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The UAE Energy Experience 2050: A bet on energy diversification and achieving sustainable development

Dr. Bramgui Radhia

University Center of Tipaza, Algeria

Email: bramgui.radhia@cu-tipaza.dz

Trifa Mohamed

University of Mohammed Seddik Benyahia Jijel, Algeria

Email: mohamed.trifa@univ-jjel.dz

Abstract---This study aims to demonstrate the extent to which renewable energy can contribute to achieving sustainable development, by clarifying the concepts of renewable energy and sustainable development. It also highlights the role of renewable energy in achieving sustainable development, with a focus on the UAE's experience in the renewable energy sector. The study uses a descriptive-analytical approach to the literature review and employs a case study method to present the UAE's experience and its applicability in this area. The study concludes with a number of findings and recommendations, the most important of which is that the UAE has succeeded in building a diversified economy that is not dependent on oil, thanks to the promotion of investment in renewable energy and foreign direct investment, as well as providing opportunities for the private sector.

Keywords---Renewable energy, Sustainable development, Solar energy, Wind energy.

Introduction

Renewable energy has received considerable global attention due to its positive impact on the environment and climate. Most countries are now striving to make renewable energy a substitute for traditional energy sources, recognising it as a vital sector that contributes significantly to development processes (achieving sustainability) without polluting the environment.

Achieving sustainability therefore requires us to support and develop renewable energy sources. Despite the challenges they face, renewable energies have the potential to achieve environmental balance, sustainable growth and energy security for present and future generations. In the context of the energy transition, the UAE's experience in renewable energy is noteworthy, as it has made significant efforts in this area, culminating in Abu Dhabi being designated as the permanent headquarters of the International Renewable Energy Agency. In addition, its initiatives have positioned the UAE as a leading example in the field of renewable energy. Our research question can therefore be formulated as follows:

To what extent has the UAE Energy Strategy 2050 contributed to energy diversification and the achievement of sustainable development?

Objectives of the study

This study aims to understand the role of renewable energy in achieving sustainable development through the following objectives:

1. Clarify the concept of renewable energy: To recognise it as an alternative source of energy.
2. To highlight the role of renewable energy: Demonstrating its contribution to the achievement of sustainable development.
3. Examine the UAE's experience: Focusing on its pioneering efforts in renewable energy, particularly solar and wind energy.

Significance of the study:

The significance of this study lies in its focus on a contemporary issue: renewable energy. It looks at energy sources and their role in achieving sustainable development while shedding light on the UAE's experience in the renewable energy sector.

Methodology:

In order to address the proposed problem and analyse the issues raised in the study, a descriptive-analytical approach and a case study method were used to arrive at findings, conclusions and recommendations.

Study framework:

In order to thoroughly examine the issue, the study is divided into three main sections:

1. The concept of renewable energy
2. The role of renewable energy in achieving sustainable development
3. Current status and future prospects of the UAE experience in renewable energy for sustainable development

Section One: The Conceptual Framework of Renewable Energy

Renewable energy refers to resources derived from energy flows that occur naturally and cyclically in the environment. Unlike non-renewable energy sources, which are often stored in the earth and can only be exploited through human intervention, renewable energy is continuously replenished.

Definition of renewable energy

Various international and governmental organisations involved in environmental protection define renewable energy as follows:

- **Definition by the International Energy Agency (IEA):** Renewable energy consists of energy sources derived from natural processes such as sunlight and wind, which are replenished at a rate that exceeds their consumption¹.

- Intergovernmental Panel on Climate Change (IPCC) definition: Renewable energy includes all energy from solar, geophysical or biological sources that regenerates at a rate equal to or greater than its use. This includes energy derived from continuous natural flows, such as biomass energy, solar energy, geothermal energy, hydropower, ocean tidal energy and wind energy. There are also many technologies available to convert these sources into primary energy, such as heat and electricity, into kinetic energy, and to provide energy services through a variety of methods².

2. Sources of renewable energy

The major renewable energy sources currently in use and expected to play a major role in meeting human energy needs include the following:

2.1 Solar energy

The use of the sun as an energy source is one of the most promising alternative energy sources due to its clean and inexhaustible nature. Many countries are focusing on the development of solar energy as a key objective. Solar energy is used directly in various applications, including:

- Heating
- Lighting
- Water heating
- Cooling
- Steam production
- Seawater desalination
- Electricity generation³.

2.2 Wind energy

Wind energy is derived from the movement of air and has been used since ancient times to sail ships, power windmills and pump water from wells. Today, the concept of wind energy is primarily associated with the generation of electricity by wind turbines and sited power plants that supply electricity to areas in need through electrical grids. According to global standards, it is possible to generate up to 20 million megawatts from this source on a global scale.

2.3 Hydropower

Hydropower is derived from the energy of flowing or falling water, such as in waterfalls, and from the movement of waves in oceans. Waves are created by the action of wind on the surface of seas, oceans and lakes. The energy from these waves can be harnessed and converted into electricity, with typical wave energy production ranging from 10 to 100 kilowatts per metre along coastlines moderately distant from the equator. Hydropower is a major source of energy

¹- Shin Khetir, Merzaq Warda "Investment in Renewable Energy as a Tool for Achieving Sustainable Development: A Review of the Experience of Oil Producing Arab Countries in the Field of Investment in Renewable Energies". Eliza Journal of Research and Studies, Vol. 6, Special Issue, 2021, p. 15.

²- Aisha Ben Naoui. "Energy Security in Algeria: An analytical perspective on the National Renewable Energy Programme for the period 2011-2030". Journal of Legal and Economic Research, vol. 4, no. 2, 2021, p. 287.

³- Shin Khetir, Merzaq Warda. Op. cit., p. 17.

worldwide, producing about 3.6 trillion kilowatt-hours in 2016, or about 16.75% of global electricity generation⁴.

2.4 Geothermal energy

Geothermal energy can be tapped from within the Earth's crust and is extracted from thermal reservoirs through drilling or other methods. These hot, accessible reservoirs are called hydrothermal reservoirs. High-temperature fluids from these reservoirs can be used to generate electricity and heat cities⁵.

2.5 Biomass energy

Biomass energy, sometimes referred to as bioenergy, consists primarily of organic materials such as wood, agricultural crops and animal waste. This energy source is renewable because it involves the conversion of solar energy into energy stored in plants through photosynthesis. As long as there are green plants, there will be solar energy stored in them, allowing us to extract biomass energy through various methods. Current biomass sources include:

- Forest residues
- Agricultural waste
- Sustainable logging
- Municipal waste
- Crops grown specifically for energy production⁶.

3. Importance of renewable energy

The importance of using renewable energy can be summarised in the following points:⁷

- Reduces dependence on imported energy and provides a valuable local alternative.
- Provides the basis for sustainable energy supply in both developed and developing countries.
- Represents one of the fastest growing markets in the world.
- Economically viable for many applications, offering significant economic returns.
- Provides a local source that supports the development needs of remote and rural areas.
- Renewable energy sources are characterised by sustainability and continuous renewal.

⁴-Mohammed Maghnem, Soufiane Abhri. "The Role of Renewable Energy in Achieving Sustainable Development in the Arab World: The National Renewable Energy Programme 2016-2030 in Saudi Arabia as a Model". *Journal of Creativity**, vol. 13, no. 1, 2023, p. 296.

⁵- Same reference as above, p. 295.

⁶- Annual report of the Secretary General. Organisation of Arab Petroleum Exporting Countries, Kuwait, no. 40, 2013, p. 204.

⁷-Rafika Moussaoui, Zohra Moussaoui."The Role of Renewable Energy in Achieving Sustainable Development." *Journal of Finance and Markets*, no. 1, 2017, p. 393.

Section Two: The Role of Renewable Energy in Achieving Sustainable Development

1. The concept of sustainable development

The concept of sustainable development was officially endorsed at the 1992 Earth Summit in Rio de Janeiro, where it was defined as “a process of development that meets the needs of the present without compromising the ability of future generations to meet their own needs”⁸.

The World Commission on Environment and Development, affiliated to the United Nations, defined it in its 1987 report as “the comprehensive and coherent processes and measures needed to change resource use, investment patterns, technological development trends and institutional changes to ensure the satisfaction of present and future human needs”⁹.

Thus, sustainable development is an approach that uses resources in a way that ensures their continued availability. It is also linked to organisational principles that aim to achieve human development goals while maintaining the capacity of natural systems to provide the natural resources and ecosystem services on which economies and societies depend. From this perspective, sustainable development aims to achieve social progress, environmental balance and economic growth¹⁰.

2. Objectives of sustainable development

Sustainable development, in its various dimensions, aims to achieve a number of key objectives, including:¹¹

- Ensuring the well-being of the population: Sustainable development seeks to balance the (population/resources) equation to ensure equilibrium. This is achieved by regulating population growth rates while increasing economic growth at a rate that exceeds population growth and remains within the carrying capacity of available economic resources. Failure to do so may result in increased economic and social burdens on the institutions responsible for meeting social spending needs.
- Conserve natural resources and reduce pollution: Sustainable development emphasises the relationship between human activities and the environment by considering ecosystems and their contents as fundamental to human life. The accumulation of waste from various sources is one of the major problems arising from the development process and hindering its progress. Therefore, the development of technologies and methods aimed at reducing waste and preventing pollution is one of the objectives of sustainable development, ensuring public health and maintaining a sustainable environment.

⁸-Boughali, S.”Opportunities and challenges for the promotion of renewable energies in Algeria.” *Annals of Sciences and Technology*, 5, 2013, p. 56.

⁹-Ahmed Abu Al-Yazid Al-Rasoul. “Continuous Development: Dimensions and Approach”. Bustan Al-Ma’rifah Library, Egypt, 2007, p. 87.

¹⁰- Mensah, J., & Casadevall, S. R. (2019). “Sustainable development: Meaning, history, principles, pillars and implications for human action: A literature review.” *Cogent Social Sciences*, 5(1).

¹¹- Samir. “Strategies for Sustainable Development: A Theoretical and Applied Approach.” *Arab Encyclopedia of Knowledge for Sustainable Development*, 2006, p. 450.

- Optimal use of natural resources and determination of the carrying capacity of ecosystems: The environment has the capacity to absorb changes resulting from human activities. When these changes exceed the limits of resource use, the result can be the depletion of land and natural resources, threatening the future of the planet.

3. The role of renewable energy in environmental protection for sustainable development

The environment is a fundamental factor in sustainable development. The use of renewable energy significantly reduces the emission of greenhouse gases produced by traditional fuels, thereby reducing environmental pollution. This positive impact on the environment is crucial.

According to a report by the Renewable Energy Policy Network for the 21st Century, renewable energy must play a central role in global energy supply to address the growing environmental and economic threats posed by climate change. In addition, World Bank reports over the past decade have emphasised the need to prioritise environmental considerations as a core aspect of development, particularly in relation to the conservation of natural resources and the monitoring of economic well-being indicators.

In this context, sustainable development aims to reduce the excessive use of fossil fuels and shift to alternative energy sources to meet the energy needs of industrialised societies while preserving the environment. This includes taking appropriate steps to mitigate global warming and prevent the depletion of the Earth's protective ozone layer¹².

4. The role of renewable energy in achieving sustainable development

Renewable energy plays an important role in achieving sustainable development, which can be highlighted through the following approaches:¹³

4.1 Economic security

Renewable energies are closely linked to the availability of technology, skilled human resources and economic viability, making them a reliable source for achieving economic development. They contribute to economic diversification by establishing a renewable energy sector and promoting the development of clean technologies. This in turn plays an important role in diversifying national economies by encouraging local development of these technologies and creating substantial export opportunities. Such actions contribute to a sustainable knowledge-based economy, while reliance on renewable energy sources promotes economic diversification and the development of the human capital needed to build a sustainable economy.

¹²- Hanish Ahmed, Hafiz Boudeyaff, Sustainable Development and Environmental Protection as the Basis for Investment in Renewable Energies, Fifth International Conference on: Strategies for renewable energies and their role in achieving sustainable development - A study of international experiences, Blida University 01, 2018, p. 3.

¹³- Houda Badrouni, Investment in Renewable Energies and Its Role in Achieving the Dual Goals of Environmental Protection and Sustainable Development in Algeria, Journal of Business Economics Leadership, Vol. 06, No. 03, January 2020, pp. 135-136.

4.2 Environmental security

Growing concern about the environmental problems caused by the consumption and production of fossil fuels calls for a shift towards technologies that support the use of renewable energy sources as a primary form of energy. The European Union has indicated that doubling the use of renewable energy could reduce carbon dioxide emissions by 402 million tonnes per year, a reduction of one third of the amount needed to reduce atmospheric CO₂ levels.

4.3 Social security

Social issues related to energy use include alleviating poverty, providing opportunities for women, and addressing demographic and urban change. The use of renewable energy sources can help to reduce unemployment, prevent poverty and avoid the waste of financial and material resources. For example, the use of solar energy in remote areas for thermal heating, steam power generation or crop drying can help break the isolation of these regions, promote the acquisition of diverse skills and experience, and ultimately contribute to local development.

5. Methods to align renewable energy investment with sustainable development

Several strategies can promote investment in renewable energy while achieving sustainable development:

- **Introduction of climate change taxes:** Imposing taxes on the public sector and energy-intensive companies to rationalise their energy consumption, while exempting the renewable energy sector from such taxes.
- **Carbon taxation:** Introducing taxes on carbon emissions to discourage the use of energy-intensive products, thereby reducing associated emissions.
- **Encouraging scientific research and investment:** Encouraging research and investment in renewable energy to promote the development of renewable energy technologies and their practical applications.
- **Introducing quota systems:** Requiring electricity companies to ensure that a proportion of their sales to the public come from renewable sources¹⁴.

Section Three: The Current State and Future Prospects of the UAE's Renewable Energy Experience in Achieving Sustainable Development

The United Arab Emirates (UAE) is an oil-rich country with significant natural gas reserves. However, the UAE is committed to diversifying its sources of income, starting with tourism and extending to the promotion of renewable energy. The country has developed a unique and innovative approach in this field to conserve its resources, protect the environment and achieve sustainable development.

1. UAE Renewable Energy Strategy 2050

Launched in 2017, the UAE Energy Strategy 2050 is the country's first unified energy strategy that focuses on balancing production and consumption, aligning with global environmental commitments, and ensuring a conducive economic environment for growth across all sectors.

¹⁴- Boudarja Ramzi, Renewable Energies and their Role in Achieving Sustainable Development: The German Experience, Milaf Journal of Research and Studies, No. 5, 2017, p. 613.

In response to significant changes in the energy sector related to global energy security and climate change, as well as falling prices and the maturation of low-emission and new energy technologies, the UAE updated its Energy Strategy 2050. This update set specific targets for 2030 and ambitions for 2050, with the aim of achieving climate neutrality.

2. Objectives of the UAE Energy Strategy 2050

The updated energy strategy aims to increase reliance on renewable energy sources, improve energy efficiency and promote the use of various forms of clean energy. It also focuses on supporting research and development programmes in energy technology, promoting innovation and encouraging investment in the sector. In addition, the strategy aims to strengthen the country's capacity to provide clean and sustainable energy, while maintaining its leadership and increasing its global competitiveness in this vital sector.

Key objectives of the strategy include:

- **Tripling the contribution of renewable energy:** The strategy aims to triple the contribution of renewable energy by 2030.
- **National investment:** It targets national investments of between 150 and 200 billion dirhams over the same period to meet increasing energy demand driven by rapid economic growth.

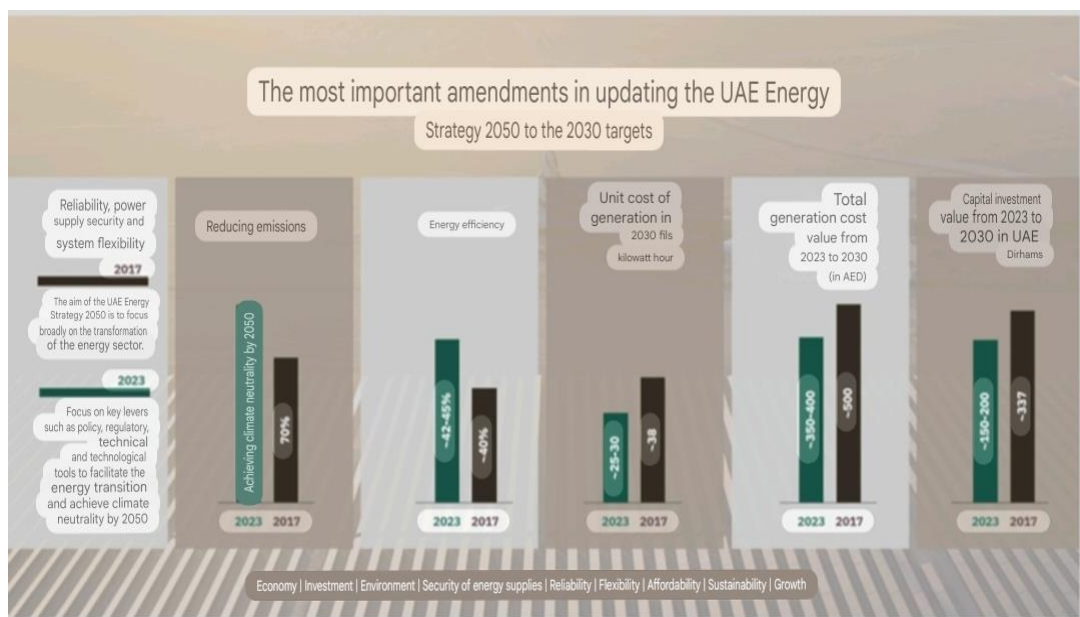


Figure 1: Key changes in the update of the UAE Energy Strategy 2050

Source: the UAE Energy Strategy <https://u.ae/ar-ae/about-the-uae/strategies-initiatives-and-awards/strategies-plans-and-visions/environment-and-energy/uae-energy-strategy-2050>

The strategy also provides new investment opportunities in renewable and clean energy, developing advanced energy-related technologies and establishing the UAE as a leading country for innovation and investment in this sector. It supports

3. UAE Renewable Energy Strategies to Achieve Sustainable Development

3.1 Current status of renewable energy in the UAE under the Energy Strategy 2050

Solar energy is one of the most important forms of renewable energy in the UAE. The country has initiated the construction of the Al Dhafra Solar Photovoltaic Power Plant, which will be the largest solar power plant in the world with a capacity of 2 gigawatts. The objectives of this project include:

- Reduce carbon emissions: Reduce carbon emissions in the UAE by more than 2.4 million tonnes per year.
- Provide electricity: Powering more than 160,000 homes in the UAE.
- Increasing solar capacity: Increasing the total solar power generation capacity in Abu Dhabi to approximately 3.2 gigawatts.

In addition, a major agreement was signed between Infinity Power, buyer Masdar and Hassan Allam Utilities to develop a 10 gigawatt wind power project when completed.

A. Solar Energy Projects

Here are some of the notable solar projects completed by the UAE:¹⁵

Solar projects in the UAE

1. Shams 1 Solar Power Plant

Shams 1 is one of the largest solar power projects in the UAE and is expected to generate approximately 7% of Abu Dhabi's renewable energy needs. The plant covers an area of 2.5 square kilometres and has a production capacity of 100 megawatts.

2. Concentrated Solar Power (CSP) Plant

In line with the Dubai Clean Energy Strategy 2050, a major announcement was made for one of the largest concentrated solar power projects in the world, with a production capacity of 1,000 megawatts by 2030. This project will surpass the largest concentrated solar power tower in Morocco, which has a capacity of 150 megawatts.

3. Mohammed bin Rashid Al Maktoum Solar Park

As part of the Dubai Energy Strategy 2050, the Mohammed bin Rashid Al Maktoum Solar Park was announced in 2012. The park is the largest single-site renewable energy project in the world, covering an area of 4.5 square kilometres in the Seih Al Dahl area along the Dubai-Al Ain road. It aims to generate 5,000 megawatts by 2050, making it a key strategic project for renewable energy generation globally¹⁶.

B. Wind Energy Projects:¹⁷

Like many countries around the world, the United Arab Emirates is looking to diversify its energy sources. Masdar has built the first wind turbine for electricity

¹⁵- Baji Abdelkader, Current State and Prospects of Renewable Energies in the United Arab Emirates, Journal of Economic Transformations, Vol. 3, No. 2, 2023, p. 09.

¹⁶- Zouaid Lzahari, Bounqab Mokhtar, Presentation of the UAE Experience in Developing Renewable Energy to Achieve Sustainable Development, Journal of Management and Economic Sciences Perspectives, Vol. 03, No. 01, 2019, p. 220.

¹⁷- Same reference as above, p. 10.

generation on Sir Bani Yas Island, 250 kilometres southwest of Abu Dhabi, with a production capacity of 850 kilowatts per hour. In addition, the Abu Dhabi Tourism and Culture Authority has partnered with Masdar to build an alternative energy station on Sir Bani Yas Island, which will later operate a desalination plant for use in agriculture and to feed the island's wildlife.

The UAE also intends to:

- Establish an energy efficiency market in Dubai: This includes the development of energy efficiency projects for 30,000 buildings to be implemented by the Emirates Central Cooling Systems Corporation (Empower), one of the initiatives of the Dubai Electricity and Water Authority, which was established in 2013 to enable Dubai to become a leading model in energy efficiency regionally and globally.
- Enabling consumers to become producers of clean energy^{**}: The Dubai Electricity and Water Authority has launched an initiative to enable consumers to become producers of clean energy. This follows the issuance of Executive Council Resolution No. (46) of 2014, which aims to facilitate the production of solar energy units within Dubai's energy distribution system.

C. Waste-to-Energy Projects

In order to achieve the UAE Vision 2050, which aims to use 50% of waste to generate energy by 2050, several companies have entered into agreements to collaborate on the conversion of waste into energy. Initiatives include the Circular Plastic Economy Programme, Emirates Global Aluminium and the world's first e-waste recycling facility in Dubai, as well as the "My Environment, My City" project in Dubai¹⁸.

4. Prospects for the UAE's energy sector under the 2050 Energy Strategy for Achieving Sustainability

The strategy assumes annual demand growth of 6% and aims to reduce carbon emissions from power generation by 70% over the next three decades. The Future Energy Strategy 2050 aims to:

- Create an energy mix: 44% from clean energy, 38% from gas, 12% from clean coal and 6% from nuclear.
- Increase the contribution of renewable and clean energy: Increase the share of renewable and clean energy in the country's overall energy mix from the current 25% to 50%.
- Allocate approximately 700 billion dirhams: This funding will be used for energy initiatives until 2050¹⁹.
- Improve individual and institutional energy efficiency: Improve efficiency by 40%.
- Meeting growing energy demand: Invest around 600 billion dirhams by 2050 to meet growing energy demand.

¹⁸- Said Tayeb, Challenges of Sustainable Development and Their Impact on Energy Transition, Journal of Finance, Investment, and Sustainable Development, Vol. 07, No. 01, June 2022, p. 130.

¹⁹- Available at the following link: <https://u.ae/ar-ae/more/uae-net-zero-2050>

- Balance supply and demand: Ensure that energy supply effectively meets demand.
- Reduce carbon emissions: Achieve a 70% reduction in carbon emissions from power generation processes.

Conclusion

In conclusion, our study has shown that the UAE has become a leading player in the global renewable energy sector. The numerous projects that it has implemented and continues to implement in this area support innovation to achieve sustainable development.

Findings

From the above, we have derived the following findings:

- Dependence on renewable energy: Turning to and relying on renewable energy is an ideal solution to achieve the dual goals of economic and environmental sustainability.
- Maintaining market position: The UAE is committed to maintaining its position in the renewable energy markets and meeting the growing local energy demand by utilising its available renewable energy resources.
- Future strategies: The UAE has developed future renewable energy strategies up to 2050 to diversify its energy sources.

Recommendations

Based on the findings, we present a series of recommendations:

- Learn from the UAE experience. There is a need to learn from the UAE's experience in promoting and developing renewable energy.
- Global economic integration: Any oil-exporting country that wants to break its dependence on oil must open up to the global economy, encourage foreign direct investment and provide opportun