OPEN ACCESS

Saudi Journal of Humanities and Social Sciences

Abbreviated Key Title: Saudi J Humanities Soc Sci
ISSN 2415-6256 (Print) | ISSN 2415-6248 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Renewable Energies in the Gulf: The Ambitious Plans of Saudi Arabia and the United Arab Emirates

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DOI: https://doi.org/10.36348/sjhss.2025.v10i01.002 | **Received:** 17.11.2024 | **Accepted:** 26.12.2024 | **Published:** 08.01.2025

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Abstract

Global warming is currently one of the world's most pressing issues. It has been a reason behind the proliferation of renewable energy (RE) systems. The majority of renewable energy sources are sustainable and release less carbon, in contrast to fossil fuels, which is why they have recently gained favour. Solar, wind, and geothermal energy have the potential to be employed in these Gulf countries to meet the region's power production needs. This is due to the Gulf country's strategic location as well as its immense oil and natural resource richness. According to previous researchers, the primary source of economic benefits for Gulf countries is global energy consumption by using crude oil and fossil fuels. The GCC is a major player in the global energy market. It is home to some of the world's largest oil and gas reserves and plays a significant role in producing and exporting energy resources. In future, as the world's energy needs shift towards renewable sources, the demand for traditional energy sources like oil and gas may decline. This could reduce the GCC's importance as a global energy supplier. Hence Saudi Arabia and the United Arab Emirates have made efforts to diversify their economies away from dependence on oil and gas exports. Saudi Arabia has launched several initiatives aimed at diversifying its economy. The most notable of these is the Vision 2030 program, which seeks to reduce the country's dependence on oil and create new economic sectors, such as tourism, entertainment, and technology. The government has also invested heavily in infrastructure projects, such as the construction of the NEOM megacity and the Red Sea Project, which are aimed at attracting foreign investment and creating new jobs. Similarly, the United Arab Emirates has been at the forefront of economic diversification, with its government launching several initiatives aimed at promoting innovation, entrepreneurship, and knowledge-based industries. One of the most notable initiatives is the Dubai Future Accelerators Programme, which brings together startups and government agencies to work on cutting-edge technologies and solutions. Additionally, the United Arab Emirates is investing heavily in renewable energy to generate 50% of its electricity from clean sources by 2050. Both Saudi Arabia and the United Arab Emirates are working towards building more diversified, knowledge-based economies that can compete in the global marketplace. At the same time, the road ahead may be challenging because of technical challenges, Economic challenges, lack of infrastructure, Regulatory challenges, Heavy Dependence on oil, Skilled labour shortage, and Regulatory environment. While taking the above as the context, the paper shall look at renewable energy development in Saudi Arabia and the United Arab Emirates. The following are major research questions which shall be explored and analysed:

- How has the development of renewable energy technologies and infrastructure in Saudi Arabia and the United Arab Emirates progressed over time, and what factors have influenced this development?
- What are the future plans and potential for continued growth and expansion of renewable energy in these countries?
- What will be the future and potential renewable energy sources and policies in Saudi Arabia and the United Arab Emirates, and what are the barriers and opportunities for their adoption and integration into the energy mix?
- How successful have Saudi Arabia and United Arab Emirates' economic diversification efforts been in reducing reliance on oil revenues?
- What are the similarities and differences between the development of renewable energy technologies and policies in Saudi Arabia and the United Arab Emirates compared to the rest of the world?
- What are the factors that have contributed to the similarities and differences, and how do they impact the potential for further growth and expansion of renewable energy in these countries relative to the rest of the world?

This paper presents a literature-based study. The study covers capacities, projects, policies, and frameworks in Saudi Arabia and the United Arab Emirates. In this study, we would make use of secondary data that has been gathered from previously published statistics and relevant literature.

Keywords: Renewable Energy, Economic Diversification, Gulf Cooperation Council (GCC), Vision 2030 (Saudi Arabia), Energy Transition.

1. INTRODUCTION

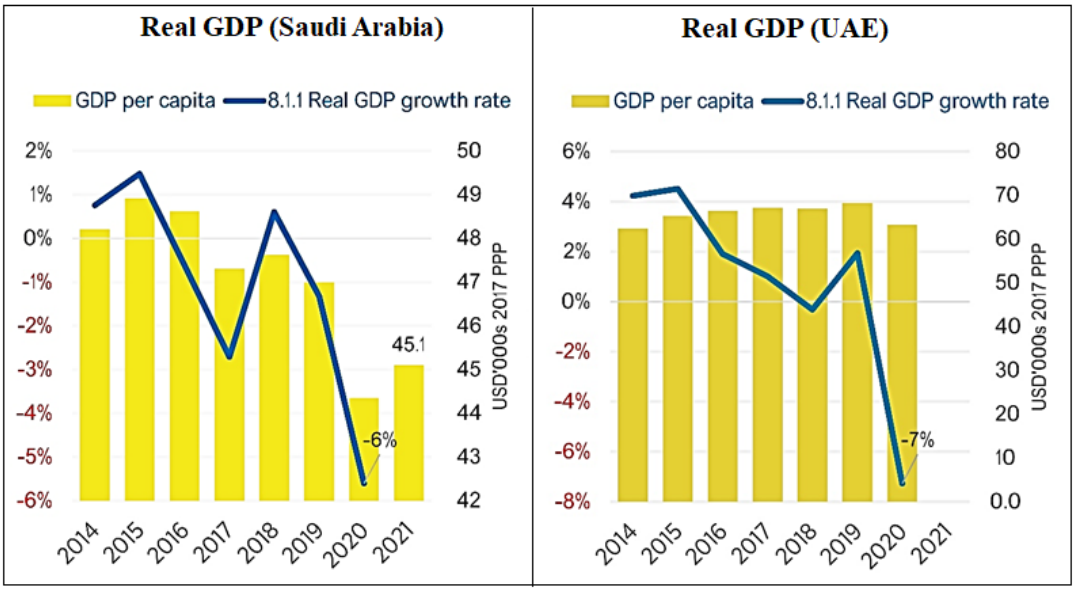
Fossil fuels are used by world economies to industrialise, urbanise, and raise standards of life, all of which contribute to pollution and global warming. Techniques for mitigating recent high carbon emissions are needed to balance greenhouse gas levels. Alternatives to fossil fuels are provided by renewable energy. The appeal of renewable energy comes from the fact that the majority of them are sustainable and emit less carbon. Due to declining solar and wind energy costs, renewable energy has rapidly developed during the previous few years (IEA 2017).

Many nations put into practice effective strategies to lessen environmental deterioration and increase environmental quality. Such strategies are produced by direct and indirect regulatory measures. Environmental awareness can be increased in civil society through environmental education, cultural norms, behaviour, and moral instruction. Governments can control the private sector by imposing restrictions on energy use and output. Implementing taxes and penalties on their output and energy use will help control high-polluting manufacturers.

West Asia is home to enormous natural resources, yet the development of renewable energy has been excruciatingly slow. The largest percentage of RE expansion was in Iran, followed by Israel ("Publications" 2023). Saudi Arabia is working to catch up to its Arab neighbours in terms of the development of renewable energy. Prince Abdul Aziz bin Salman, Saudi Arabia's energy minister, stated at the beginning of the year that the country intended to call for new bids for renewable energy projects to produce 15,000 MW of power capacity in 2022 and the following year ("Https://Powersaudiarabia.Com.Sa/," n.d.). Furthermore, the government plans to generate a staggering 15,1 TWh of renewable energy by 2024, according to the General Authority of Statistics of the Kingdom of Saudi Arabia. The National Renewable Energy Programme now includes 13 projects with a combined capacity of more than 4,800 megawatts. More than 90% of Saudi Arabia's renewable energy comes from solar energy, with the remaining 10% coming from wind farms due to the country's high solar irradiation levels. Saudi Arabia is converting to renewable energy as a result because it provides a consistent, long-lasting energy source that will support economic growth. In recent years, KSA has made major commitments to increase the use of renewable energy sources, including solar and wind power. In order to support these endeavours, new regulations and incentives have been adopted to promote the use of sustainable practices and clean technologies across several industries. The Saudi Arabian crown prince, Mohammed bin Salman, has promised that by 2030, his nation will produce 50% of its energy from renewable sources and plant 10 billion trees ("Vision 2030 Projects," n.d.). (Saudi Press Agency, a government agency) On March 28, Crown Prince Mohammad Bin Salman said:

> *"As a leading global oil producer, the Kingdom fully recognises its share of responsibility in advancing the fight against the climate crisis. Just as the Kingdom underpinned energy markets during the oil and gas era, it is going to become a global leader in forging a greener world "*(Research: Publications and Reports Knight Frank Saudi Arabia, n.d.).

The United Arab Emirates (UAE) has set ambitious plans for renewable energies as part of its vision to diversify its economy and reduce its dependence on fossil fuels. The UAE recognises the need to transition to sustainable energy sources to mitigate climate change, ensure energy security, and promote sustainable economic growth. The UAE has set a target to generate 50% of its energy from renewable sources by 2050 as part of its "UAE Energy Strategy 2050." This includes a goal to increase the share of clean energy in the country's total energy mix, with a focus on solar and wind power. The UAE has invested heavily in large-scale solar projects to harness its abundant sunlight resources. For example, the Mohammed bin Rashid Al Maktoum Solar Park, located in Dubai, is one of the world's largest solar parks and has a planned capacity of 5,000 MW by 2030. The UAE has also launched other solar initiatives, such as the "Noor Abu Dhabi" solar plant, which is the world's largest single-site solar project with a capacity of 1,177 MW. The UAE is also committed to fostering innovation in renewable energy technologies. The country has established research and development centres, such as the Masdar Institute of Science and Technology and the Masdar City, which serve as a hub for renewable energy research, development, and deployment. The UAE also hosts the annual Abu Dhabi Sustainability Week, which brings together global leaders, policymakers, and experts to discuss and showcase innovations in renewable energy and sustainability. The UAE is implementing energy efficiency measures to reduce its overall energy consumption and promote sustainable energy practices. This includes the implementation of energy-efficient building codes, regulations, and standards, as well as the adoption of smart grid technologies and demand-side management initiatives. The UAE is actively engaged in international cooperation and partnerships to promote renewable energies globally. For instance, the UAE co-founded the International Renewable Energy Agency (IRENA) and hosted its headquarters in Abu Dhabi. The UAE also provides financial assistance and investment in renewable energy projects in other countries, particularly in developing nations, to support their transition to sustainable energy sources.



2. Previous Works

Renewable Energy Development in the Gulf Cooperation Council Countries: Status, Barriers, and Policy Options (Al-Sarihi and Mansouri 2022). This paper looks at why they don't use more renewable energy sources. It does this by using secondary data like journal articles, government and company websites, reports, and newspaper stories. Technical and economic problems were thought to be the main things holding back the use of renewable energy technologies in the GCC, but this paper found that a number of other factors have also played a big role. High subsidies for hydrocarbons, low electricity rates, a fragmented energy policy, the lack of a specialised regulator and regulatory framework for renewable energy, and a tightly controlled power market are all big reasons why renewable energy isn't used more in the GCC.

"Potential of Utilisation of Renewable Energy Technologies in Gulf Countries" (Basha *et al*., 2021) This critical research shows how much renewable energy sources in the Gulf area can do and how many of them there are. This analysis talks about how important and possible renewable sources are in the Gulf area.

A recent review of energy efficiency and renewable energy in the Gulf Cooperation Council (GCC) region (Almasri and Narayan 2021) this paper looks into the scope of energy efficiency (EE) and the use of renewable energy sources like solar, wind, and geothermal energy, which have the potential to spread in the GCC area. The study looked at how much energy and electricity are being used in the area. Also, it talked about the problems that can happen when dust builds up on gadgets. It also talked about the use of different computer platforms that show how different RE technologies can be used. It also comes up with conclusions and suggestions based on the problems.

Current Situation of Renewable Energy in Saudi Arabia: Opportunities and Challenges (Zohbi and AlAmri 2020) This paper Suggests the country should take more steps, such as Resource Mapping of Renewable Energy Sources, Renewable Portfolio Standards, developing academic curricula for renewable energy, smart grid technologies, increasing research and development in the field of renewable energy technologies, and regulating to limit greenhouse gas emissions.

Renewable energy Resources and workforce case study Saudi Arabia: review and Recommendations (Barhoumi *et al*., 2020) The purpose of this study was to look at the green energy resources in Saudi Arabia and how well they can be used in terms of human resources. Studies have shown that the country has a lot of renewable energy sources, such as wind, sun, and geothermal energy. What outcomes did they measure?

Review of the renewable energy outlook in Saudi Arabia (Al-Douri, Waheeb, and Voon 2019) This study has focused on how important it is to have green, clean surroundings and a climate with the least amount of dust. The idea of "reference prices" has been clearly grasped and understood. This paper talked about the difference between real possibilities and marginal costs. A study has been done on an important question about the use up of materials that can be used up. This problem has been looked at and shown from the beginning.

The prospect of wind energy utilisation in Saudi Arabia: A review (Al-Douri, Waheeb, and Voon 2019) This paper looks at wind data from different parts of Saudi Arabia over the past ten years to see if it would be possible to make electricity. This study also gives ideas for possible places where wind power could be

made, as well as tips for how wind turbines should be made.

The transition towards sustainable energy production – A review of the progress for solar energy in Saudi Arabia (Salam & Khan, 2018a). This paper talks about the issues and problems that come up when Saudi Arabia wants to switch from oil to solar energy. It shows and talks about the things that are pushing Saudi Arabia to switch to solar power as an alternative energy source that can help the country become less dependent on oil and better care for the environment. The key to doing the solar project in Saudi Arabia last is to use a multi-pronged strategy that involves everyone.

Oil subsidies and renewable energy in Saudi Arabia: a general equilibrium approach (Salam & Khan, 2018b). This paper shows that if the costs of integrating renewable technologies were high, then the best thing for families would be to use 30–40% renewables. Also, this study shows that a policy that favoured renewable energy would make the KSA more dependent on oil since a bigger part of its GDP would be tied to oil exports, and so could be affected by changes in oil prices. Lastly, it is shown that sending a lot more oil onto the international market could have a negative effect on the price of oil on the international market, which could cancel out any possible benefits of the renewable energy policy.

Renewable energy technologies adopted by the UAE: Prospects and challenges – A comprehensive overview (Adebayo & Kirikkaleli, 2021). This work shows the different ways that the United Arab Emirates is trying to reach sustainable growth by using different types of renewable energy. The UAE is very interested in adopting and using RE technologies because they have many benefits, such as lowering carbon dioxide and other pollutants that contribute to global warming. The work looked at what the UAE might be able to do with these kinds of green energy sources to meet its energy needs.

A multicriteria decision-making approach for evaluating renewable power generation sources in Saudi Arabia (Al Garni *et al*., 2016) Based on this study, solar photovoltaic and concentrated solar power are the best methods. Wind energy is next on the list. Each renewable energy resource's performance per end-node criterion is shown, and a sensitivity analysis is done to see how the total rankings of alternatives change when the weights of each criterion are changed. By putting in place an energy mix strategy, Saudi Arabia can keep its limited energy resources for the future to support its strong economic and industrial growth.

Changing the Energy Profile of the GCC States: A Review (S Al-Maamary and Professor 2016) This study was a general look at the environmental problems that GCC countries face and the steps that these countries have taken together and on their own to fix these issues. Studies of the region's countries have shown that they are moving towards using green energy sources to fix a lot of the damage to the environment caused by years of building and using fossil energy sources. The study shows that the GCC countries are still behind in setting up power plants that use green energy, except for the UAE, which started the Masdar City project and Oman, which is working on solar energy projects.

Driving forces for renewable development in GCC countries (Patlitzianas and Flamos 2016) This paper looks at the current state of renewable energy sources (RES) in the GCC area and talks about the chances for widespread and large-scale implementation. Lastly, the main economic, regulatory, market and technological factors that drive the use of RES in each country are shown.

Comparison between hybrid renewable energy systems in Saudi Arabia (El Khashab and Al Ghamedi 2015) This paper looked at how RE sources could be used in Yanbu, Saudi Arabia. It also used HOMER software to simulate three suggested systems that had just been set up in the Renewable Energy (RE) lab at Yanbu Industrial College. The lab is a hybrid system made up of photovoltaic, wind turbine, and fuel cell devices.

Sustainable Energy Development in Saudi Arabia (Belloumi and Alshehry 2015) This paper talks about how energy conservation policies could hurt Saudi Arabia's economic growth if they aren't accompanied by steps to improve energy efficiency, develop energy-saving technologies, and encourage investment in and use of renewable energy sources that can help slow down climate change.

Future of solar energy in Saudi Arabia (Mohsin *et al*., 2021) This study shows that the cost of solar energy will be less than the cost of fossil fuel energy when environmental and health costs are taken into account.

Barriers, Risks and Policies for Renewables in the Gulf States (Lilliestam and Patt 2015) This paper does a meta-analysis of the literature and a survey to find out if there is a need for green energy in the GCC, what barriers and risks are stopping investments from happening now, and what policy solutions could be used. This paper finds that there is a long-term need for renewables to help balance the economy and get ready for a world without fossil fuels.

Renewable energy in Saudi Arabia: current status and future potentials (Tlili 2015) This paper talks about the current state of energy and focuses on renewable and energy-efficient technologies, major

successes, and current government policies and challenges.

A Review of Renewable Energy and Solar Industry Growth in the GCC Region (Mohsin *et al*., 2021) This paper looks at the recent success made in expanding renewable energy programmes and solar energy programmes in the GCC. Solar power is the most popular alternative energy source because its technology is pretty advanced, and it seems to have a lot of promise in the area, where the average daily solar radiation is over 6kWh/m2 and the sky is clear 80–90% of the time.

A review of progress in renewable energy implementation in the Gulf Cooperation Council countries (Munawwar and Ghedira 2014) The Paper shows that the GCC countries have started to be more proactive about renewable energy, which will help them move closer to sustainability. In the GCC countries, plans and policies are being changed to focus more on clean energy.

A sustainable energy transition strategy for the United Arab Emirates: Evaluation of options using an Integrated Energy Model (Sgouridis *et al*., 2013). This paper talks about the benefits of a sustainable energy transition outweigh implementation costs.

Prospects of Renewable Energy to Promote Zero-Energy Residential Buildings in the KSA (Alrashed and Asif 2012) This Paper looked at how renewable energy could be used to help ZEBs in the residential sector of the KSA. It gives a full account of the country's energy situation. It also talks about what ZEBs are all about. In this way, the piece looks into how different types of green energy could be used to power these buildings. It also talks about the things that make it hard to build these kinds of buildings.

A key review on present status and future directions of solar energy studies and applications in Saudi Arabia (Hepbasli and Alsuhaibani 2011) A big part of the country's energy needs could be met by using solar energy. If there is a big breakthrough in the field of turning solar energy into electricity, Saudi Arabia could become a top producer and exporter of electricity made from solar energy.

Renewable Energy Policies in the Gulf countries: A case study of the carbon-neutral "Masdar City" in Abu Dhabi (Reiche, 2010). The paper talks about the main features of Masdar City, analyses the reasons why the project was started, names the main people who are in charge of making it happen, and tries to figure out the policy behind Masdar City and the problems it faces. Finally, a first evaluation is made of the project's possible effects on how it spreads.

Renewable energy scenarios for major oil-producing nations: The case of Saudi Arabia (Al-Saleh 2009) This paper looks at a few possible futures for the oil-rich Kingdom of Saudi Arabia. The Delphi method was used to come up with these cases, which were made by thirty-five knowledgeable people from different backgrounds.

3. METHODOLOGY

The main objective of this study is to examine and investigate Saudi Arabia's and the United Arab Emirates renewable energy trends. Additionally, it tracks the development of this strategy and throws insight into the elements that have contributed to its failure to yet. Saudi Arabia began diversifying its economy in 1970, and the Saudi Vision 2030 document furthered this effort in April 2016. This vision especially aspires "to reinforce and diversify the capabilities of our economy, turning our key strengths into enabling tools for a fully diversified future," in the words of Prince Mohammed bin Salman bin Abdulaziz, the Crown Prince of Saudi Arabia.

Bhujanga Rao defines research methodology as "an appropriate method or methods for an exhaustive and detailed investigative study of the problem of research". This study falls under the category of analytical research, in which the researcher makes use of the information at hand to evaluate the chosen research problem critically. In this work, documentary analysis is used. The analysis of documents helps one comprehend the components and participants in the diversification strategy's evolution in Saudi Arabia and the United Arab Emirates, as well as the connections between policy and practice. Prior believes that document analysis is crucial in the social sciences because documents can catalyse social interaction in addition to containing textual information that can be used to analyse social phenomena. Therefore, document analysis can provide insight into the environment in which a given policy develops as well as how that policy affects and reflects societal change. Documents from the governments of Saudi Arabia and the United Arab Emirates, as well as the World Bank, United Nations, and World Economic Forum, serve as sources for this essay.

4. Saudi Vision 2030

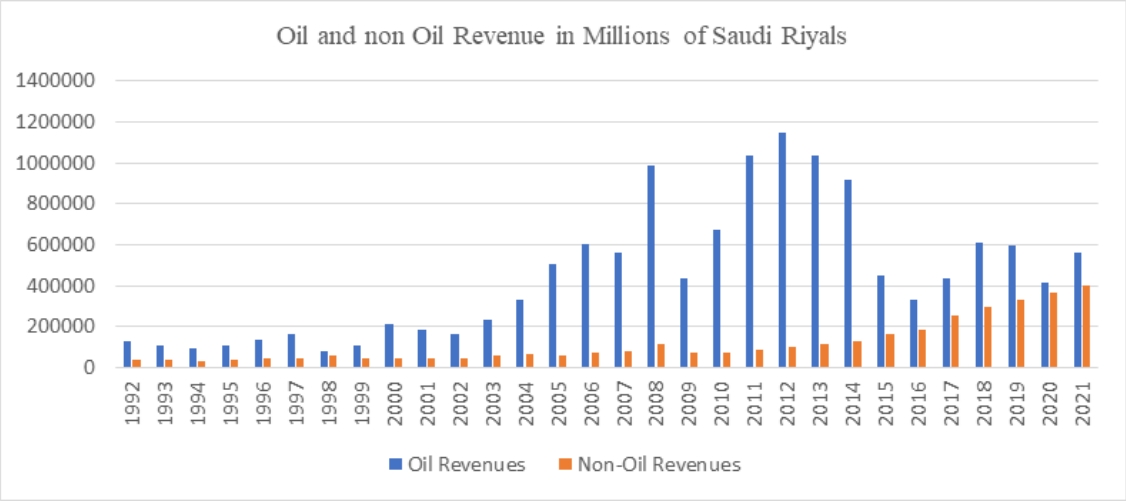
On April 25, 2016, Crown Prince Mohammed bin Salman provided the initial information (Rashad, n.d.; “Full Text of Saudi Arabias Vision 2030” 2016). The responsibility of identifying and monitoring the procedures and policies necessary to realise "Saudi Arabia's Vision 2030" has been delegated by the Council of Ministers to the Council of Economic and Development Affairs (CEDA). A bold reform plan called Vision 2030 aims to diversify the economy of the nation and strengthen its budgetary position in the face of falling oil prices. Multinational firms have the possibility to invest in the nation thanks to the policies, particularly in non-oil sectors. Goals for increasing competitiveness

and diversification are outlined in the Saudi Vision 2030. It is organised around three main areas that list specific goals to be accomplished by 2030 ("Full Text of Saudi Arabias Vision 2030" 2016).

- **A thriving society** characterised by urbanisation, culture and entertainment, sports, Umrah, UNESCO World Heritage Sites, and high life expectancy.
- **A booming economy** by employment, women in the workforce, international competitiveness, the Public Investment Fund, foreign direct investment, and exports of non-oil products
- **A nation with aspirations** of non-oil revenues, government efficiency, e-government, household savings and income, non-profits, and volunteerism.

Much attention has been placed on Saudi Aramco's proposal to privatise at least 5% of its operations. But this has obscured the greater picture of Vision 2030 and how it seeks to transform the economy of the nation. The largest oil corporation in the world, which is in charge of nearly 12% of the world's oil output, had its vision adopted by the government. Crown Prince Mohammed Bin Salman, who is widely regarded as the primary architect behind Vision 2030, initially discussed the strategy in an interview in March 2016. (Petroff, n.d.)Although there are several issues with the idea, if it succeeds, it will allow international investors access to a large portion of the Saudi economy. This overview examines the reasons behind the transition, the changes previously implemented, the issues the government is currently dealing with, the USD 2 trillion estimated cost of building a new economy, and some of the prospects that lie ahead ("Vision 2030 Projects," n.d.). The government owns the fund. Arabia's Reliance on Oil.

Table 1.1: Oil revenue and non-oil revenue, 1992-2022 in Saudi Riyals



Source: Ministry of Finance, KSA

5. Projects of Saudi Vision 2030

Since Saudi Arabia announced its Vision 2030 plan, almost $1 trillion worth of development projects have started or been announced. This is only a third of the total amount that is planned to be spent. Knight Frank says that Saudi Arabia's big Vision 2030 plan for changing the country has so far led to almost $1 trillion worth of infrastructure and real estate projects all over the country. The global property consultancy also says that the $1 trillion figure, which is led by a $575 billion investment to turn the Red Sea Coast into a global tourism and business hub, is only about one-third of what is planned to be spent.

Faisal Durrani, head of Middle East research at Knight Frank, said ("Research: Publications and Reports Knight Frank Saudi Arabia," n.d.), "The number and value of mega projects around the country, all of which are huge, are set to change the country's real estate landscape, the standard of living, lifestyle offerings, and perhaps most importantly, show the world the Kingdom's vision for an ultramodern future." "The goals that Vision 2030 is based on are becoming a reality."

Table 3.1: Major Projects of Saudi Vision 2030

Project	Area Occupied	Date of announcement	Expected Completion	Cost
New Taif project	1,250 km^2	March 1 2017	2020	$3 billion
Diriyah Gate project	1.5 km^2	July 20 2017	2030	Unknown
Al-Qiddiya project (Al-Qiddiya, south-west of Riyadh)	334 km^2	April 8 2017	2022	$2.7 billion

Project	Area Occupied	Date of announcement	Expected Completion	Cost
Al-Faisaliah project (West of Makkah)	2,450 km^2	July 26 2017	1st Phase will be completed by the end of 2020	Unknown
Downtown Jeddah	5.2 km^2	September 27 2017	1st phase will be completed by the end of 2022	$4.8 billion
NEOM (Tabuk)	26,500 km^2	October 24 2017	1st Phase will be completed by the end of 2025	$500 billion
Renewable Energy Project	Unknown	March 27 2018	2030	$200 billion
Amaala Project Along the Red Sea	3,800 km^2	September 26 2018	1st phase by the end of 2020	Unknown
King Salman Energy Park Between Dammam and Al-Ahsa	50 km^2	December 5 2018	1st phase by the end of 2021	$1.6 billion
Al-'Ula Vision	22,500 km^2	February 11 2019	2030	Unknown
King Salman Park, Sports Boulevard, Green Riyadh, and Riyadh Art	>149 km^2	March 19 2019	Unknown	$23 billion
Great Mosque of Mecca	0.250000 km^2	2017	Mid-2018	$21.3 billion
Mall of Saudi	8.666000 km^2	2017	2022	$3.2 billion
The Red Sea Project	28,000 km^2	2018	1st Phase by the end of 2022	$3.2 -$3.7 billion

Sources- The Progress & Achievements of Saudi Arabia, Vision 2030, Vision 2030 Projects

Saudi Arabia Net Zero by 2060

The Kingdom of Saudi Arabia stated during the inaugural Saudi Green Initiative Forum that it intends to achieve carbon neutrality by 2060. Implementing the Carbon Circular Economy, based on zero waste, will assist Saudi Arabia in achieving its goal of reducing carbon emissions by 278 million tonnes annually by 2030. As part of its commitment to achieving a cleaner, greener future, the Kingdom will join the Global Methane Pledge to help reduce global methane emissions by 30% by 2030. In addition, by 2030, the Kingdom will plant 450 million trees and repair 8 million hectares of damaged land, cutting carbon emissions by 200 million tonnes, with more efforts to be revealed in the years ahead ("Saudi & Middle East Green Initiatives," n.d.).

The United Arab Emirates (UAE) Vision 2030

The UAE Vision 2030 is a strategic plan that aims to diversify the country's economy and promote sustainable development. The plan includes integrating sustainability standards into the country's agenda to promote sustainable lifestyles (Dave and Shaikh 2022). The UAE government sees technology as one of the cornerstones of education in the 2021 vision (AKÇAY 2023). The plan also includes developing the country's culture sector, as highlighted in the Cultural Mandate document, which outlines the country's cultural vision for the next thirty years (Ephraim 2019). In response to climate and environmental issues, the UAE has developed several means by which sustainable development can be achieved (Elkady and Sediadi 2019). The plan also includes educational reform, with the integration of technology into education at the forefront of the planned reformation (ElSayary, Zein, and Antonio 2022). The UAE Vision 2030 is similar to the Saudi Vision 2030, which aims to diversify the Saudi economy and attract foreign investment (Mbarki 2020). However, according to a study, the UAE corporate reporting is not significantly influenced by the UAE Vision 2030 Agenda (Elmassri *et al*., 2022).

UAE Vision 2030 is based on four pillars (Briefing 2022):

Economic development: The UAE aims to achieve effective economic transformation of the Emirate's economic base and bring about global integration and enduring benefits to all.

Social development: The UAE aims to create a safe and secure society with a sustainable economy and to promote the UAE as a leading hub of technology and innovation.

Environmental sustainability: The UAE aims to preserve and enhance Abu Dhabi's natural heritage in the efficient use of resources and contribute to a better quality of life for all. Environment Vision 2030 identifies the following five priority areas:... Abu Dhabi Economic Vision 2030.

Cultural development: The UAE aims to uphold Abu Dhabi's principles, culture, and legacy and make a significant and continuous contribution to the UAE Federation.

The UAE Vision 2030 is aligned with the United Nations' Sustainable Development Goals (SDGs) and reflects the UAE's commitment to sustainable development, innovation, and leadership on the global stage. It sets a roadmap for the UAE's development

trajectory, with a focus on economic diversification, social development, environmental sustainability, and infrastructure development, towards building a prosperous and sustainable future for the UAE and its people.

6. DISCUSSION

Both Saudi Arabia and the United Arab Emirates (UAE) have made significant progress in developing their renewable energy sectors in recent years. In Saudi Arabia, the government has set a target of generating 50% of the country's electricity from renewable sources by 2030. To achieve this goal, the country has implemented several renewable energy projects, including the 300 MW Sakaka PV solar power plant, the 400 MW Dumat Al Jandal wind farm, and the 1.5 GW Sudair solar project. Additionally, the country has launched initiatives to promote the use of solar energy in residential and commercial buildings, such as the "Saudi Solar Village" program ("Saudi, UAE Lead GCC Switch to Renewable Energy Sources, Strengthen Climate Commitment" 2023). In the UAE, the government has set a target of generating 44% of the country's electricity from renewable sources by 2050. To achieve this goal, the country has implemented several renewable energy projects, including the 1.18 GW Noor Abu Dhabi solar power plant, the 5 GW Mohammed bin Rashid Al Maktoum Solar Park, and the 1.5 GW Sweihan PV solar power plant. The country has also launched initiatives to promote the use of solar energy in residential and commercial buildings, such as the "Shams Dubai" program. (Muzoriwa 2023). These factors have influenced the development of renewable energy technologies and infrastructure in Saudi Arabia and the UAE ("Https://Www.Fitchratings.Com/Research/Infrastructure-Project-Finance/Middle-Eastern-Countries-Continue-to-Target-Higher-Renewable-Energy-Capacity-11-05-2023," n.d.).

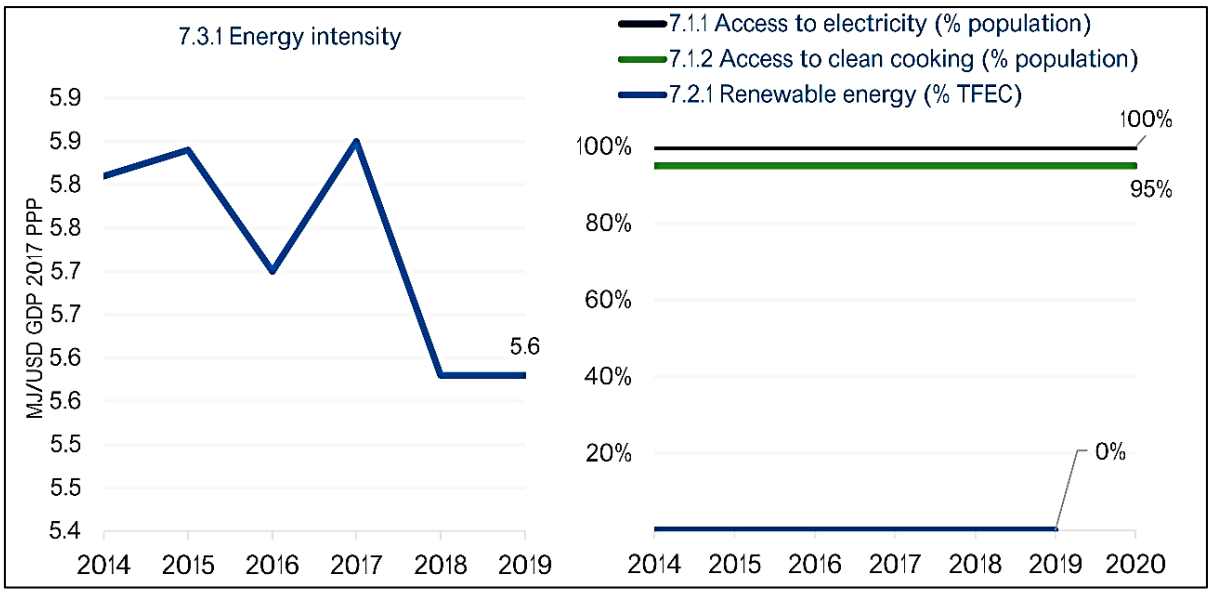
Economic diversification: Both countries are seeking to diversify their economies away from reliance on oil and gas exports. Developing renewable energy sectors provides an opportunity to create new industries, attract investment, and create jobs.

Climate change concerns: Both countries are experiencing the impacts of climate change, including rising temperatures and water scarcity. Developing renewable energy sectors helps to mitigate these impacts by reducing greenhouse gas emissions and conserving resources.

Technological advancements: The cost of renewable energy technologies, such as solar and wind, has decreased significantly in recent years. This has made these technologies more economically viable and attractive to invest in.

Government support: Both countries have provided significant government support for the development of renewable energy sectors, including subsidies, tax incentives, and regulatory frameworks that support the integration of renewable energy into the electricity grid.

Saudi Arabia



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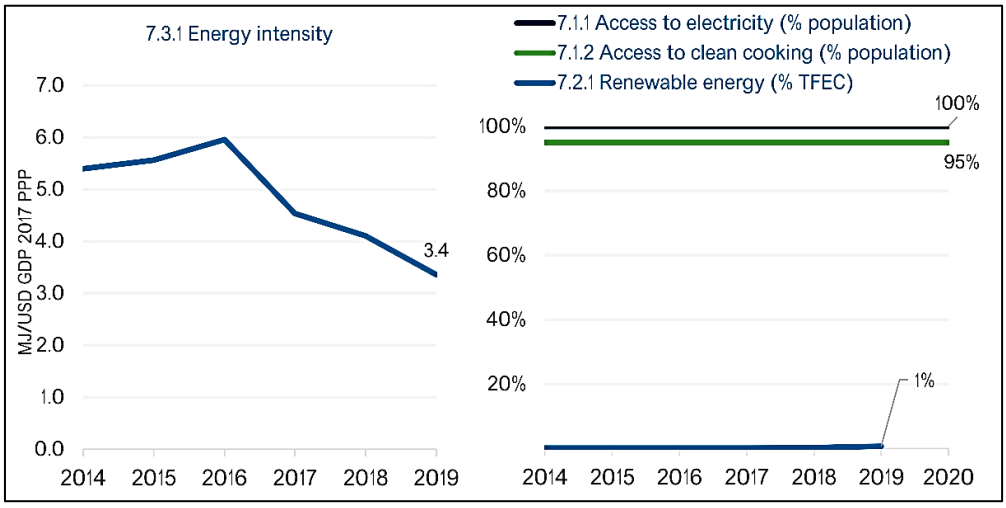
UAE



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Both Saudi Arabia and the UAE have ambitious plans for the continued growth and expansion of their renewable energy sectors in the future. In Saudi Arabia, the government plans to invest more than $50 billion in renewable energy by 2030. The country aims to install 60 GW of renewable energy capacity by that year, with 40 GW from solar and 16 GW from wind power. The country also plans to launch several initiatives to support the deployment of renewable energy technologies, such as the "Renewable Energy Project Development Office" and the "Green Hydrogen and Ammonia" initiative (H A Aldhubaib 2022). In the UAE, the government plans to invest more than $150 billion in renewable energy by 2050. The country aims to install 44 GW of renewable energy capacity by that year, with 40% coming from solar, 44% from nuclear, and 16% from other renewable energy sources. The country also plans to launch several initiatives to support the deployment of renewable energy technologies, such as the "Energy Strategy 2050" and the "Dubai Clean Energy Strategy 2050". Both countries have also recognised the potential of green hydrogen as a clean energy source and are exploring its development. The UAE has launched the "Green Hydrogen Project" in Abu Dhabi,(Dubai Clean Energy Strategy - The Official Portal of the UAE Government, n.d.-a), while Saudi Arabia has launched the "Green Hydrogen Initiative" and the "Green Hydrogen Production at Scale" program (Nakano, n.d.).

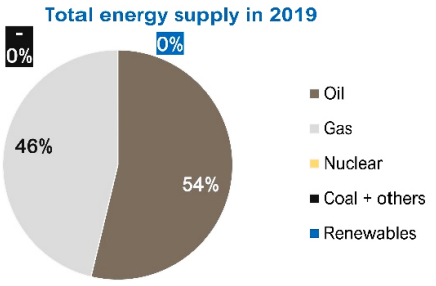
Saudi Arabia

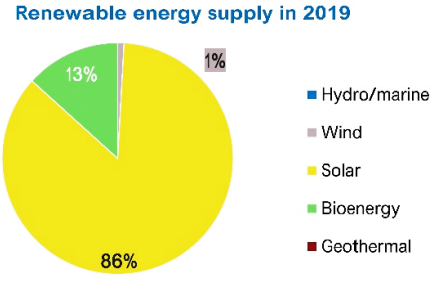
TOTAL ENERGY SUPPLY (TES)

Total Energy Supply (TES)	2014	2019
Non-renewable (TJ)	9 332 186	10 124 307
Renewable (TJ)	435	2 345
Total (TJ)	9 332 621	10 126 652
Renewable share (%)	0	0

Growth in TES	2014-19	2018-19
Non-renewable (%)	+8.5	+1.8
Renewable (%)	+438.9	+0.5
Total (%)	+8.5	+1.8

Primary energy trade	2014	2019
Imports (TJ)	996 668	1 236 025
Exports (TJ)	18 108 135	18 567 385
Net trade (TJ)	17 111 467	17 331 360
Imports (% of supply)	11	12
Exports (% of production)	68	68
Energy self-sufficiency (%)	285	271





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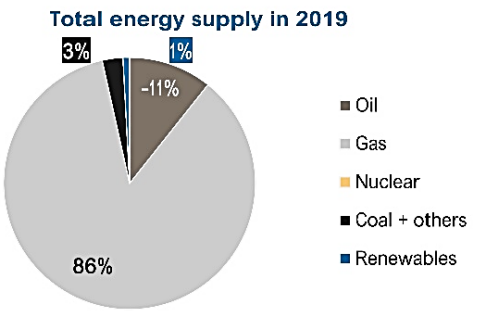
UAE

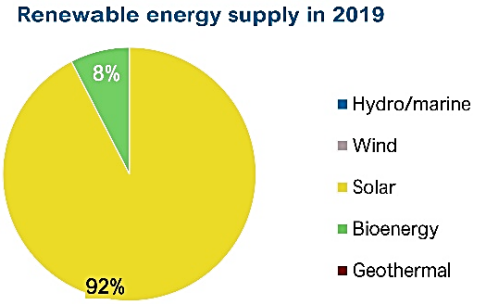
TOTAL ENERGY SUPPLY (TES)

Total Energy Supply (TES)	2014	2019
Non-renewable (TJ)	3 357 425	2 171 661
Renewable (TJ)	4 711	23 323
Total (TJ)	3 362 136	2 194 984
Renewable share (%)	0	1

Growth in TES	2014-19	2018-19
Non-renewable (%)	-35.3	-17.8
Renewable (%)	+395.1	+36.7
Total (%)	-34.7	-17.4

Primary energy trade	2014	2019
Imports (TJ)	1 910 032	2 130 146
Exports (TJ)	6 832 879	8 672 760
Net trade (TJ)	4 922 847	6 542 614
Imports (% of supply)	57	97
Exports (% of production)	75	89
Energy self-sufficiency (%)	272	443





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The future and potential renewable energy sources in Saudi Arabia and the UAE are expected to include solar, wind, geothermal, and green hydrogen. In addition to these sources, energy storage technologies will also play an essential role in the integration of renewable energy into the energy mix. Regarding policies, both countries have implemented a range of regulatory frameworks to support the deployment of renewable energy technologies ("Dubai Clean Energy Strategy - The Official Portal of the UAE Government," n.d.). For example, the UAE has established a feed-in tariff scheme to incentivise investment in renewable energy, while Saudi Arabia has launched several initiatives to support the development of renewable energy projects, including the "Renewable Energy Project Development Office" and the "Green Hydrogen and Ammonia" initiative (Nakano, n.d.). However, several barriers to the adoption and integration of renewable energy in these countries exist. These include (Al *et al*., 2019).

Fossil fuel subsidies: The countries have long-standing subsidies for fossil fuels, which make it challenging to compete with renewable energy sources on a cost basis.

Land availability: The countries have vast desert areas with limited vegetation, which can limit the availability of land for renewable energy projects.

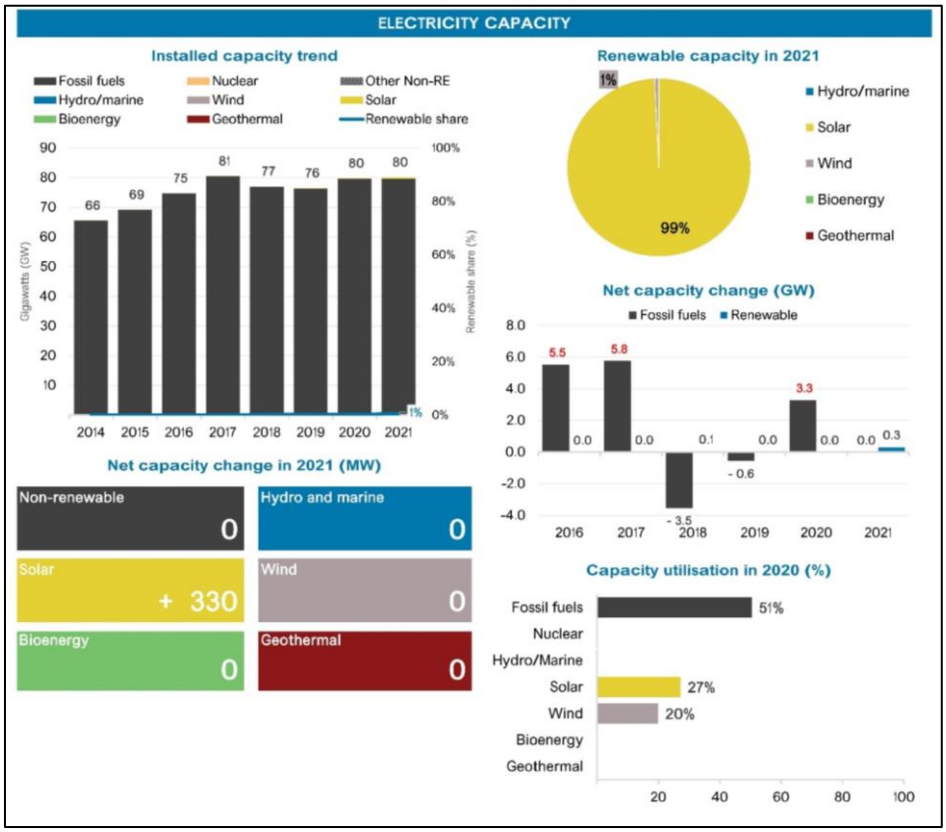
Grid infrastructure: The countries' electricity grids were primarily designed to accommodate conventional power generation, making it challenging to integrate renewable energy sources into the grid.

Regulatory and policy frameworks: Despite the implementation of supportive regulatory and policy frameworks, some barriers remain, including the need for clearer and more consistent regulations and policies for renewable energy.

Technical and financial capacity: Renewable energy technologies require specific technical expertise and financing, which can pose challenges in the countries' nascent renewable energy sectors.

Despite these barriers, there are significant opportunities for the adoption and integration of renewable energy in Saudi Arabia and the UAE. These include the countries' strong financial resources, favourable natural conditions for renewable energy production, and their commitment to reducing greenhouse gas emissions and diversifying their economies away from fossil fuels.

Saudi Arabia



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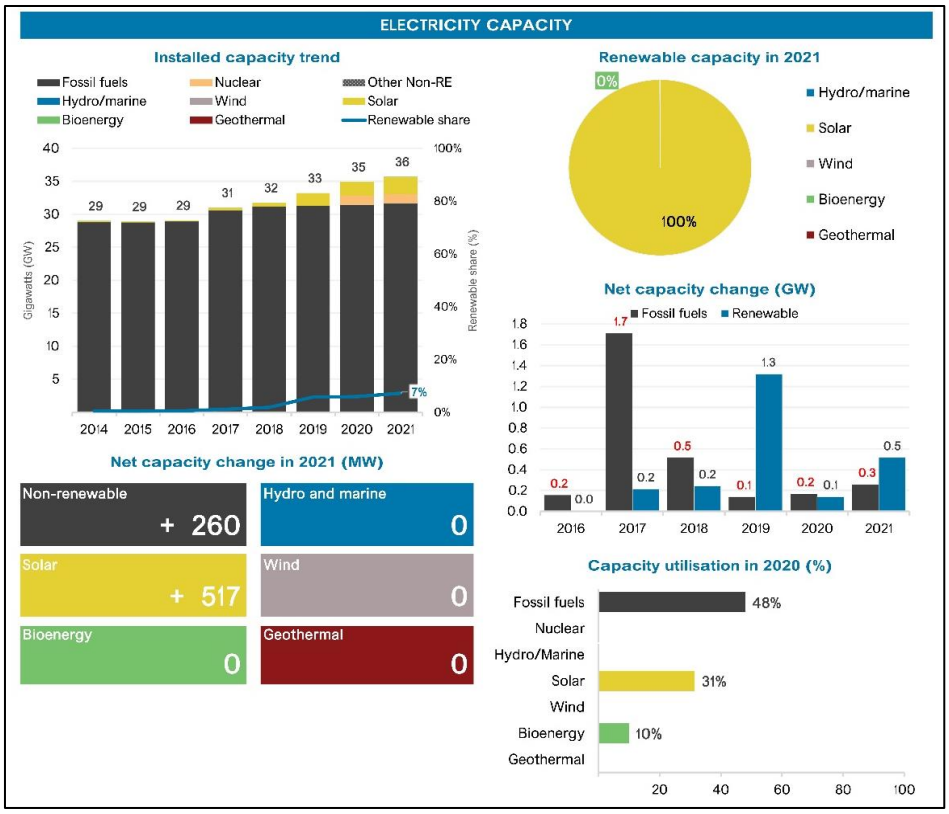

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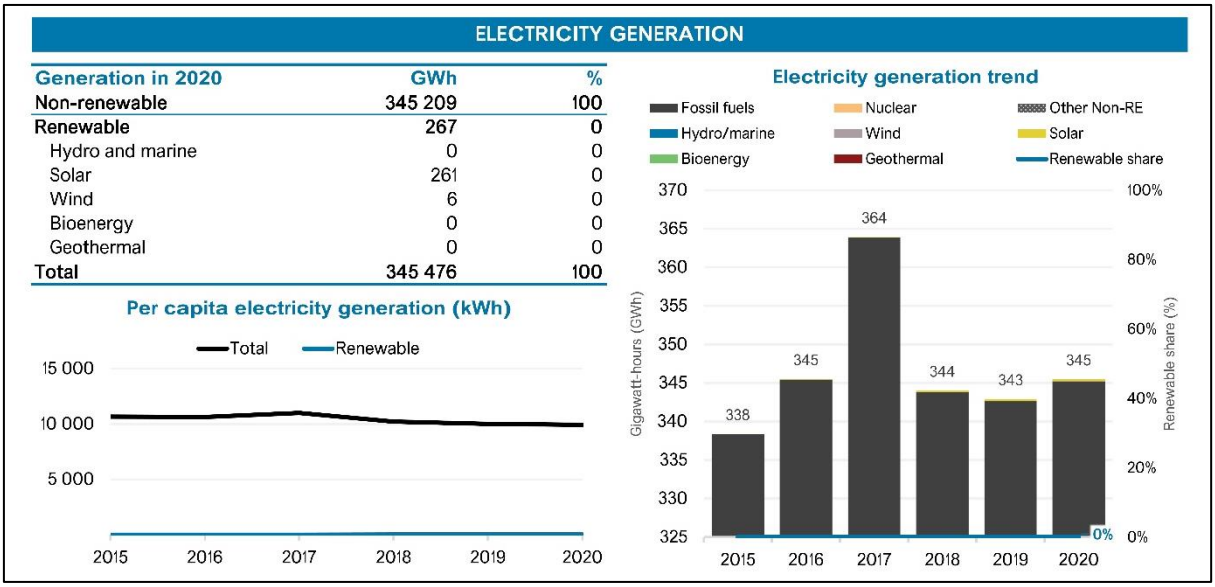
Saudi Arabia and the United Arab Emirates have long been dependent on their oil reserves as a major source of revenue. However, both countries have recognised the need to diversify their economies and reduce their reliance on oil revenues ("Dubai Clean Energy Strategy - The Official Portal of the UAE Government," n.d.). Despite having declared economic diversification as a policy objective since the 1970s, Saudi Arabia's progress toward this goal has been fairly limited. The country is still heavily dependent on oil revenue, which is unlikely to change in the years to come ("Scite: See How Research Has Been Cited," n.d.). On the other hand, the UAE has shown more success in economic diversification than Saudi Arabia. According to Albassam, the UAE has the lowest record in three economic indicators related to oil dependence: the percentage of GDP derived from the oil sector, the percentage of total revenues derived from oil, and the percentage of exports that are made up of oil (Kalaitzi and Chamberlain, n.d.). This indicates a high level of economic diversification in the UAE, among other GCC countries. The efforts towards economic diversification in both countries were partly spurred by the desire to lessen their dependence on fluctuating oil revenues, as well as dwindling oil reserves in some of these countries (Muhammad AL-Talabani *et al*., n.d.). While Saudi Arabia and the UAE have both undertaken a number of measures to diversify their economies, such as developing non-oil industries like tourism and manufacturing, the progress of Saudi Arabia has been quite limited compared to that of the UAE (Fakieh, Alghamdi, and Ragab, n.d.). It is worth noting that while Saudi Arabia, the UAE, and Kuwait have oil reserves that could last for over a century at their current levels of production, other GCC countries like Bahrain and Qatar have limited reserves that could only last for a few more decades. Furthermore, the increasing domestic oil consumption in countries like Saudi Arabia, combined with subsidised prices, could result in a rapid decline in oil exports and revenues (H., M. Esmail, and Cheong 2021). Overall, the diversification efforts in both countries have shown some success. For example, in Saudi Arabia, the non-oil private sector grew by 3.3% in 2020, despite the economic challenges posed by the COVID-19 pandemic. Similarly, the UAE's non-oil sector contributed around 70% to the country's GDP in 2020, according to the UAE Ministry of Economy. However, both countries still face significant challenges in reducing their reliance on oil revenues. In Saudi Arabia, oil exports still account for around 70% of government revenue, and the economy remains heavily dependent on the oil sector. Similarly, while the UAE has diversified its economy significantly, oil exports still play a crucial role in the country's economy, accounting for around 30% of GDP in 2020. These factors make it imperative for both Saudi Arabia and the UAE to continue their efforts towards economic diversification, not just for sustainable revenue streams but also to better align with global sustainability agendas. In conclusion, while the efforts towards economic diversification by Saudi Arabia and the UAE have been ongoing for decades, their success has varied (Kalaitzi and Chamberlain 2020).

Saudi Arabia



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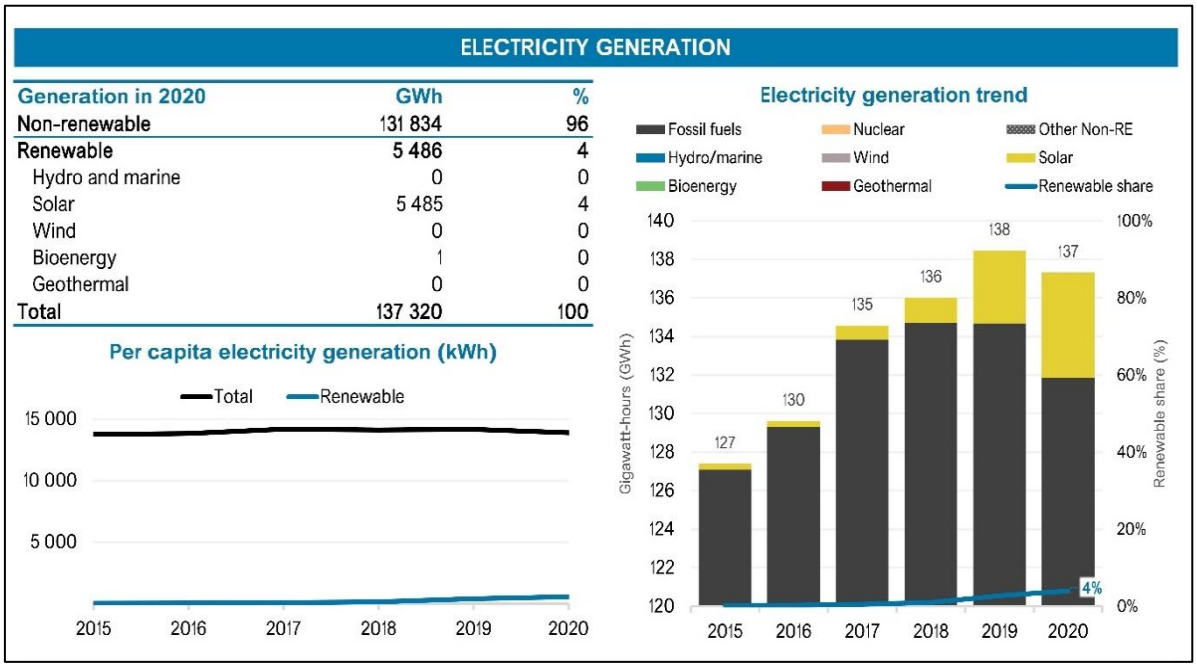
UAE



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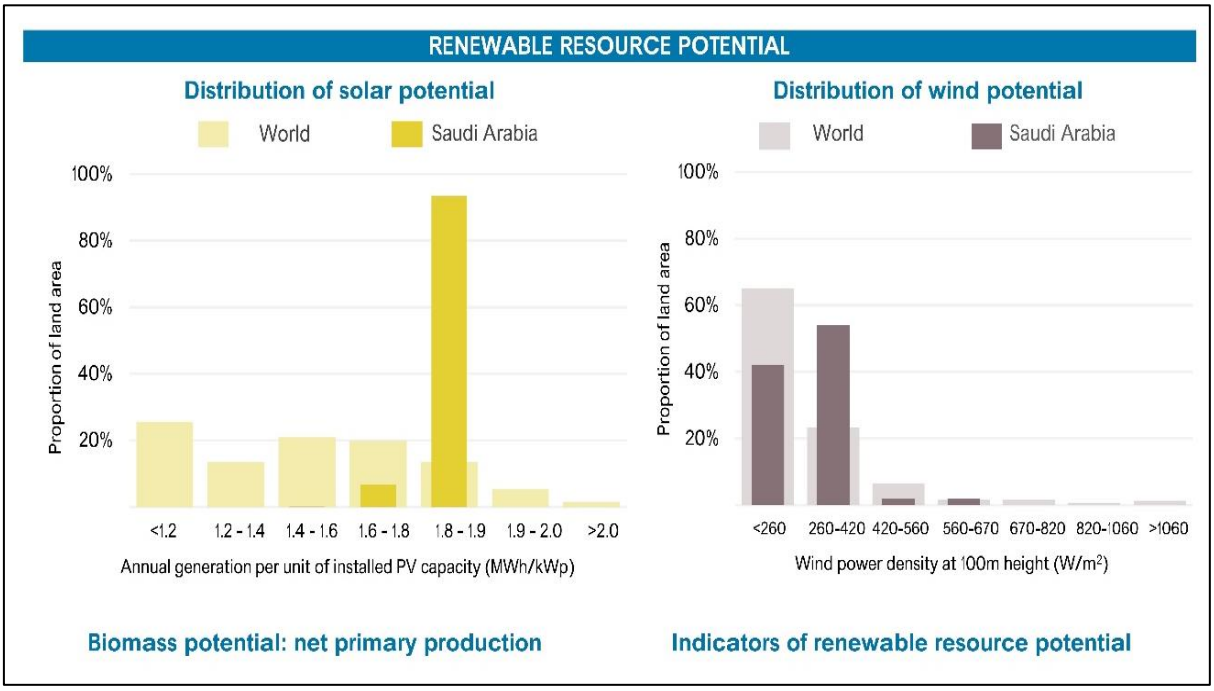
Saudi Arabia and the UAE have both made significant efforts to diversify their economies away from a reliance on oil revenues. In Saudi Arabia, the Vision 2030 plan aims to reduce the country's dependence on oil and diversify its economy by developing new sectors such as tourism, entertainment, and technology. The plan includes initiatives to create new jobs, attract foreign investment, and improve the quality of life for Saudi citizens. In the UAE, the government has implemented a range of policies and initiatives to diversify the economy, including the creation of free zones for foreign investment, investment in infrastructure, and the development of new industries such as renewable energy and advanced manufacturing.

Saudi Arabia



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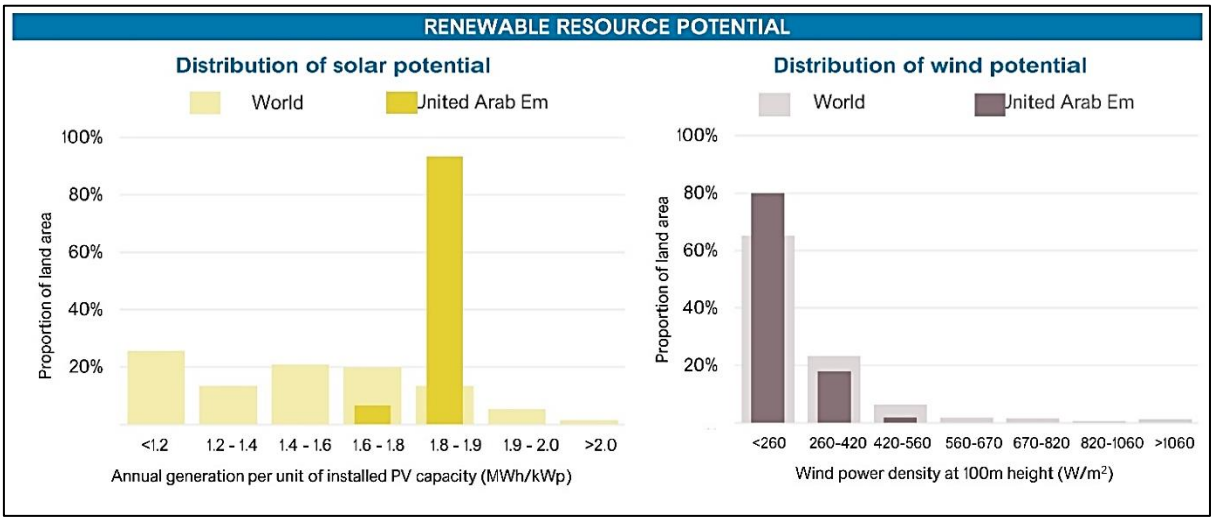
UAE



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Renewable energy technologies and policies have been developing in Saudi Arabia and the United Arab Emirates (UAE) in recent years, with a focus on solar PV technology (Ali 2023). Both countries have made significant progress in the deployment of renewable energy, particularly solar power, and have set ambitious targets for the future (Hani A Aldhubaib 2022). Saudi Arabia aims to meet 50% of its energy demand from renewable sources by 2030 (Elshurafa 2023), while the UAE has set a target of generating 44% of its electricity from renewable sources by 2050 (Bhatt 2021).

Similar to the rest of the world, the development of renewable energy technologies and policies in Saudi Arabia and the UAE is driven by the need to reduce carbon emissions and transition to cleaner sources of energy (Hajimineh and Moghani 2023). Both countries have invested heavily in the renewable energy sector, with low tariff bids for renewable energy generation, making it competitive with conventional energy (Bhatt 2021). However, there are also some differences in the development of renewable energy technologies and policies in Saudi Arabia and the UAE compared to the rest of the world. For example, Saudi Arabia and the UAE are both oil-rich countries, but they have recognised the potential of renewable energy and are investing in it heavily (Dhawi 2018). In addition, the feedback hypothesis based on a two-way relationship between renewable energy consumption and economic growth has been confirmed in Saudi Arabia and the UAE, while there was evidence of the neutrality hypothesis for some other OPEC countries (Maryam Keshavarzian and Tabatabaienasab 2021). Overall, while there are some similarities and differences in the development of renewable energy technologies and policies in Saudi Arabia and the UAE compared to the rest of the world, both countries have made significant progress in the deployment of renewable energy and have set ambitious targets for the future.

Several factors have contributed to the similarities and differences in the development of renewable energy technologies and policies in Saudi Arabia and the UAE compared to the rest of the world. One of the main factors is the availability of natural resources, particularly oil, which has historically been the primary source of energy in these countries. However, both countries have recognised the need to diversify their energy mix and reduce their dependence on fossil fuels, which has led to significant investments in renewable energy. Another factor that has contributed to the development of renewable energy in these countries is government policies and incentives. Both Saudi Arabia and the UAE have implemented policies to support the deployment of renewable energy, such as feed-in tariffs and renewable energy targets. In addition, both countries have established institutions to support the development of renewable energy, such as the Saudi Renewable Energy Project Development Office and the UAE Ministry of Energy and Infrastructure.

The impact of socio-political factors on the adoption of renewable energy is mixed. For instance, urbanisation has been found to have a positive impact on the quick adoption of renewable energy in some economies, while corruption has been found to have a negative impact (Lawal 2023). The impact of renewable energy consumption on economic growth has been studied extensively, and the results are generally positive (Shahbaz *et al.*, 2020). However, the impact of investment in renewable energy on economic growth in Arab countries has been found to be weak (Layachi and Mouhamed 2021). Population growth, industry development, and increasing income levels have also been identified as factors that lead to a greater demand for energy, which is crucial for a country's social welfare and sustainable development (Kim and Jeon 2022).

In conclusion, while there are several factors that have contributed to the similarities and differences

in the development of renewable energy technologies and policies in Saudi Arabia and the UAE compared to the rest of the world, both countries have made significant progress in the deployment of renewable energy. The potential for further growth and expansion of renewable energy in these countries relative to the rest of the world will depend on a variety of factors, including government policies and incentives, the availability of natural resources, and the impact of socio-political factors on the adoption of renewable energy.

7. CONCLUSION

Saudi Arabia and the United Arab Emirates (UAE) have made significant strides in their ambitious plans for renewable energy. While Saudi Arabia and the UAE have made progress, they still face certain obstacles in realizing their ambitious plans. Integrating renewable energy into the existing power grid infrastructure can be challenging. Saudi Arabia reached its goal of getting less than 1% of its electricity from sources other than fossil fuels by November 2021. Under the "Paris Agreement on climate change" Saudi's goal is to cut its GHGe (Greenhouse Gas Emissions) is not good. It is important that Saudi has done nothing, and according to CAT, Saudi's effort is highly insufficient, and the progress made toward the goals which were set by the Paris agreement is also highly inadequate. Saudi's situation is not good because there is no proper implementation of any policy which Saudi Arabia committed, and Saudi needs to make more and more efforts. The CAT rates the United Arab Emirates' climate targets and policies as "Highly insufficient". The "Highly insufficient" rating indicates that the UAE's climate policies and commitments are not consistent with the Paris Agreement's 1.5°C temperature limit, and lead to rising rather than decreasing emissions. CAT rate the UAE's 2030 climate target as "Insufficient" when compared to modelled domestic emissions pathways and "Critically insufficient" when compared with its fair share contribution to climate action.

Overall, the UAE's climate targets and policies are not stringent enough to limit warming to 1.5°C and need substantial improvements. Both countries need to develop adequate grid infrastructure and transmission networks to support the integration of intermittent renewable energy sources. Upgrading and expanding the grid system requires significant investments and planning. Renewable energy technologies, such as solar and wind, require suitable conditions and proper maintenance for optimal performance. Both countries need to address technical challenges, such as dust and sandstorms affecting solar panels or the intermittency of wind power, to ensure reliable and consistent energy generation. Establishing a robust policy and regulatory framework is crucial for the successful deployment of renewable energy projects. Both Saudi Arabia and the UAE have been actively working on implementing supportive policies, such as feed-in tariffs and renewable energy targets. However, continued efforts are required to streamline permitting processes, establish clear regulations, and provide incentives to attract private investments.

Despite the obstacles, Saudi Arabia and the UAE have significant future potential in renewable energy. The Gulf region has abundant solar resources, making it well-suited for large-scale solar projects. Both countries have favorable conditions for solar energy development, and the decreasing costs of solar technologies make them increasingly economically viable. There is significant potential for further expansion of solar power generation capacity in the region. While the Gulf region is known for its high temperatures, it also has potential for wind energy development, especially in coastal areas. The UAE has already made progress in wind energy, and there is potential for Saudi Arabia and other Gulf countries to tap into this renewable resource. Saudi Arabia and the UAE have been actively seeking foreign investments and partnerships to accelerate the deployment of renewable energy projects. They are also focusing on developing local capabilities and expertise in clean energy technologies. Future advancements in technology and increased investments can drive further growth and make the Gulf region a hub for renewable energy innovation. Both countries have recognized the potential of green hydrogen as a clean energy carrier. Saudi Arabia, with its vast renewable energy resources and existing hydrogen infrastructure, aims to become a major exporter of green hydrogen. The UAE is also exploring green hydrogen production and its potential applications. This emerging sector presents new opportunities for economic growth and energy export diversification.

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