

Renewable energy and its role in achieving sustainable development in Arab countries

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Received: 02/04/2025; **Accepted:** 28/05/2025; **Published:** 30/06/2025

Abstract: This study explores the role of renewable energy in sustainable development in Arab countries. Our findings show that renewable energy sources such as solar, wind and hydropower can make a significant contribution to environmental protection, reducing CO2 emissions and climate protection.

The study also highlights that investing in renewable energy projects in Arab countries can create economic opportunities, generate jobs, attract foreign investment and promote technology transfer and innovation.

The study recommends transitioning to renewable energy, investing in clean energy projects and increasing renewable energy research and development spending to promote sustainable energy development in Arab countries.

Keywords: Renewable energy; Sustainable development; Arab countries.

Jel Classification Codes : O13 ; P28; Q01

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Introduction:

In recent years, the Arab world has increasingly focused on sustainable development to address economic, environmental and social challenges. The focus is on shifting to renewable energy. The region's huge potential for solar and wind energy makes it a promising green technology hub. This article explores the role of renewable energy for sustainable development in Arab countries.

Energy is often considered a source of livelihood and comes in many different forms depending on its use: thermal, mechanical, chemical, nuclear, etc. It is characterized by the use of simple or complex technologies to convert energy from one form to another, such as converting chemical energy into electrical energy.

In this context, decades ago, the United Nations General Council reported as early as 1987 that sustainable development plays an important role in protecting future generations. This is achieved through numerous programs to protect the environment and use technology to save society and the economy.

In this sense, according to the International Energy Agency, renewable energy can be generated naturally, such as solar, wind, hydroelectric power and biofuels, which are low-carbon and sustainable. Neama, N. H., Abbood, R. H. and Al Daham, K. A. (2023)

However, there are challenges and limitations to the dissemination of green practices, including pricing issues, energy storage problems, and waste disposal, The Gulf Cooperation Council (GCC) states, including Arab countries, have recognized the potential of renewable energy to address energy security, greenhouse gas emissions, and climate change impacts. However, the current share of renewable energy in the GCC's total primary energy consumption remains low, The Kingdom of Saudi Arabia has taken steps to enhance domestic value creation from renewable energy industries as part of its efforts to diversify its energy portfolio, The Arab region is gradually embracing green energy, but faces challenges in transitioning from traditional energy sources. V., A., Isaev., Aleksandr, Filonik. (2022).

In light of the above, we can raise the following problem: How do renewable energies contribute to achieving sustainable development in Arab countries?

The structure of this paper is organized as follows: Section 1 presents a comprehensive review of previous studies on renewable energy and its contribution to sustainable development. Section 2 explores the potential of renewable energy sources within the Arab world. Subsequently, Section 3 discusses key challenges related to energy in Arab countries. Finally, the paper concludes with a summary of findings and insights.

I- Literature Review:

The shift toward renewable energy is a critical component of sustainable development in Arab countries, driven by their vast natural resources, heavy reliance on fossil fuels, and the growing global commitment to combating climate change. This literature review examines key studies and research in the field, emphasizing the role of renewable energy in fostering sustainable development across the Arab region.

Stambouli (2011) highlights the increasing political support for renewable energy at both national and international levels in recent years. The study underscores the Middle East and North Africa (MENA) region's strategic potential to lead the rapidly expanding solar and wind energy industries. Notably, Algeria recognized the importance of renewable energy early on, establishing the Solar Energy Institute as early as 1962. As a major player in global energy markets, Algeria not only serves as a significant producer and exporter of hydrocarbons but also actively participates in the renewable energy sector. Owing to its geographical advantages, Algeria possesses one of the world's richest solar energy reserves, positioning it as a key contender in the global transition to sustainable energy sources.

Belloumi and Saad Alshehry (2015) investigate the role of energy consumption in driving economic growth in Saudi Arabia from 1971 to 2012 using the autoregressive distributed lag (ARDL) cointegration approach. Grounded in neoclassical growth, endogenous growth, and ecological economics frameworks, their study confirms

the existence of a long-term equilibrium relationship between energy consumption and economic growth. The findings indicate that both conventional and non-conventional energy sources Granger-cause economic growth in the short and long run, supporting the energy-led growth hypothesis in Saudi Arabia. Consequently, the study cautions that energy conservation policies could negatively impact economic growth unless they are accompanied by strategies that enhance energy efficiency, promote energy-saving technologies, and encourage investment in renewable energy sources—such as solar and wind power—to mitigate climate change effects.

Taha et al. (2018) highlight the growing global initiatives led by the United Nations and various international organizations to promote renewable energy as a sustainable alternative to fossil fuels. This transition is driven by concerns over greenhouse gas emissions and other pollutants, particularly in the context of rising global population levels, as reported by REN21. The study emphasizes the significant role of renewable energy in mitigating the adverse effects of climate change, both environmentally and economically. A shift toward renewable energy fosters a greener and safer environment for human well-being while simultaneously contributing to economic development. This transition not only stimulates investment and job creation, thereby reducing unemployment, but also enhances societal well-being by improving education and healthcare systems—ultimately driving long-term sustainability.

Umar et al. (2020) emphasize the critical role of energy in driving social and economic development, highlighting that access to clean, affordable, and reliable energy is a fundamental objective within the United Nations Sustainable Development Goals (SDGs) to be achieved by 2030. Despite this global commitment, a significant portion of the world's energy supply remains dependent on fossil fuels, slowing the transition toward clean and renewable energy sources. The study specifically examines the challenges hindering the adoption of renewable energy in the Gulf Cooperation Council (GCC) countries, which, despite their abundant oil and gas reserves, face obstacles in diversifying their energy mix. Through a comprehensive literature review and a quantitative ranking approach based on data

collected from a representative sample across the six GCC nations, the study identifies the most pressing challenges in order of significance: policies and regulations, workforce expertise and competencies, renewable energy education, public awareness, financial costs and incentives, and government commitment.

Sedaoui (2022) highlights the diversity of energy contexts across the Arab region, where most countries remain heavily dependent on fossil fuels, with limited integration of renewable energy sources. Furthermore, the region lags behind others in improving energy efficiency, exacerbating sustainability challenges. In the Arab Least Developed Countries (LDCs), incomplete access to energy continues to hinder socio-economic development. The study emphasizes the necessity of integrating sustainable energy as a central component of national development policies, through a comprehensive approach that links energy strategies with other sectors such as transportation, urban planning, and environmental protection. Additionally, prioritizing natural resource management and ensuring inclusive, sustainable energy production and consumption should be treated as matters of national strategic importance.

Manal (2025) examines the impact of renewable energy on economic transformation and sustainable development through a systematic literature review using the Scopus database for the period 2014–2023. The study reveals that the adoption of renewable energy significantly reduces ecological footprints and greenhouse gas emissions, contributing to environmental sustainability. Wind energy, in particular, is highlighted as a key driver of sustainable economic growth. The research also emphasizes the role of renewable energy consumption in fostering economic expansion, boosting tourism, and stimulating GDP growth. Moreover, the study underscores the importance of hydrogen as a clean energy carrier when produced from renewable sources. Despite these benefits, the study acknowledges the challenges that remain, such as the need for supportive policies, financial inclusion, and technological advancements to fully capitalize on renewable energy's potential. The study recommends expanding geographical coverage, improving data quality, standardizing research methodologies, examining socio-political factors, evaluating

distributional effects, and fostering interdisciplinary collaboration to tackle the multifaceted challenges related to renewable energy and economic development.

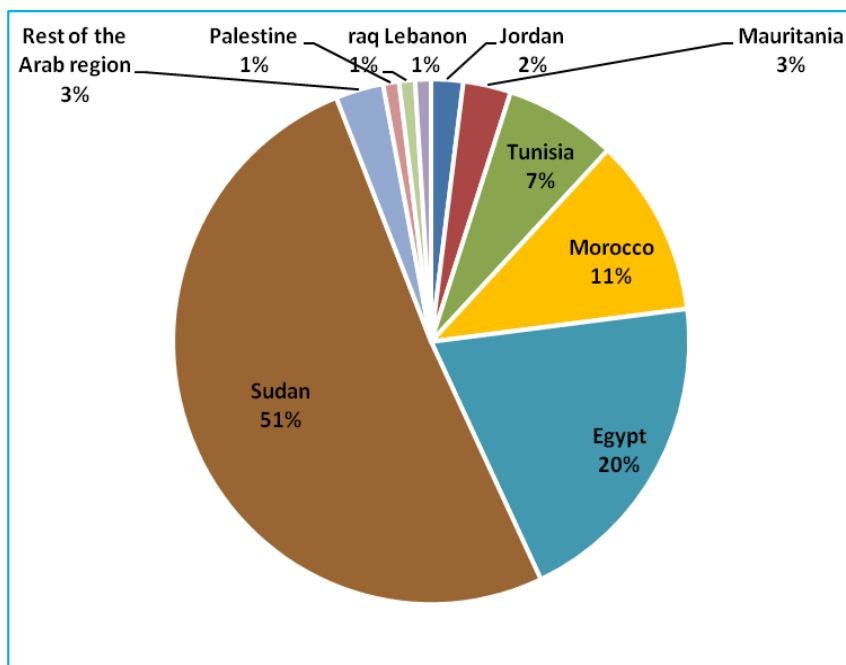
The literature reviewed in this overview underscores the critical role of renewable energy in sustainable development within Arab countries. Abundant solar and wind resources, economic benefits, environmental improvements, and policy support make renewable energy a central element in achieving sustainability goals. While challenges persist, the growing body of research points to the tremendous potential and opportunities for Arab nations to harness renewable energy to enhance their economies, improve the environment, and ensure energy security while making a substantial contribution to global sustainability efforts.

II– Renewable Energy Potential in the Arab World:

One of the key foundations of renewable energy in Arab countries lies in their exceptional potential for solar and wind energy. Bazilian et al. (2015) underscore the vast solar resources available in the region, particularly across the Arabian Peninsula and North Africa. The authors emphasize the potential to harness solar energy not only for domestic use but also to export it to energy-intensive European markets, positioning the region as an emerging solar energy hub.

The Arab world possesses substantial potential for renewable energy sources, particularly solar and wind energy. Despite the region's historical reliance on hydrocarbons and conventional energy, there is a growing interest in green energy. Countries such as Egypt and Morocco have made notable strides toward increasing electricity production from renewable sources (V., A., Isaev., Aleksandr, Filonik, 2022). However, the adoption of renewable energy across the region remains limited, with non-renewable energy continuing to dominate the energy mix. The Middle East, as a whole, has a relatively small share of renewable energy capacity compared to other regions worldwide (Amal, Rahmane., Abdelhak, Bentafat, 2018). Harnessing the renewable energy potential in the Arab world could significantly reduce CO2 emissions per capita and play a crucial role in advancing sustainable development (R, P., Praveen, 2021).

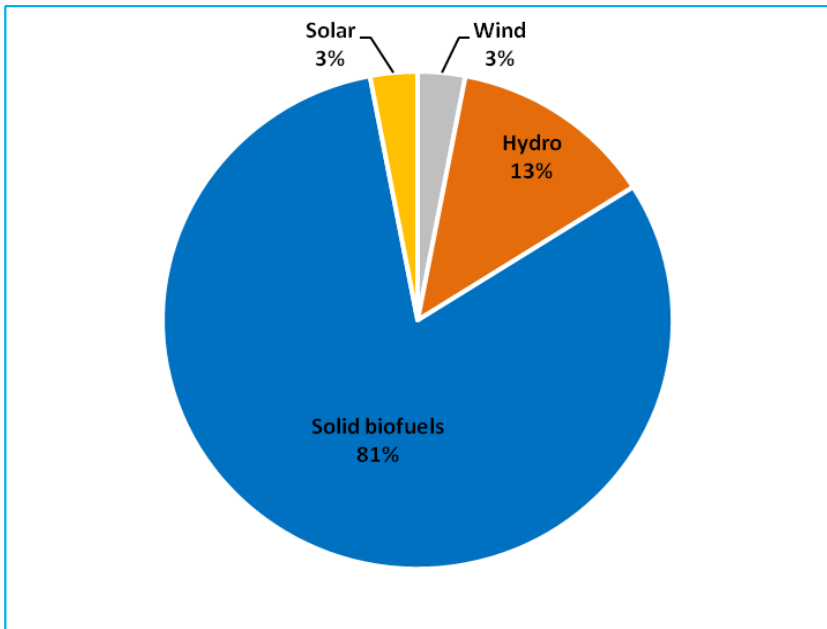
Figure (1): Total Arab renewable energy consumption by country, 2016



Source : Hafner, M., & Luciani, G. (2022).p678

The share of renewable energy has been plateauing at around 10.2% of the Arab region's total final energy consumption since 2010; it declined by another 11% between 2014 and 2016. Other, more modern forms of renewable energy such as solar and wind power have historically played a limited role in the Arab region. Hydro power forms an exception, but its deployment is limited in geographical scope, as is its potential for expansion given many important hydro resources are already being utilised. In consequence, encouraging yet slow growth in the deployment of modern renewable energy technologies in the region has not yet been sufficient to halt the region's overall trend of falling renewable energy consumption. Hafner, M., & Luciani, G. (2022).

Figure (2) :Renewable energy consumption by type of fuel in the Arab region, 2016.



Source : Hafner, M., & Luciani, G. (2022).p678

The potential for renewable energy sources such as photovoltaic, wind, and biomass is being explored, especially in hot and sunny areas like Saudi Arabia, The United Arab Emirates and Saudi Arabia are leading the way in experimenting with various renewable energy sources, including solar and hydrogen-based energy, but other countries in the region are more cautious and hesitant to fully embrace renewable energy. Aleksandr, Filonik., V., N., Baturina. (2022). Major obstacles hindering the large-scale penetration of renewable energy in the Arab region include economic and technological constraints, pricing issues, and problems with energy storage and waste disposal. Riad, Chedid., F.B., Chaaban. (2003).

II.1. Economic Benefits and Job Creation

Research conducted by Hirth (2015) points out the economic benefits associated with the renewable energy sector. The study argues that transitioning to renewable energy can stimulate local economies by attracting investments and creating jobs. In Arab countries, where unemployment is a pressing issue, the development of renewable energy projects can significantly contribute to job creation and economic growth.

Research conducted by Hirth (2015) highlights the economic benefits associated with the renewable energy sector. Investments in renewable energy can lead to increased attractiveness of regions to tourists, job creation, improved competitiveness of the local economy, and additional income for local producers such as farmers. Igliński, B., & Pietrzak, M. B.(2022). Additionally, the development of renewable energy can have positive effects on CO2 emissions, energy utilization, and power generation, leading to significant economic benefits in terms of GDP growth and employment creation. AlDarraji and Bakir (2018) found that renewable energy positively affects economic growth, and countries should be encouraged to invest in renewable energy and remove obstacles hindering its development. AlDarraji, H. H. M., & Bakir, A.(2020). Furthermore, renewable energy consumption in Southeast Asia can be influenced by factors such as foreign direct investment (FDI), gross domestic product (GDP), and carbon dioxide (CO2) emissions. Tran, Thi, Ngoc, Mai. (2023).

II. 2. Environmental and Health Impacts:

A study by Ahmed et al. (2017) explores the environmental and health impacts of transitioning to renewable energy in Arab countries. The findings indicate that renewable energy adoption can significantly improve public health and reduce environmental pollution in the Middle East and North Africa (MENA) region (Marcus, Aßmus, 2023). The study also emphasizes the importance of renewable energy in enhancing environmental quality and overall quality of life in MENA economies. However, the authors acknowledge that economic and technological constraints present challenges to the widespread adoption of green practices in the Arab world. Despite these obstacles,

the study underscores the critical need to promote renewable energy as a key solution to effectively address environment-related health issues in MENA countries. The authors conclude that, while the transition to renewable energy offers promising environmental and health benefits, overcoming these challenges is essential for successful implementation (Vikas, Prasad, 2022).

Solid biofuels remain the largest source of renewable energy consumption in the Arab region, particularly in Arab Least Developed Countries (LDCs), where they account for nearly 53% of the total final energy consumption. A significant portion of the region's solid biofuel consumption is traditional, primarily used for cooking, heating, and even lighting. However, these practices typically involve low efficiency, leading to adverse health effects due to indoor air pollution. The need for modern renewable energy solutions is critical to bridging this gap and improving both energy efficiency and public health (ESCWA, 2023).

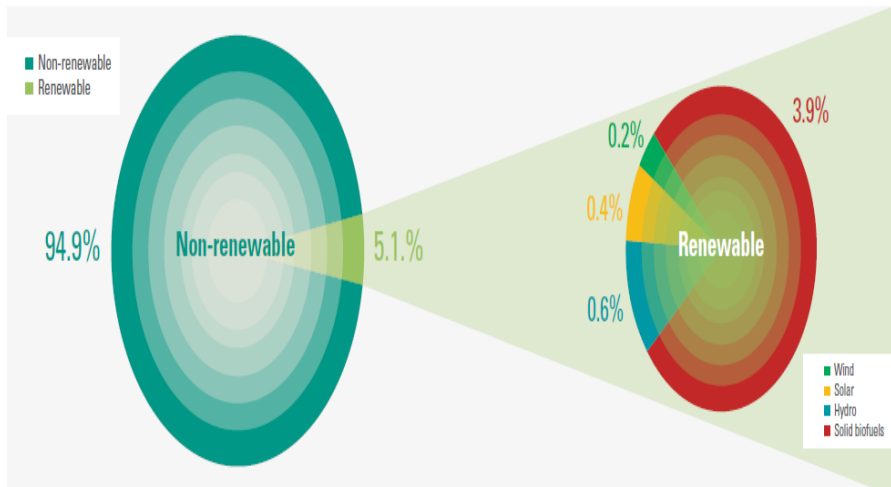


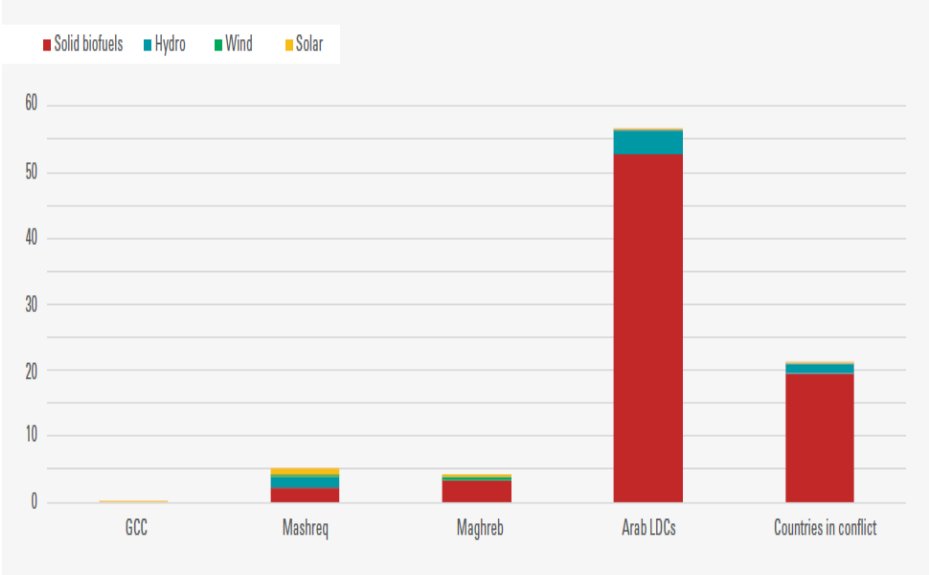
Figure (3): Total final energy consumption breakdown by source in the Arab region, 2020 (Percentage)

Source : ESCWA, (2023), p06

Arab countries, including those in the MENA region, have shown varying levels of consumption of renewable energies. Factors such as energy imports, income, and industrial value-added have been found to positively influence the usage of renewable energy in the

MENA region. Dirir, S. A. (2023). Despite the growing interest in renewable energy, the Arab region, including the GCC countries, continues to rely heavily on fossil fuels for primary energy consumption, with the share of renewable energy remaining below 1%. However, renewable energy is increasingly recognized as a crucial element for sustainable economic development. In Saudi Arabia, for instance, the consumption of renewable energy has been shown to significantly reduce CO2 emissions, with the impact becoming more pronounced at higher levels of adoption. To further improve environmental quality, policymakers are encouraged to implement supportive policies and regulations that foster the widespread adoption and utilization of renewable energy (Mehdi, Abid, 2023).

Figure (4): Share of individual renewable energy sources in total final



energy consumption, by Arab sub-region, 2020 (Percentage)

Source : ESCWA, (2023), p06

The consumption of renewable energy varies across the Arab region, with some countries in the Middle East and North Africa (MENA) possessing significant potential for renewable energy, yet still relying predominantly on non-renewable energy sources (Dirir, S. A., 2023). However, countries such as Egypt and Morocco have made

notable progress in increasing electricity production from renewable sources (V., A., Isaev, Aleksandr, Filonik, 2022). The region as a whole faces a critical challenge in balancing traditional energy sources with green energy, although renewable energy is expected to gradually carve out its role in electricity generation. The development of renewable energy is recognized as essential for the sustainable economic development of Arab countries, even amidst their substantial oil and gas wealth (Rahmane, A., & Bentafat, A., 2018).

III- Energy Challenges in Arab Countries :

Arab countries face several energy challenges, including heavy reliance on fossil fuels, volatile global energy prices, and growing energy demand due to population growth and economic development. Traditional fossil fuels, particularly oil and natural gas, have been the mainstay of energy production in the region, making these countries susceptible to fluctuations in global energy markets. Diversifying their energy mix with renewable sources is a strategic imperative.

The Arab region faces several critical challenges that hinder its transition to renewable energy, including a lack of effective energy demand management, the need for comprehensive structural and economic reforms, insufficient long-term planning, limited technological awareness, and inadequate access to financing. Additionally, the region's vulnerability to natural disasters and its heavy reliance on fossil fuels further impede the shift towards renewable energy sources (V., A., Isaev., Aleksandr, Filonik, 2022). While some countries, such as the United Arab Emirates and Saudi Arabia, have made progress in adopting renewable energy, many Arab nations remain cautious in their approach, continuing to prioritize hydrocarbons and conventional energy sources. Water scarcity and pollution also pose significant challenges, and there is a pressing need to address the interdependencies between water, food security, and energy. In the Gulf Cooperation Council (GCC) countries, the key obstacles to renewable energy adoption include inadequate policies and regulations, a shortage of skilled manpower, insufficient renewable energy education, low public awareness, high costs, lack of financial incentives, and insufficient government commitment (Umar,

T., et al., 2020). These multifaceted challenges must be addressed to facilitate a successful transition to sustainable energy systems across the region.

III.1. Economic Opportunities:

Investing in renewable energy projects can create economic opportunities in Arab countries. The renewable energy sector promotes job creation, attracts foreign investments, and contributes to technology transfer and innovation. Additionally, by reducing the need for costly fossil fuel imports, it can enhance economic stability and sustainability.

The majority of studies indicate a positive relationship between renewable energy consumption and economic growth, suggesting that renewable energy is a key driver of sustainable economic development in Saudi Arabia (Aleksandr, Filonik., V., N., Baturina, 2022). Moreover, investing in renewable energy in Saudi Arabia has the potential to generate more sustainable jobs for its citizens and promote economic diversification, thereby increasing the contribution of the non-oil private sector to the overall economy (Berradia, H., et al., 2023). Several Arab countries, including Egypt and Morocco, have already made strides in developing renewable energy-based electricity production, demonstrating the sector's growth potential. However, challenges such as technical issues, high costs, and limited financial resources must be addressed to fully capitalize on the economic opportunities renewable energy presents in the Arab world (Rahmane, A., & Bentafat, A., 2018).

III. 2. Energy Security:

Renewable energy can enhance energy security in Arab countries. Reducing dependence on fossil fuel imports mitigates the impact of global energy price fluctuations and geopolitical conflicts. Arab countries can become self-reliant in meeting their energy needs, ensuring a stable supply for their growing populations.

Renewable energy has the potential to enhance energy security in Arab countries. The natural conditions and vulnerability to natural disasters in the region prioritize the need for environmental security

and transition to renewable energy sources, Aleksandr, Filonik., V., N., Baturina. (2022). While some countries in the Arab East have made progress in adopting renewable energy sources, most countries are cautious and show inertia towards this transition, Solar energy use in Lebanon, Syria, and Iraq is driven by practical responses to intermittent electricity supplies rather than a desire for green energy, Israel and Jordan, which are dominated by fossil fuel usage, have set targets to increase their renewable energy supply but progress is slow, Cox, S. S. L., et al (2019). The Intergovernmental Panel for Climate Change (IPCC) has concluded that almost 80% of the world's energy supply could be met by renewable energy by mid-century, backed by the right policies. Al-Ajmi, D. N. (2018)

III. 3. Sustainable Development Goals:

Renewable energy aligns with the United Nations Sustainable Development Goals (SDGs). Arab countries are committed to achieving these goals, including clean energy, economic growth, and environmental sustainability. Renewable energy projects can help address several of these goals simultaneously, making them a valuable tool in the pursuit of sustainable development.

Arab countries stand to gain significantly from the adoption of renewable energy sources in achieving their sustainability goals. The use of renewable energy can contribute to Sustainable Development Goal (SDG) 7 (Affordable and Clean Energy) by providing access to clean, affordable energy sources. Additionally, it can support SDG 13 (Climate Action) by reducing carbon emissions and mitigating the impacts of climate change. Furthermore, the deployment of renewable energy can promote environmental protection and lower pollution levels (Zhi, Yung, Tay., Dimitrios, Konovessis, 2023). To support long-term sustainable energy development and economic growth, Arab countries should consider increasing investment in research and development within the renewable energy sector (Gharbi, I., et al., 2023). By implementing effective policies and regulations, Arab nations can overcome existing challenges and successfully enhance the role of renewable energy in their energy planning (Tsangas, M., et al., 2022).

III. 4. Regional and Global Cooperation:

Cooperation within the Arab world and with international partners can accelerate the adoption of renewable energy. Regional collaboration can lead to the sharing of expertise, resources, and best practices. Additionally, international support and investment can further boost the renewable energy transition in the region.

Cooperation within the Arab world, as well as with international partners, can significantly accelerate the adoption of renewable energy across the region. Despite the Gulf Cooperation Council (GCC) countries setting ambitious targets for renewable energy deployment, their progress has been relatively slow. However, the international policy trend of utilizing renewable energy auctions to stimulate deployment is well-suited to the GCC context. Moreover, regional energy subsidy reforms could provide a crucial foundation for future policy frameworks focused on carbon pricing to facilitate renewable energy adoption (Griffiths, S., & Orkoubi, D., 2018). In the Eastern Mediterranean, including the Jordan Basin, there is considerable potential for the increased uptake of renewable energy technologies. This opportunity is driven by high oil prices, investment possibilities in energy infrastructure, and the influence of the UN climate change regime. Collaborative decision-making regarding renewable energy in this region could yield significant security and human development benefits (Leloux, M., et al., 2015).

Conclusion:

The Arab world's pursuit of sustainable development is closely intertwined with the transition to renewable energy sources. Abundant solar and wind resources, economic opportunities, environmental benefits, and alignment with global sustainability goals make renewable energy a crucial element of sustainable development in Arab countries. Overcoming challenges and embracing cooperation will help the region unlock its full potential in the renewable energy sector and usher in a more prosperous, environmentally responsible future.

The most important results reached in this research paper :

Arab countries, particularly those in the Arabian Peninsula and North Africa, have an extraordinary potential for renewable

energy, primarily in the form of solar and wind resources. These regions receive ample sunlight throughout the year, making them ideal for solar energy production, and they also have significant wind energy potential, especially along coastal areas. This finding underscores the untapped opportunities for harnessing clean, indigenous energy sources.

Transitioning to renewable energy sources can stimulate local economies by attracting investments and creating jobs. The renewable energy sector offers opportunities for economic diversification, reducing the region's historical dependence on fossil fuels, which are subject to price volatility. Job creation is of particular importance in the Arab world, where unemployment is a pressing concern.

Shifting to renewable energy has the potential to mitigate air pollution, which is a significant issue in urban areas of Arab countries. The reduction of air pollutants and greenhouse gas emissions from fossil fuels can lead to improved air quality, enhancing public health and quality of life. This finding underscores the far-reaching environmental and health benefits of renewable energy adoption.

These results collectively underscore the critical importance of renewable energy as a catalyst for sustainable development in Arab countries. The vast potential for renewable resources, coupled with the economic, environmental, and health benefits, highlights the transformational role renewable energy can play in enhancing the region's energy security, promoting economic growth, and mitigating environmental challenges. Furthermore, successful case studies demonstrate that a shift toward renewables is not only possible but can serve as a model for other countries in the region as they strive for sustainable development and energy sustainability.

Based on the findings and insights from the literature on renewable energy's role in achieving sustainable development in Arab countries, several key recommendations emerge. These recommendations can guide policymakers, governments, and stakeholders in the region to effectively harness the potential of renewable energy and promote sustainable development:

- Arab countries should develop and implement comprehensive national strategies for renewable energy adoption. These strategies should outline clear targets, incentives, and timelines for transitioning to renewable energy sources.

Arab countries should prioritize investing in research and development (R&D) for renewable energy technologies. This will foster innovation, create region-specific solutions, enhance energy security, reduce fossil fuel dependency, and support sustainable economic and environmental development.

- Invest in educational and vocational programs to build the necessary skills and expertise in the renewable energy sector. This includes training for engineers, technicians, and project managers, as well as public awareness campaigns to promote renewable energy literacy.

- It is essential to encourage regional and international collaboration on renewable energy projects. By sharing resources, best practices, and facilitating technology transfer, the deployment of renewable energy infrastructure can be accelerated. This collaboration enhances efficiency, fosters innovation, and develops solutions suited to diverse regional contexts, aiding in the swift transition to sustainable energy systems.

- necessity of Diversification of Energy Sources, While transitioning to renewable energy is crucial, Arab countries should also consider diversifying their energy sources. A mix of renewables, including solar, wind, hydro, and possibly nuclear energy, can provide a more resilient and balanced energy portfolio.

These recommendations emphasize the need for a holistic approach that combines policy, investment, education, and collaboration to harness the potential of renewable energy for sustainable development in Arab countries. Implementing these recommendations can lead to economic growth, environmental protection, energy security, and the achievement of sustainable development goals in the region.

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