

# MOROCCO

## Country Report on Renewable Energy



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## I. Key Country Data

### a. Country at a Glance

Morocco is a country with a stable constitutional monarchy riddled by certain elements of controversy, most notably, the status of the Western Sahara region is a point of contention. Western Sahara is a former Spanish colony that was annexed by Morocco in 1975 and is considered a non-self governed territory by the United Nations. The *Polissario Front* group backed by Algeria, has been seeking its independence since its annexation. Since his ascension to the throne on the 23<sup>rd</sup> of July 1999, King Mohammed VI, who succeeded to his father King Hassan II, has introduced several reforms in many areas facilitated by the fact that he holds political, military and religious power over the kingdom.

Morocco is located in North Africa and has a population of 32 million inhabitants. The country spans an area of 710,850 km<sup>2</sup> including the Western Sahara region. Morocco borders the North Atlantic Ocean in the West, the Mediterranean sea in the North, Algeria in the East and Mauritania in the South. The border between Algeria and Morocco has been closed since 1994. Morocco also shares borders with Spain to the North due to the four Spanish enclaves of Ceuta, Melilla, Penon de Velez de la Gomera, and Penon de Alhucemas. It also has borders Portugal and Spain to the West on the Atlantic coast as the Canary Islands belong to Spain and Madeira to Portugal. The Atlas Mountains are located in the center of the country, they extend from South-West to North-East and thus create varied climatic conditions across the territory. Most of the South-East portion of the country is unproductive and unpopulated as it falls in the Sahara Desert. The Western Sahara region is known for being foggy due to the clash between cold offshore air and hot dry inland desert. The terrain is mostly low, flat desert with large areas of rocky or sandy surfaces rising to small mountains in the South and North-East. In northern coastal areas, there is a Mediterranean climate, whereas climatic change occurs when one moves in-land.

In order to steadily develop its economy, Morocco aims to attract foreign direct investment (FDI) from Europe. Since it joined the WTO in 1995, Morocco has developed trade agreements with the European Union, the United States, Turkey and the United Arab Emirates. In addition, as part of the free-trade zone that the state created with Egypt, Tunisia and Jordan, in 2008, Morocco was granted the "Statut Avancé" which gave it further accessibility to European programs. The current government is trying to accelerate training in certain disciplines in order to satisfy the demand in certain fields and thus, make the country more attractive for foreign investments. Additionally, Morocco has adopted a series of measures to simplify procedures and conditions for investors. The creation of additional domestic skilled workers are a national priority, the kingdom has created a national plan for training to target industrial needs. The national plan consists in training engineers in dedicated training institutes, established within the framework of international partnerships. Energy is at the heart of the country's development strategy, Morocco is looking at training candidates for high-level positions dedicated to the implementation of renewable energy and energy efficiency.

Morocco is the leader among Maghreb region countries for FDI; Foreign Direct Investments reached USD 2.57 billion in 2007. The majority of the countries who invest in Morocco are European Union member nations that represented 73.5% of total inward investments in 2007. Of European nations, France leads investments with USD 1.86 billion, followed by Spain with USD 0.78 billion. In addition, Gulf Cooperation Council (GCC) countries are involved in several large scale projects. The three main sectors for FDI are tourism USD 1.55 billion, real-estate USD 0.93 billion and industrial production with USD 0.37 billion. Morocco's two principal trade partners are France (24.6% exports; 15.7% imports) and Spain (21.2% exports; 12.1% imports). Morocco's commitment to environmental issues is present at the highest level of government with the aim of establishing an environmental strategy for sustainable development. In 1995, Morocco ratified the United Nations framework convention on climate change. In 2001, Morocco hosted the 7th Conference of the Parties to the UN Framework Convention on Climate Change (COP7) in Marrakech. In 2002, Morocco signed the Kyoto Protocol and in 2009 it participated in the Copenhagen

summit on climate change in through its Minister of Energy, Mines, Water and the Environment, Dr. Amina BenKhadra. Today, Morocco ranks in the second position among African countries for the number of clean development and renewable energy projects.

In order to achieve its ambitions, Morocco has based its plan on the development of four points that are considered the pillars of the country's sustainable development:

- a favorable geographic location;
- a huge potential for renewable energy;
- the ability to achieve major projects and;
- investment in the development of a specialized domestic labor force.

It is from this foundation that Morocco is looking to develop over the next 20 years.

In Figure 1, we can see that Morocco has experienced significant growth in GDP and as well as an important rise in inflation. On the other hand, public debt as a percentage of GDP is relatively low when compared to many nations, ranking 41<sup>st</sup> and just below the world average.

Figure 1. Morocco Economic Indexes 2004 – 2009

	2004	2005	2006	2007	2008	2009
Inflation (% change YoY)	1.2	2.1	1	2.8	2	3.9
Moroccan GDP (PPP)	101,904	108,171	120,365	126,943	138,177	159,007
Moroccan GDP(PPP)/capita	3,409	3,585	3,945	4,093	4,432	4,725
Percentage of GDP growth	4.8	3.0	7.8	2.7	6.5	4.4
Public Debt (percentage of GDP)	59.4	63.1	58.1	53.6	51.9	51.8

Source: (IMF 2010)

#### **b. Natural Energy Resources (Consumption, Import and Export of Natural Resources)**

Over an eight year period (2000-2008), primary energy demand grew at an average rate of 5.9% per year. Morocco is the largest importer of energy in North Africa with 94.6% of its energy imported in 2009; crude oil consumption represents 61% of its energy followed by coal (23%). Considered as a strategic platform for energy transit, Morocco plays a major role in the exportation of gas and electricity from Algeria to Spain. In 2009, the Ministry of Energy, Mines, Water and the Environment presented its "National Energy Strategy" that included the development of renewable energy in order to satisfy growing energy consumption and electricity demand. This strategy relies on six fundamentals:

- 1) security of supply,
- 2) diversification of national energy sources in order to reduce dependency on imports,
- 3) accessibility of energy for all,
- 4) low cost of energy,
- 5) energy efficiency,
- 6) environmentally friendly development.

On a regional scale, Morocco is a founding member of the COMELEC, which regroups Algeria, Libya, Morocco, Mauritania and Tunisia. Its main objective is to study and propose solutions to power utility companies that are members in order to share best practices. Morocco is also the fourth player of the OMEL market since 1999. It is also member of the "Mediterranean Union" that was founded in 2008; one of the Union's objectives is to develop the solar and wind energy potential of the countries of the southern

Mediterranean area in order to supply northern areas with clean electricity. More recently, in January 2009, Morocco with another 75 founding members created the International Renewable Energy Agency (IRENA). Morocco is developing a strong regional interconnection grid in order to exploit its huge electricity export potential. Morocco is developing an ambitious energy strategy with a centralized focus on sustainable development. Starting from this point, Morocco has set several measurable objectives in order to achieve its mission:

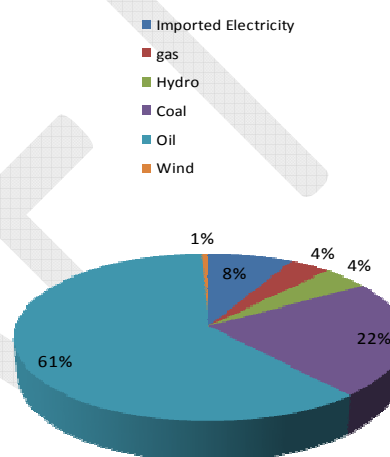
- Accessibility of energy for all; meaning, the achievement of rural electrification by 2009.
- A power capacity that is 42% produced by renewable energy by 2020.
- 12% improvement in energy efficiency of by 2020.
- Diversify its fuel sources and decrease its dependency on imported energy.
- Develop a regional interconnection with Spain.
- Increase the country's involvement in environmental issues and preservation of the environment.

Figure 2. Evolution of the Energetic Balance (ktep)

	2004	2005	2006	2007	2008
Gas & Oil	64	45	66	60	59
Hydro	414	251	256	235	238
Wind	50	50	48	70	77
<i>Production</i>	<i>528</i>	<i>346</i>	<i>370</i>	<i>365</i>	<i>374</i>
Oil	6,982	7,582	7,713	8,069	9,115
Coal	3,620	3,716	3,878	3,910	3,723
Hydro	414	251	256	235	238
Gas	45	379	479	540	533
Imported Electricity	400	212	527	910	1,108
Wind	50	50	48	70	77
<i>Consumption</i>	<i>11,511</i>	<i>12,190</i>	<i>12,901</i>	<i>13,734</i>	<i>14,794</i>
Dependency (%)	95,40%	97,20%	97,10%	97,30%	97,50%

Source: (Ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement)

Figure 3. Primary Energy Mix by Fuel Type, 2009  
(Total: 15,119 ktep)



Source: (Ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement)

In Figure 2, non-commercial biomass (wood fuel) is not present; though not officially reported, this wood fuel is widely used in Morocco and represents around 30% of total energy consumption (largely for domestic use). The energy demand in Morocco excluding wood fuel is increasing very rapidly due to population growth, improvements of standards of living, and the expansion of the industrial, commercial and residential sectors. Morocco is planning to reduce its greenhouse gas energy emissions while continuing to develop its energy capacity in order to sustain its economic development. Morocco has decided to favor renewable energy in order to satisfy a growing demand for energy use, to limit its emissions production, limit the country's exposure to oil and gas price fluctuations, and foster economic development through the sector's growth.

The Moroccan energy industry is composed of public and private actors. The National Mines and Hydrocarbons Authority is the main public authority in the energy sector. This Authority was created from the merger of several public entities:

- Office National des Hydrocarbures et des Mines (ONAREP)
- Bureau de Recherches et de Participations Minières (BPRM)
- Office National de l'Électricité (ONE)
- Centre de Développement des Énergies Renouvelables (CDER)

Major private companies operating in the energy field are :

- The Moroccan Refining Company (SAMIR)
- The Maghreb-Europe Gas Pipeline Management Company (METRAGAZ)
- Jorf Lasfar Energy Company (JLEC)
- Tahaddart Electricity Company (EET)
- Detroit Wind Energy Company (CED)
- LYDEC
- REDAL
- AMENDIS

### c. Electricity Supply: Installed Capacity, Production, Fuel Mix

#### Electricity Generation

The electricity generated in Morocco comes principally from four main suppliers: three independent producers (JLEC, EET and Théolia), the ONE, Spanish and Algerian power producer and the self generating consumers. In 2008, the ONE generated a capacity of 7,264 GWh representing 29% of the total country consumption generation. 5,758 GWh were generated by thermal plants; 1,360 GWh by hydro and 146 GWh by wind energy. The network with Algeria and Spain accounted for 17% of the electricity imported 4,261 GWh. Private producers generated 13,042 GWh (54%). The JLEC generated 10,022 GWh (41%), the EET 2,867 GWh (12%) and the Théolia wind 53 GWh. Finally, self generating consumers produced 40 GWh.

Figure 4. National Electricity Demand, 2008

Producers	GWh	Total (%)
JLEC	10,022	41
EET	2,867	11.4
THEOLIA	153	0.6
<i>Private Producers</i>	<i>13,042</i>	<i>53</i>
Thermal	5,758	23
Hydro	1,36	5.5
Wind	146	0.6
<i>ONE Production</i>	<i>7,264</i>	<i>29.5</i>
<i>Interconexion</i>	<i>4,261</i>	<i>17</i>
<i>Auto-Producers</i>	<i>40</i>	<i>0.1</i>
<b>TOTAL</b>	<b>24,607</b>	<b>100</b>

Source: (Ministère de l'énergie, des Mines, de l'Eau et de l'Environnement.)

In 2008, total installed capacity totaled 5,292 MW, with a thermal capacity of 3,449 MW. Coal represented 34%, while gas, fuel and hydro represented 12%, 11% and 7% respectively. Wind energy accounted for only 2% of installed capacity. Private producers owned 50% of total capacity, the ONE had 31.4%, and imported electricity represented 18.1%.

We found that in 2008, an increase in imported electricity from Algeria and Spain was present due to a shortage in installed capacity. Since 2005, Morocco's power generation has remained nearly unchanged; increasing from 19,118 GWh to 20,327 GWh in 2008 (+0.61%); whereas imported electricity went from 814 GWh in 2005 to 4,261 GWh in 2008 (+423%). This stagnation, in addition to an expected annual growth in demand of 7.5%, to reach 45,000 GWh by 2015, implies that further investments in this sector must be made in coming years. In 2008, a new law was passed that allows non-ONE producers to increase their generation capacity in increments of 10 MW to 50 MW on the condition that the electricity is sold exclusively to the ONE and that the project has been previously subject to tendering procedures. Independent Power Producers (IPP), are still very dependent on the ONE as the latter has an important role

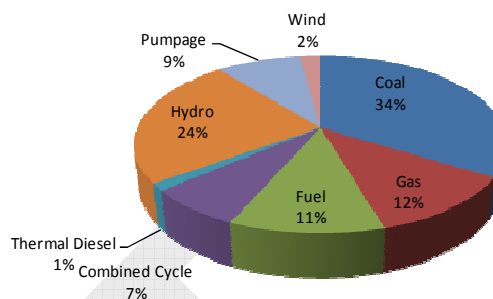
at all the levels (production, wholesale trading, and transmission). This law is in-line with law "2-94-503" passed on the 23<sup>rd</sup> September 1994, which calls for the opening of the electricity market to competition. This law was intended to reduce prices paid by consumers and to divide the electricity market into an open market segment and a regulated one.

Figure 4. Installed Capacity by Energy Source, ONE & Private Producers (MW)

	2004	2005	2006	2007	2008
Coal	1,665	1,785	1,785	1,785	1,785
Gas	615	615	615	615	615
Fuel	720	600	600	600	600
Combined Cycle		384	384	384	380
Thermal Diesel	369	69	69	69	69
<b>Thermal</b>	<b>3,369</b>	<b>3,469</b>	<b>3,469</b>	<b>3,469</b>	<b>3,469</b>
<b>Hydro</b>	<b>1,265</b>	<b>1,265</b>	<b>1,265</b>	<b>1,265</b>	<b>1,265</b>
<b>Pumpage</b>	<b>462</b>	<b>464</b>	<b>464</b>	<b>464</b>	<b>464</b>
<b>Wind</b>	<b>54</b>	<b>54</b>	<b>54</b>	<b>114</b>	<b>114</b>
<b>Total</b>	<b>5,150</b>	<b>5,232</b>	<b>5,232</b>	<b>5,292</b>	<b>5,292</b>
Network with Europe	700	700	1,500	1,500	

Source: (ONE Annual Report)

Figure 5. Installed Power Generation, 2008.



Source: (ONE Annual Report)

#### Transmission and Distribution (Shared with Private Distributors)

All electricity produced by private or public entities in Morocco is compulsorily bought the ONE. The ONE buys the electricity and then resells it to various distributors. The transmission system is fully owned by the ONE. The high voltage/medium voltage line is composed of four different networks totaling a length of 20,350 km in 2008. There are 1,361 km for 400 kV; 7,724 for 225 kV; 147 km for 150 kV; and 11,118 km for 60 kV. The 400 kV lines are essentially used for the imported capacity from Algeria and Spain. For that reason, there are three 400 kV lines connecting Algeria to Morocco and two 400 kV lines linking the Spanish grid to the Moroccan one. Morocco is looking to reinforce its interconnection transit capacity with both Spain and Algeria; it wants to increase the capacity transferred with Spain with a third line from 1400 MW to 2,100 MW and wants to increase by more than four times the one with Algeria by increasing it from 400 MW to 1,700 MW. Morocco also intends to renew its national dispatch system; it has projected to install a national dispatching center in Casablanca, a smaller dispatching center in Tit Mellil and a rescue center in Zaer. The realization of this project was completed thanks to the European Investment Bank, financing a project launched by the ONE in 2006 and ended in 2009. This electrical substation project, indented to ameliorate overall client satisfaction, by optimizing the management of the grid, properly managing electricity interruption, decreasing the cost of exploitation. The project consisted in installing seven regional dispatching centers and one central dispatching center covering four regions: the Center region was managed from Casablanca, the South managed from Agadir and Marrakech, the East from Oujda, and the North from Meknes and Rabat. Each unit is composed of one information center equipped with an computerized system and telecommunication tools (modems, wireless, fiber optics, etc.).

As part of the national plan, the Very High Voltage (VHV) line has been strengthened on three levels. Firstly, reinforce the supply for the Greater Casablanca Area. Secondly, continue to improve electric reach and reduce the overcapacity on the 225 kV line in the North. Thirdly, reduce the losses on the 225 kV line linking the North and the South. Also major rehabilitation, maintenance and extension of Very High Voltage (VHV) and High Voltage (HV) networks took place in 2009 to expand the grid to 121,022 km for Low Voltage ; 66,398 for Mid Voltage and 19,575 for VHV/HV.

Regarding the distribution network, the ONE sells the electricity directly to some clients (Very High /High Voltage power users and the "Programme d'Electrification Rurale Globale" clients (PERG)). The remainder is

delivered through the ONE and eleven distributors that are divided in two categories, seven local public distributors called “*Régies de distribution*” and four private distributors called “*Société délégataires*”. In 2008, direct sales accounted for 55% of the total of which 3,446 GWh (16%) were Very High Voltage/High Voltage customers and 8,419 GWh (39%) were Mid/Low Voltage customers. The remaining 9,703 GWh (45%) were sold to Mid/Low Voltage clients distributed by private and local operators.

Figure 6. ONE

	Number of Clients	Sell GWh	Percentage Selling
Distributors	11	9,701	44.7%
Industry	35,981	5,375	24.8%
Agriculture	25,879	1,487	6.80%
Tertiary	359,525	1,170	5.40%
Residential	3,340,015	3,196	14.70%
Administrative	50,391	782	3.60%
<b>Total ONE</b>	<b>3,811,802</b>	<b>21,710</b>	<b>100%</b>

Source: (ONE Annual Report)

Figure 7. Transmission Grid (km) VHV/HV

	2004	2008	% Change
400 kV	727	1,361	87%
225 kV	6,488	7,724	19%
150 kV	316	147	-53%
60 kV	9,655	11,118	15%
<b>Total</b>	<b>17,186</b>	<b>20,350</b>	<b>18%</b>

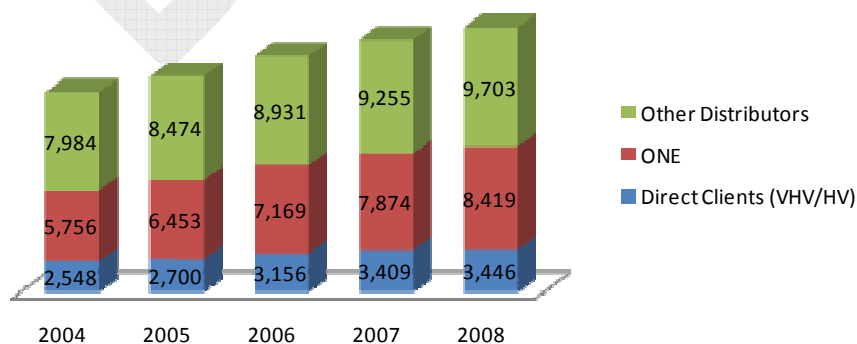
Source: (ONE Annual Report)

Figure 8. Distribution Network Supply Infrastructure

	2004	2005	2006	2007	2008
MV Lines (km)	40,560	47,079	51,842	55,103	61,634
LV Lines (km)	112,017	133,542	144,862	149,795	127,829

Source: (ONE Annual Report)

Figure 9. Sales Distribution (GWh)



Source: (ONE Annual Report)

**d. Electricity Demand: Customer Breakdown, Power Prices**

In 2008, the electricity sold in Morocco was 21,710 GWh an increase of 5.9% year-on-year. The generated electricity is used by distributors (44.7%), industry (24.8% - usually these clients use Very High Voltage/High Voltage power), agriculture (6.8%), households (14.7%), the public administration (3.6%), and by the service sector (5.4%).

Figure 10. Electricity Price in Morocco, 2009

Voltage		€/kVA	€/kWh	Price Depends On
Very High Voltage /High Voltage	General	33.5	0.05-012	<ul style="list-style-type: none"> <li>▪ Time of the day</li> <li>▪ Annual hours of consumption</li> </ul>
	Optional	26.1-145.7	0.05-0.16	<ul style="list-style-type: none"> <li>▪ Voltage level</li> <li>▪ Time of the day</li> <li>▪ Annual hours of consumption</li> </ul>
Medium Voltage	General	24.3	0.05-0.11	<ul style="list-style-type: none"> <li>▪ Time of the day</li> </ul>
	Optional	31.14-155.6	0.04-014	<ul style="list-style-type: none"> <li>▪ Time of the day</li> <li>▪ Annual hours of consumption</li> </ul>
	Agriculture	38.1-190.5	0.04-0.16	<ul style="list-style-type: none"> <li>▪ Annual hours of consumption</li> <li>▪ Time of the year</li> </ul>
Low Voltage	Households	-	0.08-0.13	<ul style="list-style-type: none"> <li>▪ Monthly consumption</li> </ul>

Source: (GTZ report 2009; Energy-policy Framework Conditions for Electricity Markets and Renewable Energies)

Electricity price in Morocco is higher than in North African neighboring countries as most of the country's energy is imported. The price of electricity paid by final customers is fixed by a decree signed by the Prime Minister. In the country's rural areas, the electricity end-user may purchase electricity using prepaid rechargeable cards costing around EUR 2.00.

#### e. Renewable Energy

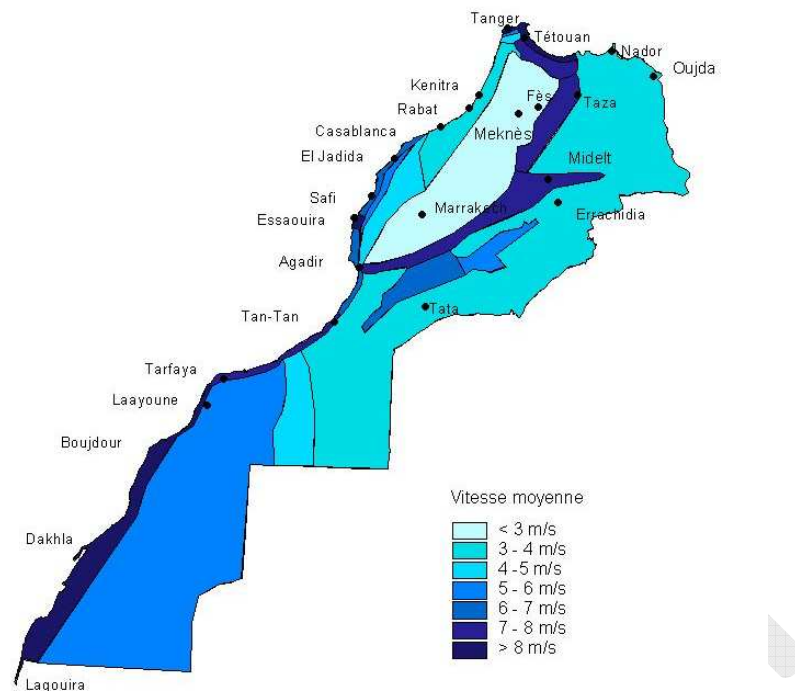
Thanks to the interconnection development program with Spain and Algeria, Morocco aspires to become a major pillar for electricity transfer in the Mediterranean region. Morocco has opted for the Build-Operate-Transfer concession model (B.O.T), which represents an opportunity for potential companies willing to enter the Moroccan market with equipment, technologies and services related to renewable energy. Morocco is planning to have a renewable capacity representing 42% of its total capacity by 2020. This renewable capacity will be divided equally between three sources (wind, solar and hydro). The total renewable energy capacity is expected to be 6,000 MW. By increasing renewable energy capacity, Morocco reduces its dependence on fossil fuels, while preserving the environment by reducing CO<sub>2</sub> emissions and fighting against climate change. The government has also reduced the VAT from 20 to 14% on equipment for use in renewable energy, in particular, the solar-fired heaters. This tax reduction will contribute to the promotion of the national market of solar-fired heaters.

#### Wind

Morocco has an excellent wind energy potential mainly in the North, and in Essaouira in the South. More than 50 measurement stations were installed by the "Centre de Développement des Energies Renouvelables" (CDER) during 2000 and 2008. (Lately, the CDER was replaced by the "Agence National pour le Développement des Energies Renouvelables"). In Tangier and Tetouan, the annual average wind speed ranges between 9.5 and 11 m/s at 40 meters elevation. In Tarfaya, Taza and Dakhla the annual average wind speed ranges between 7.5 m/s and 9.5 m/s under the same conditions. After having conducted wind measurement on the coast, the CDER moved its measurement activities to the Atlas mountains. In Morocco, onshore wind resources are highest in the western part of the country, and on the eastern islands with coastlines facing South or West. The country has good offshore wind potential, and

large areas of sea territory with a shallow water depth of 5–15 meters, where installation of turbines is most feasible. These sites offer higher wind speeds, in the range of roughly 8.5–9.0 m/s at 50 meters.

Figure 11. Morocco's Wind Map



Source: (CDER Dec 9, 2009)

The estimated wind capacity should be around 1,000 MW by 2012 and 2,000 MW by 2020. In 2008, installed capacity for wind was 114 MW. Wind farms are particularly valuable in Morocco as they also contribute to the desalination of seawater. Several projects have been completed and others are scheduled for completion by 2015. In the city of Tan-Tan 933 km south of Rabat, near the Atlantic coast, the average wind speed is 6.82 m/s at 40 meters elevation. Desalinated water production from wind energy in this area was 6,048 m<sup>3</sup>/day in 2008. In the future, the production is expected to grow to 9,502 m<sup>3</sup>/day by 2010 and 11,232 m<sup>3</sup>/day by 2015. The installed capacity was 5.6 MW in 2008 and 8.8 MW in 2010 and a projected 11.2 MW by 2015. Thus, the production in 2015 is estimated to be 25.52 GWh/year. The desalination project is operated by ONEP. Another desalination plant is in Akhfennir, near the Atlantic coast 1,000 km South of Rabat. Desalinated water production is planned to be around 860 m<sup>3</sup>/day. The project is to be implemented by ADEREE, IMET (Italy) and ONEP. One of the previously executed projects is the Essaouira wind farm that generates 210 GWh of power; the plant is composed of 71 turbines with a capacity of 850 kWp each totaling 60 MW. This project, which was financed by Kreditanstalt Fur Wiederaufbau (KfW), cost EUR 72 million and is operated by the ONE. As renewable energy and energy efficiency are considered top priorities for the country, on the 28<sup>th</sup> of June 2010 King Mohammed VI inaugurated the wind farm of Tanger (140 MW) which adds 510 GWh to the domestic power generation. This wind farm is the largest one in the country and its total cost was of 2,75 billion of Dirham (EUR 248 million) financed by a conglomerate formed by: ONE, KfW and l'Agence Francaise de Développement. It will reduce up to 470,000 tons of CO<sub>2</sub> emissions per year.