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TOWARDS THE USE OF ARTIFICIAL INTELLIGENCE FOR PREDICTION OF RENEWABLE ENERGY PRODUCTION

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Abstract- Morocco is experiencing severe energy shortages as a result of its high reliance (and over 95%) on foreign sources of supply. It must also deal with the widespread usage of traditional fuels like firewood and charcoal, which results in 30,000 hectares of annual deforestation. Renewable energy plays an important part in the state's energy strategy in order to address the concerns that this poses for both its supply and the rate of socioeconomic growth. Concretely, the national programme for the expansion of alternative energies and energy efficiency by 2030 has been realized as a consequence of the public authorities' ambition. The Moroccan government as a consequence passed Project Law rejects the key pillars of a novel energy plan. Our goal is showcasing current situation of energy industry, with a focus on the Tangier-Tetouan-Al Hoceima area, while showcasing innovative renewable technology and encouraging energy efficiency in all spheres of life. We also demonstrated Artificial Intelligence, which has the ability to grasp complicated data sets and analyse them independently based on the training they have received. This new intelligent approach will make renewable energies more predictable and therefore more valuable.

Keywords: Renewable Energies, Artificial Intelligence, Energetic Efficiency, Tangier-Tetouan-Al Hoceima Region.

1. INTRODUCTION

Energy is at the heart of all the progress and developments that humanity has known since the invention of the wheel, sailing and closer to us, the industrial revolutions of coal then oil and electricity. which undoubtedly shaped the civilization of the 20th century where urbanization, rapid transport, scientific and technological advances, constitute the pillars of the tremendous growth of trade and the wealth of nations. However, there has been a universal awareness of the need, on the one hand, to reduce inequalities between North and South, and on the other hand, to ensure sustainable development centered on people and respectful ecological and environmental balances of the planet which, otherwise, would run towards a serious impasse leading to its loss.

In this context, energy efficiency refers to the reduction of energy consumption without, however, causing a reduction in the level of comfort or quality of service in buildings. However, acting effectively to significantly reduce energy consumption requires identification of wastage factors, in order to control them in the future. This theme first attempts to examine the efforts made by Morocco, since its independence, to meet its energy needs in order to ensure its economic and social development before analyzing the energy policy put in place to meet demand. energy present and future by 2030.

For this purpose, it seemed judicious to start from today's situation, fruit of past evolution and illustration of Morocco's energy problem, and to take it as a reference base to identify energy prospects. The main objective of this article is to illustrate, through an inventory of current issues and problems, the various challenges simultaneously linked to water, energy and the environment, accentuated by the phenomenon of climate change in a Moroccan context characterized by an intensification of the use of physical resources and the degradation of its environment.

Thanks to the advantages of the energies that arise and to the country's disposal of largely favorable geographical and climatic conditions, Morocco can face the various energy challenges faced by most countries in the world. This situation leads us to ask the following question:How to develop and improve the situation of the Moroccan energy sector while making better use of renewable resources?

Which initiative in Morocco is promoting renewable energy and energy efficiency? And how can the intelligent approach make renewable energies more predictable and therefore more valuable.

2. LITERATURE REVIEW: THE ENERGY BALANCE

2.1. The Global Energy Balance

Energy is a fundamental element of our modern society, it is produced, transported, transformed and stored. Indeed, the latter is an essential consumer good for the improvement of daily life and for the development of the economy. Energy creation mainly uses fossil and fissile

fuels. Given the strong demographic growth and the industrial revolution that the world has experienced, major fossil fuels have become essential to the proper functioning of the world economy. Indeed, energy consumption remains necessary for the various sectors, namely agriculture, industry, transport and others. It also plays a crucial role in the safety, health and daily life of citizens. The energy balance represents the share of each energy source in the primary energy mix. Today, it turns out that fossil fuels are still dominant while the contribution of renewable energies remains small in the balance sheet. In addition, the energy situation at the international level is characterized by great disparity. Moreover, more than a billion people do not yet have access to electricity. Thus, energy consumption per capita differs from one country to another.

On the other hand, an American consumes nearly 16 times more energy than an inhabitant of sub-Saharan Africa and 8 times more than a Chinese citizen, while the US characterises about 5% of population. Today, it turns out that fossil fuels are still dominant while the contribution of renewable energies remains small in the balance sheet. In addition, the energy situation at the international level is characterized by great disparity. Moreover, more than a billion people do not yet have access to electricity. Thus, energy consumption per capita differs from one country to another. On the other hand, an American consumes nearly 16 times more energy than an inhabitant of sub-Saharan Africa and 8 times more than a Chinese citizen, while the US characterises only 5% of population energy in the primary energy mix.

Today, it turns out that fossil fuels are still dominant while the contribution of renewable energies remains small in the balance sheet. In addition, the energy situation at the international level is characterized by great disparity. Moreover, more than a billion people do not yet have access to electricity. Thus, energy consumption per capita differs from one country to another. On the other hand, an American consumes nearly 16 times more energy than an inhabitant of sub-Saharan Africa and 8 times more than a Chinese citizen, proves that fossil fuels are still dominant while the contribution of renewable energies remains small in the balance sheet. In addition, the energy situation at the international level is characterized by great disparity. Moreover, more than a billion people do not yet have access to electricity.

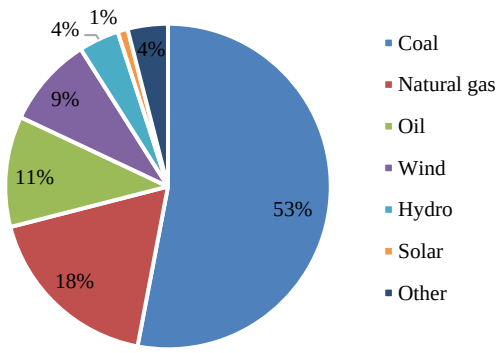

Figure 1. Final energy consumption worldwide in 2015

Figure 1 shows Electricity generation by source, 2017. Thus, energy consumption per capita differs from one country to another. On the other hand, an American consumes nearly 16 times more energy than an inhabitant of sub-Saharan Africa and 8 times more than a Chinese citizen, proves that fossil fuels are still dominant while the contribution of renewable energies remains small in the balance sheet.

Today, the transition to an energy system based on renewable energies has been motivated by the opening of markets, the desire to preserve the environment and growing concern about the depletion of fossil reserves. Renewable energie is now widely accepted as common energy sources across the world. Their tremendous expansion, particularly in the electrical industry.

2.2. The Moroccan Energy Balance

To meet its energy needs, Morocco depends heavily on imports of fossil fuels, with the respective proportions of 95% and 80%. Indeed, in 2014, energy consumption amounted to 19 million TOE against 10.5 million TOE in 2002. An increase of 80%. Figure 2 presents the Moroccan energy consumption.

Energy demand per capita is still low. It represents approximately 0.56 TOE (tonne of oil equivalent)/inhabitant, i.e., 30% of the world average and 84% of the African average. Furthermore, the energy mix is dominated by oil, which represents 61.9% in 2014. Coal represents 21.3%, followed by biomass and waste (7.2%), natural gas (5.3%), net electricity imports [1-3] .

3. RENEWABLE ENERGIES: CONCEPT AND REASONS FOR INTEGRATION

3.1. Definition of Renewable Energies

Renewable energy is defined as any usable kind of energy derived from a renewable source whose current value does not constrain future supply. There are several renewable energy industries that enable the generation of mechanical energy, thermal energy, and/or electricity.In this sense, we call renewable energies or green energies all energies whose consumption does not result in the reduction of natural resources, because it calls on elements which are recreated naturally; example (biomass, solar energy, hydraulics and wind energy, etc.). On the contrary, fossil fuels and nuclear fission are not part of it since the known deposits of these forms of energy are doomed to disappear more or less quickly. They are therefore considered as fossil fuels. In addition, fossil fuels contribute to environmental pollution and global warming [4].

3.2. Renewable Energy Sources in Morocco

In view of population growth and the modernization of national industry, the consumption of primary energy and Moroccan electricity recorded respectively an evolution of 5.7% and 7% per year in energy source (Figure 1). To satisfy the Moroccan energy market, Morocco imports almost all of its energy needs, i.e., 96%. Today, Morocco has adopted a new strategy, which is part of a long-term vision, aimed at building a diversified energy mix in which

renewable energies occupy a prominent place, in order to meet growing demand, preserve the environment and reduce energy dependence on the outside. Moreover, Morocco has geographical and climatic conditions that are largely favorable to the establishment of an energy system based on renewable energies: wind, sunshine and space. Indeed on a global scale, Morocco is the 9th country in terms of sunshine and 31st for wind power [5].

Taking into account the reasons cited above (problems in terms of energy supply, weight of its bill, pollution, etc.) and due to the presence of significant clean and healthy energy resources, Morocco is therefore led to direct its energy policy towards the diversification of sources of supply and the development of national resources, through the promotion of all forms of renewable and clean energy that can be mobilized.

Morocco, by its strategic geographical position, benefits from a remarkable potential in renewable energies: solar, wind, biomass and hydraulic mainly.

- In terms of sunlight, it ranks ninth in the world; its 710,000 km2 get between 2,800 and 3,400 hours of sunshine annually, and its 20,000 MW3 national solar technological potential. In 2017, 180 MW of solar power was built in Morocco.
- The nation boasts the world's 31st-largest wind energy deposit. Wind speeds between 7.5 and 11 m/s have been recorded throughout its 3,500 km of Atlantic coastlines, giving it a technological potential of 25,000 MW. In 2017, 800 MW of wind energy was installed in Morocco.
- In terms of hydraulics, a national technical potential of 3,800 MW has been installed thanks to the dam strategy implemented since independence up till the present.

3.2.1. Solar Energy

Within solar energy, it is necessary to differentiate between solar photovoltaic and solar thermal. The first generates electricity through the conversion of daylight. It is the photons, components of this light, which release the electrons from the photovoltaic cells present on the solar panels. These cells are made of semiconductor materials, the most commonly used of which is silicon. The direct current thus produced is then transformed into alternating current thanks to an inverter. As for him, the thermal solar allows the production of hot water thanks to solar collectors. There are also solar power plants, which use a very high temperature thermal process, which induces the transformation of water into steam to power a turbine and ultimately produce electricity (Figure 2) [4].

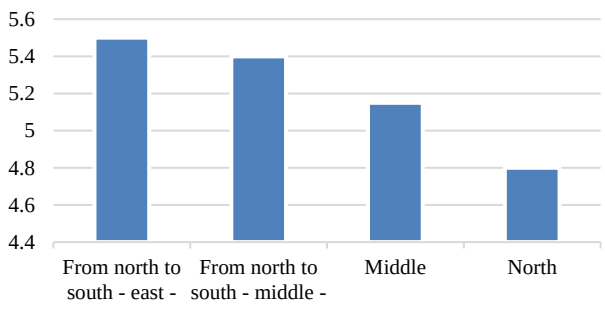

Figure 2. Solar field at KWh/m^2 in Morocco

Morocco's climate is favourable, allowing for practically year-round strong sunshine. The quantity of sunlight in Morocco varies from 2800 hours in the north to more than 3500 hours in the south, with an average incident solar radiation of 5.5 kWh/m^2/d4. It is worth noting that the "Integrated Development Project" has been launched with the very ambitious objective of establishing a total of 2000 MW of solar energy production capacity on five sites Tata, Boujdour, Ain Beni Mathar Ouarzazzate and Foum Al Oued.

All the wind conditions were fulfilled to set up and grow this new energy sector in the best possible way, with wind speeds ranging from 9.5 to 11 m/s and at a height of 40 metres. The two geographic regions from Tangier to Tetouan in the north and Tarfaya to Lagouira in the south provide the highest prospects for the development and profitability of this industry. Before and after the passage of Law 13-09 on renewable energies, during which these deposits can be exploited, self-production with access to the THT/HT/MT network is permitted. More specifically, it now makes it feasible to generate power from renewable sources for personal consumption and, if required, to sell or export it in the case of a surplus. In addition to the parks created by ONEE, IPP parks; also known as IPP-ONEE parks; will be built between 1999 and 2019; its distinguishing feature is that they will be the first private parks, jointly controlled by a foreign holding firm and a Moroccan holding company. Last but not least, this industry is distinguished by the fact that the southern provinces account for over 60% of its production. We'll address this South/South section individually [7], [8].

3.2.2. Wind Energy

Morocco has a considerable wind power potential, estimated at close to 25,000 MW nationwide, including 6,000 MW on the locations investigated, because of its advantageous geographic location with more than 3,500 kilometres of coastline. The windiest parts of Morocco are in extreme north, along the Gibraltar, in provinces of Tangier-Tetouan and Essaouira, in the southern Atlantic area from Lagouira to Tarfaya, and between Rif and Atlas Mountain. Wind deposit in the windiest areas is characterised by average wind speeds of more than 6 m/s (Figure 3) [9].

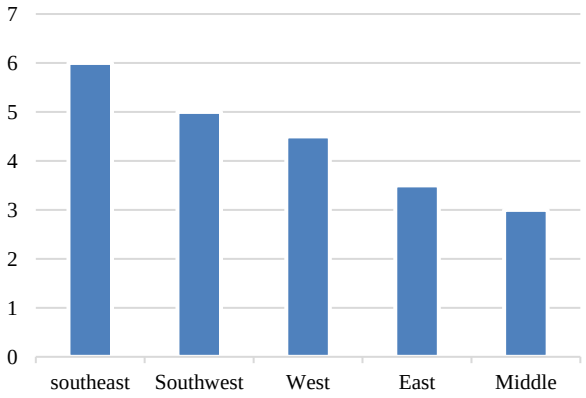

Figure 3. Wind deposits at m/s in Morocco

3.3. Moroccan Wind Energy Program

- 890 MW are already operational
- 706 MW are under development
- 850 MW developed on five new sites
- More than 2500 MW will be developed between 2021 and 2030.

4. TANGIER-TETOUAN-ALHOCEIMA, "LEADER" IN TERMS OF RENEWABLE ENERGY

Tangier – The overall electricity production capacity of the various platforms and renewable energy production plants in the Tangier-Tetouan-Al Hoceima region is around 1,000 megawatts (MW). Tangier region is a "leader" in terms of renewable energies, noting that its production capacity in these energies is roughly equivalent to half of the national capacity installed in this area.

The region has benefited from significant efforts relating to the environment, both in terms of the fight against pollution and in terms of investment in renewable energies. In this context, the region has five wind power stations, in addition to a thermal power plant producing electricity from natural gas. Tangier region has received, until the end of 2018, nearly 8 billion dirhams in investments in renewable energies, adding that, to encourage investments in this field, the city of Al Hoceima has seen the construction of the first solar panel production plant in Morocco [10].

4.1. Key Figures

- 5: Wind farms
- Contribution to capability: 18%
- Total capability: 1012 MW

Faced with the increased energy needs generated by economic growth and the construction of major infrastructures in Morocco, the public authorities have developed a strategy oriented towards the diversification of energy sources, particularly with a view to production of electricity at through national renewable resources.

4.2. Actions to Support Investors in Renewable Energy

The National Electricity Office ONE assists and supports investors to the choice of the site; The feasibility and profitability studies of the project; The follow-up of the realization; The maintenance and the exploitation; "private producers-industrial customers";

A network access contract is drawn up between ONE and the investor setting the connection and operating conditions and the commercial conditions for the purchase by ONE of surplus production.

5. TOWARDS THE USE OF ARTIFICIAL INTELLIGENCE FOR THE PREDICTION OF RENEWABLE ENERGY PRODUCTION

A neural network is a machine learning system that is designed to mimic the structure and function of the human brain. It is made up of linked nodes or neurons that are arranged in layers. Each neuron in a neural network takes input, computes it, and then sends the result to the next layer of neurons. Weights govern the connections between neurons and are modified during the learning process to maximize the network's performance on a specific task.

Image identification, natural language processing, and predictive analytics are just a few of the applications for neural networks. They are especially powerful when working with complex, high-dimensional data that is difficult to analyze using traditional machine learning algorithms [11], [12].

Figure 4. Neural Network model

5.1. Comparative Study of Different Neural Network Models

5.1.1. Feed-Forwarded Neural Networks

The input layer receives input data, which is then transformed as it moves through the network. The hidden layers consist of multiple layers of neurons that perform computations on the input data, gradually transforming it into a more abstract and useful form. Finally, the output layer produces the network's output, which can be a classification, regression, or other type of prediction based on the input data.

In a feedforward neural network, there are no feedback connections, meaning the output of a layer does not affect the same layer or any preceding layer. This makes feedforward neural networks particularly useful for supervised learning problems, where the goal is to predict an output based on labeled training data. Feedforward can be trained by several optimization algorithms like gradient descent, and are typically initialized with random weights that are updated through the learning process [13].

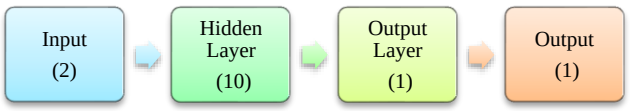

Figure 5. Feed Forwarded model

5.1.2. Resonance Neural Networks

Resonance neural networks (RNNs) are a sort of neural network that is inspired by how neurons in the brain are thought to function. They are meant to process sequences of input data, such as voice or music, and over time can learn to detect patterns in the input.The basic idea behind RNNs is that each neuron in the network has a state that evolves over time in response to the input data. This state is influenced by the neuron's own internal feedback as well as the feedback from other neurons in the network. This feedback can either reinforce or dampen the neuron's response to the input, depending on whether it is resonant with the input pattern or not.

One key feature of RNNs is that they have a form of memory, allowing them to take into account the past history of the input sequence when making predictions about future input. This is achieved by allowing the state of each neuron to be influenced not only by the current input, but also by its own previous state.

5.1.3. Self-Organized Neural Networks

They learn and organize themselves without explicit supervision. These networks are inspired by the way that the brain is believed to develop, where neurons self-organize to form functional circuits in response to sensory input. One of the most well-known examples of a self-organized neural network is the self-organizing map (SOM), which was introduced by Finnish scientist Teuvo Kohonen in the 1980s. SOMs can be used in data visualization, clustering, and feature extraction.

ART network is one of their types, which was developed by American psychologist Stephen Grossberg in the 1980s. ART networks are designed to learn to classify input patterns in a stable and adaptive way, by selectively attending to different features of the input data. They are particularly useful for tasks where the input data is complex and high-dimensional, and where there is no clear labeling or ground truth to guide the learning process.

5.2. Neural Networks for Renewable Energies

Systems for predicting the production of renewable energies via artificial intelligence are constantly being improved, thus facilitating their integration into the global electricity grid. On February 26, 2019, Google announced a new exploit from DeepMind, its artificial intelligence (AI) program. This is not an additional victory against a champion of chess or game of Go but of a much more prosaic application: the prediction of the production of a wind farm. The site in question, with a capacity of 700 MW, is located in the center of the United States where Google's data centers are based [14].

DeepMind was able to anticipate wind power generation 36 hours in advance by using an artificial neural network trained on weather forecasts and historical turbine data. Based on these projections, the park has optimized its supply agreements by delivering a certain amount of power at a specific time [15]. The Google subsidiary raised the value of its wind energy by around 20% compared to the basic scenario with no time commitment to the grid, thanks to its machine learning technique.

5.2.1. The Challenge of Valuation

If this episode is to be underlined, it is because, "Given the intermittency of renewable energies, the ability to predict the megawatt-hours produced is essential to their valuation", analyzes Antoine de Broves, Technical and Innovation Manager at Omexom, the brand dedicated to the energy transition of VINCI Energies. "Given the intermittency of renewable energies, the ability to predict the megawatt hours produced is essential to their valuation".

On the electricity market, blocks of energy are traded on a time scale of one year, one quarter, one week or one day for the next day, or even for the same day ("intraday" market). However, the negotiations most upstream of the delivery generally allow a better valuation. "Whether for wind, photovoltaic or run-of-river hydraulics, all three of which depend on weather conditions, the power of computer systems and their ability to analyze are essential", he adds.

The issue is all the more important as any sale of megawatt hours not honored is sanctioned, for example in France by financial penalties imposed by the Energy Regulatory Commission (CRE) via RTE, the manager of the public transmission network of electricity which must ensure the balance between incoming flows and outgoing flows.

5.2.2. More Sophisticated Computer Models

The example of DeepMind shows that the models for turning weather forecasts into production forecasts are constantly improving thanks to the learning curve of AI. These systems for anticipating short-term production variations are based on the use of data from satellite images analyzing clouds, depressions, air masses, etc. They are also fed by other sources such as advanced masts equipped with anemometers detecting wind variations in advance or fish-eye cameras which analyze the movement of clouds in order to anticipate a possible blackout by using auxiliary production sources.

6. CONCLUSION

To reduce energy dependence which continues to increase and to no longer be penalized by large oil bills, Morocco has made renewable energies and energy efficiency a priority sector in its development strategy; it is committed to reaching a production capacity of 6,000 MW by 2030, representing a 52% share of total energy production split between solar, wind and hydro. Since it has mostly favourable geographic and climatic characteristics, the construction of sustainable energy has taken precedence. A key player in the exploitation and use of renewable energies. as well as the infusion of the first Kwh into the national electricity network at the end of. In today's economy growth of the nation, renewable energies in the Tangier-Tetouan-Al Hoceima area play a significant role.

Renewable energies are an alternative to conventional energy systems, based on resources of fossil or fissile origin. From a global point of view, the use of renewable energy minimizes country's energy dependence, to reduce the release of greenhouse gases, and to create jobs. However, most of the renewable energy options described need support and commitment from politics and government institutions in order to develop and reach economic maturity.

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