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A Search for Effective Renewable Energy Policies for UAE and KSA

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Abstract: The current climate crisis has made it crucial for all the countries in the world to contemplate a shift to Renewable Energy (RE) sources for their energy needs. Even though the United Arab Emirates (UAE) and the Kingdom of Saudi Arabia (KSA) are ahead of most of the countries in the gulf region in terms of RE adoption and RE readiness, their share of RE in their total national energy mix is still very low compared to other countries. The purpose of this study is to examine the policies aimed at promoting renewable energy and transitioning from traditional to renewable energy sources, as well as successful policies implemented by other countries, in order to determine whether the UAE, KSA, and other gulf countries have an opportunity to revise their own RE policies or adopt new proven policies from around the world. This study employs a combination of methods, including a survey of current literature that highlights the most effective policies in terms of economic and environmental benefits and have tried to combine them to create a policy package that can be applied to both of these countries, as well as ASEAN, OPEC, and GCC countries that are geologically and economically similar.

Keywords: UAE, KSA, Renewables, Energy Policy, Sustainability

1. Introduction

The concept of using renewable energy sources to mitigate energy demands is very old. Renewable energies are derived from natural sources that are continually replenished and usage of which does not diminish its reserve. Essentially renewable energy technology uses natural resources such as the sun, wind, rivers, geothermal sources, ocean tide, biomass to produce electricity and heat [1]. Many countries, especially European and Scandinavian countries, have already adopted this technology as their primary source of energy consumption (Our World in Data). This is because renewable energy provides not only an alternative to the commonly utilized and scarce fossil fuels, but also a clean source of energy with almost no negative environmental impact. Nearly three-quarters of global greenhouse gas emission occurs because of the energy sector (Emission by Sector, Our World in Data). For this reason, the Paris Agreement by UNFCCC has included the member countries' adoption of renewable energy technologies as a strategy to meet its goal of keeping the global temperature below 2°C in this century [2]. Despite this agreement many countries are still lagging behind in implementing the agreement's renewable energy adoption policies.

Even though The United Arab Emirates (UAE) and the Kingdom of Saudi Arabia (KSA) are the top oil exporting countries in the world, these two GCC countries are ahead of most of the countries in the region in terms of RE (Renewable Energy) adoption and RE readiness [3]. However, considering the extent of their emission and per capita consumption of energy by the citizens of UAE and KSA, their share of RE in their total national energy mix is still very low and its annual growth is relatively lower than the Scandinavian countries. Policies aimed at promoting renewable energy and transitioning from a traditional energy sector to a robust renewable energy sector are already at

work for both countries.

Most of the studies regarding the RE sector concerns with its current status and challenges of implementing renewable energy policies in the respected countries [1, 4, 5]. However, due to a lack of research available that specifically focus on the renewable energy sector for both UAE and KSA, both countries are performing relatively poorly when it comes to implementing policies that will ensure further adoption of RE technology. The purpose of this study is to examine current policies, as well as successful policies implemented by other countries, in order to determine whether the UAE, KSA, and other gulf countries, as well as OPEC member states, have an opportunity to revise their own RE policies and adopt proven policies from around the world. Additionally, we seek to analyse the policies advocated by scholars in this field and incorporate those that we believe will be most useful to the targeted countries in the final package.

2. Methodology

This study employs a combination of methods, including a survey of current literature on the subject and an analysis of descriptive statistics on the Renewable Energy (RE) sector in both the United Arab Emirates and the Kingdom of Saudi Arabia. There are numerous studies of existing RE (Renewable Energy) policies for various countries in the world. However, we have yet to come across a thorough study that recommends regulations applied to both the UAE and Saudi Arabia. We looked at significant RE-based literatures from the last few decades, especially those that focused on policy challenges in the energy sector. We have chosen the most effective policies in terms of economic and environmental benefits after reviewing the relevant studies and combining them to create a policy package that can be applied to both of these countries, as well as ASEAN, OPEC, and GCC countries that are geologically and economically similar to our target countries. All of the references for the studies discussed in this paper will be found in the reference section. We also used descriptive statistical method to visualize current renewable energy trends and status in the UAE and Saudi Arabia. This strategy is utilized only as a supplement to our primary literature review study. This study's forecasting and trend data are derived from secondary sources. We utilized only simple statistical methods to graphically depict the data. This study does not perform any formal statistical analysis, and we do not admit to employing any model in our research. Anyone can obtain the data used in the descriptive statistics via the World Development Index (WDI) and Our World in Data databases.

3. Literature Review

3.1. Background

Renewable energy is considered clean because it is a pollution-free energy source. This carbon-free technology has emerged as a feasible alternative to today's petrochemical energy sources in the fight against climate change. Implementation of renewable energy is also one of the UN's 17 Sustainable Development Goals, which were created in 2015 [6]. According to the Renewable Energy Network, China, which accounted for 32% of renewable energy funding in 2016, is driving much of the investment in renewable energy [7].

Because of the role of gas, renewables, and advanced technologies, coal use has been significantly reduced in the OECD and more developed countries [8]. However, since coal is ASEAN, OECD, OPEC, China, and most of developing countries' most abundant and stable energy resource, it will continue to be the second-largest energy source for power generation after gas for the near future, in order to meet fast-growing electricity demand [9]. As GCC, OPEC and other developing countries around the world embark on an energy transition, it is critical that no one is left behind [10, 11]. This research exhibits that most of the OPEC countries are already ahead of United Arab Emirates and Saudi Arab in recent time (see table 1).

Renewable technology is expected to play a significant part in "decarbonizing" energy, which is a key aspect of climate change mitigation [12]. Renewable energy sources account for 19.3% of worldwide energy production and play a critical role in lowering carbon emissions. According to studies, using renewable energy will help reduce carbon emissions by 8.2 percent by 2050 [8, 13].

Implementing renewable energy technology provides significant economic benefits as well. Renewables have the potential to reduce reliance on imported fuel and address energy access issues for the world's 1.4 billion "energy poor" population [14, 15].

In a study done by Afzal et al. [16] where they examined the roles of ICT and economic growth and their impact on electricity consumption in the BRICS countries over the period of 1990–2014, they have found that economic growth and growth in the ICT (Information and Communication Technology) sector has statistically significant and positive effect on the electricity consumption on all BRICS countries. With the usage of increasing number of smart phones and ICT related technologies every year, the authors have found that it will drive the demand for electricity further into the future as countries become economically more developed. This is true for emerging economies as well where the growth of the ICT sector, the upcoming emerging economies (N-11) shows an increasing demand of electricity [17]. Therefore, accurate renewable energy power prediction becomes important, and numerous studies have been conducted to match future energy usage, especially in the electricity demand. Thus, forecasting models have become increasingly common in renewable-energy prediction [18–20]. This would direct the policymakers in assessing the current gap and show them what must be done to fulfil the future demand of electricity.

3.2. RE in UAE

According to Said et al. [21], the per capita carbon footprint of UAE is the largest in the world. This is due to its high

utilization of non-renewable energy to generate electricity required for desalination and air conditioning. Unsurprisingly, the energy sector of UAE contributes more than 90% to its total GHG (Green House Gas) emission. The whole sector is divided into four sub-sectors that almost entirely relies on fossil fuels. These sectors include: i) cement, iron, steel, aluminium, and other heavy industries; ii) electricity generation; iii) road transportation and civil aviation; and vi) the fossil fuel exploration industry [22]. Natural gas and crude oil are the primary energy source for electricity production in UAE. More than 99% of total electricity was generated by natural gas in 2010 [21]. In UAE, CO_2 emission from electricity generation and heat production was 63.0 Mt in 2013. In 2018, it increased to 71.0 Mt (A; IEA, Data and Statistics) Only in half a decade, emission rose to 11.27%. This will get worse if alternative sources of energy are not considered. Given the high fertility rate in the UAE, it has one of the fastest growing populations in the world [23].

With the growth of its population, the government will need to expand its production capacity to meet the access demand for electricity. Electricity consumption in the UAE in 2018 was 127.5 TWh (B; IEA, Data and Statistics). According to Khondaker et al. [22], in the absence of RE technology adoption, electricity generation would be 146 billion kWh in 2020 which was only 97.9 billion kWh in 2011. The reason for such high consumption rates can be attributed to the government's well-known tendency to heavily subsidize the electricity production industry. This has led to higher demand and inefficient use of energy. With the fastest rate of oil extraction, it has become an urgent issue for the country to make a faster switch to RE sources in order to cater to their rising energy demands in a sustainable way [24].

However, the government of UAE has recognized this problem and has recently adopted strategies to transform its energy sector from a traditional fossil fuel-based sector to renewable energy industry [25]. Some of the most ambitious and large-scale renewable energy projects are currently under development in the country's fastest growing emirates (Dubai and Abu Dhabi). Given below is a table containing all the upcoming RE project pipelines in UAE.

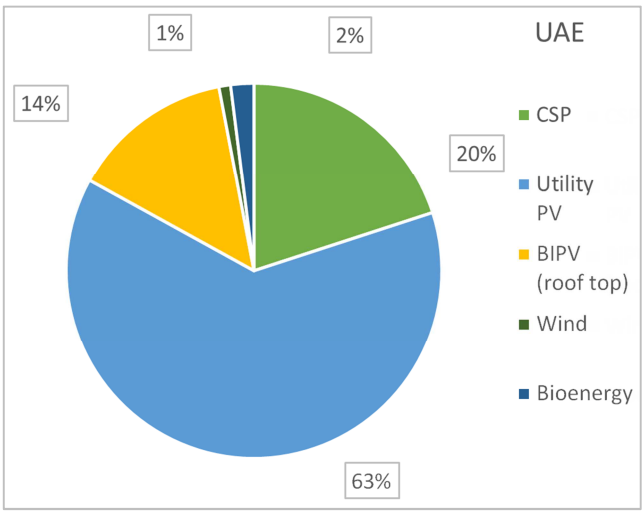
Table 1. *Upcoming RE project pipeline of UAE* [24].

Country	Project/Site	Technology	Capacity (MW)
UAE (Dubai)	Mohammed bin Rashid Al Maktoum Solar Park, Phase IV	CSP, Solar PV	950
	Mohammed bin Rashid Al Maktoum Solar Park, Phase III	Solar PV	800
	Mohammed bin Rashid Al Maktoum Solar Park, Phase II	Solar PV	200
	Mohammed bin Rashid Al Maktoum Solar Park, Phase I	Solar PV	13
UAE (Abu Dhabi)	Noor Abu Dhabi, Sweihan	Solar PV	1177
	Shams 1	CSP	100

One of the most successful RE projects in UAE is the construction of Masdar city, a carbon-neutral, zero-waste city built in Abu Dhabi. The construction of the project started in 2006 and was scheduled to end in 2016. The objective of the city is to become a modern city based on RET where 40,000 residents and 50,000 daily commuters are expected to reside [26]. Both government and private investments are the main driving force behind a project of this size in a country which has very little experience in establishing carbon-neutral villages. The model for Masdar City is unique for its kind. The city consists of a flagship RE generation plant "Masdar PV" created in April 2008. Investments of $600 million were planned to fund this gigantic plant. Annual capacity from this plant was estimated at 210 MW. The creation and development of a carbon-neutral city in Abu Dhabi is a role model for other nations in the region. Following the footprint of Abu Dhabi, regional diffusion of project like this has already occurred such as the sustainable campus of King Abdullah University of Science and Technology in Saudi Arabia, as well as recent policy initiatives in Dubai.

These large-scale energy projects increase the RE capacity in the national grid and the overall energy capacity. The projected RE capacity of UAE as an outcome of these projects for the year 2030 can break down into different RE sources. Given below is a chart showing the projected RE capacity according to the RE sources:

If UAE continues to rely completely on natural gas and oil to produce electricity, it runs the risk of exhausting its current reserve of fossil fuel. As these energy sources are non-renewable and, vulnerable to depletion, the economy of UAE will incur economic opportunity costs in the form of a loss in net oil export revenue.



Source: Praveen et al., 2020

Figure 1. *Projected RE capacities (MW) of UAE in 2030* [24].

3.3. RE in KSA

In Saudi Arabia, traditional and renewable energy sources are not equal. In truth, Saudi Arabia's use of renewable

energy sources is considerably lower than that of the rest of the world's top energy consumers. Despite the fact that the Kingdom has a greater opportunity to use non-renewable energy sources due to its vast desert land that receives constant sun exposure, its unwillingness to use renewable energy sources such as solar and wind has rendered the Kingdom's energy sector completely reliant on fossil fuels [4]. As a result, the country's fuel mix is undiversified, making it less energy secure. Furthermore, a less diverse energy mix increases future uncertainty, jeopardizing Saudi Arabia's Vision 2030 aim, which promises a more sustainable future in exchange for international investment in the country's economy. The current imbalance between the use of fossil fuels and renewable energy sources for power generation does not send the intended message, about which the Kingdom appears to be adamant. The discrepancy is clearly shown in the diagram below:

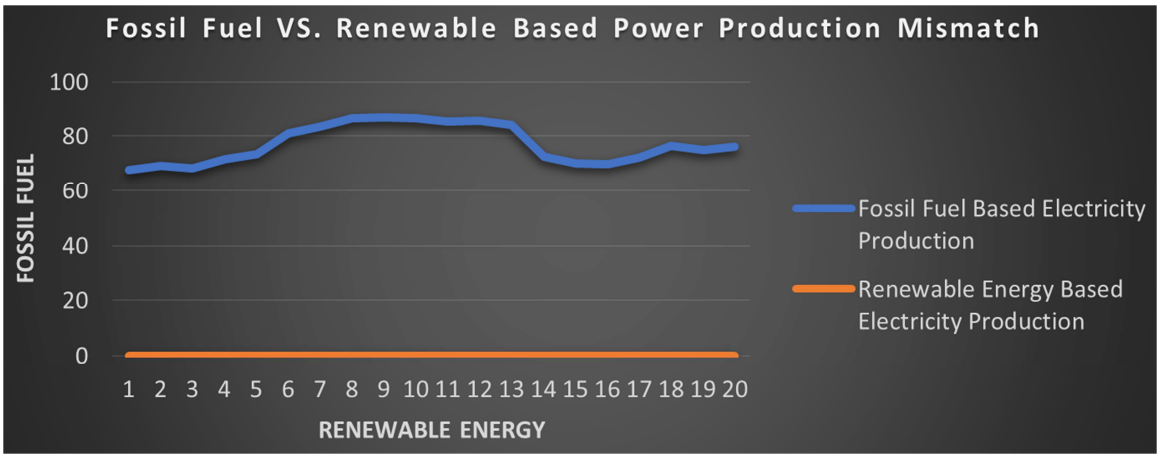


Figure 2. *Fossil Fuel VS. Renewable Based Power Production Mismatch (WDI, Our World in Data).*

According to WDI (Our World in Data), renewable energy generation (excluding hydropower) accounted for just 0.000368 percent of total electricity output in Saudi Arabia in 2012. Solar energy accounted for 0.144 percent of total electricity in the national grid in 2019 (WDI). In 2019, the solar energy input to the grid changed by about 3 TWh from year to year. As a result, the proportion of renewable energy-based power production is increasing. Other low-carbon energy sources, such as nuclear and wind power, are non-existent in the Kingdom. However, oil and gas account for the majority of the change in primary energy consumption by source, indicating that fossil fuels continue to dominate power production.

The disparity between total power use and renewable energy generation, shows that there is a lot of room for improvement. One of the most successful methods to future-proof a country's energy sector, and hence its economy, is to diversify its energy mix. There are few major RE projects that are currently under development. These projects are primarily aimed at increasing the diversity of Saudi Arabia's current energy mix. Below is a table showing two of the largest upcoming RE project pipelines of KSA.

Table 2. *Upcoming RE project pipeline of KSA* [24].

Country	Project/Site	Technology	Capacity (MW)
Saudi Arabia (KSA)	Sakaka	Solar PV	300
	Dumat Al Jandal	Wind	400

The projected capacities resulting from these future projects are given below according to the RE sources. This is a projection of RE capacity projection for the year 2030 for KSA.

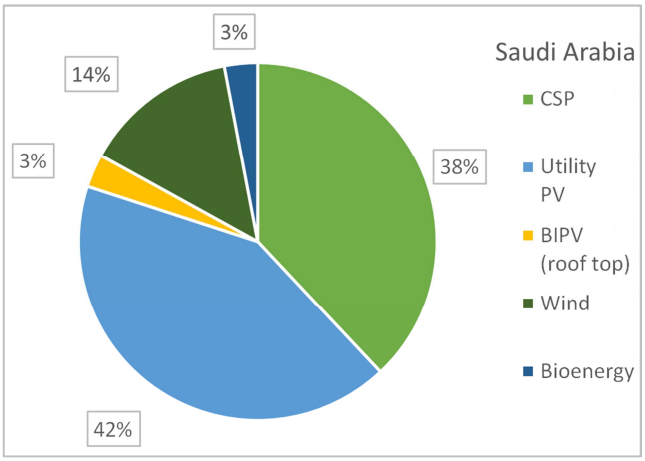


Figure 3. *Projected RE capacities (MW) of KSA in 2030* [24].

Saudi Arabia's current energy transition speed is laudable, but it is still quite sluggish [6]. and hinder its progress toward its Vision 2030 goals.

Khan et al. [27] focused on Saudi Arabia's energy security problems and dangers. Semi-structured interviews were used to collect data in order to address the study questions. The Kingdom is already showing indications of energy instability, with electricity shortages and distribution issues. From the medium to long term, the country may face rising energy insecurity on the physical, political, and economic levels. Saudi Arabia's energy security challenges could be alleviated by renewable energy. Abdmouleh et al. [28] gave an updated and thorough analysis of the renewable energy situation in the GCC nations, including an evaluation of the region's RE

potential, existing installed RE capacity and project pipeline, institutional and market frameworks. This research examines the region's key gaps in terms of RE deployment, including financial, economic, political, legislative, technological, and environmental considerations. Ramli & Twaha [29] analysed renewable energy feed-in tariffs (REFIT) for chosen locations throughout the world with the goal of extracting lessons for Saudi Arabia in their study. The application of the FIT scheme in Saudi Arabia is likely to accelerate the development of renewable energy resources in the region, as it has been observed that many countries have benefited from the application of the FIT, with a tremendous increase in renewable energy resource development as investors are attracted by improved investment security. The main goals of Azzuni et al. [30] were to propose an energy transition pathway in Jordan that would lead to a 100 percent renewable energy system by 2050 and to examine how energy security would be improved. Due to increased energy system efficiency, the results suggest that energy demand will rise in absolute terms, but at a lower rate than in a business-as-usual scenario.

Ratikainen [31] aims to investigate and analyse empirical data on Saudi renewable energy policies, using the Multi-Level Perspective (MLP) as a tool to guide the structure of the analysis and the selection of analytical dimensions, as well as to conceptualize the discussion of barriers. Saudi Arabia faces significant hurdles to the spread of renewable energy, but recent government initiatives suggest a growing willingness to overcome them.

3.4. RE Policies Around the World

According to H. Lund [32], there are three major technological changes that facilitate sustainable energy development. These are: energy savings on the demand side, efficiency improvements in the energy production, and replacement of fossil fuel by various sources of renewable energy. The author discussed the strategies, mainly enacting large-scale renewable energy implementation plans to convert Denmark's energy sector to 100% renewable energy system. His analysis suggests following three technological improvements:

1. Replacement of oil as fuel for transportation industry and incorporate electric vehicles (EV) as a solution to the emission problem.
2. Inclusion of small-scale Combined Heat and Power (CHP) plants and adding heat pumps to the system to increase the efficiency of the system. This will allow for the possible change of the heat and electricity demand ratio and maintain the high fuel efficiency of CHP plants.
3. Add electrolysers and further include wind turbines to increase the capacity of electricity supply.

According to the author, by implementing these three technological changes, Denmark will be able to convert its energy system into a 100% RE system. By combining 180 TJ/yr. of biomass with 500 MW PV and between 15 to 27 GW of wind power (depending on the savings and efficiency improvements), Denmark will be able to meet its total energy demand.

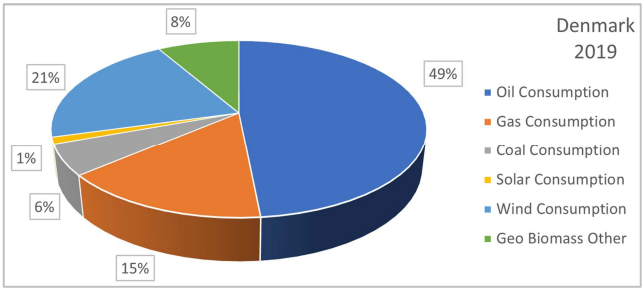


Figure 4. *Denmark's primary energy consumption by sources in 2019 (Our World in Data).*

In general, Northern European countries (Scandinavian countries) have a higher rate of renewable energy consumption than any other region in the world. The Scandinavian countries have invested a lot of effort into developing alternative energy and have tried to keep the use of hydrocarbons in their economy as low as possible, which explains the high share of RE in their energy mix [33]. Even though the Scandinavian region is enriched with fossil fuel deposits, they have managed to transform most of their energy sector to RE sources.

The renewable energy sector in China is being developed at an accelerating rate. Some of the largest solar farms in the world are currently operational in China. The renewable energy law in China was enacted in 2005 and updated in 2009. This modification of China's renewable energy law was critical in the country's shift from traditional to renewable energy sources [34].

After the revision of the renewable energy law in China, there has been an accelerating spike in the share of its primary energy from low-carbon sources. Almost 15% of its entire share of primary energy came from renewable sources in 2019, and it has been increasing every year.

This was possible by implementing strategies and policies that promote renewable energy usage both in the local and national regions. Some of the most successful policies from China can be summarised into the following points [34].

1. The Chinese central government views the development and utilization of renewable energy as a preferential energy development, as evidenced by regulations like China's renewable energy law. It also aids in the formation and marketing of the renewable energy industry. The Chinese government encourages the development and use of renewable energy at all levels and safeguards economic entities' ownership as well as investors' rights and interests.
2. The development planning and resource survey is done by the national energy department. They set long-term targets based on energy demand and the level of the country's renewable energy resources, and then present the plan to the state council for approval. This helps the state to understand the demand and condition of RE resources and helps them formulate further plans and policies to utilize and develop renewable energy technologies into the national grid.
3. The state council's standardization department provides

industrial guidance and technological support for RET. The national science and technology industries place a high premium on research and industrialization of renewable energy technologies. They provide capital support during the development phase of RET progress, lowering production costs and improving final product quality.

4. The state at all levels encourages and supports renewable energy generation and its utilization by the mass. They provide the national grid services to the isolated RE generation plants which further improve the application of RE sources in the national grid.
5. The price of the RE and electricity generated from RE sources is decided by the country's department of prices based on the different characteristics of the RE generation system and areas. The electric power enterprise in China purchases full power of renewable energy generating system based on the price regulations of the state council. Special funds are set up to finance the development of various RE projects. Some renewable energy projects have been advertised as science and technology research and engineering demonstration projects to encourage the R&D sector to continue their research without fear of running out of money. According to credit rules, financial institutions can grant preferential Finance Discount loans for the development and utilization of renewable energy projects that have been identified in the national renewable energy industry development guiding catalogue. Renewable energy industry development projects that are mentioned in the guidance catalogue are eligible for tax exemption.
6. Local governments are legally obligated to follow the state's regulations encouraging the growth of renewable energy. According to the law, local electric power firms must obtain all of the electricity generated from the renewable sources at a fixed price set by the state. For violating the RE rules, China's central government has created sanctions for the accountable executives and institutions. These laws protect the RE projects from local discriminations and helps them develop on a level playing field where they are not particularly at a disadvantage from the traditional energy sectors.

These policies in China have been very beneficial for the development, popularization, and utilization of the RE technologies. If we investigate the progression of China's share of primary energy from low-carbon sources, we can see that for the last 20 years it has gone up by a considerable margin and is still increasing every year. New projects are being planned and promoted to the development phase every year, the fact which makes the future of RE in China more promising than what we have observed in UAE and KSA.

However, being the fastest growing economy in the world China has a long way to completely become carbon neutral, especially for its energy sector. Heavy industries in China demand more energy as it becomes net exporter in the global market. Even though China has some of the largest RE plants in the world, its share of primary energy consumption from renewable sources is still very low compared to its consumption of fossil fuel. Only 14% of primary energy comes from low-carbon sources of which mere 12% comes from renewable sources such as solar, wind, biomass, and hydroelectricity.

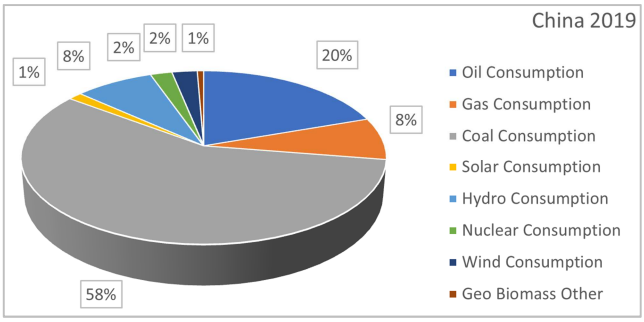


Figure 5. *China's primary energy consumption by sources in 2019 (Our World in Data).*

In their study, Abdmouleh et al. [35] have reviewed some of the most successful policies implemented by various Asian countries and countries in the EU region. In their analysis, they have found that there is no one perfect scheme or strategy for RE development that is applicable for every nation in general. They have pointed out some factors on which the choice of strategies depends. These factors are:

1. The current market stage of the technologies of interest,
2. The budget available or the means of finance to support RE projects,
3. The anticipated RE targets in the respective region, and
4. The feasibility of the technology mix, with regard to the environmental conditions in the respective country.

For supporting RE development financially, by legislative and fiscal actions, the authors included the following desired actions as policy recommendations in their study:

1. Financial actions
   a. Subsidies and grants
   b. Loans
2. Legislative actions (see also [25, 36])
   a. FIT (Feed-In-Tariff)
   b. RPS (Renewable Portfolio Standard)
   c. Competitive bidding
3. Fiscal actions

These policies and actions implemented by various governments have been successful in RE penetration in the respective countries' energy mix and therefore, can be used as guidelines for the policymakers of both UAE and KSA. The research "Recommendations on renewable energy strategies for the GCC countries" by Abdmouleh et al. [28] is particularly useful for the Gulf countries.

4. Existing Barriers in UAE and KSA

Transition from non-renewable to renewable sources of energy is a gigantic task for any nation, especially for the Middle Eastern oil exporting countries like United Arab Emirates and Kingdom of Saudi Arabia. There are many barriers that need to

be overcome to successfully implement RE technology in these countries. According to Khondaker et al. [22], currently the UAE is torn between maintaining subsidies in its traditional energy sector and sustaining fuel exports in the long run. Not to mention the fact that the initial high cost of RE projects creates reluctance among the policymakers to adopt any long-term policies. From a consumer's point of view, it is not economically advantageous to adopt renewable electricity which is already at a disadvantage against the heavily subsidized fossil-fuel generated electricity. Moreover, the UAE having seven emirates has its unique geological and economical properties. Abu Dhabi and Dubai are the two major emirates where Abu Dhabi is at the forefront of renewable energy adoption process [37]. As Abu Dhabi controls 90% of all the oil and gas reserve of UAE [38], it makes sense from the policy making perspective that adoption of RE technologies in Abu Dhabi will have greater impact to the whole energy sector. However, according to Mezher et al. [39], the main constraints for RE development in Abu Dhabi can be summarized in three categories: i) Market technologies, ii) Policy legislation, iii) Cost. Commercial skills and information about renewable energy are lacking in Abu Dhabi, the issue which makes it very difficult to promote it at a national level. No restrictions on production and construction of fuel-based industry makes it difficult to persuade businesses to adopt renewable energy technologies. Because of initial capita cost and lack of subsidy, the cost of RE industry is substantially higher than the traditional energy industry.

Table 3. *OPEC Country Performance Renewable Energy Capacity & Generation (The GlobalEconomy.com).*

Country	Year	Renewable power capacity million kilowatts	Renewable power generation billion kilowatthours
Venezuela	2019	15.48	57.65
Algeria	2019	0.73	0.73
Angola	2019	3.5	8.86
Equatorial Guinea	2019	0.13	0.58
Gabon	2019	0.33	0.98
Iran	2019	11.81	30.74
Iraq	2019	2.73	2.51
Kuwait	2019	0.11	0.16
Nigeria	2019	2.14	6.45
United Arab Emirates	2019	1.88	1.31
Saudi Arabia	2019	0.41	0.16

If we investigate the OPEC member countries' performance in RE development, both UAE and KSA are doing much worse than other member nations.

If we compare the electric power consumption of UAE and KSA with other developing and developed countries, we can see that their electricity consumption is almost at the level of highly developed countries like USA and Australia. However, if we compare their share of electricity production from renewable sources with the same countries, we see the opposite pattern. Both UAE and KSA are behind other developed and developing nations when it comes to electricity production from renewable sources. Given below are Figures 6, 7 and 8 depicting this comparison.

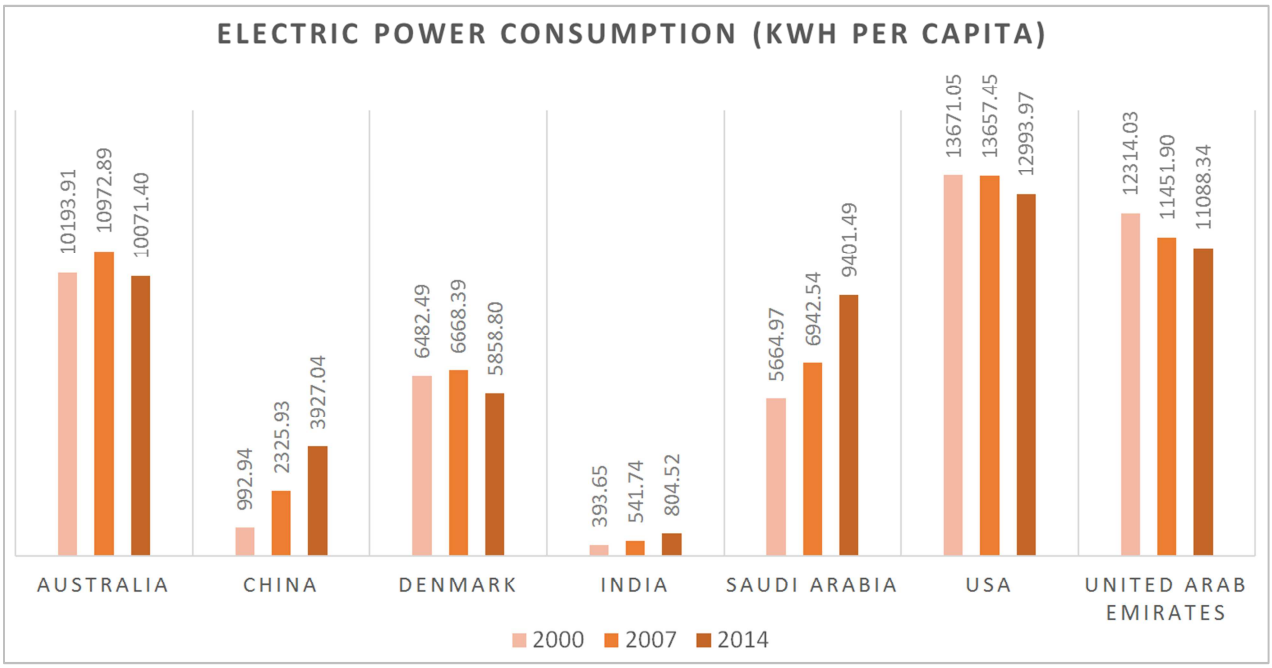


Figure 6. *Comparison of per capita electric power consumption among various countries at various time intervals (World Development Index (WDI)).*

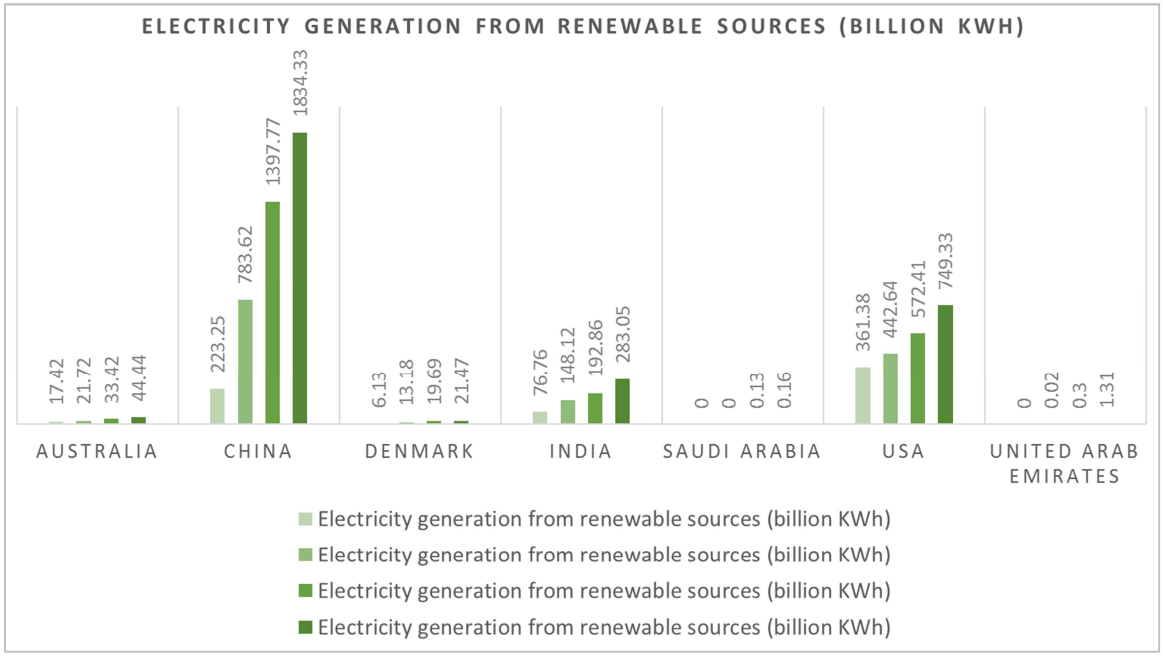


Figure 7. *Comparison of electricity generation from renewable sources at various time intervals among various countries (World Development Index (WDI)).*

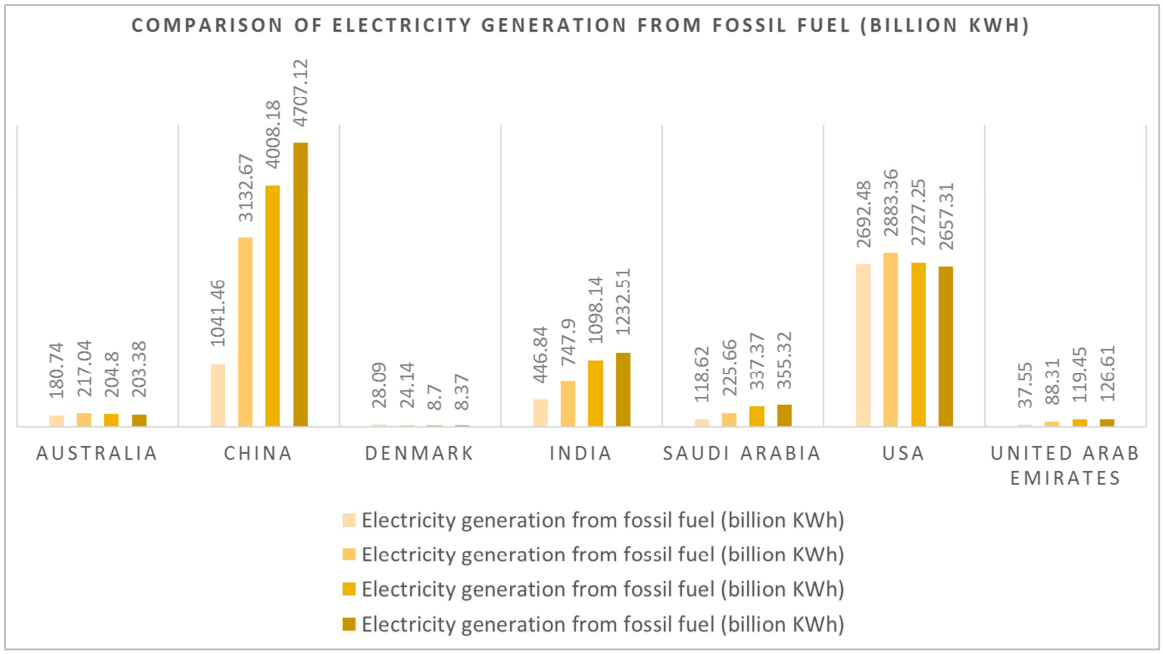


Figure 8. *Comparison of electricity generation from fossil fuel at various time intervals among various countries (World Development Index (WDI)).*

Consumption of renewable energy is also lower in the gulf countries. This proves that people in this region are more dependent on fossil fuel than other developed countries. Even heavily industrial countries like China and USA consume more renewable energy than UAE and KSA. Surprisingly, India, which is a developing country and where the citizens have much less per capita income and very few public infrastructures than other countries, has the highest percentage of renewable energy consumption of its total energy consumption.

Table 4. *Comparison of the share of renewable energy consumption of total final energy consumption among various countries at various time intervals (World Development Index (WDI)).*

Indicator	Year	Australia	China	Denmark	India	Saudi Arabia	USA	United Arab Emirates
Renewable energy consumption (% of total final energy consumption)	2000	8.42	29.60	10.72	51.55	0.01	5.43	0.08
	2007	6.95	14.88	17.68	44.90	0.01	6.30	0.11
	2014	9.32	12.06	30.23	36.05	0.01	9.22	0.14

This comparison indicates that the development of the renewable energy sector does not depend only on the financial or the technological limitations. Policies and public perception of renewable energy have a greater impact on the propagation of renewable energy usage. However, public perception of renewable energy is not the same for every nation or culture. West et al. [40] took the cultural theory approach to understand the public perception of renewable energy in their study. They have found that egalitarian and individualistic discourses were more opposed on the need of RE and to the method of expanding capacity. They have reasoned that sub-divisions in public attitudes, regardless of whether it is because of cultural theory ideal types or other attitudinal classification systems, pose major challenges for policymakers to encourage the development and utilization of renewable energy sources. Policymakers will face significant resistance if they choose to implement policies without acknowledging the divide among people's preference when it comes to adoption of renewable energy technologies. This is why mandatory policies for adopting renewables have been unsuccessful in the past. People show negative emotions for alternative energy usage when the government tries to mandate RE policies on its citizens to encourage more renewable consumption [41]. Tailoring the RE policies or tuning some elements of it to make them acceptable among the population can yield a greater gain than just going with the monolithic approach favoured by policymakers in the past.

To conclude a number of barriers, remain that can be summarized as follows:

1. Lack of an energy policy and mechanism to implement policies effectively.
2. Lack of policies specifically aimed at mitigating climate change.
3. Lack of investment in renewable energy, especially from private sectors.
4. Over-dependence on fossil-fuel reserves for economic and energy needs.
5. Subsidized traditional fuel-based electricity generation industries.
6. Lack of RET (Renewable Energy Technology) supply chain.
7. Lack of technical and commercial skills in renewable energy.
8. No direct taxation policies that can be used to incentivize the use of RE.
9. Lack of awareness of RETs and its benefits among the general population.

5. PEST Analysis of RE Sector in UAE and KSA

PEST analysis is done to assess the major influential factors that can affect a sector or an organization and understand how these major factors will change in the long run. The main focus areas of PEST analysis are political, economic, social, and technological aspect of a certain sector. If we want to have an in-depth understanding of the renewable energy sector in UAE and KSA, a PEST analysis of the sector will be very helpful both for the policymakers and researchers to garner more knowledge and understand the true barriers to make the transition from fossil fuel to renewable energy sources. Given below is a table containing the key factors that influence transition to renewable energy sources according to our findings from this research presented accordingly to the PEST analysis:

Table 5. *PEST analysis of the RE sector in UAE and KSA based on the literature.*

P (Political)	E (Economic)	S (Social)	T (Technological)
1. Heavily subsidized fossil fuel-based electricity generation industry acts as a barrier against adopting renewable energy sources for electricity production. 2. Climate change mitigating policies can be very helpful to reduce over-usage of fossil fuel. 3. There are no direct taxation policies that can work as incentives to shift to renewable energy sources for energy needs.	1. More investment in the renewable energy sector has been beneficial for other countries, especially investment from the private sectors. 2. Dependency on the fossil fuel reserves has made it almost impossible for the industries to switch to renewable sources. 3. The economy of these countries is almost completely dependent on the oil exports which create disincentive to shift toward renewable energy sources. 4. Subsidized energy price does not reflect the real cost of using non-renewable resources.	1. Lack of RET awareness among the mass population. 2. People's reluctance to embrace renewable energy because of the widespread perception of abundant fossil fuel reserves. 3. Fossil fuel has become part of cultural identity for these two nations. As a result, moving away from the traditional energy sector is difficult both for the producers and consumers.	1. There is a lack of RET supply chain in the region due to low demand. 2. Renewable energy is not technically and commercially successful in these countries due to a lack of proper marketing strategy. 3. Most of the renewable energy technologies are not native to the region. Importation of these technologies makes it very costly and time consuming to use them extensively in new projects.

The PEST analysis summarizes the key findings of this study. This will help other researchers and policymakers to get the essence of the true nature of renewable energy sector in UAE and KSA.

6. Conclusion and Way out

The aim of this study is to review the successful RE policies implemented by various countries and find out if there is any opportunity for UAE and KSA and other countries in the gulf region and the member states of OPEC to revise their own RE policies or adopt new proven policies around the world. After reviewing academic literatures focusing on RE policies of various countries, this study has found that there are a lot of new strategies that could be implemented in the gulf region. Upon review of the existing

policies and barriers in UAE and KSA, it is worth observing gaps in the current initiatives to promote the development of RE. Policymakers can mitigate this situation by adopting or revising some policies or actions as a way out of the existing barriers for RE transition. These policies or actions can be summarized for both countries as follows:

1. Take lessons from reform experiences of other countries that policymakers can incorporate into their own policy packages and improve their existing strategies. [41].
2. Legislative actions such as Feed-In-Tariff, RPS (Renewable Portfolio Standard), and competitive bidding have shown promising results in keeping the cost of energy production low, and at the same time, protecting the RE industry from the traditional fuel-based sector. Renewable portfolio standard (RPS) policies are designed to increase the contribution of RES (Renewable Energy Sources) to the energy mix. These legislative policies will be able to help the RE industry become more competitive and give them a level playing field with the conventional energy industries. [25, 28, 29, 35, 36].
3. Deregulation of the energy sector at the country level for mid-term plans and at the GCC level for long term plans. [25].
4. Cut back subsidies from the fossil-fuel industries to make the use of RES more economically beneficial from both the producers and the consumers point of view. [22, 23, 25, 28, 35].
5. A structured tax policy with strict enforcement mechanism is required as fiscal actions to develop RE (Renewable Energy) in UAE and KSA. The administrative body will be responsible for creation and implementation of appropriate tax incentives for the investors and producers of RE industries. [28].

Transitioning from non-renewable to renewable sources is not an easy feat. The policymakers are responsible for making this transition as smooth as possible while being cost efficient. However, over the years, studies and research conducted by numerous scientists and researchers have provided a clear guideline for policymakers around the world to follow. At the end it will all boil down to the intentions and conscience of the policymakers to make the right decisions for betterment of the world we abide in.

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