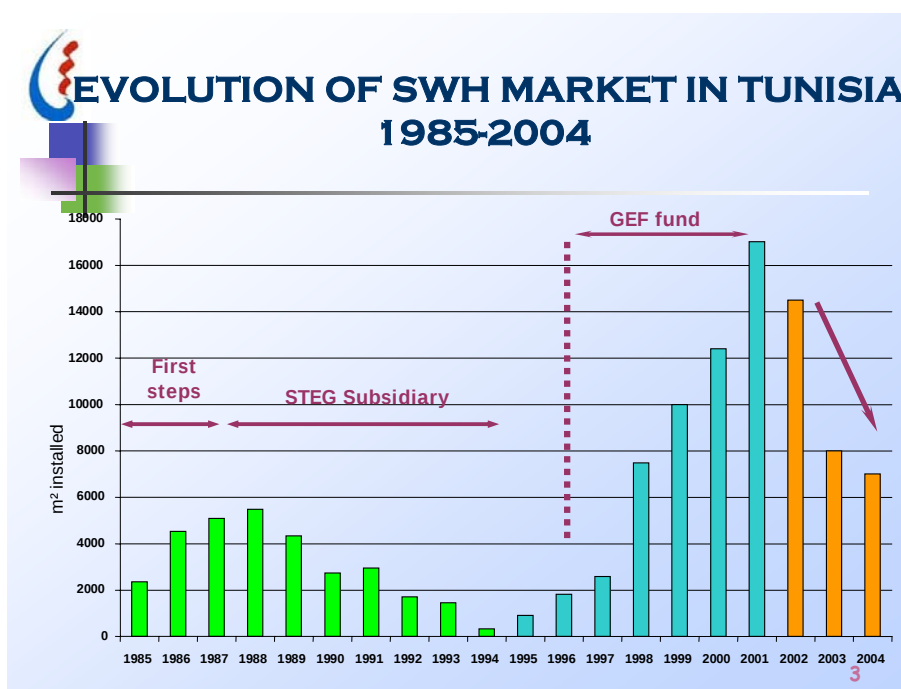
Also, within the frame of the MEDRES project⁸⁵, it is planned to study the integration of wind and photovoltaic power on the Kerkennah islands.

The industrial and commercial actors in this sector consist of several companies among which, three wholesaler and installation companies ensuring the import of various brands of panels, one electronic parts assembly company (ballasts mainly) and two companies specialised in the import and installation of photovoltaic pumping systems, and two solar battery manufacturing companies.

Solar thermal: solar water heaters

The solar water-heater is the best known and most widely established RE technology used in Tunisia. Its development, however, is hampered by its lack of competitiveness (compared to current energy prices) as well as to the size of the initial investment (compared to conventional systems such as LPG-fired/Gas-fired water heaters and electrical water heaters). Figure 62 illustrates the evolution of the SWH market in Tunisia over the period 1985-2004.

Figure 62 Evolution of SWH market in Tunisia 1985 - 2004



Source: STEG

⁸⁵ See <http://www.ome.org>

It clearly shows that the Tunisian SWH market developed in 3 main phases:

1. *1980-1996*: 33,000 m² installed. This period was marked by a high public commitment in favour of the activity:
 - Mechanism of financing based on the credit sale over 7-years duration, with a covering of the monthly payments through the electricity invoice.
 - Total exemption of import taxes of the raw materials for the production.
 - Total exemption of the solar water heaters sale taxes.
2. *1996-2002*: 50,000 m² installed. This period was marked by the set up of GEF fund comprising 2 large components:
 - Direct subsidy covering 35% of the price solar water heaters installed.
 - Measurements in order to reinforce the capacity building of the national actors in the field.
3. *2002-2004* has been a critical period with a decrease of sales

Since 2005: this period is characterized with support of MEDREP by the set up of the PROSOL Programme and the national fund comprising 2 large components:

- Direct subsidy: 200 TD for a 200 l capacity and 400 TD for a 300 l and more capacity.
- Credit sale (750 TD for a 200 l capacity and 950 TD for a 300 l and more capacity) over 5-years duration at an interest rate of 6.25 %, with a covering of the monthly payments through the electricity invoice.

PROSOL II Programme covers the period 2007 – 2011. Target for 2009 is 540 000 m² (see Figure 63). It reinforces the National SWH development programme, and involves financial mechanisms to reactivate SWH market in Tunisia. Formalities and procedures are simplified between different intervening parties. It facilitates SWH acquisition mechanism for customers and transfers the debt from suppliers to the real consumers.

It creates attractive financial mechanisms with advantageous rates, reinforces STEG implication, defines intervention limit for each operator, guarantees the credit payment by STEG and increases public awareness by setting up different information center in all STEG districts.

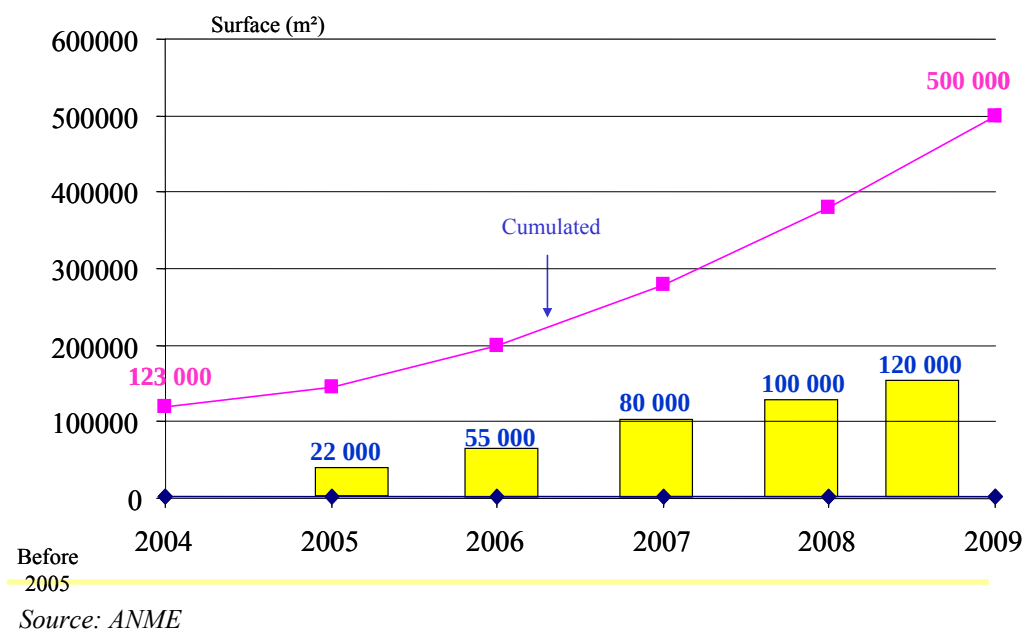
The total installed capacity as of end of 2004 amounts 122,000 m². During the years 2005 and 2006, 59,000 m² have been installed, which exceeds the initial targets for the same period. The subsidies are provided by the recently established national for energy efficiency (NFEE) with contribution from IMET. The total installed capacity by the end of 2006 amounts to 194,000 m².

The industrial and commercial sector for solar water-heaters is the most developed of all RE sectors in Tunisia. It mainly consists of:

- Eleven companies which commercialise this equipment, three of which local manufacturers and eight importers;
- A network of 300 installing agents covering the whole national territory;
- 500 direct employment positions created.

- Targets for 2009 are to set up an industrial and commercial base with more than 12 approved societies and 290 installing companies working in this field, and that the specific SWH indicator will increase from 46 m²/1000 inhabitants in 2009 to 92 m²/1000 inhabitants in 2015, against 17 m²/1000 inhabitants currently.

Figure 63 Prospects for SWH Market in Tunisia 2005-2009



Wind energy⁸⁶

In Tunisia, the wind energy sector enjoys considerable interest from both the public authorities and the private sector. STEG undertook, on its part, to construct its first 10 MW wind energy plant in Sidi Daoud on the northern coast of Cap Bon. Commissioned in 2001, this plant was extended to about 20 MW in 2003.

Tunisia has also started to open up power generation to the private sector by virtue of Law 96-27, dated April 1st 1996, which authorises the State to grant electricity production licences to independent power producers with a view to its exclusive sale to STEG. The conditions and modes of granting the licence to independent power producers are stipulated in the Decree 96-1125, dated 20 June 1996. Tunisia has thus undertaken to adapt its legal and institutional framework to this option. This has entered into force with the construction of the IPP power plants of Radès and of El Bibane.

Moreover, Tunisia benefited in 2001, via the National Agency for Energy Conservation (ANME), from a preliminary assistance extended by international cooperation for national capacity building in the field of wind energy. This assistance was aimed primarily at lifting the barriers and removing the constraints identified in order to create a competitive wind energy market. This was to be achieved by installing wind data measurement stations in sites located in various regions of the country, by conducting technical and economic feasibility

⁸⁶ For more information on the development of wind energy in Tunisia, see also UNDP-Global Environment Facility. "Development of on-grid Wind Electricity in Tunisia for the 10th Plan". UNDP-ANER, 2004 at: http://www.gefweb.org/Documents/Council_Documents/GEF_C22/CC_-_Tunisia_-_On-Grid_Wind_Electricity_-_Project_Document.pdf

studies for the implementation of wind energy projects in Tunisia, by training technicians at the national and regional levels in this field.

Furthermore, and with a view to giving concrete expression to the interest shown by the public authorities for the development of wind energy in Tunisia, a comprehensive and integrated national programme has been developed in this respect. This programme, to be implemented in the period 2004-2008, involves about 180 MW.

The wind energy sector, though still relatively expensive compared to conventional power plants, seems to currently represent the most competitive solution for RE power production in Tunisia. In addition, it emerges, within the power production sector, as the most promising medium-term means of power production favourable to the environment (thus complementing the CC plants as regards fossil based production). The wind market in Tunisia may also take advantage in the coming years of the expected costs decrease induced by technical progress and the effects of economy of scale.

In the wind energy sector, the Tunisian industry is able to provide certain project components such as electrical control panels and cabling, transformers and, possibly, towers, and this, in addition to the whole range of civil engineering and site development. Indeed, for the STEG 20 MW project, the rate of local integration has been as high as 30%. This rate is likely to increase considerably in case of relocation of certain industries to Tunisia for the manufacture of certain parts of the machine (carriage, rotor), obviously in the case of development of the local, if not regional, market.

The extension of the existing site of Sidi Daoud (Cap Bon) is ongoing and is expected to reach a total capacity of 55 MW by November 2007. STEG also recently launched a call for tender for an additional 120 MW wind power plant.

Table 23 **Wind power projects in Tunisia**

Location	Site	Status	Capacity (MW)	Start-up	Company
Cap Bon	Sidi Daoud1	existing	10,53	2000	STEG
Cap Bon	Sidi Daoud2	existing	8,72	2003	STEG
Cap Bon extension	Sidi Daoud3	to be completed	35	Nov 2007	STEG
3 wind farms	Bizerte	project	120	2009	STEG

As regards consultancies, there are private sector competencies that have started to operate in partnership with international consultants and foreign investors. In addition, the wind energy plants constructed by STEG, as well as the capacity building actions of which ANME has benefited, have made it possible to acquire know-how in this field.

A capacity building programme has also been launched regarding wind atlas, institutional framework, etc. Total wind power installed capacity will be 55 MW in 2008.

A call for bids has been launched by STEG for 120 MW of wind energy in the area of Bizerte. STEG has know-how and expertise in wind energy: Site prospecting, resources evaluation, micro-siting, installation, maintenance, monitoring...

Hybrid PV - Wind

Since 1995, 12 installations have been realised, 7 of which installed in 2005 and 5 in 2006. The power installed ranges between 0.2 and 3 kW for PV and 0.4 and 3 kW for wind. The related applications concern: water pumping, electrification, water desalination, agriculture farms, and R&D.

Biomass

Biogas

In the early 1980s, Tunisia started a pilot phase for biogas projects with the installation of about fifty household digesters in the north western region of the country where several bovine and caprine breeders are found and which are located far away from the power network. The produced biogas would serve for household lighting, cooking and refrigeration.

The strategy adopted by ANME since the mid 1990s was to resort to a capitalisation of the wastes produced by farming industries (industrial farming) and agro-business industries through the production and utilisation of biogas: energy capitalisation was then a “by-product” of the treatment of wastes. This had led to the installation in 2000 of a biogas producing company based on poultry wastes at the premises of a private company. This unit has a treatment capacity of 4 tons of chicken wastes per day and produces about 200 m³ of gas daily which are later transformed into electric power evaluated at 300 kWh/day.

Biodiesel

Tunisia started a pilot phase for biodiesel production project. The project is based on the exploitation of used vegetable oil and the initial capacity is estimated at 5000 tons per year.

Wood energy

In Tunisia, the problem of wood energy is raised more in terms of its rational use than in terms of its valorisation. In order to reduce wood consumption, the ANME has, therefore, launched a distribution programme of metal lids for the *tabouna* since the 90s, which should lower consumption by about half.

The ANME trained ten craftsmen in the north-west of the country for the manufacture of these lids. The manufacturing cost is estimated at approximately 9 dinars per lid. Currently, the ANME has distributed approximately 15,000 lids, while relying on local NGOs for a larger diffusion.

4.3. Institutional and legislative framework

Main actors

Tunisia has provided, since the early 80s, a favourable institutional framework for the promotion of energy efficiency and renewable energies. This has been illustrated by the establishment of the National Agency for Energy Conservation (ANME) which is the core component of this institutional framework as well as the creation of several bodies assigned to the implementation of the energy efficiency policy.

The National Agency for Energy Conservation (ANME)

The National Agency for Energy Conservation (ANME) is a public institution operating under the authority of the Ministry of Industry, Energy and Small and Medium enterprises. It was established in 1985 as the Agency for Energy Conservation (AME) and then renamed National Agency for Renewable Energies (ANER) in 1998.

The ANME's role is to implement the State policy for energy conservation through the promotion of energy efficiency, RE and energy substitution. Its final mission is to improve the energy balance and participate in the reduction of gas emissions generated by energy use in Tunisia.

ANME's action covers a wide range of tasks, among which:

- Developing and implementing national energy conservation programmes.
- Conducting prospective and strategic studies.
- Elaborating the legal and regulation framework to energy conservation.
- Granting of tax and financial incentives.
- Launching awareness-raising, information, education and training actions.
- Providing support to research & development and demonstration projects.
- Encouraging private investment in this sector.

Other stakeholders involved in renewable energies

Besides the public institutions directly or indirectly involved in the field of renewable energies, several other actors bring in their contribution, particularly NGOs and the private sector.

As regards public institutions, the major actors are:

- The Ministry of Industry, Energy and Small and medium enterprises which undertakes the implementation of the country's energy policy, and this through the General Directorate for Energy (DGE).
- The Tunisian Electricity and Gas Company (STEG) which has monopoly on the transport and distribution of electricity and which is, therefore, the single buyer of this energy.
- The Ministry of Agriculture, Environment and Water Resources, together with several institutions that belong under its authority, such as the National Environment Protection Agency (ANPE), the National Sanitation company (ONAS) and the Tunis International Centre for Environmental Technologies (CITET).
- The Ministry of Higher Education, Scientific Research and Technology whose missions cover the research & development related aspects in this field, via several institutions, of which the National Institute of Scientific and Technical Research (INRST), the Technopole of Bordj Cédria, the various schools of engineers (ENIT, ENIM, ENIS, ENIG) and certain Faculties, especially the Sciences Faculties.
- The Ministry of Equipment, Housing and Land Use Planning.
- The Ministry of Communication Technologies and Transport.
- The Ministry of Environment.

The involvement of civil society constitutes a pre-requisite for the development of renewable energies. Accordingly, particular interest has been granted to NGOs in view of the role they can play in this field in Tunisia.

The private sector also plays a major role which allows a gradual takeover from the public sector with regard to production activities. The private sector has already manifested interest in various activities, particularly wind energy and the recycling of wastes for power generation, as well as the solar, thermal and photovoltaic energies.

Regulatory and legislative framework

The legislative and fiscal framework related to the promotion of energy efficiency, in general, and of renewable energies, in particular is governed for the main part by the following laws and decrees:

- Law n° 93-120, dated 27 December 1993, bearing promulgation of the Investment Incentives Code, particularly articles 40, 41, 52 and 52 b. This Code has abrogated articles 12.13.14 and 15 of Law n° 90-62 and stipulated, under articles 40 and 41, a new system of incentives and of direct and indirect financial allowances.
- Decree n° 94-537, dated 10 March 1994, such as amended by Decree n° 2002-174, dated 28 January 2002, setting the amounts and criteria of granting the specific allowance inherent in investments in the field of energy efficiency.
- Decree n° 95-744, dated 24 April 1995, bearing application of articles 88 and 89 of Law n° 94-127, dated 26 December 1994, bearing Finance Law for the financial year 1995, which articles relate to setting the lists of the raw materials and products necessary for the manufacture of equipment used in the field of energy efficiency or in the field of renewable energies.
- Law n° 2004-72 dated 2 August 2004, relating to energy efficiency.
- Law n° 2005-82 dated 15 August 2005, relating to energy conservation and renewable energy, which objectives are to strengthen the rational use of energy, renewable energy deployment and energy substitution.
- Decree n° 2005-2234 dated 22 August 2005, relating to rates and amounts of subsidies concerning the actions of the above mentioned law.

The regulatory framework relating to energy efficiency, in general, and to renewable energies, in particular, has steadily developed in Tunisia for the past two decades, and at a more rapid pace in recent years. Indeed, the presidential decisions announced in May 2001 have underlined the importance of setting up an appropriate framework that is specific to each area of activity so as to encourage the private sector to invest in the field of renewable energies. These have been confirmed and strengthened in August 2005 within the new law adopted and recently during ministerial councils and presidential decisions, in response to the high increase of oil prices.

Besides decisions of a general nature related to updating the regulatory framework for energy efficiency, increasing financial incentives, designating a National Energy Conservation Day and establishing a Presidential Award in this field, decisions specific to RE relate to:

- Mandatory use of solar water heaters in new public buildings.

- Optimising a profitable use of photovoltaic energy in various fields.
- Enhancing the use of wind energy for electric power generation.
- Encouragement of energy capitalisation of wastes and geo-thermal waters.

The main tax and financial incentives related to the development of renewable energies, such as provided by the various regulatory texts, are:

- Subsidies to demonstration projects ranging to 50% of the cost, with a maximum of 100,000 TD.
- Subsidies to investment of 20%, with a maximum of 100,000 TD for SWH projects.
- Application of minimum customs duties (10%) and VAT exemption for equipment and products used for energy efficiency to which no similar equipment is manufactured locally.
- VAT exemption for energy saving equipment goods and products purchased locally.

A National Fund for Energy Efficiency has also been established. Actions concerned by this fund are the followings:

- Energy audits.
- Installations of stations for vehicle motors diagnostics.
- SWH.
- Substitution of energy by natural gas in the industry sector.
- Substitution of energy by natural gas in the residential sector.

4. Barriers, priorities and targets of renewable energies

4.1. Barriers to renewable energy development

Besides the barriers highlighted in the regional overview, the followings are in addition specific to Tunisia:

Regulatory and fiscal: the regulatory and fiscal framework in Tunisia is favourable to RE and especially to the introduction of energy efficiency measures. However, this framework needs to be strengthened especially for wind development that still lacks adapted institutional and legal framework. Recent measures have been taken towards SWH and the same is being decided for wind.

Awareness, information and communication: Lack of awareness and information about RE technologies among policy makers, energy planners, and potential users of these technologies. Important efforts are being made by the ANME in this field, but these remain modest, not the most appropriate and very weak in comparison to the efforts made for energy efficiency.

4.2. Priorities and targets for renewable energies

The strategic study on RE completed in April 2004⁸⁷, reveals that, according to a proactive scenario of development of solar water-heaters, the aggregate solar water heating area installed in Tunisia would increase by 500,000 m² in 2009, by about 1.5 million m² in 2020 and by 2.5 million m² in 2030. Such a proactive development would generate major impacts in energy, environmental, economic and social terms: an aggregate primary energy saving in the order of 160 k toe in 2010, 700 k toe in 2020 and 2 M toe in 2030 and an aggregate reduction of emissions of about 0.4 MtCO₂ in 2010; 1.7 MtCO₂ in 2020; and 4.5 MtCO₂ in 2030.

Both the Tunisian situation and the international experience reveal that the development of solar water heating and its gradual introduction in the market cannot be done appropriately unless they benefit from financial support under forms that are gradually adapted to market penetration.

As for wind and based on the evaluations of the wind energy potential in Tunisia, the strategic study on RE reveals that, according to a conservative scenario of wind energy development, the capacities installed should reach 310 MW in 2010 ; 1130 MW in 2020 ; and 1840 MW in 2030. This scenario allows a significant development with a more gradual rise in investments. Taking into consideration integration into the grid issues, the Tunisian government decided to set as an objective to reach 180 MW installed wind capacity by 2008. In this context, and as mentioned above, in addition to the extension of the existing wind farm, STEG recently has decided to set up three additional wind farms with a total capacity of 120 MW. These wind farms which will be built in the governorate of Bizerte, respectively in Metline, Beni Aouf and Jebel Kechabta, will boost Tunisia's overall wind power capacity to 180 MW.

There is also a potential for developing wind power for self production purposes. A programme is undertaken regarding the development of wind power self production in the industry sector and particularly the high electricity consumer industry. The programme concerns some 10 industries of which 6 cement factories. The total capacity is estimated at 80-100 MW. The total energy saving is estimated at 80 ktoe and CO₂ emissions at 180 kt. Such projects may take benefit from the CDM, while reducing the subsidies provided by the government to the energy sector.

As regards the PV sector's development prospects, the smallness of the area of the country, the rate of development of the electrical power network and the rapid pace of its expansion, cause the rural photovoltaic electrification potential to remain limited to about 6000 households (for which the cost of connection to the network is over 5000 Dinars), that is a power of about 600 kW. Including the other applications, such as pumping and other professional applications, the potential for the time frame 2010 would amount to 3.5 MW.

However, opportunities may be offered to reach a much greater potential for the time-frames 2020 and 2030, and this, through the creation of a strong market by the establishment of electrification programmes alongside with the national programme, the equipment of several wells with solar pumps, as well as the development of new applications such as connection to the network and water desalination. To these development conditions, one more condition should be added which also allows the enhancement of the sector, and this, by setting up a

⁸⁷ Etude Stratégique sur les Energies Renouvelables en Tunisie, ANME, 2004.

photovoltaic modules assembly plant, as well as stepping up private services companies to ensure the maintenance of the present and future installations.

As for biogas and due to the absence of local consumption of the gas produced and that the injection of that gas is not considered in the foreseeable future, the preferred solution for the development of biogas is its use for power production. It is worth underscoring the importance of the capitalisation of wastes and the use of biogas in the reduction of the greenhouse gases emissions.

The quantitative objective for power production based on biogas is to reach an installed electrical power capacity of about 30 MW in 2010; 50 MW in 2020; and 80 MW in 2030 (that is 90% of the estimated potential).

More generally, the targets foreseen by the Tunisian energy policy by 2010 are the following:

- Reducing the rate of increase in demand for primary energy by 1% yearly.
- Saving about one million toe every year, which amounts to 10% of gross energy consumption.
- Avoiding 3 millions tons of carbon dioxide on a yearly basis.
- Reaching an electrification rate of 100% in rural areas.

In this context energy efficiency and RE development have a major role to play.

5. Conclusions

The results achieved in the field of energy efficiency and RE show that Tunisia has invested a great effort in the development of energy conservation. This has been possible thanks to Tunisia's political will and the interest manifested by the public authorities, particularly in matter of access to energy through rural photovoltaic electrification and of development of the solar thermal energy sector (solar water-heaters). Progress has also been made in the field of RE through the launch of other RE sectors such as wind energy and the valorisation of wastes for power generation.

The recent increase of oil prices have led the Tunisian authorities to give new impetus to the energy conservation strategy in the country, which is being illustrated among others by the set up of a new Secretary of State in charge of RE and a very strong information, awareness raising and communication campaigns for both energy efficiency and RE (especially SWH).

In spite of these results, the present contribution of RE in the energy balance remains limited due among others to the lesser competitiveness of these energies compared to conventional energies and the lack of adapted and clear institutional and regulatory framework for wind energy. Yet, the development prospects of RE in Tunisia are promising in view of the considerable potential that the country holds for the whole range of the energy sectors studied.

An efficient capitalisation of this potential would help the country to meet the stakes targeted by the energy and environmental sectors in terms of contribution in reducing the energy deficit, providing energy supply at lower cost, ensuring access to energy and improvement of the living conditions of isolated rural populations, as well as protecting the environment.

However, in order to achieve the objectives set, the mobilisation of financial resources is also essential. Having granted particular importance to sustainable development, Tunisia expects greater international cooperation pursuant to the pledges and commitments made in Kyoto and to the various Johannesburg initiatives, and this, for purposes of achieving a better development of RE and greater energy efficiency in the country. The results to be achieved represent a challenge attesting to the country's commitment to the process of a sustainable development.

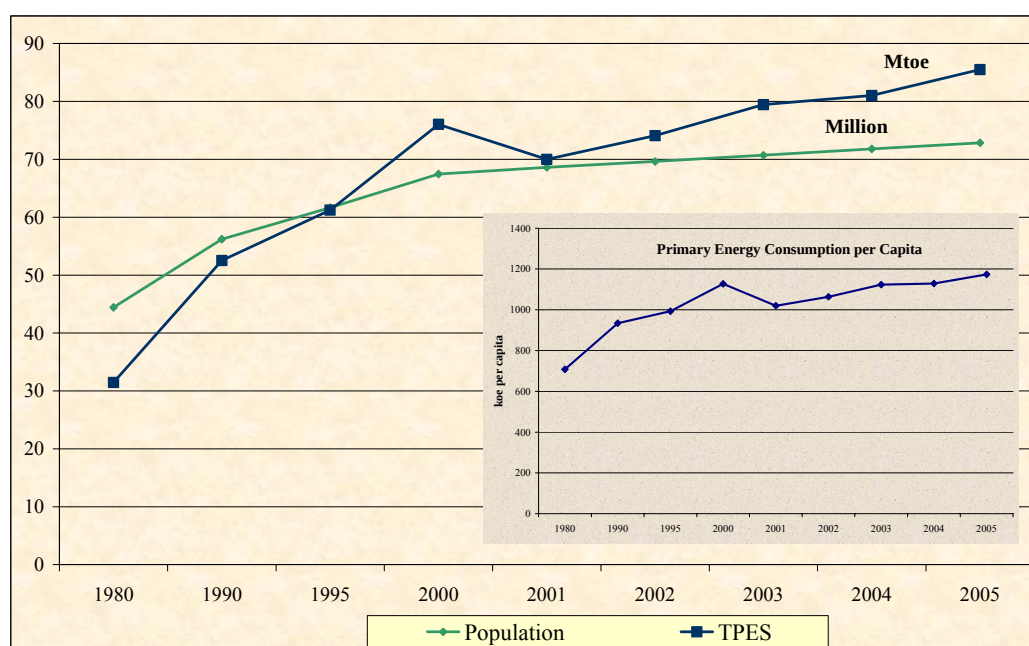
Chapter 6. Turkey

1. Energy Context

The limited production capacity of domestic energy sources relative to the growing energy demand have resulted in a high dependency on energy imports, primarily oil and gas. At present, around 30 per cent of the total energy demand is being met by domestic resources, while the rest originates from a diversified import-portfolio. Turkey attaches utmost priority to further diversification of imports in both type and origin. Exploration and production activities are also being intensified in this context. It is important to underline here that although Turkey is not a major hydrocarbon producer, its merging role as an important energy transit country makes it increasingly important to world energy markets and especially the European one.

Turkey has been experiencing substantial demand growth in all segments of the energy sector. Driven by strong population growth, urbanization and economic expansion, the primary energy consumption almost tripled over the period 1980 - 2005 (see Figure 64) while reaching about 86 Mtoe in 2005. The primary energy need of Turkey has thus been growing by some an average of 6% per year for decades. In the same period, energy consumption per capita increased from 0.7 to 1.2 toe.

Figure 64 Turkish TPES (total and per capita) and population (1980-2005)



Source: OME.

Recent forecasts indicate that this trend is expected to continue and primary energy demand is projected to reach 220 million toe in 2020, amounting to a three-fold increase compared to the current figure. Pressure on energy demand has therefore become a major concern. Being able to meet demand will require substantial investment in means of production, transport and distribution, and infrastructure developments for gas and electricity.

Estimations of the Ministry of Energy and Natural Resources evaluated investment needs for the domestic market for the period 2005-2020 at about US\$ 130 billion (around 100 for the electricity sector alone, see Table 24). The State alone cannot meet the investment needs, which is the reason why the energy sector has been opened to private national and international capital. The Turkish government indeed encourages foreign and Turkish private sector investors to undertake energy projects and is currently working on a new investment model for the construction of new generation plants to create the additional capacity needed.

Table 24 Investment Needs of the Turkish Energy Sector 2005-2020

Sector	Investment (\$ Million)
Coal Exploration & Extraction	5,109
Oil	16,000
Natural Resources	2,700
Water (DSI)	6,093
Generation (EUAS)	458
New Generation Facilities	91,276
Transmission	938
Distribution	6,000
Total	128,574

Source: Ministry of Energy and Natural Resources (MENR)

TURKISH ENERGY MARKET

Growth for infrastructure and financing

Turkish Energy sector offers one of the top growth opportunities for an array of business segments within the next decade. The growth drivers are diverse:

- *The continuing steady growth of GDP, rapid growth of consumption per capita and demographic structure in Turkey will drive a double digit demand growth at a multiple of GDP.*
- *The geographic disparity between the sources of primary energy and demand for oil and gas is also driving growth for transportation of these commodities. Turkey's strategic location among multiple sources and consumers of primary energy will continue to drive the pipeline investments, while presenting opportunities for shipping industry vertical and its adjacencies such as ports.*
- *Continuing high input prices and dependency for imported gas have been creating a compelling case for increased renewable energy investments and entry into nuclear energy production.*
- *Continuing deregulation including privatization of electric distribution will bring new investments in distribution and control technologies.*

This represents an approximately US\$100 billion business potential in the next decade for multiple industry verticals, and needless to say this would not happen without financing models.

Source: Kursat Ozkan, General Electric Turkey

The electricity sector is also facing a spectacular increase in Turkey. The country's electricity yearly demand growth rate reached 6.6% between 1996 and 2005 (Table 25) and is projected at 8.4% for the decade 2006-2015. This is in line with the new supply and demand projection

revised in February 2006⁸⁸. The electricity consumption, which peaked to 161 billion kWh in 2005, is envisaged to increase almost two-fold by 2015 reaching to 354 billion kWh (Table 26). This requires installed capacity to increase about one point eight fold – from about 38,863 MW in 2005 to 71,470 MW by 2015. These figures are well above the EU average and, combined with the low per capita consumption levels, are an indication of the vitality of the sector.

Table 25 Peak Load and Electricity Consumption of Turkish Electricity System 1996–2005

	Peak Load (MW)	Increase (%)	Electricity consumption (GWh)	Increase (%)
1996	15231	7,5	94789	10,8
1997	16926	11,1	105517	11,3
1998	17799	5,2	114023	8,1
1999	18938	6,4	118485	3,9
2000	19390	2,4	128276	8,3
2001	19612	1,1	126871	-1,1
2002	21006	7,1	132553	4,5
2003	21729	3,4	141151	6,5
2004	23485	8,1	150018	6,3
2005	25174	7,2	160899	7,2

Source: TEIAS, 2006

Table 26 Demand forecasts (2006-2015)

YEAR	Peak Load		Energy demand	
	MW	Increase (%)	GWh	Increase (%)
2006	27500	-	171430	-
2007	29810	8.4	185830	8.4
2008	32314	8.4	201440	8.4
2009	35028	8.4	218361	8.4
2010	37971	8.4	236703	8.4
2011	41160	8.4	256586	8.4
2012	44618	8.4	278139	8.4
2013	48366	8.4	301503	8.4
2014	52428	8.4	326829	8.4
2015	56832	8.4	354283	8.4

Source: TEIAS, 2006

⁸⁸ www.teias.gov.tr, Turkish Electrical Energy-10 year Generation capacity Projection 2006-2015

In 2005, total electricity installed capacity reached 38.8 GWe in Turkey. This capacity corresponds to 162 TWh generated and a total electricity demand of 161 TWh. The structure of the power generation in 2005 was the following: 45.3% by gas fired plants (combined cycle and cogeneration), 24.4% hydropower plants, 26.6% by coal + lignite power plants, remaining 3.7% by oil and LPG fired plants and others (Table 27).

Table 27 Installed Capacity and Energy Balance in the Turkish System in 2005

Category	Absolute Value	Share
Thermal Installed Capacity	25,902 MW	66.8%
Hydraulic Installed Capacity	12,906 MW	33.2%
Geothermal Installed Capacity	15 MW	0.04%
Wind Installed Capacity	20 MW	0.05%
Total Installed Capacity	38,863 MW	100%
Thermal Generation	122,242 GWh	75.5%
Hydraulic Generation	39,561 GWh	24.5%
Geothermal Generation	122 GWh	
Wind Generation	59 GWh	
Total Generation	162,200 GWh	
Total Exports	1,798 GWh	
Total Imports	636 GWh	
Total Electricity Consumption	160,899 GWh	

Source: TEIAS, 2006

The power investments which are currently in progress (licensed, under construction, in the commissioning) will add to the existing capacity just enough to meet power demand up to year 2012 and in meeting energy demand up to year 2010. After year 2010, at least 4000 MW per year of new power capacity will have to be added to the Turkish National Grid.

On the basis of power demand projections of 8.4% per year, which is in line with the Turkish Electricity Transmission Company's new long term development plan projections, a total of 32,626 MW new capacity investments will have to be added to the system to meet the peak demand between the year of 2006 and 2015 (Table 28). Installed capacity of the projects under construction is 3752 MW.

Table 28 Additional capacity requirement to meet demand (MW)

	2006-2010	2010-2015
Thermal	4590	15020
Hydro	4335	7132
Wind+Other Renewables	926	625
Total	9850	22776

Source: TEIAS, 2006

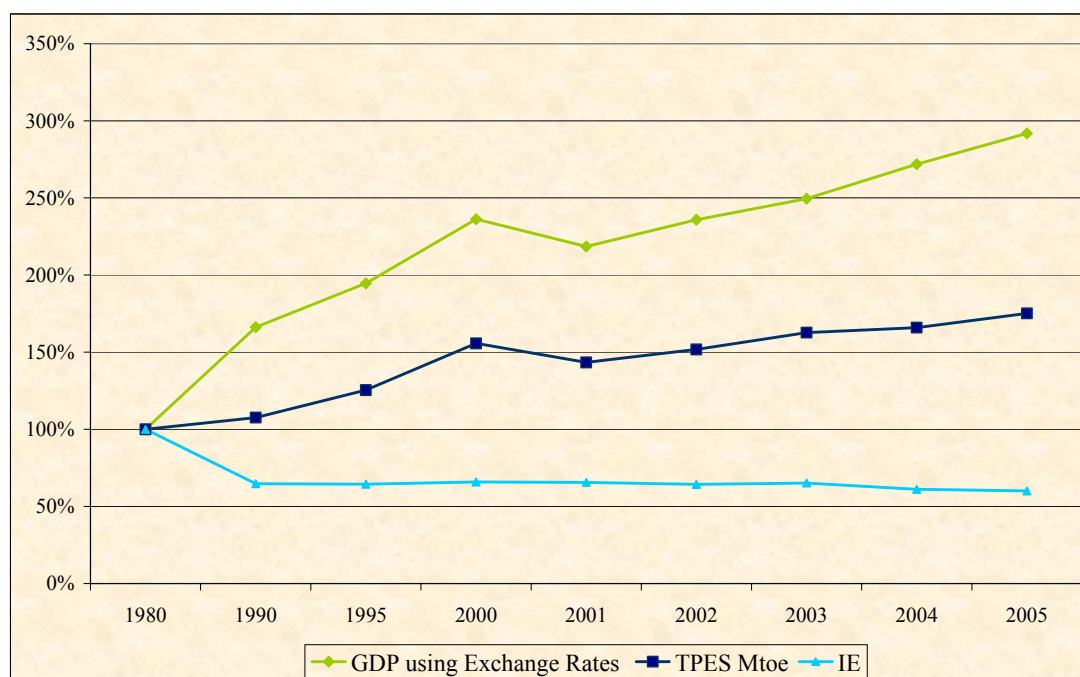
	Electricity Generation (TWh)			
	2005	2010	2020	Additional 05/20
Nuclear	0	0	32	32
Conventional Thermal	122	180	333	211
Hydro	40	57	110	70
Other Re	0,3	5,3	8,8	8,5
<i>of which</i>				
Geothermal	0,1	0,3	0,3	0,2
Wind	0,1	4,9	8,4	8,3
Total	162	242	483	321

Source: Eurelectric, Europrog December 2006,

Generating Capacity by Source (MW)			
2005	2010	2020	Additional 05/20
0	0	4 500	4 500
25 902	30 749	57 939	32 037
12 906	16 202	30 795	17 889
55	1 888	3 138	3 083
<i>15</i>	<i>50</i>	<i>50</i>	<i>35</i>
<i>20</i>	<i>1 788</i>	<i>3 038</i>	<i>3 018</i>
38 863	48 839	96 372	57 509

Figure 763 illustrates the trends for TPES, GDP and energy intensity (EI) during the period 1980-2005 (year 1980 = 100). Over the period 1990-2003, energy supply and GDP growth followed the same trend of development. The energy intensity was thus relatively stable. Since 2003, EI is on a relative decreasing trend. Globally, Turkey's EI measured at 58 koe/1000 US\$ 2000 in 1980 decreased to 35 koe/1000 US\$ 2000 in 2005.

Figure 65 TPES, energy intensity and GDP in Turkey (1980 = 100)



Source: based on OME Database

Turkey accords importance to more efficient and rational functioning of the energy sector in order to promote the competitiveness of the national economy. In this regard, substantial progress has been achieved in restructuring and liberalizing the energy market. Harmonization of the legal and regulatory framework with that of the EU is one of the priorities. The legislative framework has been modified to be compatible with that of the EU countries since 2001. In this respect, Electricity, Natural Gas and Petroleum Market Laws were enacted to enforce private sector involvement under independent regulation and supervision of the Energy Market Regulatory Authority (EMRA).

Utilization of renewable energy sources in order to reduce the energy import dependency and to foster greenhouse gas abatement is another. As we will see in more detail later, the Renewable Energy Law was enacted in 2005 in order to encourage renewable-based generation in competitive market conditions. Supporting mechanisms such as feed-in tariffs and purchase obligation are defined in the law, in conformity with the EU legislation and practice. These mechanisms are envisaged to facilitate the development of power plants based on renewable energy sources.

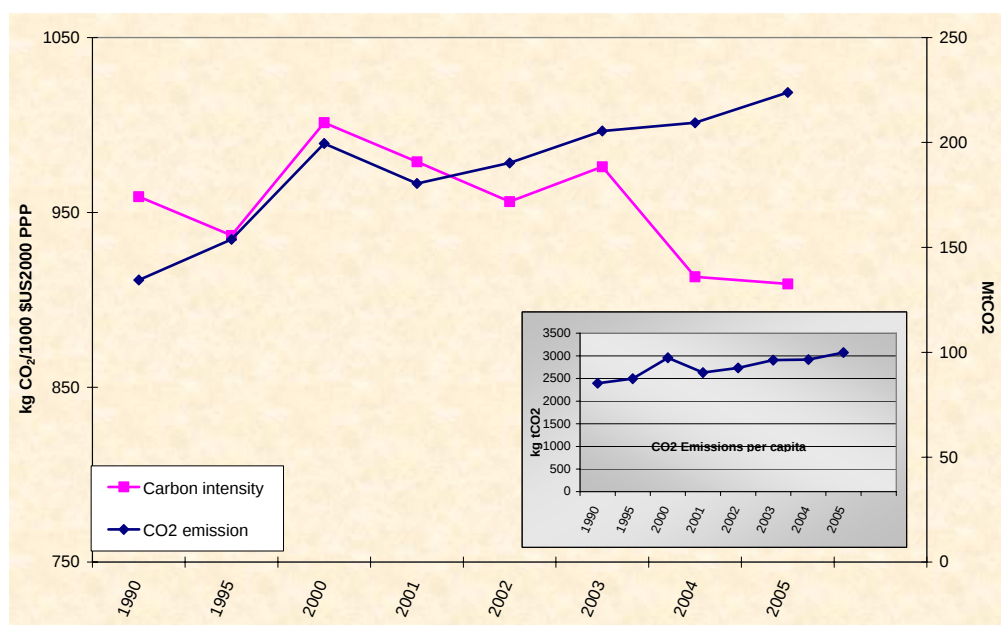
Turkey also acknowledges the need to reduce energy intensity and to improve energy efficiency. To this end, several programs aiming at improved energy efficiency are underway, while the necessary arrangements are being made with a view to enhancing the efficient use of energy and energy resources.

2. Environmental Context

Turkey is facing important environmental problems particularly due to its explosive economic growth. These are air mainly: pollution (particularly in urban areas), deforestation, concern for oil spills from increasing Bosphorus ship traffic and water pollution from dumping of chemicals and detergents.

On an increasing trend up to the early 2000s and relatively stable one over the period 2000-2003, Turkey's carbon intensity decreased at a level below the situation in 1990. In 2005, it stood at about 0.9 tCO₂ per thousand \$US2000. This decreasing trend can be primarily explained by the governments's commitment to heavily substitute coal with natural gas in all possible sectors of the economy and to promote energy efficiency and renewable energy. However global CO₂ emissions are still on a growing trend and reached 224 MtCO₂ (in comparison to 134 MtCO₂ in 1990). In addition, although low compared to advanced European economies, Turkey's per capita carbon emissions are increasing rapidly. These emissions stood in 2005 at almost 3 tCO₂ (in comparison to 2.4 in 1990).

Figure 66 *Energy-related CO₂ emissions (1990-2005)*



Source: OME

As of the UNFCCC and the Kyoto Protocol, upon negotiations at the meeting of the UNFCCC Intergovernmental Negotiation Committee at New York in May 1992, Turkey was included in the Annex I list, with OECD member countries and countries with economies in transition, and also in the Annex II list along with the OECD countries.

Through this inclusion in both annexes, Turkey was considered among industrialized countries, and thus, was obliged to fulfil all the commitments of industrialized countries. Turkey did not sign the Convention at the Rio Conference in June 1992 and has not become a Party, because of the difficulty for Turkey to stabilize emissions of greenhouse gases, particularly energy-related CO₂ emissions, to their 1990 levels by the year 2000, and to provide financial and technical assistance to developing country Parties. Nevertheless, Turkey has been a keen observer of the UNFCCC process from its start and has reiterated its request to become a Party to the Convention, subject to the deletion of its name from both annexes.

The decision No: 26 of the 7th Conference of Parties (COP7) to the UNFCCC which convened in Marrakech in 2001 deleted the name of Turkey from Annex-II and invited Parties to recognize the special circumstances of Turkey. Thus, after becoming a Party to the UNFCCC, Turkey was placed in a situation different from that of other Parties included in Annex-I to the Convention. Turkey acceded as the 189th Party to the UNFCCC on 24 May 2004. But Turkey was not a Party to the UNFCCC when the Kyoto Protocol was adopted in 1997. Hence, no quantified emissions limitation or reduction commitment was defined for Turkey in Annex-B of the Kyoto Protocol. Thus, Turkey is not a Party to the Kyoto Protocol yet. Turkey's position to the Kyoto Protocol is summarized in Table 29.

Table 29 Comparison of Turkey's position to the KP with selected countries

USA and Australia	Turkey and Belarus*
- Listed in Annex-I to the UNFCCC, - Listed in Annex-B to the Kyoto Protocol (mitigation commitment), - Signed the Kyoto Protocol but Not ratified it !	- Listed in Annex-I to the UNFCCC, - Not listed in Annex-B to the Kyoto Protocol (no quantified emissions limitation or mitigation commitment yet), - Therefore, Not a Party to the Kyoto Protocol yet !

* Belarus acceded to the KP in August 2005. The KP entered into force for the country on 24 November 2005
Source: REC Turkey, 2005

An inter-ministerial Coordination Board on Climate Change was established for the preparation of the national communication. The preparation process is being coordinated by the Ministry of Environment and Forestry. A technical committee for Climate Change has been set up to contribute to the preparation of the national communication. The REC Turkey is the Turkish national focus point for UNFCCC Article 6 (Education, training and public awareness)⁸⁹.

The Technical Committee for Climate Change operates through 8 thematic working groups (of which one on energy) in coordination with the Ministries such as the Ministry of Environment and Forestry, the Ministry of Energy and Natural Resources, the Ministry of Foreign Affairs, the Ministry of Transport, the Ministry of Agriculture and Rural Affairs State Planning Organisation and TURKSTAT.

⁸⁹ see: www.rec.org.tr/climate.htm

As for the flexible mechanisms, Turkey's most concrete experience was achieved during an EU funded SYNERGY Project which was made public during an international workshop in Istanbul on 16-18 February 2005. The following 6 projects were proposed for funding as a CDM project but the process was terminated due to the position of the Turkey to the Kyoto Protocol.

- Pyrolysis-Gasification of Municipal Solid Waste to Electricity;
- Wind Energy for the Istanbul Water Authority Durusu District Pumping Station;
- Sanitary Landfill Area LfG-to-Electricity Project;
- Power Plant Efficiency Monitoring and Optimization Software Project;
- Energy Efficient Schools in the City of Erzurum;
- Ground Cooling with Boreholes for Telecommunication Stations in Turkey.

The workshop served to develop several alternatives for future involvement of Turkey to the Kyoto Protocol, including ratification of KP in the soonest, implementing JI projects, and benefit from CDM projects as a non-Annex B Party of the Protocol.

As for carbon transactions, the first one took place in June 2006. 3C (Climate Change Consulting GmbH) purchased emission reduction certificates from Bilgin Energy's wind power plant project 'BARES II' in Balikesir. The first carbon transaction in Turkey between Bilgin Energy and 3C shows that the carbon market has become a truly global market. In early June 2006, 3C and Bilgin Energy signed an Emission Reduction Purchase Agreement for 72.000 metric tonnes of emission reduction certificates – so-called Verified Emission Reductions (VERs) – from Turkey's first large scale wind power park located in the Balikesir Region close to the Sea of Marmara. The project involves the installation of 20 wind power turbines with a total capacity of 30 MW. 3C purchased the emission reduction credits on behalf of 3C's carbon offset client Credit Suisse in Switzerland.

Turkey is an EU accession country and so environmental legislation is expected to be harmonised with EU regulations. In this context, Turkey supports the efforts of the EU to deal with the challenges of climate change. The country has always been keen to apply internationally agreed principles and to act in accordance with the requirements of "sustainability" and "common but differentiated responsibilities" and "respective capabilities".

Turkey is ready to cooperate with the international community in outlining a scheme for the post- Kyoto mechanism, in order to ensure that there is no gap between the first and second commitment periods. The major issue for Turkey having less greenhouse gas emissions per capita than both OECD countries and the countries of economies in transition, is how to contribute to reducing the burden on global resources at a low cost and without jeopardizing its economic and social development prospects.

3. Integration of renewable energy sources

Renewable energy production in Turkey reached 12.3 % of total primary energy supply i. e. 10.8 Mtoe in 2004. Electricity generation from renewables was 31 % in 2004. Renewables are the second largest contributor to domestic production after coal. Renewable energy supply in Turkey is dominated by hydropower and biomass. The contribution of wind and solar is limited but is expected to increase. This section provides a brief description of the existing RE potential, the current RE situation in the energy balance and the legislative/regulatory framework in place in Turkey.

4.1. Renewable energy resources and potential

Solar

Turkey is located in a relatively advantageous geographical position. Indeed, located in 36° and 42° N latitudes, Turkey is in the solar zone. Average annual temperature is 18 to 20°C on the south coast, falls to 14-16°C on the west coast and fluctuates between 4 and 18°C in the central parts of the country. The solar energy potential evaluations made by EIE, based on the data measured by the State Meteorological Services during 1966-1982 revealed an annual average total sunlight period of 2640 hours (daily total 7.2 hours) and an average annual solar radiation of 1311 kWh/m²-year (3.6 kWh/m²-day). Monthly solar energy potential of Turkey is given in Table 8 30. Solar energy potential according to the geographical regions is given in Table 31.

Table 30 Monthly average potential for Turkey

MONTHS	MONTHLY TOTAL SOLAR ENERGY (Kcal/cm²-month) (kWh/m²-month)		SUNSHINE DURATION (hours /month)
January	4,45	51,75	103,0
February	5,44	63,27	115,0
March	8,31	96,65	165,0
April	10,51	122,23	197,0
May	13,23	153,86	273,0
June	14,51	168,75	325,0
July	15,08	175,38	365,0
August	13,62	158,40	343,0
September	10,60	123,28	280,0
October	7,73	89,90	214,0
November	5,23	60,82	157,0
December	4,03	46,87	103,0
TOTAL	112,74	1311	2640
AVERAGE	308,0 cal/cm²-day	3,6 kWh/m²-day	7,2 hours/day

Source: General Directorate of EIE

Since 1992, EİE and DİM are taking solar energy measurements to ensure that the solar energy values can be measured in a sounder manner. Following the ongoing measurements, the solar energy potential in Turkey is expected to be 20-25% higher than the previous values. The South East Anatolian Region is the area receiving the highest solar energy in Turkey, followed by the Mediterranean Region.

Table 31 Regional Distribution of Solar Energy Potential of Turkey

REGION	TOTAL SOLAR RADIATION (kWh/m ² -year)	SUNSHINE DURATION (hours/year)
Southeastern Anatolia	1460	2993
Mediterranean	1390	2956
East Anatolia	1365	2664
Central Anatolia	1314	2628
Aegean	1304	2738
Marmara	1168	2409
Black Sea	1120	1971

Source: General Directorate of EİE

A model was developed with the data from the 8 measurement stations of EİE and with the data from the DİM measurement stations. Accordingly, the solar radiation and insolation values are calculated for 57 cities of Turkey.

In total, the average annual solar energy potential of Turkey is estimated at 87 million ton of oil. It has also been calculated that Turkey receives 11 thousand times the amount of electricity generated in Turkey in 1996 (Sozen and Arcakıglou, 2005; Sozen et al. 2004).

Wind

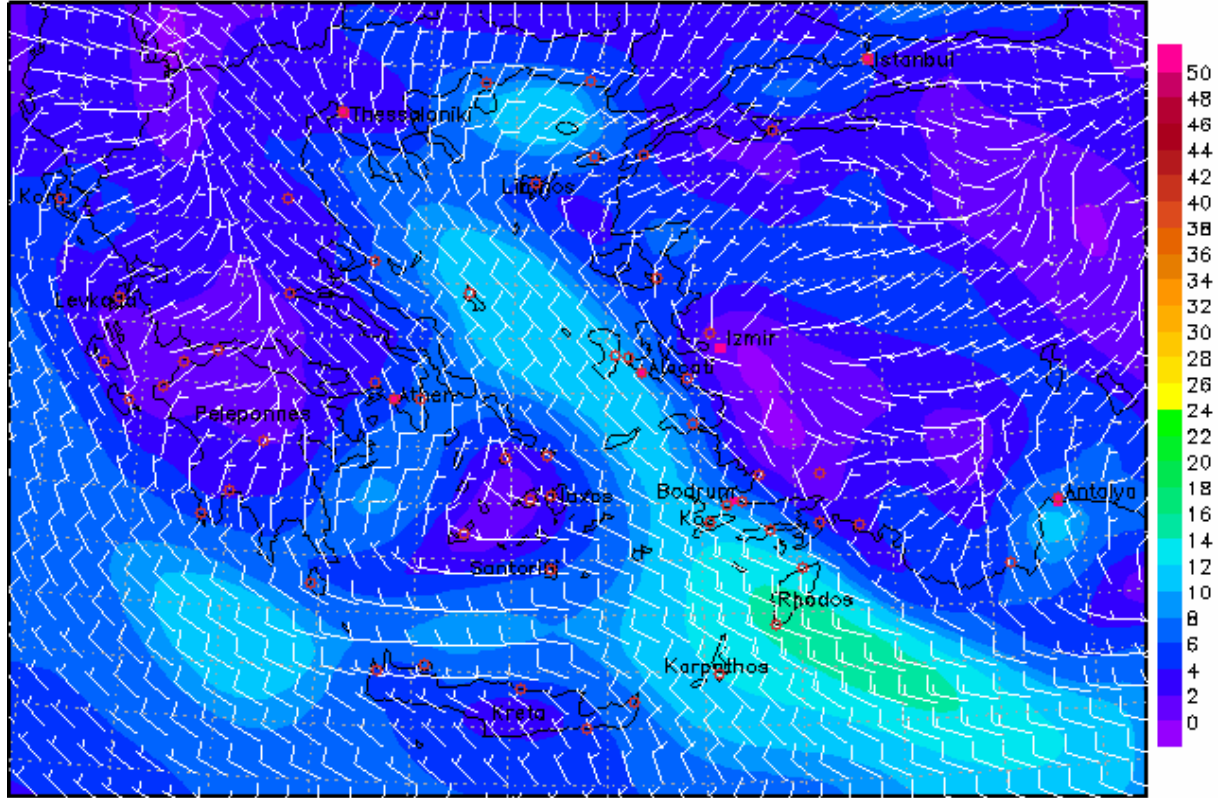
According to the EİE data, Turkey is one of the wealthiest countries in Europe in terms of wind energy, and the wind energy resources are at a level that is sufficient to meet the entire energy requirements. The EİE General Directorate and the DİM General Directorate completed the “Turkish Wind Atlas” in June 2002. Accordingly, it is stated that in terms of wind energy Bandırma, Antakya, Kumköy, Mardin, Sinop, Gökçeada, Çorlu and Çanakkale are bountiful areas.

Furthermore, the regional potential is being studied in areas such as Bandırma, Bozcaada, Çeşme, Gökçeada, Çanakkale, Karadeniz Ereğlisi, Florya and Siverek. In total, technical wind potential is approximately 88,000 MW, the second most powerful wind area on the European continent after the UK, and economically viable wind potential is approximately 10,000-12,000 MW. Figure 1067 illustrates wind forecasts by Windfinder⁹⁰ for the June 15, 2007. Figure 68 illustrates the wind atlas for Turkey.

⁹⁰ www.windfinder.com

Figure 67 Wind forecasts in Turkey (as for 15 June 2007)

wind at 15.6.2007, 6:00 local time (15.6.2007, 3:00 UTC)

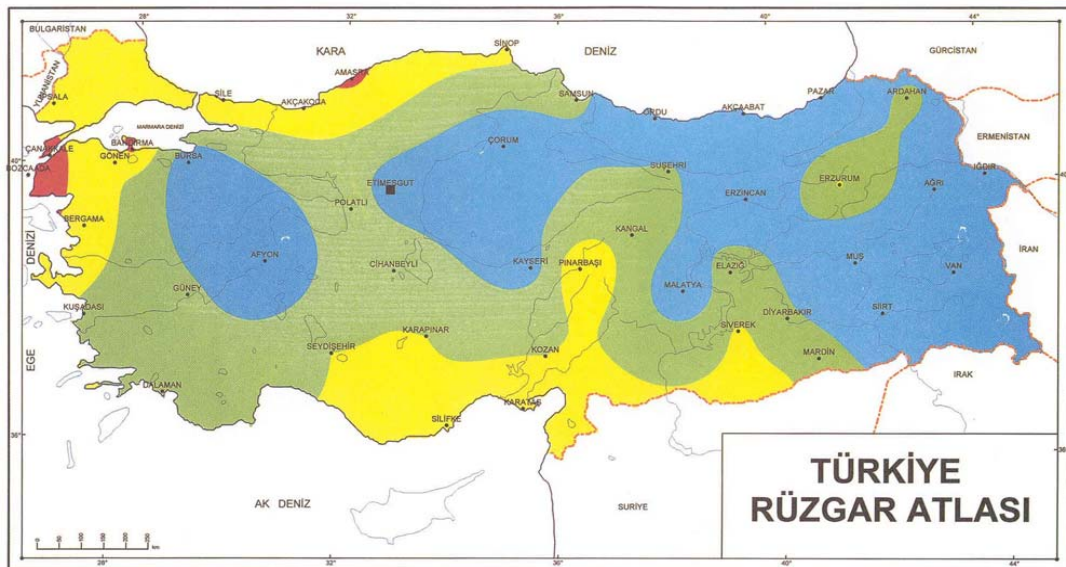


© Windfinder.com

Last Update: 15.6.2007 2:27 (Timezone: Greece), Wind in Knots

Source: Windfinder, http://www.windfinder.com/forecasts/wind_greece09.htm

Figure 68 Wind Atlas of Turkey



Beş farklı topografik durum için yer seviyesinden 50 m yükseklikteki rüzgar potansiyelleri¹

Kapalı Araçlar ² ms ⁻¹ Vn ³	Açık Araçlar ² ms ⁻¹ Vn ³	Kıyılar ⁴ ms ⁻¹ Vn ³	Açık Deniz ² ms ⁻¹ Vn ³	Tepe ve Bayır ⁵ ms ⁻¹ Vn ³
>6.0 150-250	>7.5 300-500	>8.5 400-700	>9.0 600-800	>11.5 1200-1800
5.0-6.0 100-150	6.5-7.5 200-300	7.0-8.5 250-400	8.0-9.0 400-600	10.0-11.5 700-1200
4.5-5.0 50-100	5.5-6.5 100-200	6.0-7.0 150-250	7.0-8.0 200-400	8.5-10.0 400-700
3.5-4.5 20-50	4.5-5.5 50-100	5.0-6.0 50-150	5.5-7.0 100-200	7.0-8.5 200-400
<3.5 <50	<4.5 <100	<5.0 <150	<5.5 <200	<7.0 <400

- Rüzgar potansiyeli, rüzgarın gücünü temsil etmektedir. Rüzgar türbini halihazırındaki potansiyelin % 20 ile % 30 luk bölümünü kullanabilir. Potansiyel hesaplamaları; deniz seviyesinde 1 Atm lik standart basınç ve 15 °C sıcaklığa karşılık gelen 1.23 kg/m³ hava yoğunluğuna göre yapılmıştır.
- Yerleşim alanları, ormanlar ve rüzgar kırıcıları yoğun olduğu tarım alanları (pürüzlülük sınıfı 3)
- Az sayıda rüzgar kırıcının olduğu açık araçlar (pürüzlülük sınıfı 1). İç bölgelerde en fazla tercih edilen alanlar genellikle bu sınıfta bulunmaktadır.
- Düzgün kıyı alanları ve çok az sayıda rüzgar kırıcı içeren kara yüzeyleri (pürüzlülük sınıfı 1). Eğer hakim rüzgar yönü deniz tarafından ve sürekli ise, potansiyel daha fazla olabilir. Tam tersi durumda ise potansiyel daha az olabilir.
- Kıyılardan en az 10 km uzaklıktaki açık denizler (pürüzlülük sınıfı 0).
- Bütün sınıflarda % 50 ye varan bir hız artışı görülmektedir ve bu sonuç 400 m yüksekliğinde ve 4 km çapındaki simetrik bir tepede yapılan hesaplamalarda elde edilmiştir. Rüzgar hızındaki artış; tepenin yüksekliğine, uzunluğuna ve yapısına bağlıdır.

Hydro

According to DSI, the gross theoretical potential of Turkey 's hydraulic resources, calculated with average conditions of flow and fall is 433 GW that is equal to 1.2% of the world total hydropower potential and 14% of the European hydropower potential. Accordingly, the technical potential that can be obtained from this resource, based solely on technical feasibility regardless of economical viability, is 216 GW while the usable potential based on both technical feasibility and economical viability is approximately 130 GW.

Turkey has also a lot of potential for small hydropower (<10 MW), particularly in the eastern part of the country.

Commercial biomass and wastes

Because of the plant remains and animal manure in wide agricultural areas, Turkey is rich in terms of biomass. Organic animal waste potential is 34 thousand tonnes dry mass/day. Commercial biomass potential is 15 Mtoe, of which 6 million toe is being used and 2 Mtoe may be used for biofuel production.

Biogas production potential has been estimated at 1.5- 2 Mtoe. Biodiesel production capacity is 1.5 million tonnes/ year. Bioethanol production capacity is 3 million tonnes/ year. If biomass' modern usage can be increased in Turkey, this energy would supply Turkey's energy need in the agricultural sector. In total, the amount of annual biomass potential of Turkey is approximately 32 Mtoe.

Geothermal

Turkey has one eight of the world's geothermal potential and is ranked 7th in the world. Turkey, located in an interesting position between the Euro-Asian and African continents, is among the lucky countries from the aspect of geothermal potential.

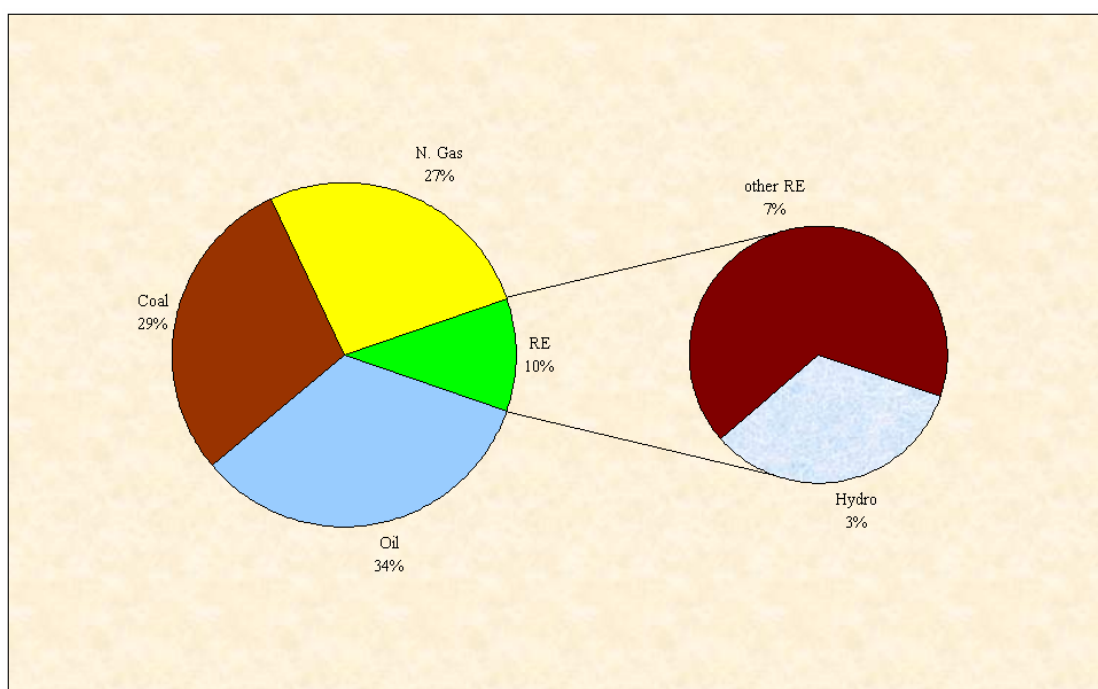
Total geothermal potential is 5000 MWe and 31,500 MWt. This potential is equivalent to 5 million household heating or 150,000,000 m² greenhouse heating or over 1 million mineral bath bed capacity or 9.3 billion USD/year Fuel-Oil equivalent (30 million ton/year) or 30 billion m³ /year natural gas. The proven geothermal capacity of the wells is 2,925 MWt.

4.2. Current renewable energy situation

Contribution of RE to the energy balance

RE sources accounted for about 9 Mtoe in 2005. Figure 1169 illustrates that the share of RE is about 10% of total primary energy supply (TPES). This includes basically biomass, waste, geothermal and hydro.

Figure 69 **The share of RE in total primary energy consumption in Turkey (2005 - %)**



Source: OME database

Main **solar energy** utilisation in Turkey is the flat-plate solar collectors for domestic water heating. The systems are widely used and commercially available in the country. Turkey is indeed one of the leading countries in the world with a total installed capacity of 12 million m² collector area as of 2005, including both household systems and large-scale use in hotels, industrial activities, etc. The systems are mostly used in the Aegean and Mediterranean regions. Total energy production amounts to 0.41 Mtoe. Annual collector manufacturing capacity is 1 million m². The EIE installed a computer-aided test stand in order to enable the manufacturers to improve the quality and efficiency of the collectors. It used the test stand to help the Turkish Standard Institute to develop new standards for collectors.

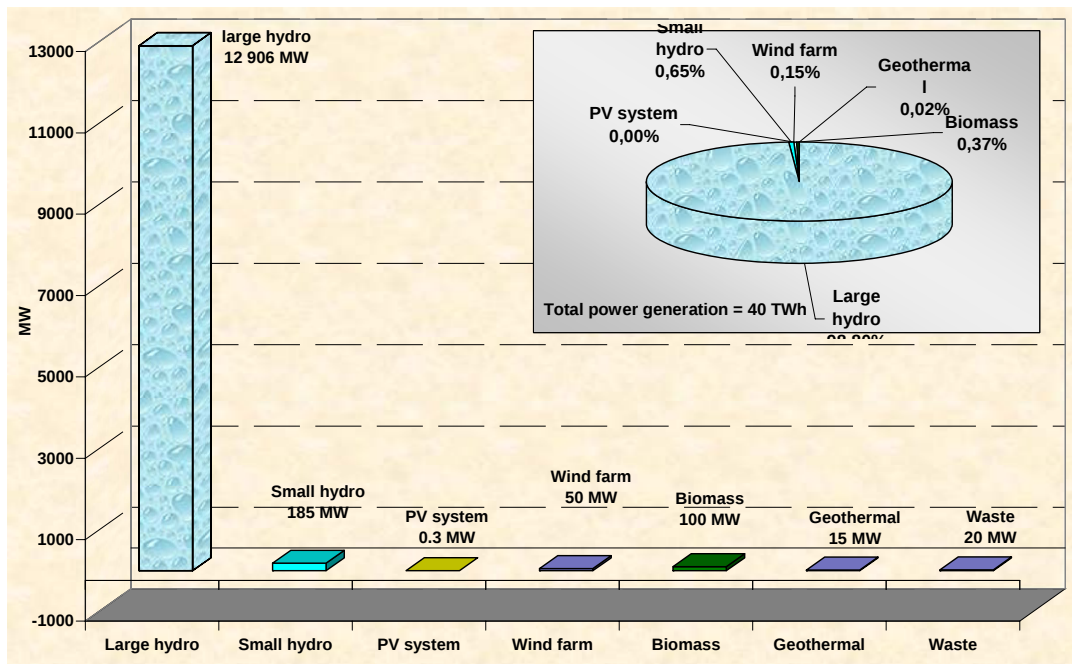
The EIE has also developed a parabolic solar cooker and has studied the possibility to use vacuum tube solar collectors in heating and cooling (IEA, 2005).

RE-based power capacity and generation

In 2005, total RE-based power capacity reached 12.91 GW, almost exclusively dominated by **hydro** resources (99.4%). About 185 MW (see the list in annex) of small hydro, 50 MW⁹¹ of wind farms, 20 MW geothermal power, 20 MW waste and 0.3 MW of **PV** applications account for the rest of RE-based power capacity.

Total RE-based power generation amounted to 39.9 TWh in 2005 (about 24.6% of total power generation), most of it generated by large hydro. Excluding large hydro, RE-based power generation represented 0.2% of the total (see Figure 12).

Figure 70 RE-based power capacity and generation in Turkey (2005, MW and TWh)



Source: OME based on OME database and direct communication

The most popular use of **geothermal energy** in Turkey is central heating systems and thermal tourism (mineral baths). According to the Turkish Geothermal Association data, geothermal power production capacity in Turkey is 20.4 MW, with production reaching 94 GWh/year. Accordingly, geothermal central heating in Turkey has a capacity of 827 MWt (equivalent to 103,000 houses) in applications such as cities, houses, thermal plants and greenhouses; and with the utilisation of a 402 MWt thermal plant, it has a total of 1229 MWt. In addition, a 25.2 MW Germencik is under construction by Gurmat ELK company and will be put on operation by 2007.

Concerning **PV systems**, utilization is limited with the usage of some governmental organisations in remote service areas such as telecom stations, traffic warning systems used during road maintenance works, irrigation and pumping systems, forest fire observation towers and highway emergency. The EIE has also implemented some small-scale stand-alone systems but also two grid-connected projects (4.8 and 1.2 kWp). Total installed peak power is estimated at 300 kWp.

⁹¹ including the 30 MW Bandirma wind farm put in operation in 2006

As for **wind**, the first wind energy in Turkey was obtained from the 55kW nominal power wind turbine installed in 1986 at the Çeşme Altinyunus Facilities. As of June 2006, the total installed capacity has reached 50 MW⁹², 95 MW are under construction and about 1,460 MW licensed. These licenses were given after the approval of related distribution/transmission companies for connection to the grid. If these wind farms could be constructed, about 1402 MW of wind would be integrated to the grid. This capacity corresponds to about 3.3% of the total installed (total installed capacity to meet the demand is envisaged as 41817 MW) and 4.7% of peak load (29810 MW) in 2007. In addition, 2750 MW total investment proposals are currently under study.

Figure 71 **Wind Farm in Bandirma**⁹³



8 new wind power plants are underconstruction with total installed power of 222,3 MW. Total license granted is 1.421 MW and total license applications is 7.420,00 MW (end of 206), Source-MRA.

⁹² Including the 30 MW Bandirma wind farm coming on stream in 2006.

⁹³ Wind farm in Bandirma (30 MW) recently inaugurated by the prime minister who said in his speech that “Turkey does not have oil and gas resources, but is rich in alternative energy resources”. Energy minister said that “with the new renewable energy law a new push is given to alternatives sources such as wind and solar”. The farm in Bandirma took 1 year to construct, has 20 turbines and will produce 120 million kWh per year. The electricity produced will satisfy the electricity need of Bandirma which has 100 000 inhabitants.

Wind Power Plants Under Operation in Turkey (2007)

Name	Location	License Type	Date	Unit power (MW)	Unit number	Total Installed Power (MW)
Delta Plastik Endustrisi Anonim Sirketi	Izmir-Cesme (Germiyan)	Autoproducer	1998	0,5	3	1,50
Alacati RES	Izmir-Cesme (Alacati)	BOT	1998	0,6	12	7,20
Bozcaada RES	Canakkale-Bozcaada	BOT	2000	0,6	17	10,20
SUNJUT Sun'ı Jut Sanayi ve Ticaret Anonim Sirketi	Istanbul-Hadimkoy	Autoproducer	2003	0,6	2	1,20
Bares Elektrik Uretim A.S.	Balikesir-Bandirma	Production	2006	1,5	20	30
Ertürk Elektrik Uretim Anonim Sirketi	Istanbul-Kumburgaz	Production	2006	0,85	1	0,85
Mare Manastir Ruzgar Enerjisi Santrali Sanayi ve Ticaret Anonim Sirketi	Izmir-Cesme	Production	2006	0,8	10	8
Total						58,95

The long term projections point out that the installed capacity of wind turbines could reach up to 1,790 MW in 2010 and 3,040 MW in 2020.

As mentioned earlier, Turkey is endowed with a high potential of **hydro** resources. Of this potential, 35% is operational (more than 135 plants representing a total generating power capacity of 12.9 GW), 8% is under construction, and the remaining 57% is at various project levels. Hydroelectric power production is 46 billion kWh annually as of mid-2006.

Turkey is developing a great deal more of hydropower plants, especially as part of the \$32-billion South-eastern Anatolia Project (GAP) along the basin of the Tigris and Euphrates rivers. Under the GAP project, which is considered one of the most ambitious water development projects ever undertaken, Turkey will erect 22 dams, 19 hydroelectric power stations (with around 7.5 GW of generating capacity), and an expansive network of tunnels and irrigation canals covering 1.7 million hectares of land. The GAP project is overseen by the South-eastern Anatolia Project Regional Development Administration. By the end of 2005, 8 hydropower plants had been completed, representing 74 percent of total planned energy projects under the GAP scheme. The 8 power stations generated 18.7 TWh of electricity in 2005, adding substantially to the share of hydroelectricity in Turkey's energy mix. The entire GAP project is scheduled to be completed by 2010.

In total, 4114 MW hydroelectric capacity are under construction or have been granted licenses by the regulator according to *May 2006 Progress Report of EPDK*. These licenses were given after the approval of related distribution/ transmission companies for connection to the grid. It is projected that an additional of 18 GW hydropower capacity will be completed by the year 2020 in Turkey.

As for **small hydro**, at present the total installed capacity is 185 MW in 74 locations, with annual generation of 260 GWh. Ten units are under construction with a total installed capacity of 118 MW and estimated annual production of 480 GWh. Furthermore, 210 projects are under planning with a total capacity of 844 MW and annual production of about 3.6 TWh.

At the end of 2006, the total installed capacity of **waste-fired** power plants was about 50 MW, all of which implemented in the industrial sector. There are no power plants in operation using biomass.

4.3. Institutional and legislative framework

Main actors⁹⁴

Electrical Power Resources Survey and Development Administration (EIE) founded on June 24, 1935 under law No. 2819 EIE, being governed by the provisions of private law and administrated in accordance with commercial methods, having the status of a juridical person and being bound to the Ministry of Energy and Natural Resources, carrying out engineering service with opportunity of production of electrical energy is an investor public organisation.

Main tasks of EIE regarding renewable energy and energy efficiency development are as follows:

- To make hydrological studies and Geotechnical research
- To execute Engineering services and design studies for dams and HEPPs
- To make research and studies for new and renewable energy resources (wind power, solar energy, etc.)
- To research water sources and other energy sources to determine if they are suitable for producing electricity.
- To carry out surveys and application studies for the rational use of energy resources
- To make studies of education, to research and to make people conscious of energy conservation at the sector of industry, residence, and transportation.
- To execute nationalizing process, control of plant of HEPP realized based on Built-Operate-Transfer (BOT) project.
- To make investigation and research on specific fields for associations and establishment against payment.

EIE is thus the responsible organization from the development of renewable energy resources in Turkey. The EIE contributed to the preparation of the Renewable Energy Law recently adopted in Turkey (see section on regulatory and legislative framework).

On the solar radiation data; the **State Meteorological Service (DMI)** collects solar data. EIE also has been separately collecting data since 1991. Standards on solar energy system were prepared by Turkish Standard Institute. Currently there are two standards:

- TS 3680 – Solar Energy Collectors- Flat Plate
- TS 3817 – Rules for the Manufacturation, Installation and Operation of Solar Water Heaters

EIE contributed to the preparation of standards. Thermal performance tests of the certificate procedure are also performed by EIE. Regarding renewable energy research, in addition to EIE, TUBITAK Marmara Research Center and some universities (Ege University Solar Energy Institute, Mugla University, METU, Kocaeli University, Firat University, Sakarya University, etc.) carry on research projects.

⁹⁴ For detailed list of main actors in renewable energy, energy efficiency and environment in Turkey, please visit http://www.managenergy.net/emap/turkey_more.htm

Some manufacturers also do exist in Turkey. As an example, Auraset was among the pioneers in Turkey in starting the manufacturing of high quality solar water heater systems. Since 1982, Auraset has cooperated with the solar institutions and solar products manufacturers around the world to let the sun become the energy of our future. The areas of expertise of the company are: promoting the use of solar water heaters throughout the world, making solar water heaters more feasible and affordable, creating new application alternatives and extending the use of solar systems for every climate through R&D activities.

The Electricity Market Regulatory Authority⁹⁵ (EMRA) has the authority to regulate and control the energy market. It conducts activities aimed at creating a transparent and competitive energy market. It is responsible for taking measures, implementing incentive schemes and ensuring coordination with the related institutions to promote the use of renewable energy resources. It will be the authority that will issue green electricity certificates in the future.

Regulatory and legislative framework

The general structure of the regulatory and legislative framework pertaining to RE in Turkey is dominated by the following laws:

1. Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electricity (' Law on RES'), No: 5346 (Official Gazette: 18 May 2005, no. 25819)

- o By- law on Principles and Procedures for Granting Guarantee of Origin (Official Gazette 4 October 2005, no: 25956)

2. Electricity Market Law No: 4628 (Official Gazette 03 March 2001)

- o By- law on Electricity Market Licensing (Official Gazette 04 August 2002, no. 24836)
- o By- law on Electricity Market Grid (Official Gazette 22 June 2003, no. 25001)
- o By- Law on Balancing and Settlement (Official Gazette 21 Dec 2004, no. 25677)
- o Communiqué Regarding the Principles and Procedures of Financial Settlement in the Electricity Market (Official Gazette 4 Nov. 2003, no. 25279)

3. Biofuel Legislation

Law on Renewable Energy

The Turkish Parliament approved on May 2005 a renewable energy law (No: 534) which will provide feed-in tariffs for electricity from renewable energy sources. The objectives of the Energy Law are (i) to encourage the expansion of the use of renewable energy resources to generate electricity; (ii) the realization of dependable, economical and qualified use of such resources; (iii) the enhancement of resource diversity; (iv) to decrease greenhouse gas emissions; (v) the correct treatment of waste; (vi) the protection of environment; and (vii) the development of the generation sector required to achieve those aims.

The definition of renewable in the scope of Renewable Energy Law is similar to the classical definition with the exception of hydro. The criterion for hydro is based on lake-storage area

⁹⁵ more information at <http://www.epdk.gov.tr/>

instead of installed capacity. Any hydro power plant with a storage area smaller than 15 km² is treated as renewable.

The new renewable energy law will support mainly wind power by setting up a purchase guarantee of the average wholesale electricity price for a period of seven years for electricity generated from renewable energies. The regulator announced the Turkish average wholesale electricity price for the 2006 as 8.98 YKr/kWh. This will be the price applicable for renewable in 2006 since the Council of Ministers didn't introduce any increase. The US\$/YTL exchange rate has been fluctuating in the 1.4-1.5 range for a long time. This exchange rate makes the price for renewable vary between 5.99-6.41 UScent/kWh. This tariff, however, is well below the average price credit offered in the leading European wind markets.

Grid operators will be obliged in principle to provide access to the grid for renewable energy generators. An important aspect is that in principle also independent power producers can benefit from the feed-in tariff which can make it easier for local and rural populations and enterprises to benefit from the new legislation and to create a broad basis for an emerging Turkish renewable energy industry.

To determine and track the type of resources used in the generation of electricity energy, and the sale of RE in Turkey and internationally, the Energy Market Regulatory Authority (the EMRA) will issue a renewable energy resource certificate (RE Certificate) to the legal person holding a generation licence. The principles and procedures regarding the RE Certificate are governed under an EMRA regulation.

The Ministry of Energy and Natural Resources is authorized to coordinate the implementation, guidance, supervision, inspection and planning of measures necessary to achieve the above. The Energy Law also provides for the applicable principles for investment in, and investment periods for, RE projects. Also, if any land owned by the Treasury or the Ministry of Forestry, or land under the supervision of the state, needs to be used for RE energy generation, those areas can either be leased or easement rights can be established on the land.

Although this law is an important step towards supporting RE in Turkey, it is not expected to be sufficient to attract investment in small hydro, PV and biomass installations. These technologies will also require additional legislative measures.

The main support Mechanism of the RE Law

Principles of Implementation (Art. 6)

The price for the RES certified electricity within each calendar year shall be the average wholesale electricity price in the previous year determined by EMRA. This price is valid for the electricity produced from the Renewable Power Plants, starting up before 2011 and for the first seven years of operation. The Council of Ministers may raise this price up to 20% at the beginning of each year. Renewable power plants which start operation before 2011 shall benefit from this price in the first seven years. After seven years, the price will be set through bilateral agreements in the market, and the purchase obligation of the retail sale companies will continue.

The amount of RES certified electricity will be published by EMRA annually. There is a purchase obligation for the retail sale companies in the market from RES-based electricity

generation. If RES certified electricity is sufficient in the market, purchase obligation ratio not lower than 8% of the previous year's sales applies. Purchase obligation ratio for each retail sale companies to purchase RES certified electricity is the proportion of the previous year's sales of each company to total energy amount of the companies.

Implementations related to Acquisition of Land (Art. 8)

50% reduction for land use permission.

Sanctions (Art. 10),

The legal entities holding retail sale license in breach of the provisions of Article 6 of this Law shall be fined by EMRA and shall be warned to eliminate the violation in 60 days.

By- law on Principles and Procedures for Granting Guarantee of Origin

The scope of this Regulation covers the principles and procedures for granting Guarantee of Origin to the legal entities engaged in generation based on renewable energy resources.

Guarantee of Origin:

The certificate granted by the Authority to the legal entity holding generation license for the purpose of identification and monitoring of the resource type in purchasing and sale of the electricity generated from renewable energy resources in domestic and international markets.

Electricity Market Law No: 4628

The Electricity Marketing Law which was promulgated in 2001 has been implemented. The aim of this law is to provide the electricity cost effectively, quality, continuously, environmentally, competitively and transparently. For these purposes the Energy Market Regulatory Authority (EMRA) was established in 2001. As mentioned earlier, this authority is autonomous and arranges the energy market in Turkey.

By- law on Electricity Market Licensing

The regulation provides incentives for RES generation facilities:

- Pay only 1% of the total licensing fee.
- Exemption from annual license fees for the first eight years following the facility completion date.
- May purchase electricity from private sector wholesale companies on the condition not to exceed the annual average generation amounts.
- Priority for system connection.

By- law on Electricity Market Grid

Design and performance criteria of generation facilities (Arts. 19 and 21)

Generating units based on renewable energy resources that are not designed for frequency and voltage control, are not subject to these conditions and requirements.

By- Law on Balancing and Settlement (Art. 18)

Exempt from the liability of being a Balancing Mechanism entity.

Communiqué Regarding the Principles and Procedures of Financial Settlement in the Electricity Market (Official Gazette 4 Nov. 2003, no. 25279) (Provisional Art. 4, Art. 6)

Until the Balancing and Settlement Code takes effect, wind generation and canal- type hydro-electric generation facilities which sell electricity to wholesale and retail licensees are exempt from settlement.

Biofuel Legislation

Petroleum Market Law No: 5015 (Official Gazette 04 Dec 2003) Definitions and Abbreviations (Art. 2(7))

Products which are or shall be subject to an equivalent tax as liquid fuel, such as methyl tarsier butyl ether (MTBE), ethanol (except for those produced artificially from domestic agricultural products and bio- diesel) can be blended with liquid fuel;

By- Law on Petroleum Market Licence (Official Gazette 17 June 2004)

Definitions (**Art. 4 (5)**) Liquid Fuel: Benzine types, naphtha (except for raw material and solvent naphtha) gas oil, jet fuel, diesel fuel and fuel oil types with biodiesel.

By- Law on Technical Criteria for Petroleum Market (Official Gazette 10 September 2004)

Definitions and Abbreviations (Art. 4(h))

Liquid fuel: Benzine types, naphtha (except for raw material and solvent naphtha) gas oil, jet fuel, diesel fuel and fuel oil types with biodiesel.

Products which are or shall be subject to an equivalent tax as liquid fuel, such as methyl tarsier butyl ether, ethanol (except for those produced artificially from domestic agricultural products and bio- diesel can be blended with liquid fuel

Products that can be blended with liquid fuel and additive materials (Art. 8)

Refineries and distribution licence owners shall blend pure biodiesel and bioethanol with diesel and benzine. Except biodiesel, other liquid fuels shall not be blended with each other.

Liquid Fuel Production (Art. 9)

Liquid fuels shall only be produced by refinery licence owners except pure biodiesel and biodiesel produced as by product in industrial facilities.

Draft Law Amending Petroleum Market Law

Article 36: Refineries and distributors, acting in petroleum market, could blend biofuel, which are provided from biofuel producers using domestic agricultural products with diesel, proportion of 2%. Blending ratio and ‘Special Consumption Tax’ of blended product shall be determined by the Ministry of Finance.

Biofuel producers may get distributor and sale licenses to sell and distribute biodiesel which are produced by using domestic agricultural products, with the commitment of a selling projection for minimum 30 thousand tonnes biodiesel annually.

4. Barriers, priorities and targets of renewable energies

4.1. Barriers to renewable energy development

Although the institutional framework has improved in Turkey with the new Law on RE, it is not enough to really allow for a large scale integration of RE in the country. The Law supports wind much more than the other RE technologies. The main barriers are:

Financial: The economics of some RE technologies are in an unfavourable competitive position due to energy subsidies in the market, especially for domestic coal industry.

Weak inter-sectoral coordination and communication. The fields of RE and energy efficiency suffer from weak inter-sectoral coordination which not only tends to slow down the promotion of such projects, but also leads to the duplication of efforts and weakens human capital build up. Attaining broad stakeholder participation and reaching coordination among different stakeholders and various sectors of government are indispensable. The full integration of the different sectors (government, private sector, NGOs) may not be possible everywhere, but a minimum of collaboration is necessary and responsibilities of the various stakeholders must be clearly defined.

Human capital: Continuity of personnel is essential. Rotation of staff prevents a long-term accumulation of experience and the process becomes too dependent on individual involvement, or lack thereof. Additional capacity building and awareness raising in certain aspects of the sector may also be needed.

4.2. Priorities and targets for renewable energies

Turkey is aiming at exploiting its RE abundant resources available. Priorities are much more focusing on wind. Targets at horizon 2013 are presented in Table 32.

Table 32 Targets for RE integration in Turkey

	Units	2007	2010	2013
Hydroelectric	GWh	53,195	57,009	71,770
Geothermal Electricity	GWh	384	384	384
Geothermal Heat	Gtoe	1,208	1,650	2,239
Wind	GWh	3,841	4,890	5,938
Solar	Gtoe	441	495	558

Source: TEIAS, 2006

5. Conclusions

The energy strategy of Turkey is multi-dimensional. The gap in Turkey's energy supply and demand is one of the key elements which determine its energy policies. Hence, Turkey pursues policies to ensure diversified, reliable and cost-effective supply sources for its growing energy need in order to match its economic and social development while continuing the process of liberalization of its energy market. Another aspect of this strategy is to become a major consumption and transit terminal in its region. With its emerging and growing economy Turkey is facing a gradual increase in its demand for energy, estimated at an average 8 % per annum.

Enhancing the overall economic efficiency of the energy sector has been one of the biggest challenges for Turkey. In line with the ongoing harmonization process of the Turkish legislation with the EU, a new legal framework was put into effect to end the state monopolies and allow private sector participation in energy industries. The new Electricity Market Law allows for the non-discriminatory access to electricity transmission and connection services for all users. The same applies to natural gas and oil, as defined within the framework of Natural Gas Market Law and Petroleum Market Law. The new market models are based on cost-effective pricing so as to achieve competition in all segments.

Turkey aims at full utilization of the indigenous hard coal and lignite reserves, hydro and other renewable resources such as wind and solar energy to meet the demand growth in a sustainable manner. Integration of nuclear energy in the Turkish energy mix will also be one of the main tools in responding to the growing electricity demand while avoiding increasing dependence on imported fuels.

Thus, Turkey's interest in domestic renewable energy sources is gradually increasing in an effort to reduce dependency on foreign sources for energy production and the recently adopted Law on RE, although not sufficient to enhance RE in the country on a large scale is an important step in this direction.

Turkey also needs to increasingly focus on the demand side (energy efficiency) and less on the supply side in its energy security policies. Turkey's use of energy intensity is above the OECD average. Turkey can lower the energy intensity of its economy through conservation, adoption of energy-efficient technology, and the promotion of spheres of production that are less energy intensive. While the shifting emphasis to less energy intensive sectors can be painful domestically, in the long-run it will help Turkey achieve economic growth and promote the sustainable development of the country.

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ANNEX

Appendix A: Glossary

AAU:	Assigned Amount Units
ADB:	African Development Bank
AFD:	Agence Française de Développement
ANCC:	National Agency on Climate Change
ANER:	Agence Nationale des Energies Renouvelables
ANME:	Agence Nationale pour la Maîtrise de l'Energie
APEQUE:	Association pour la Promotion de l'Eco- Association pour la Promotion de Efficacité et la Qualité des Entreprises
APRUE:	Agency for the Promotion of the Rational Use of Energy
ARCE:	Association of researchers dealing with climate change issues
BEA:	External bank of Algeria
BOOT:	Build, Own, Operate, Transfer
BPRM:	Mining Research and Participation Bureau (Morocco)
CC:	Combined cycle
CDER:	Centre de Développement des Energies Renouvelables
CDM NC:	Clean Development Mechanism National Council
CDM PS:	Clean Development Mechanism Permanent Secretariat
CDM:	Clean Development Mechanism
CED:	Detroit Wind Energy Company
CER:	Certified Emission Reductions
CIEDE:	Centre d'Information sur l'Energie Durable et l'Environnement
CITET:	International Centre for Environmental Technologies
COP:	Conference of Parties
CSES:	Centre for Solar Energy Studies
DGE:	Direction Générale de l'Energie
Dh:	Dirhams
DNA:	Designated National Authority
DSI	General Directorate of State Hydraulic Works (DSI in Turkish acronym)
EB:	Executive Board
EC:	European Commission
EEAA:	Egyptian Environmental Affairs Agency
EEHC:	Egyptian Electricity Holding Company
EEPP:	Egyptian Environmental Policy Program
EET:	Tahaddart Electricity Company
EGD:	Electricity and Gas Distribution
EI:	Energy Intensity
ENIE:	National enterprise for the electronic industries
ERU:	Emission Reduction Unit
ESCOs:	Energy Service Companies
ET:	Emission Trading
FFEM:	Fonds Français pour l'Environnement Mondial

GAFI:	General Authority for Investment and Free Zones
GDP:	Gross Domestic Product
GECOL:	Libyan General Electricity Company
GEF:	Global Environment Facility
GEF:	Global Environment Facility
GHG:	Greenhouse gas
GME:	Maghreb-Europe Gas Pipeline
GPTC:	General post and Telecommunication of Libya
GT:	Gas turbine
GTZ:	German technical international cooperation office
GW:	Gas turbine
GWh:	Giga watt
GWh:	Giga watt hour
HCDS:	High Commission for the Development of the Steppe
ICP:	Insurance commercial partnership
IEA:	International Energy Agency
IMET:	Italian Ministry for Environment and Territory
IPP:	Independent Power Producer
ISCCS:	Integrated Solar Combined Cycle System
JI:	Joint Implementation
JLEC:	Jorf Lasfar Energy Company
KFW:	Kreditanstalt für Wiederaufbau
KP:	Kyoto Protocol
KP:	Kyoto Protocol
kWh:	kilo watt hour
LCOE:	Levelised cost of energy
LH:	Large Hydro
LOI:	Letter of intent
LYD:	Libyan Dinar
m ² :	Square meter
MATEE:	Ministry of Land-Use Management, Water and the Environment
MEDENER:	Network of the Mediterranean agencies in charge with energy efficiency
MEDREP:	Mediterranean Renewable Energy Programme
MEE:	Ministry of Electricity and Energy
METRAGAZ:	Maghreb-Europe Gas Pipeline Management Company
MOP:	Meeting of Parties
MSEA:	Ministry of State for Environmental Affairs
MSSD:	Mediterranean Strategy for Sustainable Development
MTPE:	Ministry of Territorial Planning and Environment
MW:	Mega watt
MWh:	Mega watt hour
NEAL:	New Energy Algeria
NGOs:	Non government organisations
NRC:	National Research Center

NREA:	New and Renewable Energy Authority
OEP:	Organization for Energy Planning
OME:	Observatoire Méditerranéen de l'Energie
ONAREP:	National Oil Exploration Authority (Morocco)
ONE:	Office National de l'Electricité
OTEC:	Ocean thermal conversion
PAM:	Policies and Measures
PDD:	Project Design Document
PERG:	Global Rural Electrification Program
PIN:	Project Information Note
PPA:	Power Purchase Agreement
PPP:	Power Purchase Parity
PV:	Photovoltaic
R&D:	Research and Development
RE:	Renewable Energy
RES:	Renewable Energy Sources
REWP:	Renewable Energy Working Party
RO:	Reverse Osmosis
SEMCs:	Southern and Eastern Mediterranean countries
SONELGAZ:	Algerian national electricity and gas distribution company
SSE:	Subsidizing solar equipment
ST:	Steam Turbine
STEG:	Société Tunisienne d'Electricité et du Gaz
SWH:	Solar Water Heaters
t:	Ton
TD:	Tunisian Dinars
TMIE:	Tunisian Ministry for Industry
toe:	Ton oil equivalent
TPES:	Total Primary Energy Supply
TWh:	Tera Watt hour
UNDP:	United Nations Development Programme
UNEP:	United Nations Environment Programme
UNFCCC:	United Nations Framework Convention on Climate Change
WBCSD:	World Business Council for Sustainable Development
WSSD:	World Summit for Sustainable Development

Appendix B: Electricity interconnection in the Mediterranean region: status and prospects

SUMMARY

In recent years, the SEMCs undertook to interconnect their power networks in order to further develop electricity exchanges. Among them, several interconnections are already in operation. This report describes the electricity interconnections in the Mediterranean region, including the ones which have been recently commissioned.

In addition to the existing interconnections, namely those of the Maghreb, Algeria is already interconnected to Tunisia (4 connections) and to Morocco (2 connections), recent connections were brought into service, including those linking Spain to Morocco, Libya to Egypt, Egypt to Jordan, and Syria to Jordan and Lebanon.

Several new interconnection projects are under way linking Morocco to Algeria (third connection), Algeria to Tunisia (fifth connection), Tunisia to Libya, Libya to Egypt, Syria to Turkey, and Turkey to Greece. Concerning the interconnections presently planned at 220 kV, their voltage is planned to be increased to 400 kV at a later stage.

With the start-up of the Spain-Morocco link in 1997, the two Mediterranean shores are already interconnected. After the recent doubling of the Spain-Morocco line in July 2006, the interconnection of the two shores will be further strengthened with the new undersea cable from Algeria to Spain and the interconnection projects Turkey-Greece, Algeria-Italy and Tunisia-Italy.

The new projects will enable major SEMCs to interconnect as well as to connect with the European network⁹⁶ following the completion of the "electrical loop" around the Mediterranean in 2008-2009. OME participated to the «MedRing»⁹⁷ study related to the behaviour of the "Mediterranean electrical loop" which is supported by the European Commission. The MedRing project (26 months study) was completed in May 2003.

Thanks to the completion of "the Mediterranean electrical loop", an increase in Mediterranean electricity exchanges is expected by 2010. According to the estimations of the MedRing study, power exchange will increase from the 69 TWh in 2005 to 75 TWh by 2010.

⁹⁶ In this respect, UCTE has played a major role providing the technical bases for many interconnections :- the grids of South-East Europe are parts of the UCTE synchronous system since 1974; - from 1995, the electrical systems of Poland, Czech Republic, Slovak Republic and Hungary are synchronously interconnected with UCTE; - North African countries Morocco, Algeria and Tunisia were interconnected with the main European electricity system via Gibraltar in 1997; - after meeting technical conditions, and successful completion of numerous tests, Bulgarian and Romanian operators of transmission systems became full members of UCTE in 2003; and - Western Ukraine has been running permanent operation with the UCTE system since 2003.

⁹⁷ Med-Ring study is coordinated by CESI, and in which most electricity companies from North, South and East Mediterranean are involved and almost all of them are OMEcompany members.

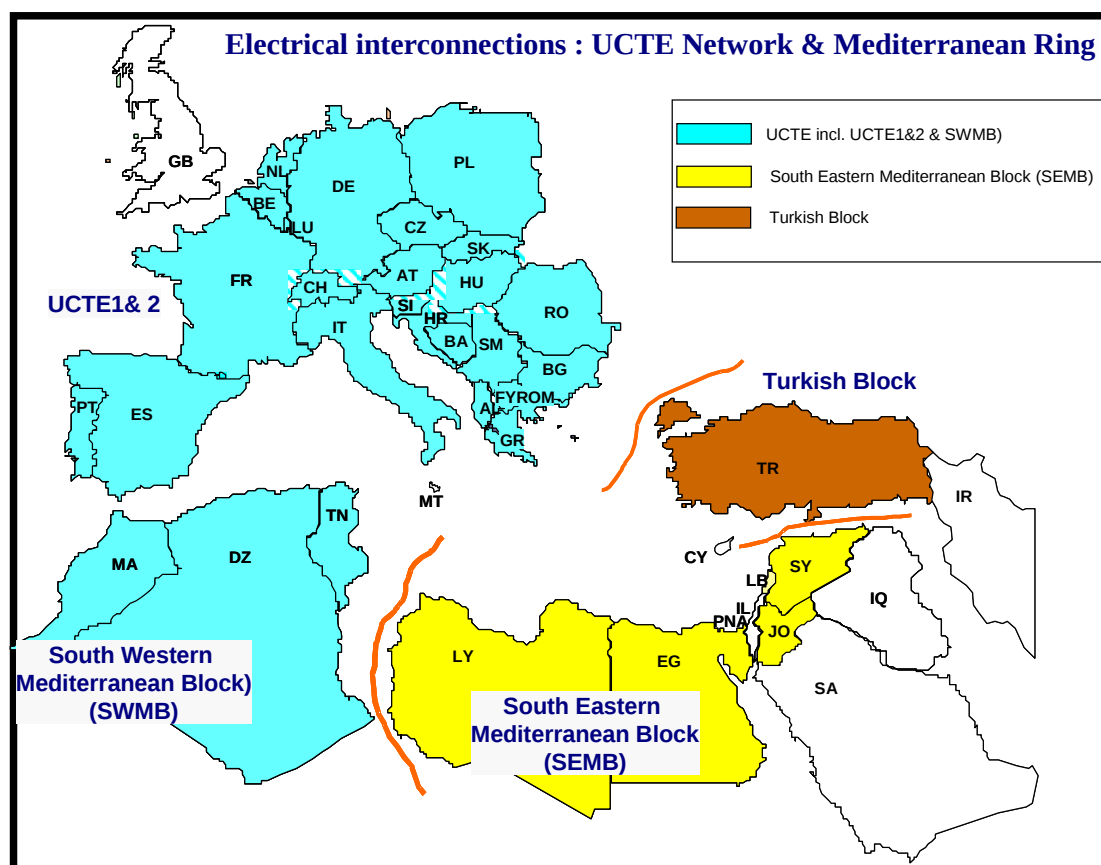
FOREWORD⁹⁸

The Mediterranean ring and the UCTE network

As far as the electricity interconnections are concerned, four Blocks of mediterranean countries exist currently: **South-Western Mediterranean Block (SWMB)**, **South-Eastern Mediterranean Block (SEMB)**, **Turkish Block** and the **Mediterranean Isolated Systems**. The SEMB and SWMB blocks are already connected to the UCTE network.

Regarding the current European and Mediterranean electric power system, it includes a variety of regional, national and supranational supply systems. Some of these systems are operated synchronously under the same frequency control regime, and are interconnected by a great number of AC links, thus forming in reality a single, densely meshed, system. Other systems are interconnected by one or more powerful DC interconnectors, leading to manageable structures. Some others have to be operated as isolated systems, reflecting the geographical borders in the area.

To be clear, the following main blocks (see the following map) are briefly presented hereafter: **UCTE (UCTE1 & UCTE2 reconnected since 10 October 2004)**, **South-Western Mediterranean Block (SWMB connected to UCTE in 1997)**, **South-Eastern Mediterranean Block (SEMB)**, **Turkish Block** and the **Mediterranean Isolated Systems**.



The Union for the Co-ordination of Transmission of Electricity (UCTE⁹⁹) coordinates the operation and development of the electricity transmission grid from Portugal to Poland and from Belgium to Romania and Greece. UCTE is the association of transmission system operators in continental Europe in 23 countries. The UCTE network ensures safe electricity supply for some 450 million people in one

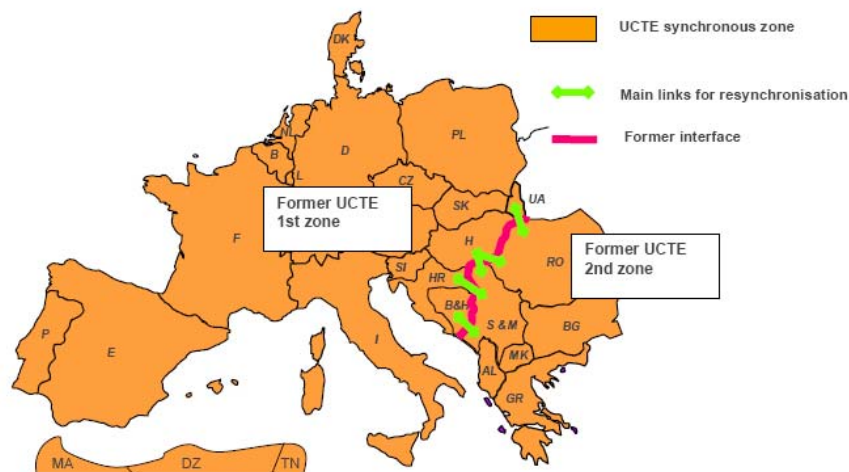
⁹⁸ This report is updated based on "Report of Systmed & Systint, State of the Art 2006 (April 2007)", and on UCTE and Eurelectric web site informations, on Medelec fifth meeting Paris 10 -11 April 2007, and Comelec and OME mediterranean companies Members.

⁹⁹ UCTE web site www.ucte.org and Eurelectric web site www.eurelectric.org

of the biggest electrical synchronous interconnections worldwide, with an annual electricity consumption totalling approximately 2600TWh.

Due to the wars in ex-Yugoslavia in 1991 and 1992, during which most of the transmission links in Croatia and Bosnia-Herzegovina were destroyed, **the UCTE system** was for almost 13 years divided into two synchronous areas referred to as **UCTE1 and UCTE2**. After the long preparation and reconstruction, finalized with commissioning of needed transmission infrastructure, resynchronization of two UCTE zones was successfully realized on October 10th 2004. Following one-month successful test phase, a gradual commercial exchange between former zones started on November 1st, 2004. This important reconnection will allow the reintegration of the electricity markets of the former 2nd UCTE synchronous zone – Bulgaria, Romania, Serbia and Montenegro, Former Yugoslav Republic of Macedonia, Albania and Greece - into the European Union's internal electricity market.

The UCTE¹⁰⁰ area now comprises the following countries (from west to east): Portugal, Spain, France, Belgium, Luxembourg, Netherlands, Switzerland, part of Denmark, Germany, Italy, Austria, Czech Republic, Slovenia, Poland, Slovakia, Hungary, Croatia, Bosnia and Herzegovina, Albania, Serbia and Montenegro, Former Yugoslav Republic of Macedonia, Greece, Romania, Bulgaria and western most part of Ukraine. To this system, there are also the three Maghreb countries (Morocco, Algeria and Tunisia) synchronously interconnected and named here after as the South-Western Mediterranean Block (SWMB).



The South-Western Mediterranean Block (SWMB) includes three countries at present: Morocco, Algeria & Tunisia. A submarine connection between Spain and Morocco was put into operation in October 1997. This cable (operated at a capacity of around 350 MW) synchronously connects the SWMB to Spain and UCTE, and was doubled in May 2006. Today, the electric systems of the three Maghreb countries are interconnected with 6 existing lines: two between Morocco and Algeria (both 225 kV lines) and four between Algeria and Tunisia (two at 90 kV, one at 150 kV, one at 220 kV). An additional 400kV double circuit line between Morocco and Algeria will soon be in place, though operated at 225 kV in initial step. At the end of 2007, a new line between Algeria and Tunisia will also be initially operated at 225 kV though being aimed at becoming a 400 kV line.

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The South-Eastern Mediterranean Block (SEMB) today includes the electric systems of five countries (Libya, Egypt, Jordan, Syria and Lebanon) that are synchronously interconnected. Libya was connected to Egypt in 1998 through a double circuit 220 kV overhead line; Egypt was connected in 1999 to Jordan, via a 13 Km 400kV submarine cable 600 MW capacity from Aqaba in Jordan to Taba in Egypt. The Jordanian System was connected in 2001 to Syria through a single circuit 217 Km 400kV overhead transmission line from Amman North in Jordan to Der Ali in South Syria. To the West, work is in progress to reinforce the interconnection between Syria and Lebanon through a single 400 kV circuit, from Damas in Syria to Kesara in Lebanon. This interconnection is expected to be put in operation sooner. To the North, a 400kV line exists towards Turkey, but at present it is not operational.

The Turkish block includes the system of Turkey without its small isolated part in the southern region supplied by Iran. Two 400 kV interconnection lines exist between Turkey and Bulgaria, and one 400 kV line between southern Turkey and the northern part of Syria. However, these lines are not used currently.

The Mediterranean Isolated Systems : Palestine, Israel, Cyprus and Malta

The electrical systems of Palestine, Israel, Cyprus and Malta constitute “electrical islands” not interconnected to any other electrical networks of the Mediterranean Basin. This situation is meant to change in the case of Palestine and Israel, which could become part of the Mediterranean Ring if the two lines Egypt-Gaza and Gaza-Israel would be built. These projects are at present still in the design phase but were identified as a priority for the Palestinian Authority by the European Commission.

In conclusion, currently, the UCTE synchronous area comprises the SWMB Block including Morocco (linked by the AC cable with Spain), Algeria and Tunisia. Investigations on further interconnection between SEWB and SEMB through a line between Tunisia and Libya (already forming a synchronous block with Egypt, Jordan and Syria) are under way¹⁰¹. Special attention is given to inter-area oscillations, their damping (by installation and setting of Power System Stabilizers in certain units), and to defense plans, assuring that a disturbance does not propagate throughout the system.

Regarding the Mediterranean Ring and the link between the two blocks SWMB (Maghreb) and SEMB (Mashreq), two connections are already completed but not in operation yet: Tunisia-Libya and Syria-Turkey. These connections are pending to UCTE decision¹⁰² after measurement campaign investigating the stability of the Mashreq system, and a study to be performed on preparation of electrical integration of Turkey¹⁰³. After successful completion of two UCTE projects: Synchronous interconnection of Mashreq countries (SEMB) and the synchronous interconnection of Turkey, the UCTE frequency would reach both sides of the Turkish-Syrian border. Then, the UCTE would investigate the stability of the interconnection binding three continents, and would take an appropriate decision of closing/not closing the Mediterranean ring.

¹⁰¹ After the test conducted by UCTE in November 2005, the link stay not yet on-stream. According to UCTE representative in the Medelec meeting, Paris 10-11 April 2007, it is still waiting the agreement of UCTE.

According to UCTE representative, to prevent the problems, it is necessary to : - Commission the scheduled network reinforcements in the Tunisia-Algeria-Morocco systems (400 kV corridor Spain-Morocco- Algeria, additional 225 kV interconnection line Algeria -Tunisia), - Check the Automatic Generation Control (AGC) proper performances in some countries.

¹⁰² UCTE communication “Tunisia-Libya and Turkey interconnections and the Mediterranean Ring, June 2004”, <http://www.ucte.org/pdf/Aboutus/Mission/Tunisia-Libya-Turkey.pdf>

¹⁰³ UCTE communication “11 October 2005- Preparation of electrical integration of Turkey has started” http://www.ucte.org/news/e_default.asp#11102005. A major study on the possible electrical integration of Turkey into Europe was kicked-off on 28 September 2005 in Brussels. The study will be performed by UCTE as the body in charge of assessing any extension of the interconnected system. The results of the study are foreseen to be available in May 2007. Improvements of the frequency control performance of the Turkish power system (mid 2007 to mid 2008); the trial parallel operation will be conducted in 2008.

Also, the Syria-Turkey connection is pending to UCTE decision after a study which will be to be performed.

I- INTRODUCTION

The development of interconnections has allowed for a considerable increase in international electricity trade. In 2005, the total volumes between Mediterranean countries and their neighbours reached 237 TWh (117 TWh exported & 121 TWh imported, see detailed physical electricity exchanges given by the table on annex) including:

- 66 TWh exported from France (including 14.5 TWh to Italy and 7.2 TWh to Spain),
- 11.1 TWh exported by Spain (including 9.5 TWh to Portugal, 0.75 TWh to France and 0.9 TWh to Morocco),
- 9.5 TWh exported by Slovenia (including 8 TWh to Italy and 1 TWh to Croatia),
- 9.2 TWh exported by Croatia (including 7.9 TWh to Slovenia and 1.3 TWh to Bosnia-H.)
- 3.2 TWh from Serbia-M (including 2 TWh to Macedonia, 0.9 TWh to Bosnia-H and 0.3 TWh to Albania)
- 2.8 TWh exported by Portugal to Spain.

About 29% of this total quantities (237 TWh) constitute the intra Mediterranean trade : The details of the 69 TWh power exchanges between Mediterranean countries are given in the table below, of which only 5 TWh (7%) exchanged between Southern and Eastern Mediterranean Countries (SEMCs) including the exchanges with Europe (Morocco-Spain). This is due to the limited capacity of existing power interconnections in the SEMCs.

The largest share of the 5 TWh exchanged between SEMCs took place mainly between Morocco and Spain, Morocco-Algeria-Tunisia as well as Libya-Egypt-Jordan-Syria-Lebanon, and a part between the Balkans and Greece.

Electricity Exchanges between Mediterranean Countries in 2005 (GWh)

Electrical Interconnections	Exports	Imports	Total
Portugal-Spain	2806	9477	12283
France-Spain	7284	749	8033
France-Italy	14493	702	15195
Italy-Greece	268	711	979
Italy-Slovenia	2	7931	7933
Slovenia-Croatia	1076	7944	9020
Croatia-BiH	1340	2735	4075
BiH-Serbia& M.	893	911	1804
Serbia& M.-Macedonia	1990	1	1991
Greece-Macedonia	71	796	867
Greece-Albania	1056	15	1071
Albania- Serbia&M.	711	193	904
Spain-Morocco	898	111	1009
Algeria-Spain			0
Algeria-Morocco	136	105	241
Algeria-Tunisia	139	142	281
Tunisia-Libya		0	0
Egypt-Libya	151	105	256
Egypt-Jordan	741	3	744
Syria-Jordan	241	2	243
Syria-Lebanon	455		455
Israel-PNA	1665		1665
Total intra-Mediterranean	36416	32633	69049

Source: UCTE 2005; Eurelectric Oct 2005; UAPTDE 2005; Comelec; Companies & OME

In recent years, the SEMCs undertook to interconnect their power networks in order to further develop electricity exchanges. Among them, several interconnections are already in operation (see hereafter the table and the brief description of the existing electrical interconnections under operation).

II- EXISTING ELECTRIC INTERCONNECTIONS in the MEDITERRANEAN

The effort for the construction of new power plants that is necessary to keep the adequate reliability indexes and security margins in the Mediterranean national systems can be mitigated by suitably exploiting the electrical interconnection among the countries¹⁰⁴ and reinforcing them to allow bigger power and energy exchange.

See the following table summarizing the main characteristics of the existing electric interconnections in the Mediterranean region.

Country	(from Substation)	to Country	(to Substation)	Type AC/DC	Voltage [kV]	Thermal limit (A) winter	year operation
Algeria	Ghazaouet	Morocco	Oujda	AC	225	640	1988
Algeria	Tlemcen	Morocco	Oujda	AC	225	640	1988
Algeria	Djebel Onk	Tunisia	Metlaoui	AC	150	510	1984
Algeria	El Aouinet	Tunisia	Tajerouine	AC	225	640	1984
Algeria	El Aouinet	Tunisia	Tajerouine	AC	90	380	1952
Algeria	El Kala	Tunisia	Fernana	AC	90	510	1956
Morocco	Mellousa	Spain	Tarifa	AC	400	2x730 MW	1996/2006
Tunisia	Medenine	Libya	Abukamash	AC	220	2x620	2003 *
Tunisia	Tataouine	Libya	Rowis	AC	220	620	2003*
Libya	Tobruk	Egypt	Saloum	AC	220	2x630	1998
Egypt	Taba	Jordan	Aqaba	AC	400	1270	1997
Egypt	Saloum	Libya	Tobruk	AC	220	2x630	1998
Jordan	Irbed	Syria	Cheikmiskin	AC	230	770	1980
Jordan	Amman North	Syria	Der Ali	AC	400	1450	2001
Lebanon	Deir Nebouh	Syria	Tartus	AC	230	770	1972
Syria	Tartus	Lebanon	Deir Nebouh	AC	230	770	1972
Syria	Aleppo	Turkey	Birecik	AC	400	n.a.	Not in oper.
Turkey	Babaeski	Bulgaria	Maritsa East	AC	400	500 MW	n.a.
Turkey	Hamitabat	Bulgaria	Maritsa East (III)	AC	400	2000 MW	2002
Turkey	Hopa	Georgia	Batum	AC	220	300 MW	
Turkey	Kars	Armenia	Leninakan	AC	220	300 MW	
Turkey	PS3	Iraq	Zakho	AC	400	500 MW	
Turkey	Igdir	Nahcievan	Babek	AC	400	100 MW	
Turkey	Dogubeyazit	Iran	Bazargan	AC	154	100 MW	
Turkey	Baskale	Iran	Khoy	AC	154	200 MW	
Greece	Arachthos	Italy	Galatina	DC	400	500 MW	end 2001
Greece	Kardia	Albania	Elbasan	AC	400	600 MW	
Greece	Thessaloniki	Macedonia	Negotino	AC	400	1400 MW	
Serbia&M.	Prizen	Albania	Fierza	AC	220	300 MW	
Serbia&M.	Podgorica	Albania	Vau Dejes	AC	220	275 MW	

*construction completed in 2003 but not in operation yet (waiting UCTE green light)

¹⁰⁴ All the existing interconnection lines among the Mediterranean countries (European side and South and East Mediterranean side) are reported on the table here.

Since the end of 1997, the grids of **Spain and Morocco** have been interconnected by a single 400 kV circuit in alternative current including some 27 km of submarine cable line links the substations of Tarifa in Spain and Ferdouia in Morocco. The thermal limit of this interconnection is 730 MW. In 2005¹⁰⁵, the transfer of energy was 836 GWh from Spain to Morocco, and 53 GWh from Morocco to Spain. The current ATC of the interconnection is of 400 MW. In July 2006 a second submarine link was put in operation, having the same characteristics as the existing one.

Morocco and Algeria are interconnected by two single 225 kV circuits, both commissioned in 1998. The links are rated for 640 Amp. The commercial capacity between the countries is about 240 MW. In 2005¹⁰⁶, Morocco exported 105 GWh to Algeria, and Algeria exported 136 GWh to Morocco. A third 400kV line, to be initially operated at 225 kV, was completed recently to reinforce interconnection between these two countries and will coming on stream sooner in 2007.

Tunisia is nowadays interconnected with Algeria through 4 lines: one at 225 kV, another one at 150 kV and two at 90 kV. In 2005¹⁰⁷, the commercial capacity between these two countries was of 258 MW, allowing a transfer of 139 GWh from Algeria to Tunisia and of 150 GWh from Tunisia to Algeria. A fifth 400kV line, to be initially operated at 225 kV, was completed recently to reinforce interconnection between these two countries and will coming on stream sooner in 2007.

Tunisia and Libya could in the future possibly be synchronously interconnected by two links: a double circuit 225 kV line between the substations of Medenine in Tunisia and Abou Kammech in Libya and single 225 kV circuit between Tataouine in Tunisia and ElRouis in Libya. These lines have been constructed (2003), but their operation has not yet begun. A request to close these two lines, which would extend the main UCTE synchronous area to Libya, Egypt, Jordan, Lebanon and Syria, was presented to UCTE. A UCTE study is therefore ongoing a synchronisation test carried out in November 2005. According to the Medelec meeting Paris 10-11 April 2007, results presented by UCTE representative were however unsuccessful. UCTE envisaged other tests (probably with coming onstream of the 400 kV lines in North Africa), and therefore it will planned to put it in operation.

Libya and Egypt are interconnected by a double 225 kV circuit linking the substations of Toubruk in Libya and Saloum in Egypt. The link was commissioned in 1998 and the commercial capacity between the countries is of 600 MW. Currently however, due to technical limitations, the maximum exchangeable power is of 180 MW. In 2005, Libya exported 105 GWh to Egypt, and Egypt exported 151 GWh to Libya. A second line of 1000 MW is projected between Tobruk (Libya) and Aldbaah (Egypt) and would be in operation by 2010-2015.

The following described interconnections are part of the six countries interconnection project (EIJLST). This project includes Egypt, Jordan, Syria, Lebanon, Turkey and Iraq.

Egypt and Jordan have been interconnected since 1997 by a single 400 kV circuit with a capacity of 550 MW between Taba (Egypt) and Aqaba (Jordan). This capacity is expected to be increased to 1100 MW by 2010. Egypt exported about 741 GWh to Jordan and 472 GWh in 2006.

Jordan and Syria have been connected since 2001 through a single 400 kV circuit between Amman North (Jordan) and Der Ali (Syria) with a capacity of 800 MVA. Syria exported 241 GWh to Jordan in 2005 and 42 GWh in 2006¹⁰⁸. The electric energy exchange between the two networks continued in kind, and a tariff is expected to be agreed upon for electric energy exchange between the two sides

Lebanon and Syria are connected through a 225 kV line that was commissioned in 1972. In 2003, the commercial capacity between the two countries was about 200 MW, which allowed the Lebanese system to import 455 GWh¹⁰⁹, from Syria. A new 44 km line at 400 KV is being commissioned.

¹⁰⁵ In 2003, the transfer of energy was 1466 GWh from Spain to Morocco, and 36 GWh from Morocco to Spain.

¹⁰⁶ In 2003, Morocco exported 108 GWh to Algeria, and Algeria exported 116 GWh to Morocco.

¹⁰⁷ In 2003, a transfer of 96 GWh from Algeria to Tunisia and of 115 GWh from Tunisia to Algeria

¹⁰⁸ In year 2003, Egypt exported about 797 GWh to Jordan.

¹⁰⁹ In 2003, Lebanese import 367 GWh from Syria and export 188 GWh to Syria.

Syria and Turkey erected a 400 kV line in 2003. Its operation however will probably be initiated only after the connection of Turkey to UCTE. This Syria-Turkey connection is pending to UCTE decision¹¹⁰ after a study which will be performed by a consortium lead by RWE Netz and HTSO (contract under negotiation in June 2004) and will last 15 months.

Between **Turkey and Bulgaria** there are currently two 400 kV circuits linking respectively Babaeski s/s and Hamitabat s/s in Turkey to the Maritsa East power plant in Bulgaria, without interconnection to the Bulgarian Grid (pocket operation).

In March 2002, **Turkey and Greece** signed a Memorandum of Understanding for the construction of a 400 kV line between Babaeski in Turkey and Filippi in Greece. The line is under construction to be commissioned in Q1,2008.



¹¹⁰ UCTE communication "Tunisia-Libya and Turkey interconnections and the Mediterranean Ring, June 2004", <http://www.ucte.org/pdf/Aboutus/Mission/Tunisia-Libya-Turkey.pdf>

III- NEW ELECTRIC INTERCONNECTION PROJECTS IN MEDITERRANEAN

In addition to the existing interconnections, namely those of the Maghreb, Algeria is already interconnected to Tunisia (4 connections) and to Morocco (2 connections), recent connections were brought into service, including those linking Spain to Morocco, Libya to Egypt, Egypt to Jordan, and Syria to Jordan and Lebanon.

Several new interconnection projects are under way linking Morocco to Algeria (third connection), Algeria to Tunisia (fifth connection), Tunisia to Libya, Libya to Egypt, Syria to Turkey, and Turkey to Greece. Concerning the interconnections currently planned at 220 kV, their voltage is planned to be increased to 400 kV at a later stage.

With the start-up of the Spain-Morocco link in 1997, the two Mediterranean shores are already interconnected. After the recent doubling of the Spain-Morocco line in July 2006, the interconnection of the two shores will be further strengthened with the new undersea cable from Algeria to Spain and the interconnection projects Turkey-Greece, Algeria-Italy and Tunisia-Italy.

The new projects will enable major SEMCs to interconnect as well as to connect with the European network following the completion of the "electrical loop" around the Mediterranean in 2008-2009. OME participated to the «MedRing»¹¹¹ study related to the behaviour of the "Mediterranean electrical loop" which is supported by the European Commission. The MedRing project (26 months study) is completed in May 2003.

Thanks to the completion of "the Mediterranean electrical loop", an increase in Mediterranean electricity exchanges is expected by 2010. According to the estimations of the MedRing study, power exchange will increase from the 69 TWh in 2005 to 75 TWh by 2010.

This section of the report describes the major interconnection projects, including the one which have been recently commissioned. The 20 power interconnection projects include:

- Interconnection Spain -Morocco
- Interconnection Morocco- Algeria
- Interconnection Algeria – Tunisia
- reinforcement of the interconnections in North Africa (ELTAM project)
- Interconnection Algeria-Spain
- Interconnection Algeria-Italy
- Interconnection Tunisia-Italy
- Interconnection Tunisia-Libya
- Interconnection Libya-Italy
- Interconnection Libya-Egypt
- Interconnection Egypt-Jordan
- Interconnection Egypt-Palestine
- Interconnection West Bank – Gaza (Palestine)
- Interconnection Palestine -Jordan
- Interconnection Jordan-Syria
- Interconnection Syria-Lebanon
- Interconnection Syria-Turkey
- Interconnection Turkey-Greece
- HVDC link, Sardinia-Peninsula of Italy (SAPEI link)
- HVDC link, Balearic Islands – Mainland

¹¹¹ Med-Ring study is coordinated by CESI, and in which most electricity companies from North, South and East Mediterranean are involved and almost all of them are OMEcompany members.

The future projects in the South Mediterranean area concern the creation of a new 400/500 kV corridor from Morocco to Egypt to allow larger power exchanges at regional level. In the Eastern Mediterranean countries, the proposed interconnection projects concern the reinforcement of the existing links through 400 kV lines. In addition, two potential projects plan interconnection of the Palestine grid with the respective grids of Jordan and Egypt.

HVDC interconnections in the Mediterranean basin

Recently, issues of security of supply, integration of electricity markets and economic cooperation in the Mediterranean region have driven some attention to the idea of North-South HDVC links (between Spain/ France/ Italy and the Maghreb countries). Early in 2000, significant feasibility studies were begun to identify the most economically viable undersea corridors. The impetus to start these studies came in particular from Algeria and Libya, which are much interested in increasing their exports to Europe.

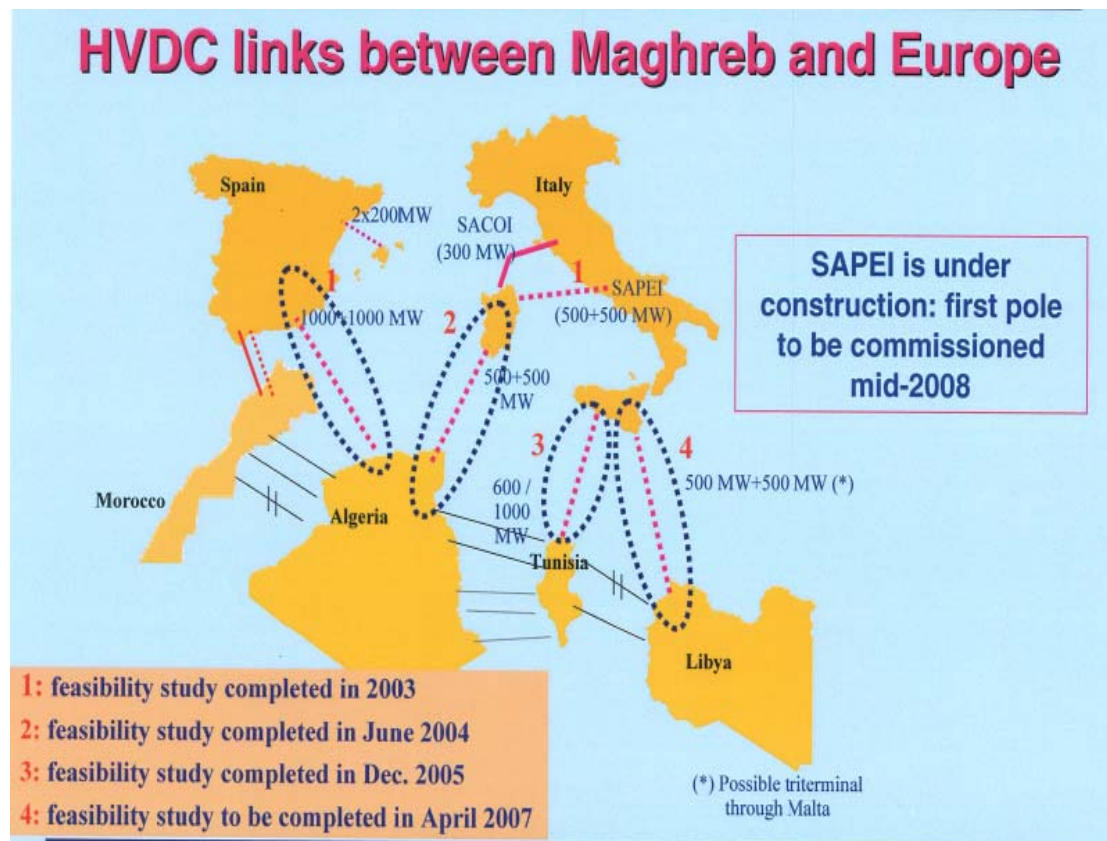


Figure: Possible HVDC interconnections in the Mediterranean region (Source: communication B. Cova (CESI) and al, Medelec 11 April 2007)

The feasibility study Algeria-Spain was conducted by CESI for the AEC (Algerian Energy Company), with the involvement of the Spanish and Algerian TSOs. Completed in 2003, the study came to the conclusion that, besides transmission costs, the production costs in Algeria (gas costs plus costs for the financing of power stations) and the sales prices in Spain would strongly influence the profitability of the project. Much though is still given to the idea of submarine cables between Algeria and Europe and Algeria organised an international conference in late 2005 with the view to seek for the involvement of foreign partners. Decision on the possible implementation of the project is now in the hands of AEC, Sonelgaz and Red Electrica de Espana.

If a decision to build the interconnection would be made, the study suggests that the best solution would be a 1000 MW and 500 kV direct HVDC connection between Terga (Algeria) and the Litoral de Almeria (Spain), together with a 200 MW AC connection crossing Morocco. The significant depth

of the sea (1900 m) is however a critical element that would call for substantial engineering work (maximum depth reached so far: 1000 m for the connection Italy-Greece).

The Algeria-Italy feasibility study was also conducted by CESI (and TERN) on behalf of the Italian and Algerian TSOs. It was completed in June 2004. Two solutions for a 500 to 1000 MW 400 kV interconnection were studied: a “direct” line between El Hadjar (Algeria) and Latina (Italy) and an “optimised” line between El Hadjar and South Sardinia. The “direct” line is reaching the limits of the technical feasibility given the depth of the sea in the region (2000 m). The “optimised” solution faces equivalent problems but with lower levels of investment and power losses (cost estimated to € 750-900 million for the direct line; € 205-578 million for the optimised line). The construction of this line is however also under question as its financial feasibility is uncertain and the project is strictly tied to the entry in service of the SAPEI project (HDVC cable between Sardinia and mainland Italy).

A consortium of Algerian and foreign companies was established in November 2005 for the realisation, exploitation and financing of the two undersea cables (Algeria-Italy via Sardinia; Algeria-Spain).

A feasibility study for a 600 MW Tunisia-Italy interconnection was carried out by CESI and finalised in February 2006. It is expected that this interconnection could be in operation by 2010-2011. The estimated cost is around € 380-410 million.

Finally, a study for an interconnection Libya-Italy is also to be completed in May 2007.

Interconnection developments in the Mashrek region

Several projects exist in the region, which have different status. Among these are notably the following:

- The upgrade of the Libya-Egypt double circuit 220kV interconnection to 400kV in Libya and 500kV in Libya (with a transformation from 400 to 500 kV in Tobruk, Egypt); also: the reinforcement of the interconnection with a second line of 1000 MW between Tobruk and Aldbaah (Egypt), projected for 2010-2015;
- The reinforcement of the current 400kV Egypt-Jordan submarine cable to 1100 MW by 2010;
- The doubling of the interconnection capacity between Lebanon and Syria (to 400 MW) in two phases. The first phase, already commissioned in 2004, now allows for the transfer of 300 MW. Around 2010, the second phase should be commissioned;
- The doubling of the existing 350 kV interconnection between Syria and Jordan by 2010.
- The coming on stream by 2007 of the two new lines between Algeria and Tunisia, and between Algeria and Morocco. The construction is completed and the starting of operation will be by 2007 (firstly operated at 225 kV and later under 400 kV).

Table: Major Electricity Interconnection Projects in the Mediterranean Region

Electrical Line	Thermal Limit (A)	Length (km)	Tension kV AC or DC	OVL or subsea	Year of operation
Spain - Algeria	2000		500 DC	subsea	2010+
Italy - Algeria	-		400 or 500 DC	subsea	2010+
Italy - Tunisia	500		500 DC	subsea	2010+
Algeria - Morocco (3 rd line)	1720x2	250	220 AC (400 AC)		2007 (2010)
Algeria-Tunisia (5 th line)	1720	120	220 AC (400 AC)		2007 (2010)
Tunisia-Libya (3 rd line)		210	400 AC		2010
Libya-Egypt (2 nd line)	-		400/500 AC		2010-2015
Reinforcement EG-LI-TU-AL-MO (ELTAM project)			400 AC		2015
Egypt-Jordan (2 nd line)	880	20	500/400 DC	subsea	2010
Egypt-Palestine	1440		220		2007
Palestine (WB)-Palestine (Gaza)	1440		220 or 240		2007
Palestine - Jordan	1450		400		2007
Jordan-Syria (2 nd line)		210	400 AC		2010
Lebanon - Syria	1660	22	400 AC		2004 (2010)
Syria-Turkey	1440	124	400 AC		End 2008
Turkey-Greece	2165/2887	250	400 AC		Q1, 2008
Libya- Italy			HVDC		study to be completed Apr.07
Sardinia-Peninsula of Italy			HDVC		mid-2008
Belearic Islands – Mainland Spanish Peninsula system			HVDC		forseen 2009

A short description of these 20 electrical interconnection projects is given hereafter:

1 - The Spain-Morocco interconnection

This interconnection connects the European electric network to that of the Maghreb countries. This 400 kV undersea connection in alternating current (AC) (made up of 4 cables, of which one for reserve) passes under the Strait of Gibraltar (length 28.5 km, depth 615 m) connecting Tarifa in Spain to Fardioua in Morocco.

The maximum transit capacity of the interconnection in steady operation is 700 MW allowing an overload of 200 MW during 20 minutes. The interconnection was brought into service in October 1997. In 2005, the electricity exchanges amounted to 1 TWh from Spain to Morocco. This is the equivalent of a 200 MW power plant or 6% of the ONE production.

A second AC cable at 400 kV was completed in July 2006. The new link raised the physical transit capacity from current 700 MW to 1400 MW (of which commercial exchange capacity will increase from 400 to 1000 MW).

2- The Algeria-Spain interconnection

A study of a HVDC connection from Algeria to Spain through submarine cable (connection of about 240 km) with a capacity of 2000 MW is achieved. In fact, Algeria is planning to dedicate this undersea connection to electricity exports. It will link Hassi Ameer in Algeria to Almeria in Spain. The start-up for the cable is planned after 2010.

Sonelgaz and Red Electrica decided to award the feasibility study of this interconnection project to the Algerian Energy Company (AEC) and to CESI as Consultant. The interconnection feasibility study was completed in 2002 and additional specifications were finished in 2003.

Three routes were proposed: the first with 232 km length and 1900 m maximum depth water; the second of 281 km length and 1800 m maxi depth; and the third with 355 km length and 1500 m maxi depth. And two alternatives: a 1200 MW alternative (scenario of 100 MW DC+200 MW AC); and a second alternative 2000 MW (scenario of 2000 MW AC).

Much thought is still given to the project of sub-marine cables between Algeria and Europe. In this context, in November 2005, an international conference on the integrated projects of power stations and Transmediterranean cables Algeria-Spain and Algeria-Sardinia-Italy, was held in Algiers. The objective of this meeting was to involve the interest of foreign partners and to set up a partnership for the study, the design, construction, the exploitation and the financing" of these projects.

3 - The Algeria-Italy interconnection

Algeria has also been examining the possibility of a second project of 500 to 1000 MW, devoted to electricity exports which will connect Hadjar in Algeria to Cagiali in Italy through an undersea cable via Sardinia.

In 2001 a Protocol was signed between the two countries to allow network operators in both countries (GRTN in Italy and the Sonelgaz in Algeria), to undertake a prefeasibility study for a 500-1000 MW interconnection capacity (400 kV, DC). The feasibility study was lead by CESI (Centre de Recherche en Ingénierie Electrique Italien)/TERNA (Entreprise Italienne de Transport d'Electricité) in December 2002, and completed in June 2004.

Among the principal variants studied: the direct link Algria-Italy with 720-1075 km length; a 265-660 km link via Sardinia; and a 485-585 km link via Sicily. The cost is estimated of 750-900 Million Euros for the direct link, and 205-578 Million Euros for the indirect variants. The link would be rated for 500 MW in the first stage and 1000 MW by 2015.

The results of the study have been presented in Algiers on November 12, 2005 : the most promising route (both technically and economically) is a direct link Algeria –Sardinia (El Hadjar – Sarlux): with a first phase: : 500 MW, later 1000 MW (bi-polar). This link should connect to the planned SAPEI (Sardinia – Italian peninsula) to be build by 2010. For the 1st phase (500 MW) Algeria-Sardinia connection, the South-North Sardinia transmission network does not need reinforcement. The second phase (1000 MW) needs reinforcement of the South-North Sardinia transmission network.

In this last meeting about “International Electrical Interconnections Conference” taking place at Algiers on November 12, 2005, a consortium of Algerian and foreign companies has been created for the realization, the exploitation and the financing of the two projects of electric interconnection underwater Algeria-Italy via Sardinia, and also Algeria-Spain.

4 - The Tunisia-Italy interconnection

The project for interconnection of the electric grids of Tunisia and Italy through a 500 kV HVDC link is at a pre-feasibility stage with a transfer capacity of approximately 600 MW (probably 1000 MW in a second phase). This link would be in operation by 2010. A new feasibility is decided and completed in Decemeber 2005.

5 - The Algeria-Morocco interconnection

In addition to the 2 electric connections between Algeria and Morocco, a project for a 3rd connection is planned between Hassi Ameur in Algeria and Bourdim in Morocco. This 400 kV connection is composed of a 200 km section in Algeria and a 50 km one in Morocco, but will start initially at 220 kV with a capacity of 600 MW.

This new 400 kV double circuit line is under construction, and will be put on stream by 2007 running initially stage at 225 kV; and switching in the future to 400 kV voltage.

6 - The Algeria-Tunisia interconnection

Tunisia is currently interconnected with Algeria through 4 lines (one at 225 kV, one at 150 kV and two at 90 kV). Such interconnections will be reinforced by 2005 with a

fifth line at 400 kV (under construction), which will be operated at 225 kV until 2010.

This 400 kV connection, between El-Hadjar in Algeria and Djendouba in Tunisia, will be initially operated at 220 kV with a capacity of 600 MW and will be coming on stream by 2007. It is expected to be reinforced by 2010 to 400 kV allowing a transport capacity of 1200 MW.

7 - The Tunisia-Libya interconnection

The construction of the first two electric interconnection lines (220 kV) between Tunisia and Libya have been completed in 2003 (the first line is between Mednine in Tunisia and Abu Kamash in Libya, and the second line is between Tatouine in Tunisia and Rowis in Libya). The total transfer capacity among the two countries is 600 MW.

A study by Red Electrica and Hydro Quebec concerning the operation of the interconnection was also carried out. The lines have been constructed (2003), but their operation has not yet begun (UCTE tests are underway since November 2005¹¹²). The final closing of these two lines would extend the main UCTE synchronous area to also include the systems of Libya, Egypt, Jordan, Syria and Lebanon.

The first phase of the interconnection between Tunisia and Libya is going to take place through two 225 kV lines (1 single circuit and 1 double circuit). The double circuit is already finished and the single circuit is in the testing phase.

The reinforcement of the existing interconnection through a third line at 400 kV is planned. It will link, through a 400kV line (1000 MW), Bouchema in Tunisia and Rowis in Libya. Its operation is foreseen for 2010.

8 - The Libya-Egypt interconnection

The 300 MW interconnection capacity (AC-220 kV) between the two countries (Tobruk in Libya and Saloum in Egypt) started at the end of 1998. It will connect Egypt to the Maghreb countries when the link between Libya and Tunisia starts operating. The commercial capacity between the countries is 600 MW, but due to technical limitation the maximum exchangeable power is about 180 MW. In 2005, Libya exported 105 GWh to Egypt, and Egypt exported 196 GWh to Libya. These exchanges will soon double in value.

The existing interconnection through a double circuit at 220 kV is expected to be upgraded to be operated at 400 kV in Libya and 500 kV in Egypt, with a transformation from 400 kV to 500 kV in Tobruk (Tractebel is carrying out a study regarding the operation of the line at 400 kV). The reinforcement with a second line (1000 MW) is projected between Tobruk in Libya and Aldbaah in Egypt which is planned to be in operation by 2010-2015.

¹¹² After the test conducted by UCTE in November 2005, the link stay not yet on-stream. According to UCTE representative in the Medelec meeting, Paris 10-11 April 2007, it is still waiting the agreement of UCTE.

According to UCTE representative, to prevent the problems, it is necessary to : - Commission the scheduled network reinforcements in the Tunisia-Algeria-Morocco systems (400 kV corridor Spain-Morocco- Algeria, additional 225 kV interconnection line Algeria -Tunisia), - Check the Automatic Generation Control (AGC) proper performances in some countries.

9 - Transversal reinforcement of interconnections in North Africa (project ELTAM)

A study on the reinforcement of interconnections between Egypt, Libya, Tunisia, Algeria and Morocco (ELTAM) to 400 kV was launched in 2000. It was lead by Tractebel Engineering and financed by the Arab Fund (FADES). The study was completed in 2004.

A full 400 kV reinforcement of interconnections is expected to facilitate market integration between the five countries. Following on from the conclusions of the study, which was finalised in 2004, the completion of all 400 kV interconnection lines is expected by 2010-2015:

- 400kV interconnection Tunisia-Libya (Bouchemma – El Rowis);
- 400kV interconnection Libya – Egypt (Tobruk – Saloum) including 400kV/500kV transformers in Tobruk.

Meanwhile, the introduction of the 400 kV is gradually beginning to take place. In Tunisia, STEG planned to build a 400 kV axis in the system between the north and south of the country (expected by 2015). In Algeria, in June 2005, the first 400 kV station came into operation in Skikda. Three Algerian 400 kV lines had already been completed in 2002 and 2003, though still being operated at 200 kV for now. In Algeria, the 400kV backbone from West to East is expected to be completed before 2010.

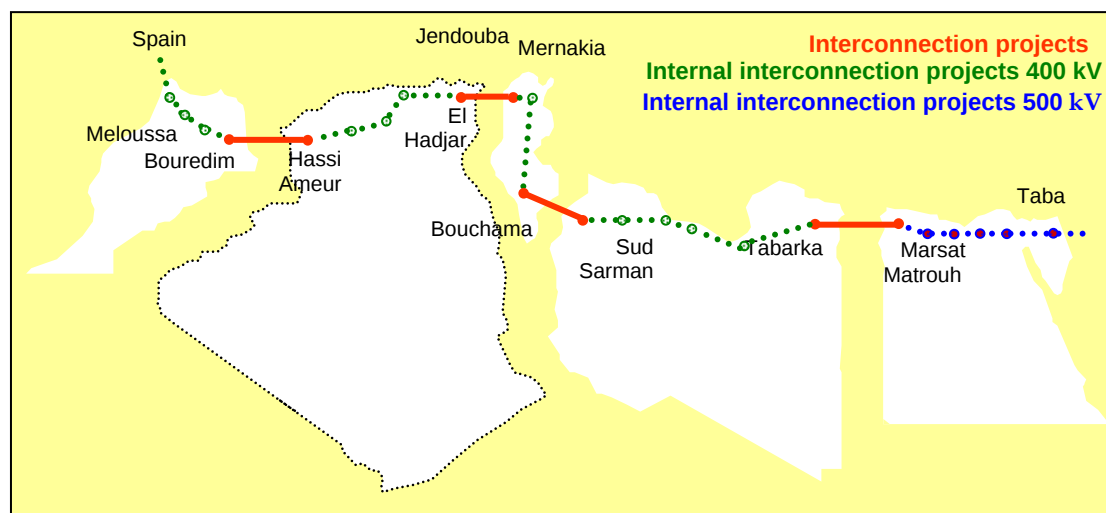


Figure : *Interconnection projects in 400-500 kV for the whole ELTAM region (Source: presentation at the 2006 Convention of COMELEC).*

10 - The Egypt-Jordan interconnection

The 500 and 400 kV interconnection cables between Taba in Egypt and Aqaba in Jordan via the Sinai and the Gulf of Aqaba (with an undersea cable of 20 km) started operating at the end of 1998 with a capacity of 550 MW. In 2005, Egypt exported about 740 GWh to Jordan in 2005 and 472 GWh in 2006.

Existing 400 kV interconnection between Egypt and Jordan through a submarine cable is expected to be reinforced in order to double the interconnection capacity to 1100 MW. The reinforcement is foreseen for the year 2010.

11 – The Egypt-Palestine interconnection :

The project for interconnecting the grids of Egypt and Palestine through a single 220 kV line is at a pre-feasibility stage; the interconnection is foreseen after 2007.

The situation is however meant to change in the case of Palestine and Israel, which could become part of the Mediterranean Ring if the two lines Egypt-Gaza and Gaza-Israel can possibly be erected in some years. The Palestinian National Authority and the Israel Electric Corporation (IEC) are planned

to build a 161 kV double circuit line to the Gaza strip. These projects are at present still in the design phase but were identified as priority project by the Palestinian Authority by the European Commission and the Energy Ministers of these countries.

12 - The Palestine (West Bank) - Palestine (Gaza) connection :

The project for the interconnection of Palestine-West Bank with Palestine-Gaza is at a pre-feasibility stage. The link would consist of a double 220 kV or 400 kV circuit, which is planned by 2007.

13- The Palestine – Jordan interconnection:

The project for interconnecting the grids of Palestine and Jordan is at a prefeasibility stage. The double 400 kV circuit would be in operation by 2007.

14 - The Lebanon-Syria interconnection

The 225 kV line connecting the grids of *Lebanon and Syria* was commissioned in 1972. In 2005, the commercial capacity between the two countries was about 200 MW, which allowed the Lebanese system to import 455 GWh from Syria. The two countries, already interconnected at the 230 kV level, will be firmly linked with a double circuit 400 kV OHL project. This new line, 44 km long, will be commissioned in two phases. The first one, already commissioned (2004), allows a transfer of 300 MW. The second phase, expected to be commissioned in 2010, will allow the doubling of the interconnection capacity.

The first phase of the study entitled "Feasibility Study for the Establishment of a Coordination Control Centre (CCC) for the Electrical Interconnection between Turkey, Lebanon, Syria, Iraq, Jordan, Egypt, Libya, Tunisia, Algeria and Morocco (EIJLST and ELTAM countries)" was concluded in January 2003 by Swedpower International, and financed by the Arab Fund for Economic and Social Development.

15 - The Jordan-Syria interconnection

Jordan and Syria have been connected since 2001 through a single 400 kV circuit (210 km length, of which 60 km in Jordan) between Amman North in Jordan and Der Ali in Syria with capacity of 800 MVA. The project was officially inaugurated on March 14th, 2001. Electricity imported by Jordan from Syria was 241 GWh in 2005 and 42 GWh in 2006.

The doubling of the existing 400 kV interconnection between Syria and Jordan electric grids (from 350 to 700 MW in commercial capacity) is envisaged for 2010.

16 - The Syria-Turkey interconnection

The first stage of the interconnection between the Turkish and Syrian electricity systems concerns the construction of a single 400 kV line rated for 350 MW. The Turkish and the Syrian sides were completed in 2003. The exploitation of this line depends on internal reinforcements in Syria and on further studies and will probably not take place prior to the connection of the Turkish system to the UCTE through Greece.

According to the last communication from UCTE¹¹³, this Syria-Turkey connection is pending to UCTE decision after a study which will be to be performed over 15 months.

17 - The Turkey-Greece interconnection

The existing Turkish interconnections include those with Syria, Azerbaijan (Nahcievan), Armenia, Georgia, Bulgaria, Iraq and Iran. In 2003, Turkey imported 1.2 TWh through these existing lines from these countries and exported 0.5 TWh.

¹¹³ UCTE communication "11October 2005- Preparation of electrical integration of Turkey has started" http://www.ucte.org/news/e_default.asp#11102005. A major study on the possible electrical integration of Turkey into Europe was kicked-off on 28 September 2005 in Brussels. The study will be performed by UCTE as the body in charge of assessing any extension of the interconnected system. The results of the study are foreseen to be available at the beginning of 2007. Also, the Syria-Turkey connection is pending to UCTE decision after a study which will be to be performed.

Power interconnection projects with Turkey relate to the links with Greece, the EIJLST as a whole, Iran/Turkmenistan, Georgia/Azerbaijan and the Balkans.

As a reminder, the EIJLST interconnections are part of the six countries interconnection project (EIJLST). This project includes Egypt, Iraq, Jordan, Lebanon, Syria and Turkey.

With Mediterranean countries, there is currently only one connection in operation with Syria (40 MW capacity, 66 kV over 6 km) between Cag Cag in Turkey and Kamishi in Syria.

With other countries, the most important connections are the Bulgarian lines (500 MW & 2000 MW capacity, 400 kV, over 136 km) where the exchanges reached nearly 1136 GWh in 2003. These exchanges should reach 4000 GWh/year at mid-term thanks to a new 2000 MW capacity and 400 kV line (between Hamitabat in Turkey and Maritiza in Bulgaria), which was completed recently.

Other projects exist between Turkey and Balkan countries. Turkey, Greece and former-Yugoslavia are «bridges» or links between the electric supply networks in the Balkans and the Mediterranean loop.

Regarding the project with Greece, in March 2002, **Turkey and Greece** signed a Memorandum of Understanding for the construction, by year 2007, of a 400 kV line between Babaeski in Turkey and Filippi in Greece. The financing of the part on Turkish territory is ready (World Bank Loan). The construction Agreement was signed on May 2003. This 400 kV interconnection between Babaeski in Turkey and Philippi in Greece (250 km length, including 50 km in Turkey and 750 MW capacity), will start operation in first quarter of 2008.

By 2008, the isolated Turkish block should be connected to the other 2 blocks (Turkey-Greece to the North and Turkey-Syria to the South). It should however be mentioned that these interconnections have also already been postponed several times. According to last meeting of Medelec in 11 April 2007 at Paris, construction of the Turkey_Greece interconnection has started, and is expected to be commissioning in first quarter of 2008. Also the synchronous parallel interconnection of Turkish Power System to UCTE has the highest priority, and it is seen as the prerequisite for the realisation of other projects. That means, the Turkey –Greece interconnection is expected to be firstly in operation (expected in 2008). The prospective timetable for Turkey, a finalisation of the technical analysis (18 months since October 2005) will be completed in April 2007, the improvement of the frequency control performance of the Turkish Power System will be between Mid-2007 to Mid-2008 and the trial parallel operation is expected in 2008.

As far as the second **Turkey-Syria** interconnection (400 kV, 1000 MW capacity) is concerned, construction has been completed in 2003 but its operation will probably be initiated only after the connection of Turkey to UCTE (through Greece, not before end 2008).

Between **Turkey and Bulgaria**, a new second line (2000 MW) is put in operation linking Babaeski s/s and Hamitabat s/s in Turkey to the Maritsa East power plant in Bulgaria, with about a total capacity of 2500 MW. In 2003, Turkey imported 1136 GWh from Bulgaria.

18 - The Libya- Italy interconnection:

The project for interconnection of the electric grids of Libya and Italy through a HVDC link is considered, between Abu Kamash in Libya to Partanna in Italy (Sicily). The feasibility study will be completed by May 2007. This link would be in operation by 2010.

19 - The SAPEI link: Sardinia-Peninsula of Italy :

The feasibility study of the SAPEI link, connecting Sardinia to Italy, .has been completed in 2003 by GRTN. The SAPEI is under construction, first pole to be commissioned in mid 2008.

20 - The HVDC link : Balearic Islands – Mainland:

Concerning the HVDC link Balearic Islands – Mainland, the feasibility study, including the functional specifications has competed in the first quarter 2005. The study is carried out jointly by REE and CESI. The commissioning is foreseen by 2009.

II - CONCLUSION

The electricity production in the Mediterranean between 1971 and 2005 increased by 8% per year in Southern and Eastern Mediterranean countries (SEMCs) as opposed to 3.7% in the northern shore. According to national projections up to 2020, the growth rate should reach 6% and 1.6% in the South and North, respectively. SEMCs should therefore increase electricity production by about 65 TWh per year. Installed power capacity in the region reached 412 GW in 2005, 98 GW of which constructed between 1994 and 2005 (55 GW was completed within the last decade in the North and 43 GW in the SEMCs), a fourth of which under IPP schemes.

Satisfying planned future demand, the growth of power generation in the Mediterranean from 1780 TWh in 2005 to 2750 TWh in 2020, will require the construction of new power stations, amounting to 200 000 MW capacity over the period. Installed capacity by 2020 should reach 610 GW in the region as a whole, representing an increase of 200 GW (75 per cent in the SEMCs).

Concerning the SEMCs, electricity generation will double by 2020, increasing from 450 TWh (with 100 GW) today to 1060 TWh (with 220 GW) by 2020. This involves the construction of more than 120 000 MW capacity by 2020, namely about 1.2 times the existing park.

The greatest part (55% by 2020) will be natural gas fuelled power stations, given their low investment costs and the availability of natural gas resources in the Southern Mediterranean Countries. This trend is present in most countries, with Egypt and Libya having decided to ultimately only use gas for thermal production.

These new power stations require important financing needs for the SEMCs. Approximately 15 GW have already found financing, but the remaining would require investment needs in the range of \$50 billion (for the power generation sector alone). Therefore, it is essential to optimise the electric supply networks and reinforce the electric interconnections in the SEMC. These interconnections allow -inter alia- the reduction of new power plant construction and savings on investments and fuels. According to the preliminary evaluation of the economic survey on electric interconnections within the MedRing project, fuel savings could reach several billion dollars. Also, savings on investments are estimated to be even higher.

Over the past 10 years, great efforts were undertaken to increase interconnections. A few low capacity interconnections with a zero trade balance existed in the past between Maghreb countries. Since then, many interconnections have been completed and there currently are other projects and plans to reinforce at 400 kV.

For the moment, apart from the Morocco-Spain exchanges, the South-South exchanges remain very weak. With the completion of interconnection projects and the closing of the electrical loop planned for 2008, the electrical exchanges should reach, according to the first estimates of the MedRing study about 75 TWh in 2010 against 69 TWh in 2005. Although the Mediterranean Ring will nearly be closed, it will necessitate a reinforcement of the south links, especially by upgrading the network and interconnections to 400 kV level.

The development of electricity interconnections and exchanges will allow for the optimization of power generation and the decrease in the need for new capacity. The extent of electricity exchanges will depend on the differences between production costs and, thus, indirectly on fuel prices in the different Mediterranean countries.

Much thought is still given to the project of sub-marine cables between the Maghreb and Europe. The Mediterranean electricity ring is not perfectly integrated yet, with the continued existence of three distinct regional blocs - mainly due to technical problems regarding the security of the system. The ring, however, should close by 2008.

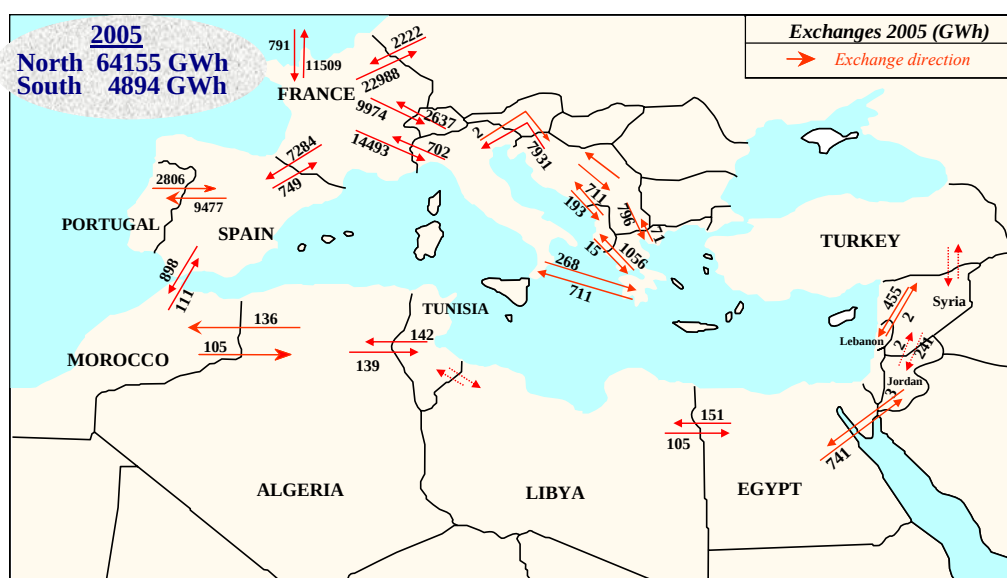
In conclusion, the potential for electricity and, in general, energy exchanges by 2010-2020 will depend on the future economic development of Mediterranean countries and co-operation between them. It is, therefore, essential to overcome the obstacles and constraints hampering sustainable development, and develop infrastructure needs that will increase exchanges, particularly electric and gas interconnections.

(Total) Electricity Imports & Exports in Mediterranean Basin in 2005 (GWh)

Countries	Exports	Imports	Total
Portugal	2806	9477	12283
Spain	11124	10201	21325
France	66248	7101	73349
Italy	1406	48542	49948
Greece	1838	5632	7470
Slovenia	9540	9287	18827
Croatia	9286	10700	19986
Bosnia-H.	3628	2251	5879
Serbie & M.	3147	8563	11710
Macedonia	797	2395	3192
Albania	726	1249	1975
Turkey	1800	600	2400
Syria	696	2	698
Lebanon	0	455	455
Israel	1665	0	1665
PNA	0	1665	1665
Jordan	5	982	987
Egypt	937	108	1045
Libya	105	196	301
Tunisia	150	58	208
Algeria	132	197	329
Morocco	158	972	1130
TOTAL in Mediterranean	116194	120633	236827

Source: UCTE 2005; Eurelectric Oct 2005; UAPTDE 2005; Comelec; Companies & OME

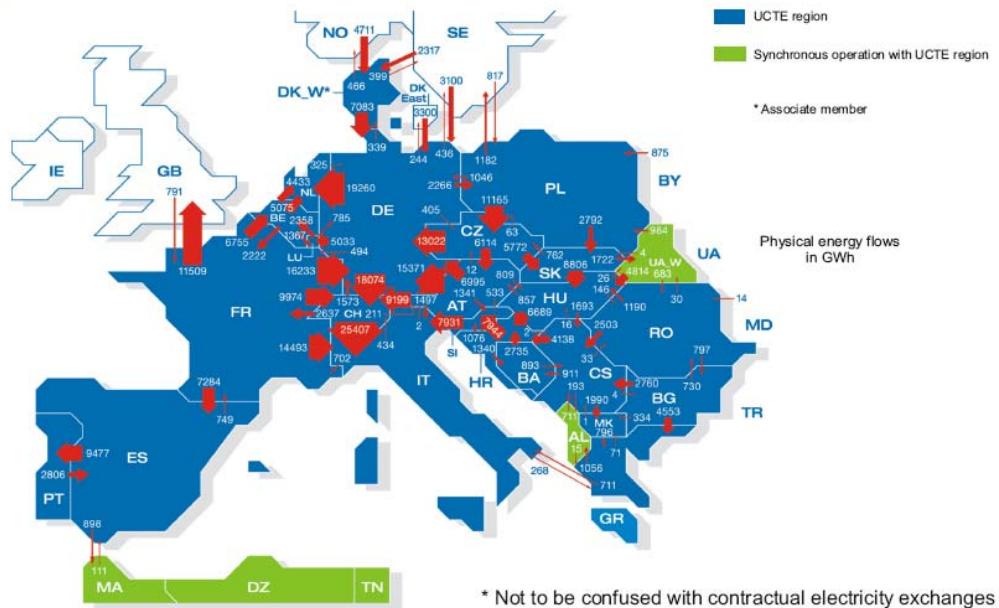
Intra-Mediterranean Physical Electricity Exchanges 2005



Source: OME, December 2006



Physical electricity exchanges 2005



Appendix C: Existing and planned RE projects in the region

Small hydro power plants

Country	Name	type	Year	Capacity	Cap. Tot.	
Algeria	AHZEROUFTIS	small hydro		5,0	5,0	
Algeria	GHOURIET	small hydro		4,2	4,2	
Algeria	IGHZER N' CHBEL	small hydro		2,7	2,7	
Algeria	ILLITEN	small hydro		8,0	8,0	
Algeria	SOUK EL DJEMAA	small hydro		9,0	9,0	
Algeria	TIZI MEDEN	small hydro		4,5	4,5	
Algeria	GHRIB	small hydro		7,0	7,0	
Algeria	HAMIZ	small hydro		1,6	1,6	
Algeria	OUED FODDA	small hydro		15,0	15,0	
Algeria	BOU HANIFIA	small hydro		6,0	6,0	
Algeria	TESSALA	small hydro		2,4	2,4	
Algeria	BENI BEHDEL	small hydro		3,3	3,3	
Algeria	ERRAGUENE	small hydro		16,0	16,0	
Total small power plants				85	MW	
Country	Name	type	Year	Nb of groups	Cap. Tot.	
Tunisia	EL AROUSSIA	small hydro	1956	1*4,9	4,9	
Tunisia	FERNANA	small hydro	1958	1*9,7	9,7	
Tunisia	KASSEB	small hydro	1969	1*,7	0,7	
Tunisia	NEBEUR	small hydro	1956	2*6,5	13	
Tunisia		small hydro		1,2	1,2	
Total small power plants					29,5 MW	
Country	Name	type	Year	Nb of groups	Cap. Tot.	River
Morocco	KASBA ZIDANIA	small hydro	1935-36	2	7,1	
Morocco	Mansour Ed DAHBI	small hydro	juin-69	2	10	Draâ
Morocco	TAURART	small hydro	sept-47	2	2	Talambot
Morocco	BOU AREG	small hydro	mai-05	1	6,4	
Morocco	Fes amont	small hydro	avr-05	3	1,2	Cheracher
Morocco	Fes aval	small hydro	févr-30	2	1,9	Boukhareb
Morocco	Taza	small hydro	avr-05	2	0,6	Taza
Morocco	Meknes	small hydro	avr-05	3	0,6	Boufekrane
Morocco	N'Ait M'hamed (Agadir)	small hydro	mai-02		0,3	bassin du Souss
Morocco	Askaw (Igudi Agadair)	small hydro	mai-02		0,2	
Morocco	Oum Rbai	small hydro	mai-02		0,22	Oum Rbai
Morocco	Maaser	small hydro	project			
Total small power plants					30,5	MW

Existing Wind Farms

Country	Location	Site	Type	Cap (MW)	Start-up	Company
Algeria			wind	0,45	existing	
Algeria	El Taref		wind	0,5	under study	APRUE
Algeria	El Taref		wind	0,1	under study	APRUE
Algeria	Tamnrasset		wind		under study	Sonelgaz
Algeria	Tindouf Project		wind	10	2008	NEAL
Egypt	Hurghada	Hurghada	wind	5	1995	
Egypt	Zaafarana	Zaafarana1	wind	30	Dec 2000	with Danida
Egypt	Zaafarana	Zaafarana2	wind	33	Mar. 2001	with KfW
Egypt	Zaafarana	Zaafarana3	wind	30	Dec 2003	with Danida
Egypt	Zaafarana	Zaafarana4	wind	47	June 2004	with KfW
Egypt	Zaafarana	Zaafarana5	wind	85	Dec 2006	with Spain
Egypt	German phase IV	project	wind	80	2007	
Egypt	Japan wind farm	project	wind	120	2008	
Egypt	Danish Phase III	project	wind	120	2010	
Egypt	Japan phase II	Gabal El Zayt project	wind	220	2008-2012	
Morocco	Tetouan		wind	3		ONE
Morocco	Tetouan	Koudia AlBaida	wind	50	Aug. 2000	Cie Eolienne du Detroit
Morocco	Essaouira	Sidi Kaouki	wind	0,050	2000	52 foyers
Morocco	Moulay Bouzerktoume		wind	0,015	2000	71 foyers
Morocco	Ouassen		wind	0,007	2000	
Morocco	Lamdint/Taroudant		wind	0,060	2002	
Morocco	Essaouira		wind	60	Apr. 2007	by Gamesa (Spain)
Morocco	Tanger	project	wind	140		under tendering
Morocco	Tarfaya	project	wind	60		under tendering
Tunisia	Cap Bon	Sidi Daoud1	wind	10,53	2000	STEG
Tunisia	Cap Bon	Sidi Daoud2	wind	8,72	2003	STEG
Tunisia	Cap Bon extension	Sidi Daoud3	wind	35	Nov 2007	STEG
Tunisia	project of 3 wind farms	Bizerte	wind	120	2009	STEG
Libya	projet 1	Dernah	wind	25	2005-06	GECOL
Libya	projet2	Dernah	wind	26	2007	GECOL

Existing Solar installations

Country	name	site	type	start-up	apacity (MW)	Tot Cap.	comments	Company
Algeria	20 villages	South of Algeria	PV systems		0,46	0,46	876 foyers with 106 PV systems	Sonelgaz
Algeria	wilaya Tindouf	3 villages	PV systems	existing	0,078		156 foyers with 20 PV systems	Sonelgaz
Algeria	wilaya Adrar	2 villages	PV systems	existing	0,023		45 foyers with 8 PV systems	Sonelgaz
Algeria	wilaya Illizi	8 villages	PV systems	existing	0,078		393 foyers with 45 PV systems	Sonelgaz
Algeria	wilaya Tamanrasset	5 villages	PV systems	existing	0,278		282 foyers with 33 PV systems	Sonelgaz
Algeria	in 21 locations	in 21 locations	others PV		0,719	0,719	lighting, Telecommunications, water pumping,...	
Algeria	SPPI (solar power plant project)	Hassi R'Mel	solar thermal (sol)	2009	150	150	Under construction since Dec 2006 by Abener (Spain)	Abener-Spain (66%), NEAL (20%) & BEA (14%)

Country	name	site	type	start-up	Cap. (MWp)	Tot Cap.	comments	Company
Tunisia	11000 foyers		PV systems		1,1	1,1	11000 foyers with 1100 PV systems	STEG
Tunisia	water solar heating		water solar heating	end 2006	148 000 m2		solar heaters	
Tunisia			others PV		1	1	lighting, Telecommunications, water pumping,...	STEG

Country	name	site	type	start-up	Cap. (MWp)	Tot Cap.	comments	Company
Libya	Ras Jdeer	project	PV desalination (d	2006	0,05	0,05	experimental sea water reverse osmosis desalination plant	GECOL
Libya	Hun PV power Plant	project	Hun PV power pl	2006	1,0	1,0		GECOL
Libya	160 foyers	project	PV systems	2005-06	0,2	0,2	200 foyers with 160 PV systems	GECOL

Country	name	site	type	start-up	Cap. (MWp)	Tot Cap.	comments	Company
Egypt	Wadi El-Natroun	PV pumping system with water production	Water Pumping	1989	14 kW	14	PV pumping system with water production in 80 - 100 m3ld	
Egypt	Water pumping	PV portable unit with water production	Water Pumping	1994	2,2 kW	2,2	PV portable unit with water production in 20 - 30 m3ld	
Egypt	Matrouh governorate	Household Lighting system at Matrouh gove	Household Lighting		212 W	0,212	Household Lighting system at Matrouh governorate	
Egypt	Alexandria- Cairo desert road	Lighting System for traffic signe at Alex. - C	Traffic Sign Ligh	2003	450 W	0,45	Lighting System for traffic signe at Alex. - Cairo desert road	
Egypt	Research Center EEHC	pumping &RO water desalination at Research	Desalination	1986	7kW	7	PV pumping & RO water desalination plant for producing 5 - 7 m3ld at Research Center EEHC	
Egypt	El-Hamrawein on Red Sea	PV desalination RO plant at El-Hamrawein o	Desalination	1984	18.5 kW	18,5	PV desalination RO plant at El-Hamrawein on Red Sea with a productivity of 60 m3ld	
Egypt	Abou-Ghosoon on Red Sea Coast	PV/Diesel powered RO water desalination ur	Desalination with	1985	8 kW	8	hybrid PV/Diesel for RO water desalination for 5 m3ld of water at Abou-Ghosoon on Red Sea coast	
Country	name	site	type	start-up	Cap. (MWp)	Tot Cap.	comments	Company
Egypt	4567 foyers				1,1	1,1	4567 foyers	
Egypt	others PV		others PV	end 2005	3,9	3,9	lighting, Telecommunications, water pumping,...	
Egypt	Domestic Solar Water Heating systems (l	200 000 DSWH	Domestic Solar W	end 2005	500000 m2		200 000 DSWH	
Egypt	Kurimat	solar/NG	solar thermal (sol)	2010	150	150	Under tendering	

Country	name	site	type	start-up	apacity (MW)	Tot Cap.	comments	Company
Morocco	2540 villages (29312 foyers)		PV systems	end 2006	6	6,0	rural electrification of 2540 villages by PV systems	ONE, CDER
Morocco	59800 foyers by TEMASOL		PV systems	underway			rural electrification by PV systems	by TEMASOL for ONE & CDER
Morocco	solar heating		thermal solar		100000 m2		solar heaters	
Morocco	Ain Beni Mathar	solar/NG	solar thermal (sol)	Q1, 2009	472	472	Convention GEF (WB) for 43,2 M\$ signed in 23 April 2007	
Morocco	projected 150 000 foyers		PV systems	under way				ONE, CDER

Existing Biomass installations

	name	site	type	start-up	Capacity (MWp)	Tot Cap.	comments
Tunisia	Sousse		biogs pilot from chicken waste	2000	0,05	0,05	biogas pilot of electricity prod from chicken wastes

	name	site	type	start-up	Capacity (MWp)	Tot Cap.	comments
Egypt	El Gabal El Asfer		biomass power plant	1997	18	18	
Egypt	El Gabal El Asfer		biomass power plant	2003	18	18	
Egypt	El Gabal El Asfer	project	biomass power plant	2010	18	18	
Egypt	El Gabal El Asfer	project	biomass power plant	2015	18	18	
Egypt	El Gabal El Asfer	project	biomass power plant	2017	18	18	

	name	site	type	start-up	Capacity (MWp)	Tot Cap.	comments
Morocco	individual biogas digesters		biogas digesters	1985			350 units installed
Morocco	Be;sergao biogas Plant		biogas plant	1986			

