Innovation and competition for renewable energy sources in Egypt according to sustainable development requirements – Case Study

Sameha Salem Eid

Department of Administrative, Legal, and Environmental Economic Sciences, Institute of Environmental Studies, Al-Arish University, North Sinai, Egypt

Abstract

There is difficulty in achieving sustainable development and preserving the environment in Egypt due to the lack of expansion in the use of clean renewable energy. Egypt's economic development is linked to the energy sector and therefore there is an urgent need for new and clean energy resources that has become the top priority in Egypt. In addition, due to the limitations of traditional energy sources and the environmental damages related to their use, Egypt faces great challenges, including financial, technical, and human challenges, as it is in the process of implementing and completing the integrated strategic energy plan. Besides, there is the problem of the lack of readiness of the institutional building in Egypt until now and the consequent delay in the process of replacing the traditional energy with renewable energy. Further, the expansion of the use of new and renewable energy sources as the most important challenges in developing energy strategies and policies and achieving sustainable development, to face the growing gap between energy resources and the size of demand for them, and to secure their necessary supplies to achieve economic growth commensurate with the goals of the sustainable development strategy.

Keywords

Renewable sources, Sustainable development, Innovation, Clean energy

I. Introduction

The Arab Republic of Egypt is the most populous country in North Africa and the

Arab region, and it is one of the most countries in the world in which the population is increasing rapidly, which led to an increase in demand and need for energy sources, putting great pressure on local energy resources, especially after the fuel crisis that passed the country in 2014.

Egypt's economic development is related to the intense competition in the energy sectors, which represents 13.1% of the gross national product [1]. Therefore, the Arab Republic of Egypt seeks by the year 2030 to achieve a diversified, balanced and sustainable competitive economic development.

Five key goals must be implemented in order to achieve energy sustainability: lowering carbon dioxide emissions, minimizing all adverse environmental effects, enhancing the security of the switch to clean energy while achieving energy efficiency, lowering the cost of energy production, and advancing the use of green technology [2].

To increase energy efficiency and achieve energy sustainability, a variety of potential technologies are needed. According to the 450 scenarios created by the International Energy Agency, green technical advancements will be crucial in reducing carbon dioxide emissions [3]. Therefore, it can be concluded that existing and emerging technology for decreasing these emissions, when backed by sensible policies, can show the concentration of greenhouse gases and reduce these emissions.

The continuing development of the world's energy system is driven by innovation. Renewable energy sources have become a competitive energy choice as a result of numerous inventive methods. Power generation solutions are at the forefront of the rapidly expanding pace of innovation in renewable energy. Solar and wind power have become more affordable quickly, positioning these technologies at the center of the energy transition. More adaptable power systems are required to maximize their share while maintaining low electricity costs [4].

According to studies, Egypt's current energy mix and trend are similar to those of other developing nations, where the proportion of renewable energy used to generate electricity is decreasing over time despite an increase in the adoption and investment of renewable energy [5, 6]. This is because of the country's higher-than-average rate of growth in energy demand. Natural gas, which accounts for more than 75 percent of Egypt's current power production, is the dominant fuel [7]. More than half of all-natural gas is used in the power industry, and the share of renewable energy has decreased from 13% in 2010 to 10% in 2014 [7]. Despite having 4.5 billion barrels of crude oil reserves and ranking as the twenty-fifth largest oil producer in the world [8], Egypt's resources are fast depleting.

II. Renewable Energy Sources (RESs) in Egypt

In Egypt, there is a large potential for the production of renewable energy. In particular, wind and solar power could provide energy services continually, enhancing energy security [9-11]. Additionally, diversifying Egypt's energy production from one that relies heavily on fossil fuels and natural gas to one that makes greater use of renewable energy sources could help the country become more energy secure while preserving its gas exports and foreign exchange earnings, reducing its environmental impact, and promoting the growth of a "green economy" (or a low-carbon development society).

The Ministry of Electricity issued a strategy for renewable energy in 2015 that is characterized by integration and sustainability, integrated Sustainable Energy Strategy, and it is expected to bear fruit. It is expected that the renewable energy capacity will reach 42% of the total electricity capacity in Egypt by the year 2035. And not only that, but it will make Egypt a center for renewable energy between Europe, Asia, and Africa, by expanding and communicating with the Arab region and others. The electricity sector in Egypt succeeded in generating

30% of the new energy through the use of wind [1].

This section discusses the RESs that are accessible in Egypt, their current state, and their potential for future growth. The supportive environment for renewable energy and the related regulatory framework are also covered. RESs can reach a wide range of advantages, and renewable energy technologies offer a dependable and secure energy option. Hydropower, wind, solar, and biomass energy are just a few of the RESs that Egypt has access to and that have the potential to be developed and deployed more widely.

Hydropower

Egypt is a major user of the water-energy resource. It has historically served as Egypt's primary energy source and continues to do so now, producing 2.8 GW of energy yearly, with an estimated increase to 2.9 GW by 2030 [1]. In Egypt, hydropower is the most developed renewable energy technology. From 2011/2012 to 2016, the average annual growth rate of energy produced by hydropower plants was 1.2 percent. For instance, in Egypt in the 1970s, power produced from water sources made for nearly 50% of all electricity produced. However, due to a growth in the use of thermal power plants, wind farms, and other renewable sources, only 7.2% of the electricity produced in 2015–2016 came from water-energy resources [12].

Wind energy

The wind atlas for Egypt in 2016 is shown in Fig. 1 and displays the various locations' wind speeds [13]. The nation boasts a wealth of wind energy potential, particularly in the Gulf of Suez region. Due to the strong and consistent wind speeds, which on average range between 8 and 10 m/s at an altitude of 100 m, this is one of the best places in the world to utilize wind energy. Additionally, Egypt has a lot of desert regions and locations on both sides of the Nile in the New Valley and Beni Suef Governorate that are appropriate for constructing wind power plants, making it economically

advantageous to engage in wind energy in Egypt.

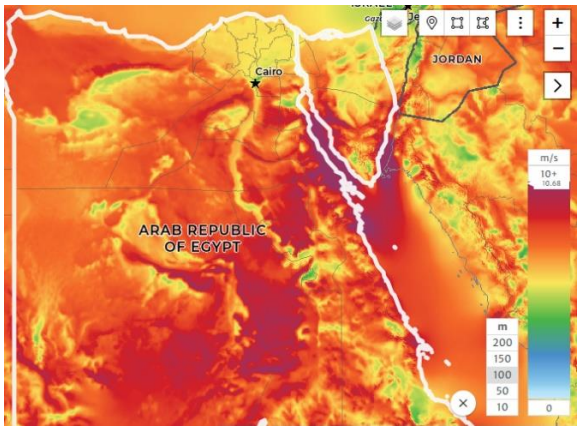

Fig. 1 Egypt’s wind atlas [13].

The first wind energy facility in Egypt was built in 1993 and has a total capacity of 5.2 MW. The overall energy output is anticipated to reach 13.2 GW following the construction and start-up of the wind power plants in 2021, and 20.6 GW in 2030. In particular, the Egyptian government wants to use and profit from wind energy in light of the 2035 strategy, a plan for sustainable and integrated development to protect the environment. Wind energy is one of the RESs that governments around the world strive to use and exploit. Scholarly investigation of the use of wind energy in Egypt began in 1991 [14].

In addition to providing a brief overview of the energy landscape, Moness et al. [15] evaluated studies from 1991 to 2019 on the growth of wind energy in Egypt. As a result, a vision for current gaps, forward-looking directions, and interesting research fields has been planned.

Photoelectric power

Africa's northeastern corner is where Egypt is located. Between latitudes 22° and 36° north and between longitudes 24° and 37° east of the Greenwich line, it is situated above the cancer's path. According to this source, the global horizontal irradiation from the north to south of Egypt ranges from 2000 to 3200 kWh/m^2, and the annual direct normal irradiation density ranges between 1970 and 3200 kWh/m^2, as shown in Fig. 2.

Figure 2 depicts Egypt's enormous potential for solar energy, and it is one of the world's best locations for utilizing all forms of solar energy. Since its inception in Egypt forty years ago, photoelectric electricity has been tested in a variety of settings, including lighting, advertising,

and road lighting. The contribution of solar photovoltaic to the total domestic energy began to appear at a rate of 3 GW annually after the government adopted the diversification of energy sources and the exploitation of solar energy, even though photoelectric power has not yet contributed significantly to the total domestic energy. Additionally, this percentage is anticipated to reach 22.9 GW annually in 2021 and 31.75 GW annually in 2034 [15].

Concentrated solar power

One more RES used in Egypt is concentrated solar energy, as depicted in Fig. 2. Utilizing lenses to focus sunlight onto a tiny area, concentrated solar energy turns the light into heat, which powers steam turbines connected to a generator to produce electricity. In the Al Kurimat area, the Egyptian government has built the nation's first 140 MW-capacity concentrated solar energy generating plant [39]. The government is attempting to stimulate investment in other fields of renewable energy; thus this was not the final step in investing in concentrated solar energy. The four energy goals—sustainability, governance, competition, and energy supply—will be met as a result.

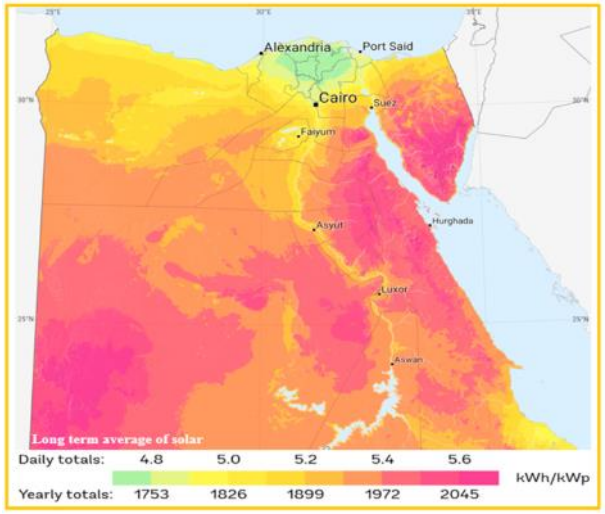

Fig. 2 The potential of Egypt's solar energy [16].

III. Innovation and directions for sustainable energy sources

Innovation in the field of energy and climate change is essential in order to achieve a more sustainable future, and then energy companies realize that the ability of companies to innovate using new types of energy and distribution technologies will determine their ability to change, as the market will witness many

developments during the coming decades in the field of Energy production, and with the increasing applicability of renewable energies technologies, innovation can turn into a source of great wealth.

This is because innovations in renewable energy storage technologies and carbon capture, nanotechnology, artificial intelligence, nanotechnology, advanced manufacturing, gene modification, biofuels, robotics and advanced software systems. Block chain, 3D printing, data analysis, water desalination with renewable energy, and electric vehicles are expected to play a major role in sustainable development over the next five years and in a shift towards sustainability globally.

And that the convergence between emerging technologies and others aims to improve efficiency, as well as efficiency in electricity consumption, and to develop smart systems that reduce carbon emissions, thus providing capabilities that contribute to global warming and accelerating the transition to a sustainable future. This is in light of the wave of new trends that contribute to shaping future technology, in light of the trend of more sectors towards adopting sustainability as a result of the adoption of digitization and the emergence of emerging youth projects, with potential developments within the sectors of renewable energy and climate change, water, the future of mobility, space, biotechnology, and technology.

Then the international interest in renewable energy multiplies, diversifying its sources, to reduce waste in energy, and thus we find that innovation determines the future of renewable energy, as the importance of renewable innovations becomes clear in the transition towards sustainable energy which requires identification of the developments in the sector.

Modern and advanced technology represents the focus of progress in the twenty-first century. The word technology is a constant expression throughout the stages of civilizational development. There is no disagreement about the major

changes brought about by rapid and continuous technological developments in the design and development of various industrial products.

Iv. Conclusions

Development depends on energy, and sustainable development depends on sustainable energy systems. Many other nations and other sectors, such as transportation, are still only at an introductory level in terms of renewable penetration, despite the fact that the world has experienced rapid development, particularly over the last few decades, with penetration levels of renewable energy sources reaching double-digit percentages in electricity supply in several countries. The increasing demand for productive capacity for industrialization, urbanization, and the wealth of society has led to a global distribution of primary energy consumption in a highly uneven distribution. Per capita consumption of energy from the industrial market economies is equivalent to three-quarters of the primary energy in the world as a whole. Economic development depends on providing the necessary energy services, both to raise and improve productivity.

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