

The development of wind potential in Morocco

S.Nabdi

PhD student/Industrial techniques laboratory
(LTI), Sidi Mohammed Ben Abdellah University,
Faculty of Sciences and Techniques (FST),
Road d'Immouzer, B.P.2202, Fez, Morocco
nabdisouad@gmail.com

Dr.B.Herrou

Professor/EST FEZ, Industrial techniques
laboratory (LTI), Sidi Mohammed Ben
Abdellah University, B.P. 2202, Fez, Morocco
herroubrahim@yahoo.fr

Abstract: The massive development of industry and the overall increase of the population are the leading cause of the big demand and the gradual consumption of energy. Therefore, diversifying sources of energy and look for other renewable sources are becoming a necessity for the endurance of the traditional ones. Morocco, like all countries at the global scale, its energy sector depends mainly on imports of fossil fuels, and this is endangering its energy security in the short and long term. Hence the need to opt for renewable energy and specifically in wind energy. From this perspective, our job is to identify wind energy worldwide. Next, define the different energy sources and developing those of wind turbines in Morocco. Finally, we will present the results obtained from the forecast and suggestions for improving the wind sector.

Key words: Energy, Wind turbines, Development, Wind Potential, Morocco

I. INTRODUCTION

The world today is facing two major battles that are climate change and the eradication of poverty and inequality. In addition, we add to these challenges the progressive energy demand justified by the increase of the world population.

Morocco, as elsewhere in the world, the population is confronted on the continued increase in energy demand and specifically electricity. The main causes of this solicitation are economic growth and the galloping industrialization and the growth of population and individual wealth. While it is a country that has almost no fossil resources and its energy system depends essentially 95% of fuel imports to meet its needs. [1]

In this country of North Africa, consumption is gradually increasing in parallel to his attempts to become a developed country. It is an energy importing country due to the lack of sufficient conventional energy sources that can be accepted as the engine of development. Therefore, Morocco is confronted with the obligation to convert its energy system and choose the one renewable.

In our study, we are going to analyze the wind energy that are considered by recent studies like an important

energy source for Morocco, and we will try to present the potential of this energy to cover the needs of electricity in our country in short- and long-term all offering some suggestions for the development of this innovative energy.

II. WIND ENERGY SECTOR IN THE WORLD

A. The global wind power

Wind energy is the most advanced renewable energy source because it is more pure and environmentally friendly. This energy knows a remarkable development since the 1990s and the wind industry has evolved into a powerful industry with high technology. From an economic perspective, renewable energies were previously considered ancillary sources with minors and uncertain contribution which are unable to compete traditional energy sources, and this because of their low intensity and difficulty to control their intermittently. [2]

Despite the doubts of decision-makers, wind energy at present is constantly growing. The world production goes from 24,322 MW in 2001 to 196,630 MW in 2010 and 282 275 MW in 2012 with over 44,609 MW installed just in 2012 [3]. The data clearly show that the global power of the established wind power is doubled once every three years.

We notice from the World Wind Energy Report 2012 that the United States, Germany, Spain and Denmark with other European countries in addition to China and India are the countries with the bulk of energy in the world up to 203 000 MW. While Asian countries have recently increased their power with a share of 36.3% of new installations, followed by North America with 31.3%, Europe 27.5% and Latin America with 3,9%, against the power of Oceania with 0.8% and Africa with 0.2% [3,4]. Therefore, operation of wind power to provide electricity has reached a significant level in the world with a production can reach 580 TWh / year, so a 3% share of the overall power consumption. We are adding (Fig.1) that global installed capacity in 2014 is about 52,129 MW; with a dominance of the Asian market presented by China with an installed capacity reaching 23 351 MW followed by the USA with 4854 MW. [5, 6, 7, 8, 9, 10]

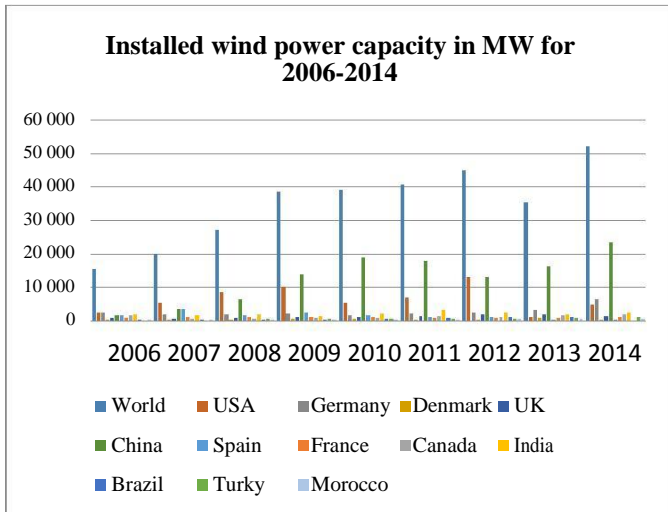


Figure 1: Installed wind power capacity in MW for 2006-2014

B. Wind power in the countries of North Africa

To this day, renewables remain unusable in the countries of North Africa. They provide just 3.5% of the electricity in the region. We note that in Morocco the renewables energies generate 11% of electricity with a share of the wind turbine of 2% and an installed capacity of 291 MW (end of 2013) [11], against 260 MW installed (end of 2011) in its neighbor Algeria, which aims for an increase of up to 1700 MW by 2030 [12]. In some countries in the region such as Egypt, renewables produce 9.5% of electricity with an installed capacity of 545 MW of wind turbines (end of 2013) [11] in a policy to increase its renewable energy capacity 7.2 GW in 2020. Followed by Tunisia with a wind capacity of 190 MW (end of 2013) and a renewable energy contribution of 6% in the production of electricity, which aims to increase the number to 25% with a capacity of 1700 MW for wind in 2030. Not forgetting that Libya is a country in the region that has a large wind potential is not yet well exploited with a capacity installed of 60 MW in 2012 in a vision to attain 2200 MW by 2025.

III. SOURCES OF ENERGY IN MOROCCO

Energy is essential for the economy and for social and cultural life. Accordingly, it is a necessity irrevocable provide consumers a safe and consistently. The energy demand is growing, especially the consumption of electrical energy. Operated from inexhaustible deposits, sun, wind, heat from the earth, waterfalls or the tidal renewable energy are revealed today, as vital sources of production of electricity in the energy mix . Morocco has a variety of renewable energy sources:

- The solar energy
- The wind energy

- The biomass
- The hydropower
- The geothermal

While Morocco suffering from a dependence on non-renewable energy conventional (coal, oil, natural gas). In fact, Morocco as an importer of oil, it is strongly influenced by the global oil situation. The oil bill becomes very heavy, which reflects negatively on the national economy through an amplification of trade deficit and a rise in consumer prices. [13] In recent years, in order to lower the public debt and in order to secure and improve its energy supply, Morocco has started to develop a policy which is based on two pillars. On the one hand, the country encourages local production of fossil fuels through the exploration of oil deposits in the water digs in its territory; and secondly, it is directed towards the development of renewables in its mix of energy.

We present below in Fig.2, the electrical production by source: [14]

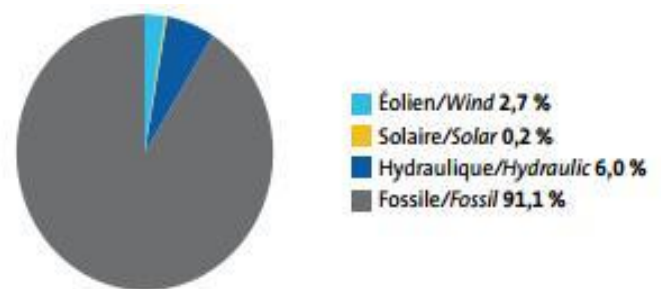


Figure 2: Structure of electricity production by source

We observe in Fig.2 that the bulk of electricity production comes from fossil with 91.1% and hydro with a share of 67.2% of the total renewable, followed by wind power occupying a growing share of 30% in 2012 [14] and that the solar photovoltaic currency between its components and thermodynamics with a share of 2.8% of the sustainable balance sheet. Although its power amounts to 1745 MW, Morocco's hydroelectric production is highly variable depending on the annual rainfall which is characterized by instability from one year to another. Consequently, Morocco's energy bill is dominated by crude oil and oil products top the list of components with a share of 89%, followed by coal, natural gas and electricity. The share of each product in the energy bill in 2013 was as follows: [15]

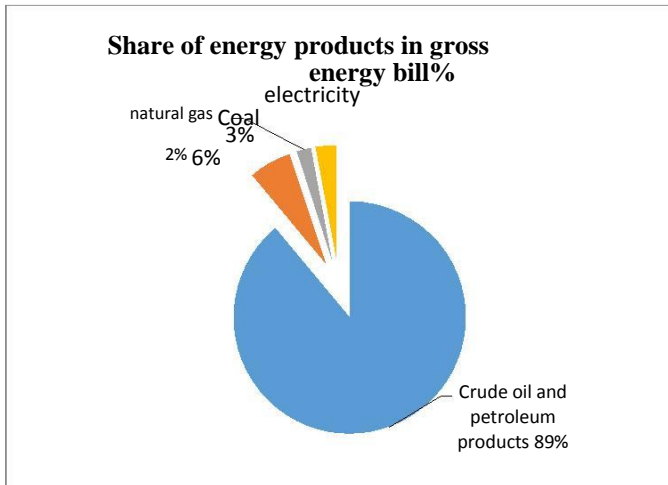


Figure 3: Share of energy products in gross energy bill %

By analyzing the energy resources and the energy bill in Morocco, which depends mainly from the imported conventional sources, the adoption of a renewable energy policy is essential to alleviate the energy dependency on oil.

IV. WIND ENERGY IN MOROCCO

A. The wind in Morocco

Morocco is characterized by its geographical position which enhances its wind resources. In fact, our country being under the influence of various pressure systems over the seasons. The mapping of the wind in Morocco is presented as follows: [16]

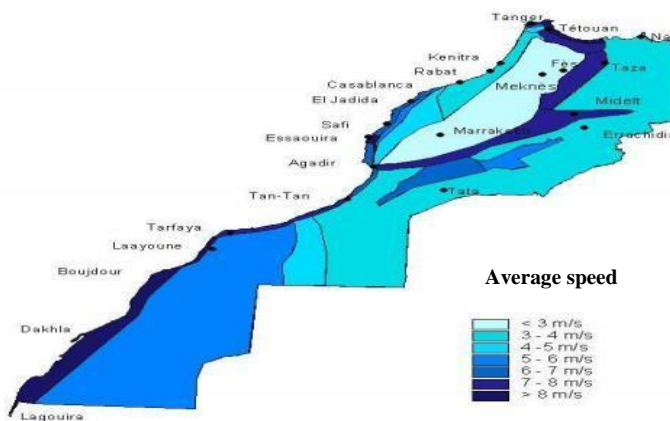


Figure 4: Wind mapping in Morocco

We observe in Fig.4 that Morocco has an important wind power because of its location in the Strait of Gibraltar and the Mediterranean Sea and its coast very important extending on 3500 km. Therefore, Morocco has the advantage to enjoy an especially rich wind energy potential

compared to other countries in the vicinity, it occupies the 31st place in the world. The country has strong wind potential with an important field in its coastal areas, which cover 3500 km with wind speeds greater than 6.5m / s and up to 11m / s.

It should be noted that Morocco has a technical capacity evaluated of more than 10,000 MW. While this potential is limited primarily by the integration capacity to the grid. This limit can be reduced by new investments to strengthen the power grid; however the constraints of maintaining the stability of the network, especially in times of low load, are an inevitable reality which gives an exploitable resource of 6000 MW. [13] The regions with the most wind are located in coastal areas of the north and south.

- Tangier and Tetouan with average annual speeds of 8 to 11m / s
- Dakhla, Laayoune, Tarfaya and Taza Essaouira with average annual speeds of the order of 7 to 8.5 m / s

B. The wind potential in Morocco

Morocco is the 29th most attractive country in the world in renewable energy and in particular wind energy. It ranked first in the Mena region and second in Africa, according to the new edition of the Barometer of renewable energy "Renewable Energy Attractiveness Index Country" prepared by Ernst & Young in 2014 [17]. These performances show that Morocco's efforts for the development of renewable energies have borne fruit. The Moroccan government is launching programs for the promotion of wind power subsidiary. Indeed, the country has several sites dedicated to the production of electric energy from the renewable energy (Fig.5), and in particular from wind, we summarized its sites in Fig.6. [18]

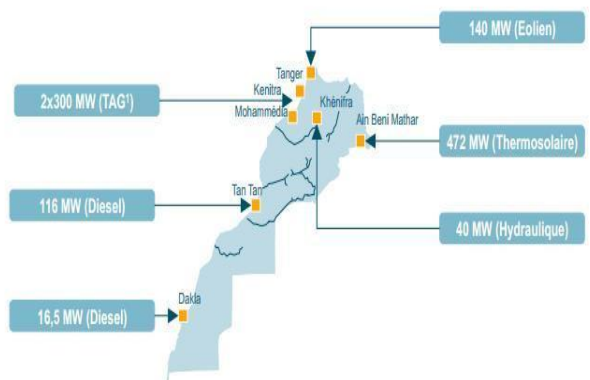


Figure 5: Executed renewable energy projects in 2009-2012

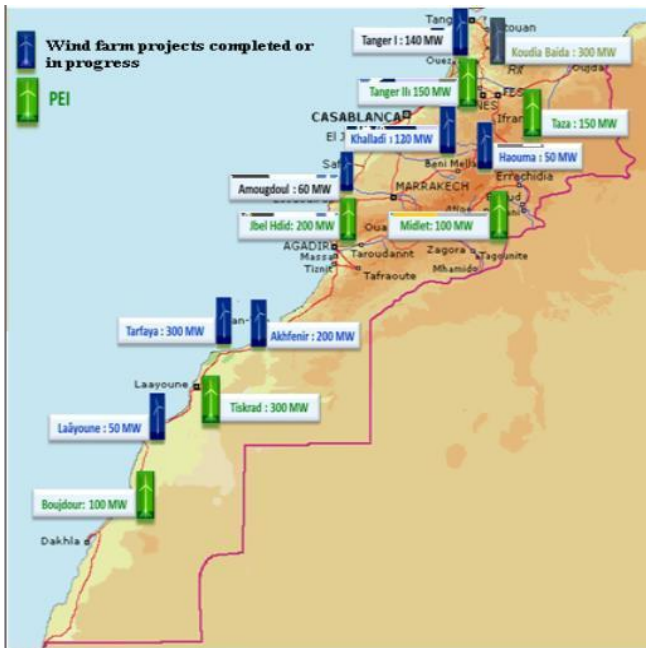


Figure 6: Wind farm realized and those developing

The figures above, we present the different projects carried out in the territory of Morocco, to note: a project Tanger I with a capacity of 140 MW installed and a forecast of another site Tanger II with a capacity of 150 MW, Tarfaya followed by a site with a 300 MW capacity and that of Laâyoune 50MW. These projects show the serious involvement of the Moroccan government in the adoption of renewable in long-term.

C. Strategy and issues in 2020

Morocco has made its efforts in political initiatives that illustrate perfectly the weight of renewable energy. To reduce its dependence on energy imports, he began to exploit renewable energy resources as mentioned before. Among these efforts, we will find the project delegated to the local energy company Nareva Holding. It was commissioned in late 2014, followed by the Tarfaya park that is a crucial project to Morocco to achieve the objectives of the integrated program with 1000 MW of wind power to generate end of 2015 and 2,000 MW in 2020 (Figure 6): [19]

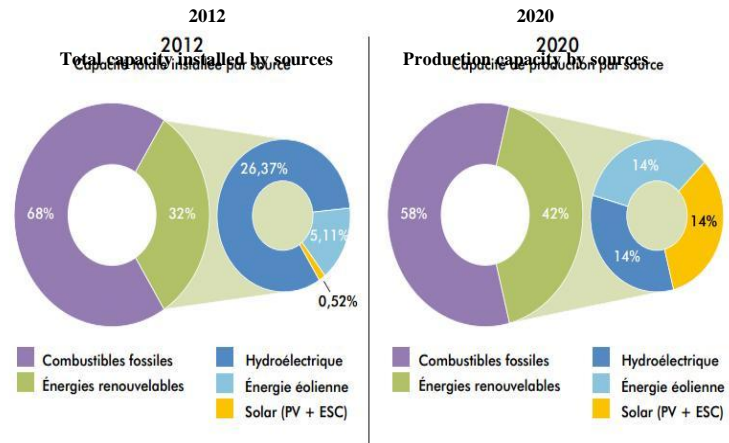


Figure 7: Total installed capacity in 2012 and installations of renewable energy in 2020

It should be noted that the country's strategy is to reach a target of 42% renewable energy with a share of 14% for wind power. Indeed, a significant increase was recorded in Morocco especially in recent years, and it is expected that this increase will continue. We must affirm also that the exploitation of wind energy at present is not seen in the desired level because of the investment and operating problems. Therefore, a long-term planning is required to ensure the necessary energy with sufficient amounts under a secure and stable system. However, the database must be detected and collected with precision to make such long-term planning. We add that a detailed study of impact and dependability of wind power equipment remains paramount to ensure better conditions of operation and maintenance.

V. CONCLUSION

The global requirements in terms of energy are still covered largely by fossil fuels. While these resources will be extinct in the future and for preventing such environmental problem caused by over consumption of fossil fuels requires the country to assess their energy resources and exploit existing ones more effectively.

In this context, our work is a contribution to the assessment of the energy potential in Morocco and more specifically the wind energy. In conclusion of the work, the transmission system should be improved and studies must be coordinated to the extent of encouraging the use of wind energy especially in electricity. And in order to increase production, certain wind equipment must be improved in phase of design for efficient and effective operations.

We can affirm that the existing wind farms and those currently under construction in Morocco are appreciated by users because of their potential contribution to solving the energy problem. However, the wind potential that Morocco has it is not fully exploited because of operational problems and performance relative to investment. Therefore, and as

perspective of this work, we will develop an operational safety assessment approach in the design phase for wind turbine to have systems with optimum maintainability and maximum availability.

REFERENCES

- [1] Ahmed Lahlimi Alami, Emile H. Malet, Jean Marie Chevallier : " Prospective énergétique du Maroc 2030, enjeux et défis". Haut-commissariat au plan du Maroc, actes du séminaire, 2015.
- [2] Gabriel Audet : " Energie éolienne au Québec : L'aspect de l'acceptabilité sociale lié au choix de modèle de développement", Université du Québec, Montréal, DÉCEMBRE 2009
- [3] Lauha Fried, Steve Sawyer, Shruti Shukla and Liming Qiao: "World wind energy report", 2012
- [4] İsmet Akova : "Development potential of wind energy in Turkey ", EchoGéo,16 ,mars /mai , 2011
- [5] EurObserv'ER : " Baromètre éolien : +10,1 % La croissance du parc éolien de l'UE ", Février, 2015
- [6] Lauha Fried, Steve Sawyer, Shruti Shukla and Liming Qiao: "GLOBAL WIND REPORT: ANNUAL MARKET UPDATE 2013", GWEC, October, 2014
- [7] Lauha Fried, Shruti Shukla, Steve Sawyer, Sven Teske: "GLOBAL WIND ENERGY: outlook 2014", GWEC, Greenpeace International, DLR, Ecofys and The University of Utrecht, October, 2014
- [8] Angelika Pullen, Steve Sawyer: "Global Wind Report: Annual market update 2011", April, 2011
- [9] Angelika Pullen, Steve Sawyer: "GLOBAL WIND REPORT", GWEC, second edition, may, 2008
- [10] Angelika Pullen, Meera Ghani Eneland: "Global Wind : 2006 report", GWEC, 2006
- [11] Richard Bridle, Lucy Kiston, Petre Wooders, "Fossil-Fuel Subsidies: A barrier to renewable energy in the Middle East and North African countries", the International Institute for Sustainable Development, 2014
- [12] Ouahiba GUERRI, "L'Énergie Éolienne en Algérie : Un bref aperçu, la Division Énergie Éolienne ", Centre de Développement des Énergies Renouvelables, Ministère de l'Enseignement Supérieur et la Recherche Scientifique, Algérie, 2011
- [13] Sara Atouk : "LES ÉNERGIES RENOUVELABLES ET LES POPULATIONS RURALES PAUVRES : LE CAS DU MAROC ", Essai présenté au Centre universitaire de formation en environnement en vue de l'obtention du grade de maître en environnement, Université de SHERBROOKE, juillet, 2013
- [14] Fondation énergie pour le monde, EDF : "La production d'électricité d'origine renouvelable : détail par région et par pays ", Quinzième inventaire, 2013
- [15] Direction de l'observation et de programmation : " Analyse des indicateurs énergétiques ", Ministère de l'énergie, des mines, de l'eau et de l'environnement, 2013
- [16] Ministère de l'énergie, des mines, de l'eau et de l'environnement : "Programme intégré de production électrique éolienne ", Tanger, le 28 juin 2010
- [17] <http://www.fellah-trade.com/fr/developpement-durable/energies-renouvelables-maroc>
- [18] Ministère de l'énergie, des mines, de l'eau et de l'environnement : " Les énergies renouvelables au Maroc : stratégie et plan d'action ", Atelier Mission Maroc, Casablanca, 20 Novembre 2012
- [19] Anna leidreiter, Filippo Boselli, World Future Council, " 100% énergies renouvelables : Renforcer le développement au Maroc ", Mars, 2015

AUTHOR PROFILE



Souad NABDI, Engineer in Industrial Engineering & Logistics from the National School of Applied Sciences of Tangier in 2012. Currently doing PhD in engineering sciences, physical sciences, mathematics and computing in Industrial

techniques laboratory (LTI) from Sidi Mohammed Ben Abdellah University, Faculty of Sciences and Techniques (FST), Fez, Morocco. His research interest in improving the parameters of the dependability from the design phase, and apply it on a wind turbine.

