KADİR HAS UNIVERSITY
SCHOOL OF GRADUATE STUDIES
PROGRAM OF ENERGY AND SUSTAINABLE DEVELOPMENT

THE RENEWABLE ENERGY TRANSITION IN THE UNITED ARAB EMIRATES

EMAN BASSAM ABUSAADA

SUPERVISOR: PROF. DR. VOLKAN Ş. EDİGER

MASTER'S THESIS

ISTANBUL, JANUARY, 2020

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Submitted to the School of Graduate Studies of Kadir Has University in partial fulfillment of the requirements for the degree of Master's/PhD in the Program of Energy and sustainable development

ISTANBUL, JANUARY, 2020

I, EMAN BASSAM ABUSAADA;
Hereby declare that this master's thesis is my own original work and that due references have been appropriately provided on all supporting literature and resources.

Furthermore, both printed and electronic copies of my work will be kept in Kadir Has Information Center under the following condition as indicated below:
The full content of my thesis will be accessible only within the campus of Kadir Has University.

EMAN BASSAM ABUSAADA

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08/01/2020 ISTANBUL

ACCEPTANCE AND APPROVAL

This work entitled **THE RENEWABLE ENERGY TRANSITION IN THE UNITED ARAB EMIRATES** prepared by **EMAN BASSAM ABUSAADA** has been judged to be successful at the defense exam held on **08/01/2020** and accepted by our jury as **MASTER'S THESIS**.

APPROVED BY:

Prof. Dr. Volkan Ş. Ediger (Advisor) Kadir Has University

Assoc. Prof. Dr. Gökhan Kirkil Kadir Has University

Asst. Prof. Dr. İstemi Berk Dokuz Eylül University

I certify that the above signatures belong to the faculty members named above.

Dean of School of Graduate Studies
Prof. Dr. Sinem Akgül Açıkmeşe
DATE OF APPROVAL

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ABSTRACT

Energy regimes have shifted from one source to another throughout history. The world is currently in the midst of a transitional period from a fossil fuel-dominated regime to a more sustainable one. Past experiences reveal that energy transitions are difficult and require considerable effort. The present-day transition will be even more difficult for the oil and gas-exporting countries of Gulf Cooperation Council (GCC) because most of their budget revenues come from hydrocarbon-export income, their domestic consumption is increasing rapidly, and their resources are continuously depleting. The United Arab Emirates (UAE) has been the most successful country in the GCC to transition its energy regime, alongside Saudi Arabia. It has a special place not only by hosting the permanent headquarters of the International Renewable Energy Agency (IRENA) but also by supporting scientific research and development and promoting the shift towards sustainable renewable energy sources (RES). This study investigates the major trends of the scientific studies on renewable energies in the UAE that carried out bibliometric analysis between 1988 and 2018 based on the Scopus database. Around 48% of the 1,908 articles published on renewable energy in the Middle East concern the UAE, while 63% of the author affiliations of these articles are also in the UAE. This study also investigates the acceptance and awareness level of UAE citizens about the transfer to green technology using a random sample that met the criteria as cohesive. The information produced in this work can be useful for governmental institutions to understand how to more effectively knit together the various strengths in the country, and for research centers and institutes to find strategic partners that can coordinate in areas related to the UAE's transition. This thesis will increase the information available about renewables in GCC countries in the international academic literature, yet more significant efforts need to be made to understand the phenomenon and its future development.

Keywords: renewable energy, energy transition, United Arab Emirates, bibliometric analysis, questionnaire analysis

BİRLEŞİK ARAP EMİRLİKLERİ'NDE YENİLENEBİLİR ENERJİ GEÇİŞİ

ÖZET

Enerji rejimleri tarih boyunca bir kaynaktan diğerine doğru yer değiştirmiştir. Dünya şu anda fosil yakıtların ağırlıklı olduğu bir rejimden daha sürdürülebilir bir rejime geçiş döneminin ortasındadır. Geçmiş deneyimler, enerji geçişlerinin zor olduğunu ve ciddi çaba gerektirdiğini ortaya koymaktadır. Bugünkü geçiş, bütçe gelirlerinin çoğu hidrokarbon ihracat gelirlerinden oluşan, petrol ve gaz ihraç eden Körfez Arap Ülkeleri İşbirliği Konseyi (KİK) ülkeleri için daha da zor olacaktır, bu ülkelerin iç tüketimi hızla artmakta, ve kaynakları sürekli tükenmektedir. Birleşik Arap Emirlikleri (BAE), Suudi Arabistan ile birlikte enerji rejimi geçişinde KİK'te en başarılı ülkedir. BAE sadece Uluslararası Yenilenebilir Enerji Ajansının (IRENA) daimi ev sahibi olarak değil, aynı zamanda bilimsel araştırma ve geliştirmeyi destekleyen faaliyetler yürüterek, sürdürülebilir yenilenebilir enerji kaynaklarına geçişi teşvik ederek özel bir yere sahip olmuştur. Bu çalışma, Scopus veritabanına dayanarak, BAE'de 1988 ve 2018 yılları arasında bibliyometrik analizler yapan yenilenebilir enerji hakkındaki bilimsel çalışmaların ana eğilimlerini incelemektedir. Orta Doğu'da yenilenebilir enerji ile ilgili yayınlanan 1.908 makalenin yaklaşık %48'i BAE'yi ilgilendirirken, bu makalelerin yazarlarının %63'ü de BAE'dedir. Bu çalışma aynı zamanda ülke vatandaşlarının yeşil teknolojiye geçiş konusundaki kabul ve farkındalık düzeylerini ölçütleri birleştiren rastgele bir örnek kullanarak araştırmaktadır. Bu çalışmada üretilen bilgiler, devlet kurumlarının ülkedeki çeşitli güçleri nasıl daha etkin bir şekilde bağladığını anlamalarını, araştırma merkezleri ve enstitülerinin BAE'nin geçişi ile ilgili alanlarda koordine edebilecek stratejik ortaklar bulmasını sağlamaktadır. Bu tez, uluslararası akademik literatürdeki KİK ülkelerinde yenilenebilir enerji kaynakları hakkında mevcut bilgiyi artıracaktır, ancak olguyu ve gelecekteki gelişimini anlamak için daha büyük çaba sarf edilmesi gerekmektedir.

Anahtar Kelimeler: yenilenebilir enerji, enerji geçişi, Birleşik Arap Emirlikleri, bibliyometrik analiz, anket analizi

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LIST OF ABBREVIATIONS

BP	British Petroleum (oil company)
°C	The degree Celsius
CO_2	Carbon Dioxide
EIA	U.S Energy Information Administration
EU	European Union
GCC	Gulf Cooperation Council
GDP	Gross Domestic Products
GHG	Greenhouse gases
GWh	Gigawatt hour
IAS	Integrated Awareness Strategy
IEA	International Energy Agency
IMF	International Monetary Fund
IRENA	International Renewable Energy Agency
OAPEC	Organization of Arab Petroleum Exporting Countries
OPEC	Organization of the Petroleum Exporting Countries
RES	Renewable energy sources
TWh	Terawatt hour
UAE	The United Arab Emirates

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INTRODUCTION

Throughout human life, energy has been, and always will be, a vital aspect of humans' very existence from the energy that humans use and store inside their bodies to the energy that they generate to make life easier and better (Johns, 2015). Thousands of years ago, humans used renewable energies to burn wood and harness wind and hydropower (Solomon and Krishna, 2011). From the 1800s, a major transition occurred once coal, the first fossil fuel, became an important source of power (Fells, 1991). Since then, humans moved from coal to oil and natural gas due to some dynamics related to basic innovation, economics and environmental concerns, and even geopolitics.

Nowadays, humans are suffering from the negative effects of using fossil fuels and are attempting to transition to using more renewable energy sources (RES). This transition is occurring because fossil fuels have created four major challenges: resource scarcity, uneven distribution, global climate change, and price volatility. The resource scarcity means that fossil fuels are exhaustible and will deplete one day. The global reserves/production (R/P) ratio, which measures the average life of a specific resource's reserves, is 132.0, 50.0 and 50.9 years for coal, oil and gas, respectively (BP, 2019). The second reason is that fossil fuel resources are unevenly distributed around the world, as large consuming countries have almost no hydrocarbons resources in their lands (for instance, 15.9% of global oil consumption is in the European Union, while the EU only accounts for 3.6% of global oil production), and the major producers are not the main consumers (for instance, 33.3% of global oil production is in Middle East countries, while the Middle East accounts for only 8.8% of global oil consumption). The third and most pressing problem is global climate change, rising greenhouse gases (GHG) emissions, and environmental degradation, which have resulted from the extraction, distribution, and burning of hydrocarbons (van Vliet et al., 2012). The fourth and final challenge is price fluctuations. For instance, the dramatic rise in oil prices during oil crises in the 1970s and in natural gas prices during Russia–Ukraine gas dispute in 2006-7 and 2014.

RES are potential substitute for fossil fuels and can solve many of these problems. Renewables could reduce addiction to fossil fuels suppliers in oil-importing countries and create a new segment of the economy, as part of overall economic diversification in

both producers and consumers. Thus, an economic system based on RES is sustainable. Moreover, renewables are cleaner (either lower carbon or carbon-free) and more environmentally friendly in comparison with fossil fuels. This can combat the environmental problems created by overusing hydrocarbons and keep global warming under 2 degrees Celsius as agreed in Paris agreement. Furthermore, RES are available everywhere and can be used as domestic sources after deciding the best energy mix that suits the specific needs of each village, city, or country (Othieno and Joseph, 2016). Renewable energy techniques will be inexpensive soon and solar and wind are already significantly cheaper than fossil fuels. Finally, RES can contribute to a better life on earth. It is therefore logical that the world is transitioning to them.

Fossil fuels still have the lion's share of primary energy consumption globally (Figure I.1). Global energy consumption by source in 2018 was 84.7% fossil fuels, 4.4% nuclear, 6.8% hydropower, and 4.0% renewable energies. The share of renewable energy is still so small, but it has been increasing dramatically.

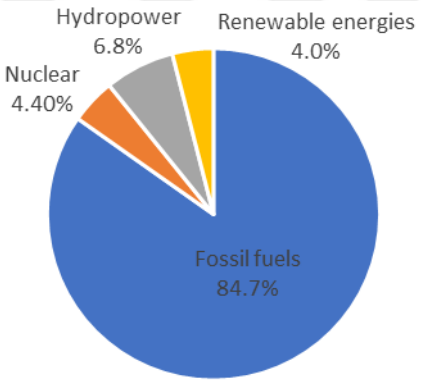

Figure I. 1 Primary energy consumption in the world by sources (Source: BP, 2019)

Nowadays, many countries around the world can be classified as leaders in growing the share of renewable energy in their energy mix; some areas around the world even run on one hundred percent RES (Johns, 2015). Some European countries, including Portugal with renewables around 15% of consumption, Germany and Finland with above 14.5%, Sweden and the United Kingdom with above 12%, and Spain with above 11% are notable examples. China also seems to demonstrate promising steps towards a smooth transition, as it has around one third of the world's installed capacity in both solar energy and wind energy. The main driver for those countries to convert to fossil-fuel-

free is their lack of enough domestic energy to meet their demand, but this is not the case with the hydrocarbon's exporters in the Middle East (Mohr et al., 2015).

The biggest challenge for countries in the Middle East to switch to renewables is the hydrocarbon export revenues. The other main challenge is the increasing domestic demand for energy as the result of generous governmental subsidies on oil and gas alongside the rapid rise of population (Al-Maamary et al., 2017).

The heart of these challenges falls to the Gulf Cooperation Council (GCC), an alliance of six Middle Eastern countries including Saudi Arabia, Kuwait, the United Arab Emirates (UAE), Qatar, Bahrain, and Oman. The real challenge for GCC countries to use more renewables is that they are the main producers and exporters of oil and gas in the world. Nevertheless, the Gulf countries have launched many green initiatives, written policy and strategy studies, and worked hard to implement all renewable energy aspects in real life (Abdmouleh et al., 2015). It is apparent that those countries have real ambitions to switch to renewables; this is not simply "greenwashing". The leaders of Saudi Arabia and the United Arab Emirates (UAE), have allocated funds for research and development, implemented environmentally friendly projects, and worked on green policies and strategies (Bhutto et al., 2014). In 1982, Ali Ahmed Attiga, OAPEC Secretary-General, laid plan this view: “The recognition that oil is an energy resource limited in life span has prompted strong interest in the development of alternative sources of energy. We as oil producing countries naturally share this interest as a means of diversifying our energy sources for the day when the oil wells run dry” (Quoted by Kettani & Malik, 1982).

This thesis will discuss the transition challenges in the UAE, both the social acceptance for the transition and development of the research to improve it. A study of the transition to renewable energy in UAE is highly relevant to the global transition, as the future energy trajectory of UAE will have wide-reaching effects, not only within the country but also in the Middle East and the entire world. If the main oil and gas producers switch to renewable energy, this would mean a major reduction in the extraction of cheap fossil fuels and less environmental damage to the planet. If fossil fuel consumption continues, the transition will continue but will be much harder and take much longer.

The main research question to be answered is: How will the UAE accomplish the renewable energy transition? This thesis seeks to answer the following sub-questions in the UAE: What is the research level related to green technology? What view do people have regarding the transition's likelihood? What is the level of social awareness of climate change? And finally, what is the level of social acceptance of the transition?

Significant scholarly attention has been devoted to the subject of the renewable energy transition in the world, specifically how it has emerged and progressed and what constitutes barriers and drivers for such a transition. There exists no consensus, however, on which indicators best measure what drives and hinders such a transition. For instance, Podobnik (1999) examines the global energy transition from coal to oil in the nineteenth and twentieth centuries while focusing on three dynamics including social unrest. Smil (2000) sheds light on energy consumption in the last century with its relationships between fossil fuels inputs on one side and economic outlook and social accomplishments on the other. Both these early studies concluded that the new transition will occur in the twenty-first century to more ecologically friendly and sustainable energy resources to minimize the environmental impacts of fossil fuel production and consumption.

The largest share of recent studies has focused on energy transitions in European countries. For instance, Pacesila et al. (2016) who analyze renewable energies in the European Union member, state and rank the countries based on their RES. Their results show that the energy dependence of EU countries is not determined only by renewable energy production rate; it also depends on many other factors that include economic development, energy consumption (domestic and industrial), energy efficiency, and energy policy. In terms of most successful countries in the transition, Pacesila et al. (2016) cite Germany, which relies on RES for 25% of its consumption. Abdulrashid and Ozturk (2017) argue that RES helped consolidate German economic growth prospects, making renewable energy consumption, economic growth, and capital cointegrated in the long run. Augustus et al. (2016) present a comparative analysis of energy governance regarding nonconventional renewable energy sources in Germany and Brazil and highlight Germany's excellent success in fostering RES. Several valuable

lessons can be extracted from the German experience, starting from relying less on fossil fuels to ending with investing more on renewables.

Another successful example of the transition is China. Eisen (2011) discusses the possibilities that China creates for deploying renewable energy within the range of implemented green laws and programs and confirms that the Chinese government has already taken serious steps to implement renewables. Nevertheless, more action is still required.

Studies relating to the Middle East are less common. Meisen and Hunter (2007) analyze the potential for renewables in the region and then focus on applications and implementation of solar energy technology. Hochstrasser (2015) discuses the challenges and opportunities for renewables and recommends that the Middle East harness international expertise. Griffiths (2017) conducts a review and assessment of energy policy in the Middle East after an analysis of some social, political and economic factors and shows that the region is switching to renewables, but with a high rate of result uncertainty.

Energy transition in GCC is studied extensively. Krupa, et. al. (2019) focus on renewables in the resource-rich countries in the GCC. Al-Maamary, Kazem and Chaichan (2017) demonstrate that economic growth in the Gulf States is slower than the growth in energy consumption. Also, for understanding renewable energy in the GCC, the studies of Doukas et al. (2006); Alnaser and Alnaser (2011); Bhutto et al. (2014); Munawwar and Ghedira (2014); Abdmouleh, Alammari and Gastli (2015); Atalay, Biermann and Kalfagianni (2016); and Bekhet, Matar and Yasmin (2017) are all highly valuable. Some studies focus on specific GCC countries, such as Saudi Arabi (Al-Ajlan et al., 2006; Saleh, 2011; and Alkhathlan and Javid, 2013) and Qatar (Sofotasiou, Hughes and Calautit, 2015; Mrabet and Alsamara, 2017; and Charfeddine, Yousef Al-Malk and Al Korbi, 2018). These studies vary in their policy prescriptions according to the capacities of each country to generate renewables.

Some studies include information related to the UAE but within the context of other countries. Publications on UAE renewable energy are rare, but there are some relevant articles. Mokri et al. (2013) assess the potential capacity of solar energy in the country's

energy portfolio, energy industry, energy policies, and solar projects. They also discuss wind power. Al-tajer and Poullikkas (2015) examine the possibilities and capacities for wind energy in the Emirate of Sharjah, in specific. From another perspective, Mezher et al. (2011) mention the challenges and opportunities for renewables in Abu Dhabi, the largest emirate, and the capital of the UAE. Al-Amir and Abu-Hijleh (2013) examine energy policy in the UAE and discuss how to develop policies to encourage greener practices in Emirati society. Afshari and Friedrich's (2016) explore energy efficiency and suggest tradable energy savings certificates in Abu Dhabi to enhance energy efficiency in buildings. Related to Masdar city, the world's first zero-carbon city in Abu Dhabi, Madichie (2011) studies the UAE initiative as a city fully powered by renewable energy and headquarters for the International Renewable Energy Agency (IRENA). Reiche (2010) discusses the renewable energy policies in the city whereas Elchalakani, et. al. Aisheh (2014) explain how sustainable concrete was used for construction. In terms of climate change, Al-Iriani (2005) considers the relationship between climate conditions and electricity consumption and recommends some policy actions including electricity demand-side management (DSM) programs. Khondaker et al. (2016) argue that the largest contributor (with 90%) to greenhouse gas (GHG) emissions in the UAE is the energy sector. Both studies suggest a shift towards renewable energies and other alternatives away from oil and gas. Lastly, Al-Maamary, et. al. (2017) emphasize that the UAE already took significant steps to execute the convention on renewable energies compared to other GCC countries.

The methodological approach of this study is based on data analysis, using bibliometric study and questionnaire analysis. The desk study consisted of reviewing and analyzing previous research efforts using the bibliometric technique to understand the field better and recognize the scientific research level. The field study consisted of analyzing people's opinions as received through a questionnaire designed to check some concepts and attitudes. Firstly, the analysis of the scientific studies of renewable energies in the UAE, which was conducted through reviewing bibliometric studies between 1988 and 2018 based on the Scopus database, sough to study the major trends of research about this topic. Then, a questionnaire was distributed to people identified as citizens of UAE, Arab immigrants, and people from other nationalities who are currently residing in the UAE. This questionnaire was filled and gathered remotely and virtually and analyzed to

check the level of people's acceptance to replace cheap and subsidized fossil fuels with renewables in their daily life. The survey aims to understand the awareness of the differences between fossil fuels and renewables, climate change, and facts related to the depletion of hydrocarbons.

This work is presented in four chapters. The first chapter presents general information and explains the historical development of fossil fuels in the UAE. It also provides details about the policies, strategies, and projects relating to the renewable energy transition. The second chapter analyzes and discusses the bibliometric study, while the third chapter reveals the findings of the questionnaire. The fourth chapter includes conclusions and recommendations.

1. THE RENEWABLE ENERGY TRANSITION IN THE UAE

1.1 UAE Background

The UAE has a population of around 10 million people. The capital city is Abu Dhabi, its official language is Arabic, and its currency is dirham (1 American dollar equals 3.67 UAE dirham). The UAE President has been Sheikh Khalifa Bin Zayed Al Nahyan since 2004. Located along the southeast coast of the Arabian Peninsula, it borders Oman to the east and north and Saudi Arabia to the west and south. The UAE has a unique location, as it lies south of the most important transit point for world crude oil in the world, the Strait of Hormuz. Covering an area of around 84 thousand square kilometers, the country is mostly large flat desert lands, with sand dunes forming part of the outer reaches of the Rub' Al Khali Desert. Besides the desert, there is varied topography, with the flat coastal areas fronting the Arabian Peninsula and the Hajar Mountains in the northeast. Figure 1.1 details country's geography.

Figure 1. 1 Map of the UAE

After the Trucial States gained their independence from the British in 1971, they formed an alliance and rebranded themselves as the federated United Arab Emirates. Formed on 2 December 1971, the UAE consists of seven emirates: Dubai, Abu Dhabi, Sharjah, Ajman, Ras al-Khaimah, Fujairah, and Umm al-Quwain (Bahgat, 2013). Since its formation, the UAE established genuine memberships to regional and international groupings. On the same date as its establishment, the UAE became the eighteenth

member of the Arab League. It later became a member of the United Nations Security Council. Abu Dhabi became a member of the Organization of the Petroleum Exporting Countries (OPEC) in 1966. When the emirates federated in 1971, membership was transferred to the UAE. One year later, in 1972, it became a member of the Organization of Islamic Cooperation. Ten years later, the UAE was a co-founder of the GCC along with the Kingdom of Saudi Arabia, Kingdom of Bahrain, State of Kuwait, State of Qatar and Sultanate of Oman.

1.2 The UAE's Economic Outlook

At the beginning of the last century, the UAE's economy was dependent on fishing and the declining pearl industry. The discovery of oil and gas, however, transformed its economic outlook. Since the UAE was founded, it has been one of the largest economies in the GCC and the Middle East. According to the International Monetary Fund (IMF), the country's real nominal gross domestic production (GDP) growth in 2019 was 2.8%, while its GDP was US$427.88 billion with current prices. The UAE has the fourth-largest economy in the Middle East (after Turkey, Iran and Saudi Arabia) and is one of the highly developed countries in the region. The GDP per capita with current prices is U.S.$39,810, which is one of the highest in the world and third highest in the Middle East.

The economy of UAE is based on oil export revenue. About 30% of the country's GDP is from oil and gas exports. The UAE's proven oil reserves are estimated to be 97.8 billion barrels, which are 5.7% of the total reserves in the world, the eighth largest after Venezuela, Canada, Russian Federation, Saudi Arabia, Iran, Iraq, and Kuwait. Besides, three percent of natural gas proved reserves lie in the region (BP, 2019).

By 1971, the UAE was producing almost 2% of the world's oil. By 2018, this had doubled to be almost 4% (BP, 2019). The UAE is considered the fourth largest oil producer in the Middle East and the world's seventh largest producer at present (EIA, 2019). Since the discovery of oil in 1958, the country has become a modern state with a high standard of living. Oil exports have led to a much-diversified economy, allowing most of the seven emirates, most notably Dubai, to transform into global hubs for retail, finance, and tourism.

1.3 Historical Development of Oil and Gas

The first big petroleum discovery in the Middle East occurred at Masjed Soleyman in Iran in 1908. This oil well set off a wave of exploration, extraction, and exploitation that changed regional and global history. Abu Dhabi and Dubai started thinking of exploring oil and gas. At that time, the UAE was a group of separated emirates. In the early 1940s, the states started working on oil extraction, but unfortunately, the Second World War halted these efforts. After the war, however, oil exploration and production companies continued their work, and oil was found in 1958. The well, known as Murban-3, began producing crude oil in May 1960, but exports did not begin until 1963. Oil was discovered in other emirates after that: Sharjah in 1974 and Raʾs al-Khaymah, which has limited oil and gas reserves, in 1984. On the other hand, exploration and drilling in Ajman, Umm al Qaywayn, and Al Fujayrah have not yielded significant finds.

Gas was discovered in 1977 in Abu Dhabi, further bolstering the UAE's outlook. Sharjah also began producing natural gas in the 1980s. The first oil fields attracted many international companies to the UAE, which created a reliance on international companies and workers rather than Emirati citizens. In 1988, government policy changed prioritized building up the refining sector and, with TAKEER, the country became a major refiner by 1999. In 2004, the 75-year concession that Abu Dhabi signed with international companies ended, meaning that it no longer had to share ownership with foreign shareholders.

1.4 UAE Energy Mix

Oil is accounted for 40% of the UAE's primary energy consumption, while natural gas accounted for 59% in 2018. Figure 1.2 shows the evolution of energy consumption and production (Mtoe) in the UAE from 2000 to 2018.

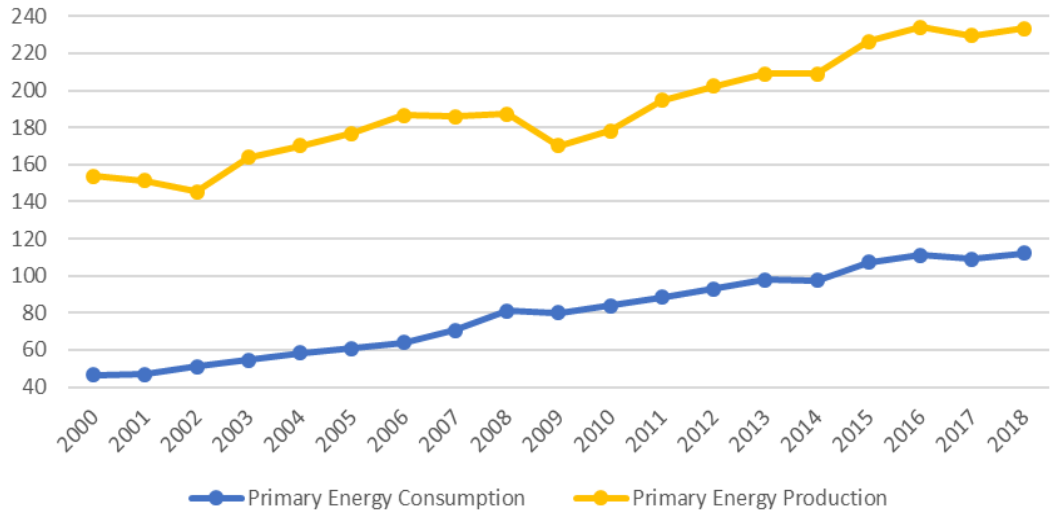

Figure 1. 2 Primary energy production and consumption in the UAE Source: BP, 2019

The above figure shows energy production growth of 2.9% per year from 2000. Energy consumption has grown nearly two times as quickly as production over the last 18 years.

The UAE has long been an important supplier of energy and is now becoming an increasingly relevant consumer of energy as well. The country does, however, have one of the world largest gas reserves. Due to its high level of consumption and a gradual shift towards gas-based power generation, the UAE has become a net importer of gas since 2007. The Dolphin Project, which imports natural gas by pipeline from Qatar to the UAE, is a case in point. The first commercial deliveries of Qatari gas began in the summer of 2007 and will continue throughout the 30-year term of the development and production-sharing agreement signed with the Government of Qatar. The installed capacity for generating electricity was 136.9 terawatt hour (TWh) in 2018. Natural gas had the largest share with 98.1%, oil was 1.2%, and total renewables were 0.7%. The growth rate in electricity generation was 5.5% during the period between 2007 and 2017, with 1.8% during 2018.

1.5 Transition to RES

The rising population and the environmental problems have hampered economic growth, as thousands of projects were stopped due to a lack of funding (Abdmouleh, Alammari, & Gastli, 2015). The adoption and sustainable use of all forms of renewable energy could offer a practical way for the UAE to meet its energy needs with an

environmentally friendly approach that creates a better economy, healthier citizens, and a cleaner environmental. This accomplishment is quite natural. The world is shifting to low carbon energy recourses more broadly (Sgouridis et al., 2016). The renewable energy transition will strengthen the UAE in terms of "3 Es": energy, economy, and environment (Jamil, et al., 2016). It will be part of the global transition and thus supported by IRENA and will permit the UAE reach its 2030 climate goals. The UAE should act decisively to develop renewable energy projects and benefit from them in terms of economic development and investment. Green technology can help save the economy and offer a better life for citizens in addition to better environmental conditions with less CO_2 emissions.

There are various favorable types of RES, including solar, wind, biomass, tidal and wave energy. Solar and wind are the fastest-growing sectors, primarily due to their large abundance, favorable environments in the UAE, and relatively advanced technological development. The UAE can mainly benefit from solar energy and wind energy in some specific places. Solar potential is 10 times more than wind (Al-tajer & Poullikkas, 2015). Several solar photovoltaic (PV) and concentrated solar power (CSP) projects in Abu Dhabi and Dubai broke world records, with both technologies having received the lowest bids recorded globally in 2016 (APICORP Energy Research, 2017). Figure 1.3 presents the cumulative installed solar energy (PV power) in the UAE since 2009.

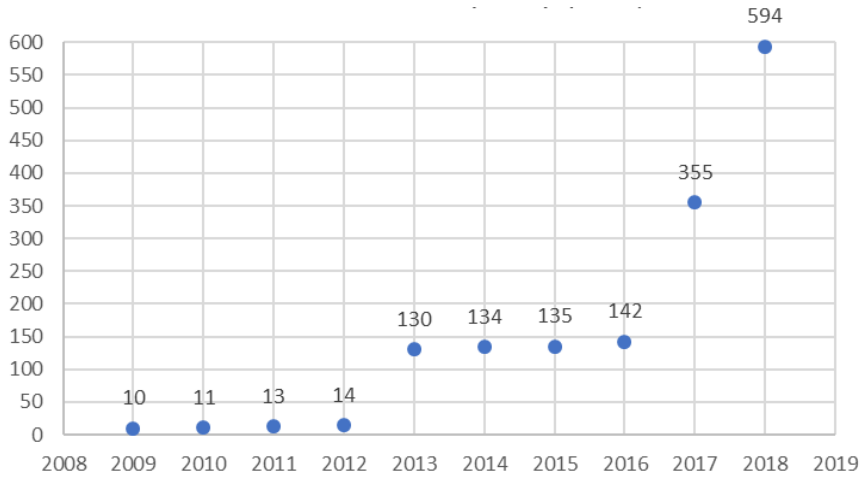

Figure 1. 3 The cumulative installed solar energy in the UAE
Source: BP, 2019

There is no doubt that regulatory support, including renewable energy laws and national targets, have been pivotal in contributing to the expansion of the UAE's renewables

sector. The UAE states have already undertaken some policies, projects, and sector-wide efforts in order to contribute to domestic energy security and long-term economic and environmental sustainability. It is expected that after the implementation of these policies, investment will rise and its effect on the environment will be apparent. Many of these policies and plans still exist on paper only (Al-maamary, et al., 2017). The UAE has launched initiatives that are of potentially pivotal importance for the overall success of the country's renewable energy efforts. Many attempts and plans have been made in relation to people's awareness, and the most recent one is a flagship public awareness campaign under the name 'My Energy, My Responsibility' in May 2018, as part of the Integrated Awareness Strategy (IAS) 2022 in Dubai.

Financially, the cost of electricity from solar power plants is now twice the cost of electricity generated by fossil fuels (Mokri et al., 2013). There are three suggested aspects to improve this situation and use more solar energy in the UAE. These include: the government subsidizing solar power, removing or decreasing subsidies for the electricity of the grid, and waiting for a decline in the price of solar panels. According to the situation on site, solar panels on building roofs will be more beneficial than large plants because the largest population concentrations in the south of the UAE are the sunniest. The UAE has the immense advantage of available funds for green projects, which may develop into international technology and innovation leaders in that field. Renewable energy plans and targets can be summarized in three major points. The first target is to generate 800 megawatts (MW) of solar power by 2020. The share of RES in Dubai will increase by up to 5% and the share of nuclear power in Abu Dhabi is planned to reach 12% by 2030, with four nuclear power plants with a total of 5.6 gigawatts (GW) of power generated. The second target is to have 1 GW PV and CSP at the Mohammed bin Rashid Al Maktoum Solar Park, which is planned in Dubai by 2030 (Mills, 2015). The third target is related to energy conservation, as the UAE plans to reach a 15% decrease in electricity demand. At the same time, in 2013 the Dubai Municipality launched the Dubai Demand Side Management (DMS) Strategy 2030. Several aspects of the demand for electricity and water in Dubai are addressed by eight programs: building regulations, building retrofits, district cooling, standards and labels for appliances and equipment, water reuse and efficient irrigation, outdoor lighting, tariff rates, and Shams (means sun) Dubai.

The Shams Dubai program was the first comprehensive framework for solar rooftop in the GCC and aims to encourage people who are living in Dubai to install solar PV systems on the rooves of their homes and buildings. It allows people to generate electricity for their needs, connect their PV systems to the grid, and offset any excess generation from their electricity bills. The municipality is using several implementation mechanisms to achieve the target set in the DMS Strategy, which includes institutional setting and capacity building, governing by example, information systems, financing mechanisms, policies and regulations, technologies and studies, awareness improvement, and, finally, measurement and verification. Moreover, TAQATI, Dubai's energy efficiency program, was established by the Dubai Supreme Council of Energy in 2016 as a dedicated program management office to support the implementation of the DSM Strategy. As a result of these real steps, the savings in electricity demand reached 9.9% at the end of 2018. Table 1.1 presents the actual annual electricity savings by program of the DSM Strategy in 2018. It presents the 2018 targets and the 2017 savings and compares the set target in the strategy with the actual demand.

Table 1. 1 Annual electricity savings in 2018, Source: TAQATI report 2018

DSM Program	2017 Savings (GWh)	2018 Savings (GWh)	2018 Target (GWh)	Year-overyear growth (%)	Actual vs. target (%)
Building Regulations	390	657	483	68%	36%
Building Retrofits	194	256	131	32%	95%
District Cooling	277	428	359	54%	19%
Standards and Labels	1,559	1,970	1,603	26%	23%
Outdoor Lighting	15	24	37	61%	-35%
Tariff Rates	1,147	1,105	1,073	-4%	3%
Shams Dubai	23	62	n/a	209%	n/a
Grand Total	3,604	4,501	3,687	25%	22%
Total as % of baseline	**8.20%**	**9.90%**			

Most recently, in November 2018, Dubai's municipality hosted Solar Decathlon Middle East at the Mohammed bin Rashid Al Maktoum Solar Park. This international competition involved fifteen teams from 28 international universities, which competed against one another in designing, building and operating sustainable solar-powered houses. The only energy sources accepted in those designed houses were RES with creative ideas and innovative technologies to adapt to global climate change and build

eco-houses. In addition, the Dubai Supreme Council of Energy (DSCE) and TAQATI and representatives of all the DSM program owner entities led the development of the Integrated Awareness Strategy (IAS) 2022. The IAS covers all DSM programs and defines strategic objectives and measurable targets for each program from 2018 to 2022, with a focus on general awareness, willingness to energy efficiency, and acceptance of renewable energy systems usage.

2. BIBLIOMETRIC STUDY

Literature review on previously published studies in a specific scientific area are vital for gaining a deeper understanding and classifying the developing scientific level of a particular research area. The increase in the production rate of scientific output has long been recognized (Lehman, 1947). The general increase in scientific publications can be attributed to three causes. The first is the global increase in the number of scientists. The second is the increasing number of scientific discoveries worth communicating to peers and the public. The third is the administrative pressure of academic institutions on their members to publish (Pautasso, 2012). These reasons can be applied to the increase in the number of studies about the transition to renewable energy in the UAE, which have experienced marked scientific and economic growth in the last decade. One more plausible reason for the increase in scientific publications on renewables in the country could be the improvement in means of communication to share scientific publications with peers all over the world.

The UAE is classified as one of the most successful GCC countries, alongside with Saudi Arabia, in the green transition of its energy regime by supporting scientific research and development. This chapter investigates the major trends of scientific studies on renewable energies in the UAE by carrying out a bibliometric analysis. Its purpose is to evaluate scientific research on renewable energy in the UAE and to increase understanding of the development in the scientific approach towards recognizing green solutions and demonstrating trends in RES in the UAE. For that purpose, published scientific documents from 1988 to 2018 in the Scopus database about renewable energy in the UAE are analyzed using the bibliometric methods.

2.1 Methodology and Database

Bibliometric analysis is a systematic methodology that includes quantitative analysis of scientific publications with a view to identifying specific research phenomena (Andrés, 2009). This analysis has previously been used in studies related to librarianship; nowadays the analysis method is used towards studies related to several scientific fields, e.g. information sciences, to measure scientific progress in those fields (Ball, 2017). The detailed process is first made up of applying some statistical and mathematical procedures in order to investigate the mathematical regularities, distributed architecture,

varying patterns, and quantitative management of studied information. The next step is analysing the structure, features, and patterns of the underlying science and technology (Mukherjee, 2010).

The accuracy of the bibliometric study relies on the quality of the bibliographic search that is carried out. The results' analysis depends on checking the scientific development or productivity level, which directly depends on the database and the methodology of searching. Conducting a search in a well-known database with good coverage, the accuracy of data and fewer spelling mistakes makes the bibliometric study easier to conduct and the resulting analysis more accurate (Neuhaus and Daniel, 2008).

For classification and analysis of the documents, several measures are included in this bibliometric study to analyze RES holistically and in relations to specific RES. The procedure began with a search for “renewable energy” in the Scopus database in terms of "article title, abstract, keywords" then specified results that included "United Arab Emirates". The analysis started with the year of publication to the affiliation or sponsor-funded parties among the authors and countries or territories. It finished with the type of documents, subject area, and sources of these documents. This data was then analyzed using Microsoft Excel to gather more scientific indicators to identify the different characteristics of the publication groups and categorize them to ascertain the scientific approach taken toward the transition to RES in the UAE.

Three major databases used for bibliometric studies in the scientific community are Web of Science, Scopus, and Google Scholar. The source of the data used in this work is the Scopus database, which was launched in 2004. It is considered to be the world's largest abstract and citation, therefore offering the widest coverage and ease of use (Burnham, 2006; Falagas et al., 2008; Jacso, 2008). Scopus database covers nearly 22,000 titles from over 5,000 publishers, of which 20,000 are peer-reviewed journals in the scientific, technical, medical, and social sciences. This data is annually updated from countries around the world (Aghaei Chadegani, 2013).

2.2 Discussions and Analysis

This section will discuss data gathering, the processing of publication, and analysis of results. The results show a total of 909 documents matching the criteria set in the methodology procedure. Those publications came from 76 different sources journals.

The analysis starts with a general analysis of the number of publications in each year among the specified period. By tracking this number, we can chart the annual improvement of the scientific level and account for different reasons for this change, including the level of funding and interest in renewable sources in the UAE. The second part of analysis measures the authors, classifying them by institution and country. The third part analyzes the subjects of the publications to illuminate differences and trends over time.

2.2.1. Temporal Analysis of Publications

A total of 909 articles were published on renewable energies in the UAE between 1988 and 2018. An Egyptian scholar authored the first and only article in 1988, a study of solar power in Arabic-speaking-countries (Abdul-Hamid, 1988). This illustrates that solar power, which is eminently available in the UAE, was first recognized by a scientist living outside the country. The first articles written by scientists from the UAE appeared in the proceedings of a symposium held in the UAE in November 1992 (Patlitzianas & Flamos, 2016). The articles, as well as the symposium, focused on several topics, including cogeneration in the Gulf region, pollution control, and renewable energy.

The total number of annual publications rose from only 1 to 13 with an average of fewer than two articles per year during the first 20 years between 1988 and 2008. However, a steady increase occurred after 2009 (Figure 2.1). In 2009, 33 documents were published, which almost equaled the total number of articles published during the first 20 years (37 papers). From 2010 to 2018, the fewest number of articles published was 29 in 2010 and the most was 194 articles in 2018. This post-2010 increase in scholarship was unsurprising. After the second session of the preparatory commission for IRENA, the organization selected Abu Dhabi as its interim headquarters in June 2009. The permanent headquarters of IRENA was then established in Masdar City in 2011. The number of publications increased more rapidly afterward, especially after 2014. This increase reflected a tendency around the world to study the renewable energy transition, including oil and gas-exporting countries.

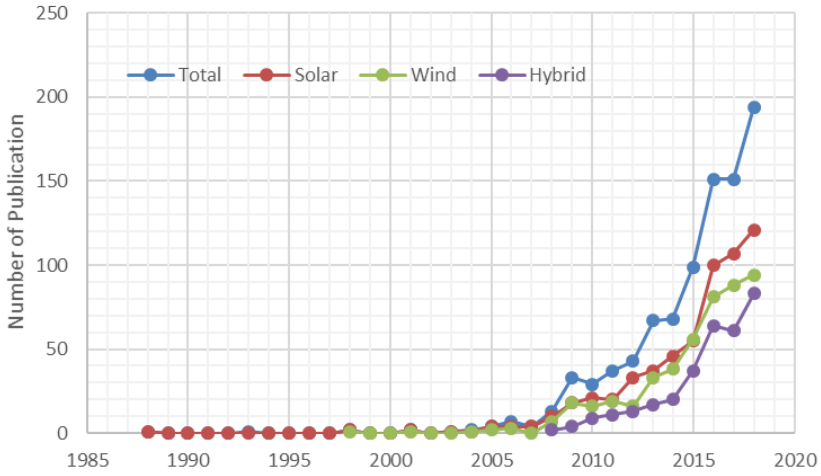

Figure 2. 1 Growth of publication output from 1988 to 2018

2.2.2. Authors of Publications

The articles published from 1988 to 2018 included authors from 160 different affiliations, 82 different countries, and 45 funding sponsors. Of the 160 authors, 61% were from the UAE and 11% from the United States. The top-ten country affiliations are shown in Table 2.1.

Table 2. 1 Top 10 countries of authors

Country	Number	Percentage
UAE	555	61.06%
United States	104	11.44%
Canada	56	6.16%
United Kingdom	53	5.83%
Australia	40	4.40%
India	39	4.29%
Italy	32	3.52%
Malaysia	32	3.52%
Saudi Arabia	31	3.41%
China	29	3.19%

The analysis revealed that almost all publications were written in English and were written either by a single author or in collaboration with one of more authors. Table 2.2 presented the list of top-ten authors with the number of documents indexed in the Scopus database. Also, the table shows where the author is currently working in terms of affiliation and country. The result shows that four of the top authors are currently working in the UAE, and three of them are working in several departments at Khalifa

University, the top affiliation. The most prolific writer was Toufic Mezher, who has been a Professor of Engineering Systems and Management at Khalifa University since 2017. He published some of his documents as journal articles and wrote book chapters, too. Before joining this university, he was a professor from 2008 to 2016 at the Masdar Institute of Science and Technology, the most common sponsor. The next top authors separated into two classifications. Three authors currently work in the United Kingdom, Canada, and the United States, but all were previously in the UAE at one point in their careers: Lamont (Petroleum Institute), El Chaar (Power and Water) and Woon (Khalifa University), respectively. The remaining three authors in the top-ten are researchers in universities that have a budget to cover the expenses of scientific research that focuses on the renewable energy transition in the UAE.

Table 2. 2 Top 10 authors of publications

Author	Number	Affiliation	Country
Mezher, T.	20	Khalifa University of Science and Technology	United Arab Emirates
Janajreh, I.	17	Khalifa University of Science and Technology	United Arab Emirates
Lamont, L.A.	16	University of Ulster	United Kingdom
Al-Durra, A.	14	Khalifa University of Science and Technology	United Arab Emirates
Muyeen, S.M.	14	Curtin University	Australia
Farid, A.M.	13	Dartmouth College	United States
El Chaar, L.	12	General Electric Canada	Canada
Woon, W.L.	12	Expedia Inc.	United States
Ghenai, C.	11	University of Sharjah	United Arab Emirates
Javaid, N.	10	COMSATS University	Pakistan

Of the top ten affiliations, seven were in the UAE, while the other three were in the United States (fifth place), Canada (seventh place) and Qatar (ninth place). Khalifa University of Science and Technology (KU) has the largest share of documents published with more than a quarter of the total published papers (254, 27.94%). Table 2.3 shows the top-ten affiliations with their locations and the number of publications for each affiliation.

Table 2. 3 Top 10 afflations' of publications

Affiliation	Country	Number
Khalifa University of Science and Technology	United Arab Emirates	254
United Arab Emirates University	United Arab Emirates	57
American University of Sharjah	United Arab Emirates	52
University of Sharjah	United Arab Emirates	35
Massachusetts Institute of Technology	United States	28
Higher Colleges of Technology	United Arab Emirates	28
University of Waterloo	Canada	16
American University of Ras Al Khaimah	United Arab Emirates	15
Qatar University	Qatar	14
Heriot-Watt University, Dubai Campus	United Arab Emirates	13

Figure 2.2 presents the distribution of documents according to the funding sponsor for the top ten sponsors. The total number of funding sponsors is 45, and they are spread around the world. These efforts and funding budgets showed clearly that the trend of shifting to renewable energies is a common issue that researchers worldwide are curious about. It is not only students, researchers, or experts living in the UAE who write or publish about the UAE's renewable energy transition. Others outside the country are interested in the global transition or in oil or gas-exporting countries, which fueled their research.

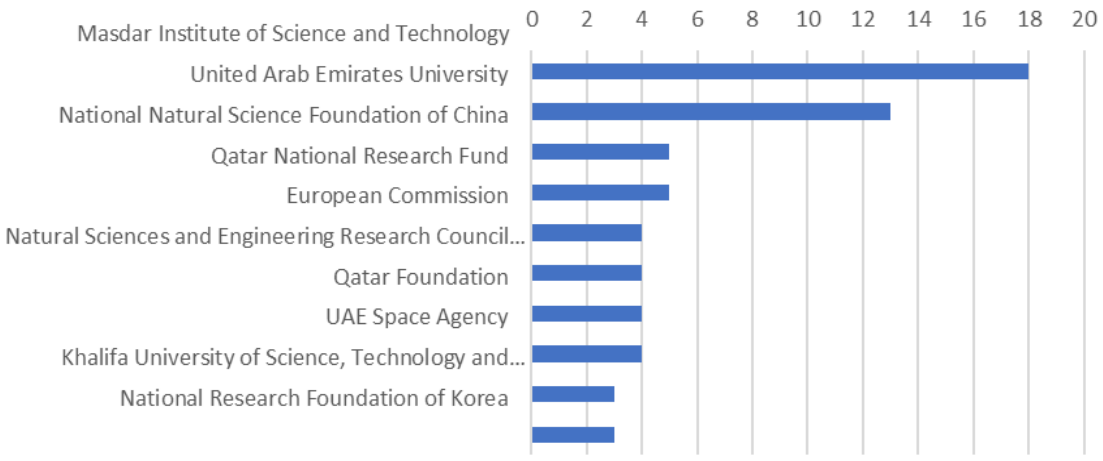

Figure 2. 2 Distribution of documents by the top ten funding sponsors

2.2.3. Subjects of Publications

Most papers focused on solar and wind energy, but there were also papers that explored a combination of more than one renewable energy source, which we call “hybrid system”. The first paper on renewable energy in the UAE, published in 1988, was on solar energy. The first studies on wind, biomass and geothermal energies were published in 1998. Publications related to wave energy followed in 2005 and on hybrid energy systems in 2008 (Fig 00). Over the last four years, the number of solar publications increased significantly, reaching 121 documents in 2018. Similar to solar energy publications, the number of documents cited in the Scopus database that related to wind energy rose to 99 publications in 2018 (Fig 1). The resources that were most frequently used as keywords in renewable energy publications in the UAE were solar and wind energy with a percentage of 64.58% and 52.15%, respectively. Although the hybrid system studies were more recently written, they now constitute the third-highest percentage of articles (35.31%) after solar and wind energy articles. The percentage for other systems was biomass (14.96%), geothermal (9.13%), and wave energy (5.28%).

The classification of the documents according to type showed that nearly half of all studies were published in the form of articles (47%), whereas almost a third of the studies were conference paper (31.6%). Figure 2.3 shows how the distribution of the publications depends on their type. The studies could be classified according to 24 topics. These vary from experimental approaches to theoretical approaches (policies, available systems, informational studies, ... etc.), with many variations in between. Figure 2.4 shows the ten most common types of studies found in the Scopus database. This variety revealed that energy studies were more than purely scientific. Energy has an interdisciplinary nature, including several disciplines in the social sciences, physical sciences, and engineering.

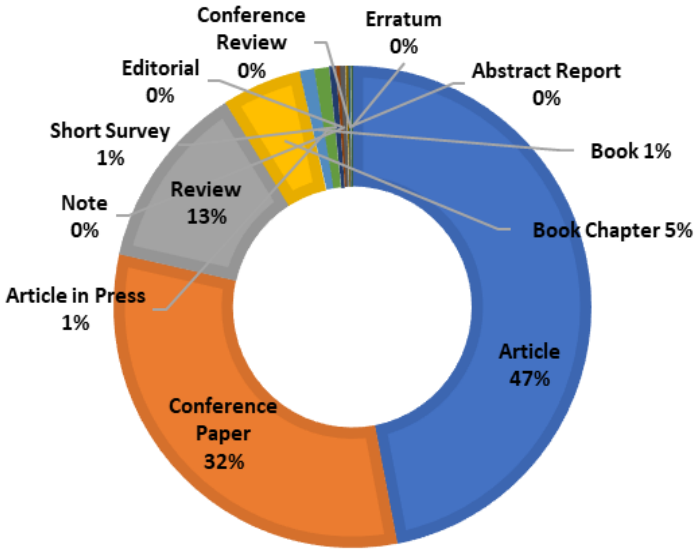

Figure 2. 3 Distribution of documents by type

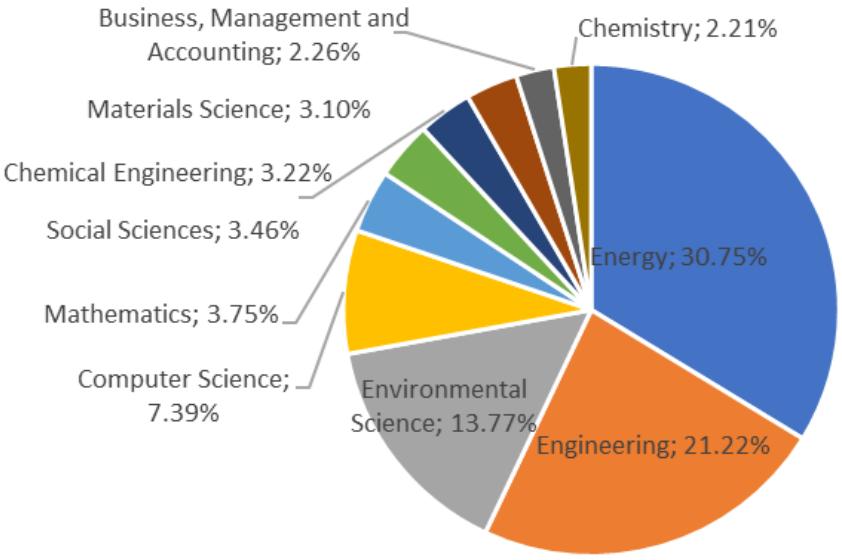

Figure 2. 4 Distribution of documents by subject area

3. QUESTIONNAIRE

In this chapter, a special questionnaire was designed to assess the level of awareness and acceptance of the renewable energy transition in the UAE and knowledge about RES and climate change. This questionnaire distributed to a sample of people all of whom currently live in the UAE. The questionnaire mainly checks people's awareness of renewable energy usage in their homes as well as electricity demand in the domestic sector. The main categories are general awareness, benefits, support and assistance, willingness, and action. The first section related to knowledge about policies, supportive strategies, and renewables' usage in the UAE. The second section sought to measure how informed people were about the benefits related to reducing or ending the consumption of fossil fuels, and whether people were environmentally friendly consumers or even prosumers. Next, the questionnaire sought to understand whether people were aware of the support and assistance that municipal and governmental parties can offer to citizens if they decide to start helping the ecosystem and use RES to generate power rather than oil and gas. The fourth section measured the willingness of people and their decisions, and whether these were affected by rules or regulations, economic benefits, strategic goals, and environmental issues. The last section measured how seriously people were about taking practical steps in their own lives to encourage the transition.

3.1. Study area

The UAE's population in 2018 was 9.54 million and is estimated to rise to 9.68 million in 2019, according to the data provided by the World Bank. The population was only 4.8 million in 2008, according to the UAE government's official website. The population has therefore almost doubled in a span of 10 years, which is complicated by the fact that people are people from many different cultures and backgrounds are now living in the country and provide a diverse expatriate community. Table 3.1 shows in detail the number of people in each age bracket in the UAE. The largest age group sample is between 25 and 54 years old, which indicates a large number of expats and immigrants living in the UAE. Some statistics suggest that around 80% of the population is not originally Emirati.

Table 3. 1 UAE Population Classified by Age

Age (years)	0-14	15-24	25-54	55-64	65+
Number of people (million)	1.36	1.21	6.29	0.54	0.14
Percentage (%)	14.20	12.70	65.90	5.70	1.50

3.2. Data Sources

The UAE population lives in seven emirates and is distributed almost unequally over the country. Roughly 70 percent live in Dubai and Abu Dhabi, with more than 3 million residents in each emirate. This is a logical result, as Dubai is the country's commercial capital, and Abu Dhabi is the political capital. Figure 3.1 shows the population percentage by geographical region in 2018 (World Bank, 2019).

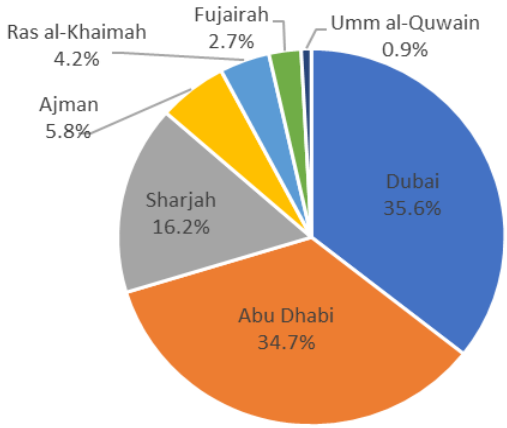

Figure 3. 1 The UAE population in each emirate in 2018 Source: World Bank, 2019

The data from the questionnaire was collected from the people who are living in Dubai. There are three reasons why Dubai was chosen. The first is that the Dubai population is about 3.32 million with a mix of nationalities, which can capture the whole mix of the UAE's people. The second is that the Dubai Municipality is focusing on the renewable energy transition, having already initiated green strategies to renewable energy usage and conducting several eco-initiatives. The third is the relatively ease of disseminating the questionnaire compared to other emirates. The researcher has a strong network there, including friends and colleagues whom not only answered the questionnaire but also shared it with to their family members, relatives, friends, and colleagues.

3.3. Methodology

The questionnaire was developed in four steps. The first was the preparation of the questions to cover the main areas that the thesis addresses and to answer the research sub-questions. The second step was designing a virtual questionnaire using Google Forms so that it will be easier to disseminate in the UAE. The template was chosen to be easy to complete and in the English language to allow people from different nationalities to participate. It was distributed throughout the researcher's and her friends' network among different categories of people from different backgrounds, cultures, genders, levels of education, nationalities, educational levels, and job positions. It also included such professionals as professors in universities and engineers in Dubai Municipality who are currently working on the Dubai Demand Side Management Strategy. The questionnaire was sent to 110 participants who are currently living in Dubai. The third step was analyzing the collected data using Google Forms for a normal analysis and SPSS (Statistical Package for the Social Sciences) program for more detailed analysis.

The survey consists of two sections: demographics and topic questions (as shown in Appendix A). The first section investigates general demographic and personal information about the people who filled the questionnaire, including age, gender, nationality, the highest level of education attained, living status, house ownership and family members. The second section investigates in detail citizens' awareness and acceptance of the "transition from fossil fuels to renewables" and what factors influence them. This section includes twelve questions, eleven of which were obligatory, and one was optional. There were three types of questions. The first type was the Yes or No question. The second type was multiple answer question with a five-point scale (5-strongly agree, 4-agree, 3-undecided, 2-disagree, 1-strongly disagree). The last question permitted a free writing response.

Google Forms provides a default of direct-and-simple analysis for the whole question, which is accepted for the first type of questions but not for the second part. As a result, the analysis of a total of 6 questions is done by the SPSS program (those questions are the obtained data from the second type of question and the eleventh question). The questions are arranged in sequence in terms of paragraphs starting from A and ending with F. The collected data from 110 people was checked and evaluated separately, and

then converted to values (numbers) and recorded for each question on a Microsoft Excel spreadsheet. The questionnaire results were tested using the ANOVA method. The analytical method ANOVA is used to check the relation (interaction and effect) between independent variables and the dependent variable, when more than two groups were compared. The results were analyzed in the Results and Analysis section of this chapter, which investigates the interaction between the many variables contributing to the renewable energy transition in the UAE and the effect of demographic categories.

3.4. Result and Analysis

This section represents the results of the questionnaire analysis, including reliability in the questionnaire sections, demographic data analysis, weighted averages for questionnaire results, and differences in the results according to demographic information.

3.4.1. Test of reliability

1- Cronbach's Alpha test

Cronbach's alpha coefficient of reliability (α) is measured to be 0.76. The value is $0.7 \leq \alpha < 0.8$ so that α is acceptable.

2- Split-half method

According to the table below, it is clear that the Cronbach's Alpha value for the two parts of the questionnaire is not equal (0.654 for the first part and 0.639 for the second part). As a result, the value of the Guttman split-half coefficient equals 0.662. As the Guttman coefficient value is above 0.65, it is an acceptable value.

Table 3. 2 Reliability Statistics of the Questionnaire

Cronbach's Alpha	Part 1	Value	0.654
		N of Items	15[a]
	Part 2	Value	0.639
		N of Items	15[b]
	Total N of Items		30
Correlation Between Forms			0.495
Spearman-Brown Coefficient	Equal Length		0.663
	Unequal Length		0.663
Guttman Split-Half Coefficient			0.662

According to the results, there is a good internal consistency score and accurate measuring of the variable of interest in the questionnaire parts.

3.4.2. Demographic Data Analysis

This part shows the differences between demographic information for the questionnaire's responders. Starting with age, Figure 3.2 shows that the largest age group is between 25 and 54 years old, which fits with the general population breakdown of the UAE (Table 3.1). Then, the age group between 15 and 24 years comes with 30% of total responders and, finally, people between 54 and 63 years old were the smallest share of this survey. In terms of gender, men accounted for 52% and women 48%. In terms of nationality, 22% of responders were Emiratis, while the rest were non-Emirates separated into different nationalities, with around half number of responders coming from Arabian people who are living in the UAE (Fig 3.3). The highest level of education for people was for those graduated from middle or high school to bachelor's degree and college, with a percentage of 58.7%. Of the responders, 8.3% completed higher education, either a master's or Ph.D.

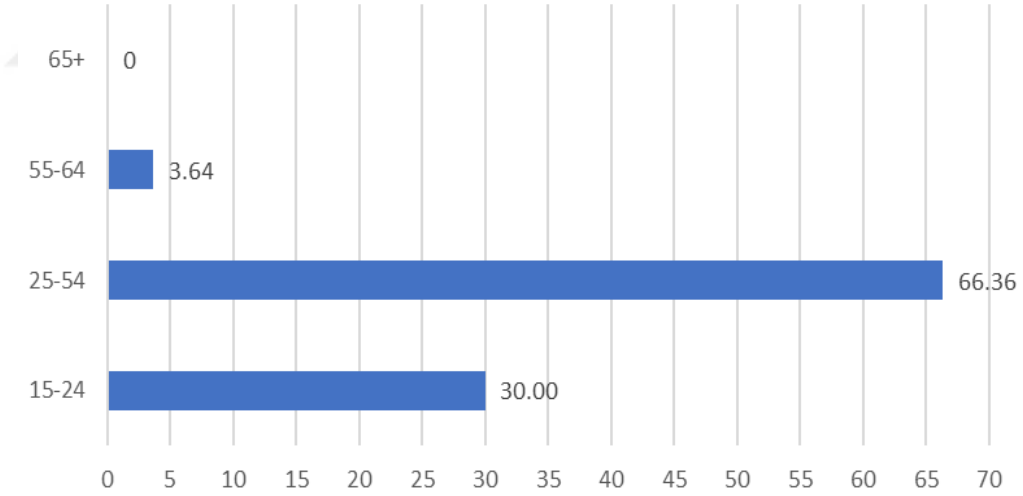

Figure 3. 2 The age groups analysis of the participants

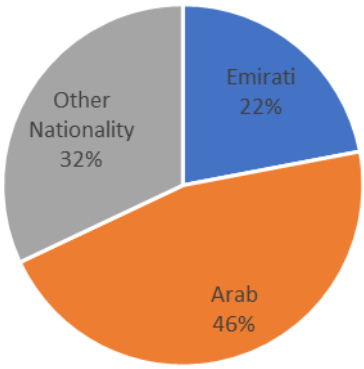

Figure 3. 3 The nationality results analysis in the sample

The last two questions asked about the home, including the number of family members living in the same place. The decision to have a renewable system, after all, could be a family decision, not simply one taken by an individual. The results of these questions are shown in the Figures 3.4 and 3.5.

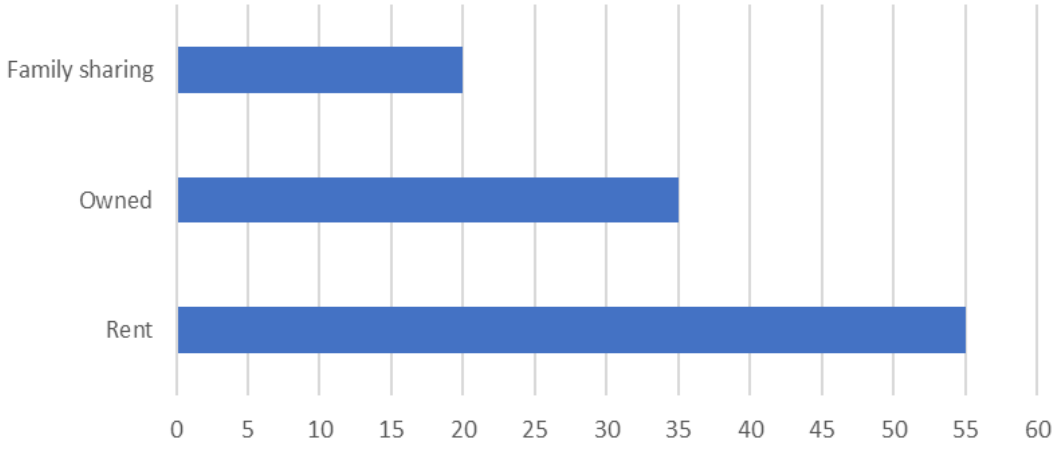

Figure 3. 4 The home property results analysis in the sample

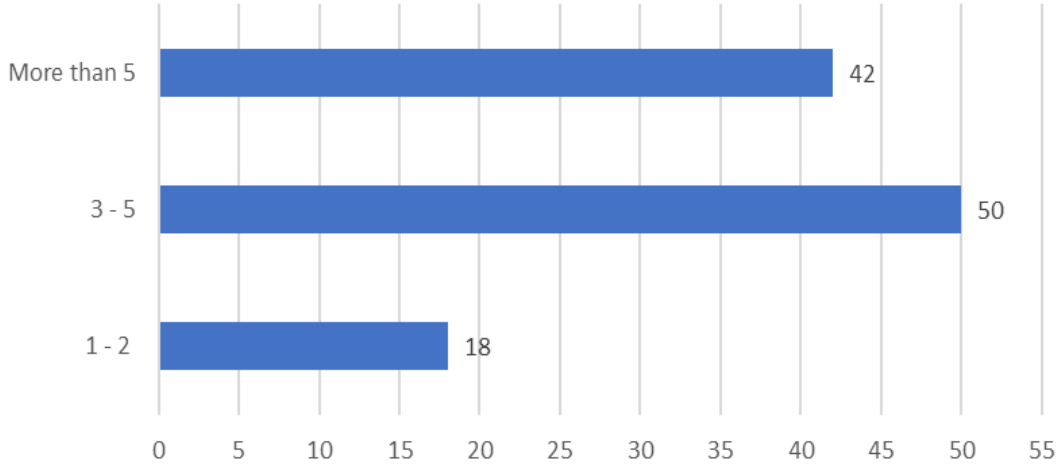

Figure 3. 5 The number of family members results analysis in the sample

3.4.3. Weighted Averages for Questionnaire Results

The value of the weighted averages of all the questions was averaged. The weighted average for each question equals 69%, 73%, 66%, 73%, 78%, and 84%, respectively, as shown in the tables below. For each question, item value, percentage, and standard deviation were measured. Then each sub-question was ranked in ascending order according to the calculated values.

Table 3.3 1 The Weighted Averages of the question A

Item	Item value	Percent	Std. dev.	Rank
Renewable energy resources are clean and environmentally friendly	4.4	88%	0.86	6
Fossil fuels are cheaper than renewable energy sources.	3.4	68%	1.031	4
There are many existing solar or wind-powered energy systems in my community.	3.3	67%	1.025	3
Our government has appropriate renewable energy regulations and strategies.	3.6	71%	0.944	5
I do not see any disadvantages to using fossil fuels	2.8	55%	1.248	1
Energy scarcity in the UAE will not be a problem for the foreseeable future because our country is a major oil producer and exporter in the world	3.1	63%	1.23	2
Total	3.4	69%	1.18	

Table 3.3 2 The Weighted Averages of the question B

Item	Item value	percent	Std. dev.	Rank
Climate change is an important global problem, posing a serious threat to people.	4.4	88%	0.721	6
Climate change is a natural phenomenon, we can't do anything about it	2.8	55%	1.226	2
The global temperatures have been rising over the past decade	4.2	83%	0.862	5
Each one of us is responsible for reducing the carbon footprint	4.0	81%	0.898	4
It should be mandatory to reduce energy usage if it reduces climate change	3.9	78%	0.986	3
The climate change topic is exaggerated by the media, in fact it is not that big of a deal	2.7	53%	1.245	1
Total	3.7	73%	1.22	

Table 3.3 3 The Weighted Averages of the question C

Item	Item value	percent	Std. dev.	Rank
Switching to renewables is impossible for technical and economic reasons	3.0	60%	1.149	2.5
We can begin using renewable energy after oil and gas run out.	3.0	61%	1.252	2.5
The major impediment to replacing fossil fuels with renewable energy is people acceptance to implement the new systems	3.6	72%	0.951	4.0
Vested interests in perpetuating the fossil fuel system prevent renewables from growing	3.8	76%	0.771	5.5
Technological progress in renewable energy will soon make it so inexpensive in the normal market	3.8	77%	0.956	5.5
No option of renewable energy can make a real difference to reduce climate change	2.7	54%	1.163	1.0
Total	3.3	66%	1.14	

Table 3.3 4 The Weighted Averages of the question D

Item	**Item value**	**percent**	**Std. dev.**	**Rank**
The best solution would be to transit into renewable energy.	4.2	84%	0.731	6.0
Energy efficiency will solve the problem	3.8	77%	0.862	3.0
We cannot collect enough energy utilizing renewables to replace the amount of energy we currently access from fossil fuels	3.2	65%	1.066	2.0
Oil and gas resources of the UAE will never finish	2.5	50%	1.247	1.0
The government should increase the incentives for people who try to use reduce energy consumption	4.1	81%	0.798	4.5
Municipality should offer local incentives, rebates, or loans for solar systems	4.1	82%	0.78	4.5
Total	3.7	73%	1.11	

Table 3.3 5 The Weighted Averages of the question E

Item	Item value	Percent	Std. dev.	Rank
Establishing more renewable energy facilities will boost public health and reap numerous environmental benefits	4.3	86%	0.724	5.5
Reducing electricity bill	4.3	85%	0.728	5.5
Being as a source of income from selling excess energy generated	3.8	76%	0.917	2.5
Achieving energy sources diversity in my home and in the country	3.9	79%	0.876	4.0
After installation renewable system facilities, there is low to zero maintenance required	3.2	64%	1.168	1.0
Renewable energy can guarantee a huge and steady energy supply to a nation for many years	3.8	77%	0.991	2.5
Total	3.9	78%	0.98	

Table 3.3 6 The Weighted Averages of the question F

Item	**Item value**	**percent**	**Std. dev.**
How likely would you be to recommend your friend or colleague to start using them?	4.2	84%	0.822

3.4.4. Result Differences According to Demographic Information

The last part of the results discussion and analysis relied on the ANOVA and the Scheffe methods. In this section the differences in the results according to age, gender, nationality, last educational certificate received, home property, and number of family members living in the same house are studied. Table 3.4.1 shows the differences in the results according to the age category.

Table 3.4 1 The differences in the results according to the age category (ANOVA)

		Sum of Squares	df	Mean Square	F	Sig.
Average A1	Between Groups	1.106	2	0.553	1.536	0.220
	Within Groups	38.522	107	0.360		
	Total	39.628	109			
Average B	Between Groups	.467	2	0.234	1.156	0.319
	Within Groups	21.628	107	0.202		
	Total	22.095	109			
Average C	Between Groups	1.252	2	.626	1.891	0.156
	Within Groups	35.422	107	.331		
	Total	36.674	109			
Average D	Between Groups	1.050	2	.525	2.753	0.068
	Within Groups	20.409	107	.191		
	Total	21.460	109			
Average E	Between Groups	2.983	2	1.491	4.056	.020
	Within Groups	39.343	107	.368		
	Total	42.326	109			
Average F	Between Groups	1.146	2	.573	.846	0.432
	Within Groups	72.454	107	.677		
	Total	73.600	109			
Average ALL	Between Groups	.948	2	.474	4.204	0.017
	Within Groups	12.061	107	.113		
	Total	13.009	109			

The values of (sig) in Table 3.4.1 clearly show that there are no statistically significant differences in the questionnaire results according to age in the first four questions and the sixth one. However, there are statistically significant differences according to age in the fifth question and in the overall questionnaire results. A post-test was obtained in this case using the Scheffe method to check which age group dominated over other groups and is shown in Table 3.4.2.

Table 3.4 2 The differences in the results according to age (Scheffe analysis)

Dependent Variable	(I) age	(J) age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Boundary	Upper Boundary
Avg_a1	15-24	25-54	-.013-	.122	.994	-.31-	.29
		5-64	.526	.315	.253	-.26-	1.31
	25-54	15-24	.013	.122	.994	-.29-	.31
		55-64	.539	.309	.222	-.23-	1.31
	55-64	15-24	-.526-	.315	.253	-1.31-	.26
		25-54	-.539-	.309	.222	-1.31-	.23
Avg_B	15-24	25-54	-.133-	.091	.349	-.36-	.09
		55-64	-.184-	.236	.739	-.77-	.40
	25-54	15-24	.133	.091	.349	-.09-	.36
		55-64	-.051-	.231	.976	-.63-	.52
	55-64	15-24	.184	.236	.739	-.40-	.77
		25-54	.051	.231	.976	-.52-	.63
Avg_C	15-24	25-54	-.205-	.117	.219	-.49-	.08
		55-64	.114	.302	.931	-.64-	.86
	25-54	15-24	.205	.117	.219	-.08-	.49
		55-64	.319	.296	.562	-.42-	1.05
	55-64	15-24	-.114-	.302	.931	-.86-	.64
		25-54	-.319-	.296	.562	-1.05-	.42
Avg_D	15-24	25-54	-.202-	.088	.078	-.42-	.02
		55-64	-.011-	.230	.999	-.58-	.56
	25-54	15-24	.202	.088	.078	-.02-	.42
		55-64	.191	.225	.697	-.37-	.75
	55-64	15-24	.011	.230	.999	-.56-	.58
		25-54	-.191-	.225	.697	-.75-	.37
Avg_E	15-24	25-54	-.332-*	.123	.029	-.64-	-.03-
		55-64	.068	.319	.978	-.72-	.86
	25-54	15-24	.332*	.123	.029	.03	.64

		55-64	.400	.312	.443	-.37-	1.17
	55-64	15-24	-.068-	.319	.978	-.86-	.72
		25-54	-.400-	.312	.443	-1.17-	.37
Avg F	15-24	25-54	-.200-	.167	.487	-.61-	.21
		55-64	.079	.433	.983	-.99-	1.15
	25-54	15-24	.200	.167	.487	-.21-	.61
		55-64	.279	.423	.805	-.77-	1.33
	55-64	15-24	-.079-	.433	.983	-1.15-	.99
		25-54	-.279-	.423	.805	-1.33-	.77
Avg_ALL	15-24	25-54	-.178-*	.068	.037	-.35-	-.01-
		55-64	.102	.176	.847	-.34-	.54
	25-54	15-24	.178*	.068	.037	.01	.35
		55-64	.279	.173	.275	-.15-	.71
	55-64	15-24	-.102-	.176	.847	-.54-	.34
		25-54	-.279-	.173	.275	-.71-	.15

*The mean difference is significant at the 0.05 level.

The results in the previous table reveal that the age group between 25 and 54 dominated the differences in the results of the fifth question and the overall results over the age group of between 15 and 24. This is a logical result given the fact that 65.90% of people in the UAE are between 25 and 54 years old, but are alarmed that the next generation will not have the ability to control their future options related to green transition, at least in the near future.

The second table (Table 3.5.1 and 3.5.2) in this part presents the differences in the results according to gender. The values of (sig) in the whole columns in both of Tables 3.5a and 3.5b are higher than 5%, which means being male or female does not affect the questionnaire replies, as there are no statistical differences according to gender.

Table 3.5. 1 The results differences according to gender according to group statistics

Question	Gender	N	Mean	Std. Deviation	Std. Error Mean
Avg_A	Male	63	3.34	.595	.075
	Female	47	3.56	.597	.087
Avg_B	Male	63	3.64	.421	.053
	Female	47	3.68	.491	.072
Avg_C	Male	63	3.26	.580	.073
	Female	47	3.39	.578	.084

Avg_D	Male	63	3.66	.360	.045
	Female	47	3.65	.540	.079
Avg_E	Male	63	3.81	.673	.085
	Female	47	4.01	.534	.078
F	Male	63	4.14	.895	.113
	Female	47	4.28	.713	.104
Avg_ALL	Male	63	3.56	.329	.042
	Female	47	3.68	.358	.052

Table 3.5. 2 The results differences according to gender according to independent samples test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Avg_A	Equal variances assumed	.104	.748	-1.899-	108	.060	-.218-	.115	-.446-	.010
	Equal variances not assumed			-1.898-	99.048	.061	-.218-	.115	-.446-	.010
Avg_B	Equal variances assumed	.816	.368	-.456-	108	.649	-.040-	.087	-.212-	.133
	Equal variances not assumed			-.446-	90.164	.657	-.040-	.089	-.217-	.137
Avg_C	Equal variances assumed	.113	.738	-1.156-	108	.250	-.129-	.112	-.350-	.092
	Equal variances not assumed			-1.157-	99.471	.250	-.129-	.112	-.350-	.092

Avg_D	Equal variances assumed	3.947	.049	.145	108	.885	.012	.086	-.158-	.183
	Equal variances not assumed			.137	75.494	.892	.012	.091	-.169-	.193
Avg_E	Equal variances assumed	3.632	.059	-1.742-	108	.084	-.207-	.119	-.443-	.029
	Equal variances not assumed			-1.801-	107.561	.074	-.207-	.115	-.435-	.021
F	Equal variances assumed	.143	.706	-.843-	108	.401	-.134-	.159	-.448-	.181
	Equal variances not assumed			-.871-	107.501	.385	-.134-	.153	-.438-	.170
avg_ALL	Equal variances assumed	.830	.364	-1.773-	108	.079	-.117-	.066	-.248-	.014
	Equal variances not assumed			-1.751-	94.419	.083	-.117-	.067	-.249-	.016

The third table presents the results differences according to nationality.

Table 3.6. 1 The results differences according to nationality (ANOVA)

		Sum of Squares	df	Mean Square	F	Sig.
Avg_a1	Between Groups	2.090	2	1.045	2.979	.055
	Within Groups	37.538	107	.351		
	Total	39.628	109			
Avg_B	Between Groups	1.736	2	.868	4.562	.013
	Within Groups	20.359	107	.190		

	Total	22.095	109			
Avg_C	Between Groups	.958	2	.479	1.435	.243
	Within Groups	35.716	107	.334		
	Total	36.674	109			
Avg_D	Between Groups	.056	2	.028	.141	.868
	Within Groups	21.403	107	.200		
	Total	21.460	109			
Avg_E	Between Groups	1.297	2	.648	1.691	.189
	Within Groups	41.029	107	.383		
	Total	42.326	109			
F	Between Groups	1.514	2	.757	1.123	.329
	Within Groups	72.086	107	.674		
	Total	73.600	109			
Avg_ALL	Between Groups	.623	2	.311	2.689	.073
	Within Groups	12.386	107	.116		
	Total	13.009	109			

The values of (sig) for whole questions (except the second question) in Table 3.6.1 are within the accepted values, which means that nationality including cultural background did not affect people's opinions in this sample. All the Emirati citizens and people from several nationalities responded with no direct effect of not being citizens of Emirates. The Scheffe test results were calculated in the case of the second question to check which nationality group has more effect over other groups and are shown in Table 3.6.2.

Table 3.6. 2 The results differences according to nationality (Scheffe)

Dependent Variable	(I) nationality	(J) nationality	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
avg_a1	Emirati	Arab	.046	.138	.947	-.30-	.39
		other Nationality	.357	.164	.099	-.05-	.77
	Arab	Emirati	-.046-	.138	.947	-.39-	.30
		other Nationality	.311	.142	.094	-.04-	.66
	other	Emirati	-.357-	.164	.099	-.77-	.05

	Nationality	Arab	-.311-	.142	.094	-.66-	.04
avg_B	Emirati	Arab	-.267-*	.102	.035	-.52-	-.01-
		other Nationality	-.034-	.121	.962	-.33-	.27
	Arab	Emirati	.267*	.102	.035	.01	.52
		other Nationality	.233	.104	.088	-.03-	.49
	other Nationality	Emirati	.034	.121	.962	-.27-	.33
		Arab	-.233-	.104	.088	-.49-	.03
avg_C	Emirati	Arab	-.186-	.135	.389	-.52-	.15
		other Nationality	.002	.160	1.000	-.40-	.40
	Arab	Emirati	.186	.135	.389	-.15-	.52
		other Nationality	.188	.138	.400	-.16-	.53
	other Nationality	Emirati	-.002-	.160	1.000	-.40-	.40
		Arab	-.188-	.138	.400	-.53-	.16
avg_D	Emirati	Arab	-.055-	.104	.870	-.31-	.20
		other Nationality	-.043-	.124	.943	-.35-	.27
	Arab	Emirati	.055	.104	.870	-.20-	.31
		other Nationality	.012	.107	.993	-.25-	.28
	other Nationality	Emirati	.043	.124	.943	-.27-	.35
		Arab	-.012-	.107	.993	-.28-	.25
avg_E	Emirati	Arab	-.264-	.144	.192	-.62-	.09
		other Nationality	-.203-	.172	.499	-.63-	.22
	Arab	Emirati	.264	.144	.192	-.09-	.62
		other Nationality	.061	.148	.919	-.31-	.43
	other Nationality	Emirati	.203	.172	.499	-.22-	.63
		Arab	-.061-	.148	.919	-.43-	.31
F	Emirati	Arab	.109	.191	.850	-.37-	.58
		other Nationality	.333	.228	.347	-.23-	.90
	Arab	Emirati	-.109-	.191	.850	-.58-	.37
		other Nationality	.224	.196	.523	-.26-	.71
	other Nationality	Emirati	-.333-	.228	.347	-.90-	.23
		Arab	-.224-	.196	.523	-.71-	.26
avg_ALL	Emirati	Arab	-.137-	.079	.229	-.33-	.06
		other Nationality	.026	.094	.963	-.21-	.26

	Arab	Emirati	.137	.079	.229	-.06-	.33
		other Nationality	.163	.081	.139	-.04-	.37
	other Nationality	Emirati	-.026-	.094	.963	-.26-	.21
		Arab	-.163-	.081	.139	-.37-	.04

*The mean difference is significant at the 0.05 level.

According to the results shown in the previous table, it is clear that the differences in the responses related to the nationality variable in the second question are due to the differences between the responses of Arabs and Emiratis, and that the Arabs' responses dominated in this question over those of Emiratis.

The fourth table presents the results differences according to educational levels. The sig value shows that there are no differences in the sample replies to whole questions according to education level. So, holding a Ph.D. or graduating from the middle school did not affect the results.

Table 3.7 1 The results differences according to educational levels (ANOVA)

		Sum of Squares	df	Mean Square	F	Sig.
avg_a1	Between Groups	3.006	5	.601	1.707	.139
	Within Groups	36.622	104	.352		
	Total	39.628	109			
avg_B	Between Groups	.245	5	.049	.233	.947
	Within Groups	21.850	104	.210		
	Total	22.095	109			
avg_C	Between Groups	1.614	5	.323	.957	.447
	Within Groups	35.060	104	.337		
	Total	36.674	109			
avg_D	Between Groups	.580	5	.116	.578	.717
	Within Groups	20.880	104	.201		
	Total	21.460	109			
avg_E	Between Groups	4.094	5	.819	2.227	.057
	Within Groups	38.232	104	.368		
	Total	42.326	109			
F	Between Groups	5.082	5	1.016	1.543	.183

	Within Groups	68.518	104	.659		
	Total	73.600	109			
avg_ALL	Between Groups	.354	5	.071	.582	.714
	Within Groups	12.655	104	.122		
	Total	13.009	109			

The table below shows the results differences according to the home property for the targeted sample.

Table 3.8. 1 The results differences according to home property (ANOVA)

		Sum of Squares	df	Mean Square	F	Sig.
avg_a1	Between Groups	.243	2	.122	.331	.719
	Within Groups	39.384	107	.368		
	Total	39.628	109			
avg_B	Between Groups	1.511	2	.755	3.927	.023
	Within Groups	20.584	107	.192		
	Total	22.095	109			
avg_C	Between Groups	.189	2	.095	.278	.758
	Within Groups	36.485	107	.341		
	Total	36.674	109			
avg_D	Between Groups	.058	2	.029	.145	.865
	Within Groups	21.402	107	.200		
	Total	21.460	109			
avg_E	Between Groups	.959	2	.480	1.241	.293
	Within Groups	41.366	107	.387		
	Total	42.326	109			
F	Between Groups	3.884	2	1.942	2.981	.055
	Within Groups	69.716	107	.652		

	Total	73.600	109			
avg_ALL	Between Groups	.457	2	.228	1.946	.148
	Within Groups	12.552	107	.117		
	Total	13.009	109			

The sig value shows that there are no differences to whole questions, except the second one, between people who rent their homes and those who own them or share them with others (Table 3.8.1). The Scheffe method was applied to check which category dominated the second question. It showed that the people who rent have more effects on the answers of the second question than those who share their homes with others (Table 3.8.2).

Table 3.8. 2 The results differences according to home property (Scheffe)

Dependent Variable	(I) home_p	(J) home_p	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Avg_A1	Rent	Owned	.080	.136	.841	-.26-	.42
		Family sharing	.109	.154	.778	-.27-	.49
	Owned	Rent	-.080-	.136	.841	-.42-	.26
		Family sharing	.029	.173	.986	-.40-	.46
	Family sharing	Rent	-.109-	.154	.778	-.49-	.27
		Owned	-.029-	.173	.986	-.46-	.40
Avg_B	Rent	Owned	.118	.098	.489	-.13-	.36
		Family sharing	.309*	.111	.024	.03	.59
	Owned	Rent	-.118-	.098	.489	-.36-	.13
		Family sharing	.191	.125	.313	-.12-	.50
	Family sharing	Rent	-.309-*	.111	.024	-.59-	-.03-
		Owned	-.191-	.125	.313	-.50-	.12
Avg_C	Rent	Owned	.098	.131	.758	-.23-	.42
		Family sharing	.036	.148	.972	-.33-	.40
	Owned	Rent	-.098-	.131	.758	-.42-	.23
		Family sharing	-.062-	.166	.933	-.47-	.35
	Family sharing	Rent	-.036-	.148	.972	-.40-	.33
		Owned	.062	.166	.933	-.35-	.47
Avg_D	Rent	Owned	.017	.100	.986	-.23-	.27

		Family sharing	.061	.114	.865	-.22-	.34
	Owned	Rent	-.017-	.100	.986	-.27-	.23
		Family sharing	.044	.127	.941	-.27-	.36
	Family sharing	Rent	-.061-	.114	.865	-.34-	.22
		Owned	-.044-	.127	.941	-.36-	.27
Avg_E	Rent	Owned	.158	.139	.528	-.19-	.50
		Family sharing	.218	.158	.388	-.17-	.61
	Owned	Rent	-.158-	.139	.528	-.50-	.19
		Family sharing	.060	.177	.944	-.38-	.50
	Family sharing	Rent	-.218-	.158	.388	-.61-	.17
		Owned	-.060-	.177	.944	-.50-	.38
F	Rent	Owned	.340	.181	.177	-.11-	.79
		Family sharing	.421	.205	.127	-.09-	.93
	Owned	Rent	-.340-	.181	.177	-.79-	.11
		Family sharing	.081	.230	.940	-.49-	.65
	Family sharing	Rent	-.421-	.205	.127	-.93-	.09
		Owned	-.081-	.230	.940	-.65-	.49
Avg_ALL	Rent	Owned	.102	.077	.417	-.09-	.29
		Family sharing	.156	.087	.207	-.06-	.37
	Owned	Rent	-.102-	.077	.417	-.29-	.09
		Family sharing	.054	.097	.860	-.19-	.30
	Family sharing	Rent	-.156-	.087	.207	-.37-	.06
		Owned	-.054-	.097	.860	-.30-	.19

*. The mean difference is significant at the 0.05 level.

The last table presents the results differences according to the number of family members living in the same home.

Table 3.9 1 The results differences according to home property (ANOVA)

		Sum of Squares	df	Mean Square	F	Sig.
Avg_a1	Between Groups	1.220	2	.610	1.699	.188
	Within Groups	38.408	107	.359		
	Total	39.628	109			
Avg_B	Between Groups	.036	2	.018	.087	.917

	Within Groups	22.059	107	.206		
	Total	22.095	109			
Avg_C	Between Groups	.261	2	.130	.383	.683
	Within Groups	36.413	107	.340		
	Total	36.674	109			
Avg_D	Between Groups	.343	2	.171	.868	.423
	Within Groups	21.117	107	.197		
	Total	21.460	109			
Avg_E	Between Groups	1.702	2	.851	2.241	.111
	Within Groups	40.624	107	.380		
	Total	42.326	109			
F	Between Groups	.704	2	.352	.516	.598
	Within Groups	72.896	107	.681		
	Total	73.600	109			
Avg_ALL	Between Groups	.043	2	.022	.179	.836
	Within Groups	12.966	107	.121		
	Total	13.009	109			

The results in terms of sig values revealed no differences in the answers according to the number of family members in the home.

4. CONCLUSIONS and RECOMMENDATIONS

The renewable energy transition in the UAE appears to be on the verge of taking off. There have been important steps taken in policymaking, initiatives, strategies, green-energy plans, and even the rise of green parties, all of which will enable a future transition. Yet, to date, there have not been enough concrete steps towards implementing these plans. The share of RES in the total energy mix remains negligible (only 0.2% of the total primary energy consumption) and has thus not succeeded in stopping or even limiting the burning of fossil fuels to generate electricity in any sector of the economy in any material way.

The efforts currently underway are being done systematically. Programs and initiatives are progressing on a daily basis, which shows the intention of the country to shift to greater usage of RES in the coming years. However, a deep transition to RES still requires more developed methods and larger support from the government and municipalities.

This thesis has focused on the UAE's renewable energy transition from the perspective of the scientific studies and people's awareness. The bibliometric study estimated the quantity and quality of research about the transition, while the questionnaire sought to ascertain the opinions and preferences of people living in the country. Those two approaches together provide important insights into the progress of the transition and some additional information about RES development in the UAE. The key findings of this thesis can contribute to solving an important problem, namely the availability of information about RES in the GCC countries, which is still underdeveloped in the international literature.

The first set of findings of this thesis is related to understanding the scientific study of RES in the UAE. The second chapter includes the bibliometric analysis of the data collected from the Scopus database on the transition to RES in the UAE published over the span of 30 years, from 1988 to 2018. The analysis determined the most frequent patterns in the academic literature, which can provide detailed insight into the research efforts that have been undertaken to better understand RES in the UAE. A total of 909 publications met the criteria set for the analysis. A manual check was completed to include several classifications according to variables that shaped the quality and

quantity of research. The number of publications on solar and wind was predominant. There was a notable increase in the number of documents published after 2008 about solar and wind energy in the UAE, and approximately half of the total contributions were published within the last four years. This increase is resulted largely because of IRENA's establishment in the country and sound governmental policies. IRENA enriched the research approach towards the UAE, especially by encouraging domestic researchers. In addition, aggressive government policies and initiatives, which aimed to diversify and strengthen the UAE's economy with RES and energy efficiency programs, played important roles. The results revealed that 75% of the publications were articles or conference papers, and almost all of these studies were written in English. About 160 authors were involved, and more than one author wrote many of the papers. The number of authors and affiliations indicated that many publications were co-authored by researchers from different affiliations, which means that there is some collaboration occurring across national borders. Moreover, the number of fund sponsors interested in investing in RES-related research came from the UAE and outside the country. It was also noteworthy that China, the European Union, and Canada have also funded research to study issues related to the UAE renewable energy systems. These findings showed that the trend of transitioning from fossil fuels to RES have become an international issue in the twenty-first century.

The second set of findings of this thesis is based on a virtual questionnaire that sough to understand people's awareness and acceptance towards several issues, including the benefits and definitions of RES, climate change, and the accessibility to install renewable energy systems in the country. The sample included 110 people living in Dubai, and included many different categories of gender, age, educational levels, and other classifications that normally affected the answers. According to the results gained from the questionnaire analysis, there was a good internal consistency score and accurate measuring of the variable of interest in the questionnaire parts. The demographic analysis showed that the largest age group that answered the questions was people between 25 and 54 years old and less than a quarter of people were Emirati citizens. The weighted averages for questionnaire results for all questions were calculated to be higher than the average. The differences in the results according to the demographic information were also calculated for each question. The values of (sig) in

half of the questions set clearly showed that there were no statistically significant differences in the questionnaire results according to gender, educational level, or the number of family members living in the same home. The other three sets of questions show differences in the results according to age, nationality, and home property. People between 15 and 24 years old will be the ones who most significantly shape the future of RES and the renewable energy transition, but they did not have the right to decide to install renewable systems or even know enough information about RES and climate change. The people who are living in rented houses were found to be not part of decision making to install renewable energy systems but once they have the chance to own houses, they have enough motivation to generate electricity from RES. More than eighty percent of participants said that they will recommend that friends or colleagues start using RES in their daily lives.

The results obtained from this thesis provide valuable information for policymakers in the UAE and other oil and gas-rich countries to better identify plans and understand the situation of their countries according to the viewpoints of their citizens. This research could also be vital for other researchers, who can apply bibliometric study to other energy-related fields and recognize which ideas have already being well covered and choose the research topics that should be studied, in light of their absence in the existing literature.

The recommendations for future research can be classified into three major categories. The first recommendation is to keep studying the circumstances in the oil and gas-rich countries, especially the GCC countries. These countries are playing an outsized role in providing the world with hydrocarbons and their transformations can change the whole equation for the renewable energy transition. If these countries shift to renewables, it will reflect not only on their countries but also on the entire world. The research level is not that high, however, and there are many areas that need more coverage and understanding. Further studies on the opinions of all stakeholders, including industry players and government entities, could be compared to this questionnaire and could help lead, in a small way, to the implementation of the renewable energy transition. Experts and researchers should be able to give their opinions and thus find collaboration between the government’s efforts and people's acceptance of the need to shift to RES. The findings from those questionnaires and interviews, in other words, could form the

basis to build the policy and initiatives in the UAE. Moreover, researchers should be funded by a larger number of sponsors or even by the government, so that it will be easier to study the phenomena of the renewable energy transition without financial hardship.

The second recommendation relates to the accessibility of data and research. The government should take concrete steps and accept the requests of researchers to interview the people who are managing the transition process, as a large number of them are from the royal family. It was hard to reach and meet with these people, who can give more helpful and informed insights into the transition's progress, especially researchers who are living outside the country and face financial hardship in getting a visa to enter the UAE or meet people in such important positions. The easier it is to reach those people and talk with them, the better the research results will be, and the more benefits will be obtained for subsequent research and applied steps.

The third recommendation is to focus more on the adaption to climate change, not only in terms of using RES but also in energy efficiency applications and energy conservation. The more that citizens use energy, the more the country will experience economic and environmental problems. The transition to renewables could be part of the process to reduce the carbon footprints in the UAE and mitigate the negative effects of climate change. This adaption should begin in kindergarten and primary school, as these children will be the future generations who will be most affected by climate change. If citizens are educated at an early age about the costs and negative effects of using fossil fuels as well as the benefits of using RES, they will make environment-friendly choices about energy in the future and create a better life and more protected environment.

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CURRICULUM VITAE

Personal Information

Name Surname : Eman Abusaada
Place and Date of Birth : Palestine, 20/11/1990

Education

2018- 2020: M.A. Energy and Sustainable Development, Kadir Has University, Turkey.

2008- 2013: B.Sc. Civil Engineering, Islamic University of Gaza (IUG), Palestine.

Language Skills

Arabic (native), English (Advanced), Turkish (Intermediate)

Honors and awards

- Kadir Has university scholarship (50% of master's degree fees), 2018
- Asil Vakfi, a master's degree scholarship, 2018
- Techwoman fellow, Fellowship in the Silicon Valley in the US, 2015
- "Creatives" project grant for undergraduate gradation project, IUG, 2013

Work Experience

2016 - 2018	National Monitoring Engineer- Infrastructure Engineer
	UNOPS- MMU Project (CTG Global contract)
2015	Office Engineer
	Khozendar Sons Company l.td.
2014 - 2015	Damage Assessment Engineer
	UNRWA (Infrastructure and Camps Improvement Department)
2014	Damage Assessment Engineer
	UNDP (in a joint venture with Palestinian Contractors Union)
2013 - 2014	Office Engineer – part-time job
	Al Hawasem Company for Trading and Contracting
2016 - 2017	Project Coordinator - Banat-tech program
	The US Consulate of Jerusalem
2016	Project Coordinator
	The Agricultural Development Association, GIZ-funded project
2015	Techwomen Mentee
	SunEdison, The US office (Operational and solar headquarters)

Contact:

Telephone : 00905537166982
E-mail Address : em.abusaada@gmail.com

APPENDIX A

A.1 The questionnaire

I. Participation Information

This questionnaire is for a research study concerned with renewable energy alternatives to oil and gas within the UAE and the public opinion on such. This survey aims to identify the citizens' awareness and acceptance of "transition from fossil fuels to renewables" and what factors influence them.

Through this brief survey, all the information you provide will be completely confidential and anonymous and will not be passed on to any third parties. As you'll see in the following section none of your personal information is asked.

Your response will only be used for survey purposes and will be destroyed once research completed. No one other than the researcher will know your individual responses to this questionnaire. In case you have any queries regarding the survey, please contact me at emabusaada@gmail.com.

II. Demographic Data

Age:

15-24	25-54	55-64	65+

Gender:

Male	Female

Nationality:

Emirati	Arab	Other Nationality

Highest level of education

Middle school	High school	College	Bachelor's Degree	Master's Degree	Doctoral Degree

Home property:

Rent	Owned	Family sharing

Number of Family Members Living in the Same House:

1-2	3-5	More than 5

III. Questions

1- Do you know the difference between renewable (solar, wind, geothermal, etc.) and fossil fuels (coal, oil, natural gas)?

Yes	No

2- Please state your level of agreement to the following points:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Renewable energy resources are clean and environmentally friendly					
Fossil fuels are cheaper than renewable energy sources.					
There are many existing solar or wind-powered energy systems in my community.					
Our government has appropriate renewable energy regulations and strategies.					
I do not see any disadvantages to using fossil fuels					
Energy scarcity in the UAE will not be a problem for the foreseeable future because our country is a major oil producer and exporter in the world					

3- Do you know what climate change means?

Yes	No

4- Please state your level of agreement to the following points:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Climate change is an important global problem, posing a serious threat to people.					
Climate change is a natural phenomenon, we can't do anything about it					
The global temperatures have been rising over the past decade					
Each one of us is responsible for reducing the carbon footprint					
It should be mandatory to reduce energy usage if it reduces climate change					
The climate change topic is exaggerated by the media, in fact it is not that big of a deal					

5- Do you think there is an urgent need to switch from fossil fuels to renewables?

Yes	No

6- Please state your level of agreement to the following points:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Switching to renewables is impossible for technical and economic reasons					
We can begin using renewable energy after oil and gas run out.					
The major impediment to replacing fossil fuels with renewable energy is people acceptance to implement the new systems					

Vested interests in perpetuating the fossil fuel system prevent renewables from growing					
Technological progress in renewable energy will soon make it so inexpensive in the normal market					
No option of renewable energy can make a real difference to reduce climate change					

7- It is estimated that oil in the UAE will run out within the next 92 years, and gas much earlier, in just 68 years. Are you concerned about these statistics?

Very concerned	Concerned	Neutral	Not concerned	Not concerned at all

8- Please state your level of agreement about solutions to declining of oil and gas in the UAE

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The best solution would be to transit into renewable energy.					
Energy efficiency will solve the problem					
We cannot collect enough energy utilizing renewables to replace the amount of energy we currently access from fossil fuels					
Oil and gas resources of the UAE will never finish					
The government should increase the incentives for people who try to use reduce energy consumption					
Municipality should offer local incentives, rebates, or loans for solar systems					

9- Have you already owned a renewable energy system such as solar panels or wind in your properties?

Yes	No	Planning to have

10- The following benefits may let you purchase a renewable energy system for your home. Please rate each one of the benefits you are likely to enjoy.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Establishing more renewable energy facilities will boost public health and reap numerous environmental benefits					
Reducing electricity bill					
Being as a source of income from selling excess energy generated					
Achieving energy sources diversity in my home and in the country					
After installation renewable system facilities, there is low to zero maintenance required					
Renewable energy can guarantee a huge and steady energy supply to a nation for many years					

11- How likely would you be to recommend your friend or colleague to start using them?

Highly recommend	Recommend	Neutral	Not Recommend	Highly not recommend

12- Any comments/suggestions to help promote consumption of renewable energy? (optional)

IV. Thank you for sharing your thoughts with me.