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Article

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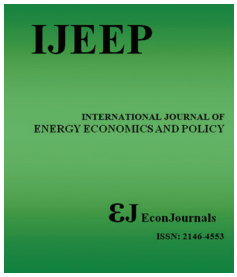

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Challenges and Barriers for Renewable Energy Implementation in the United Arab Emirates: Empirical Study

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ABSTRACT

One of the leader's countries with high awareness of Renewable Energy (RE) implementation is the United Arab Emirates (UAE). This research aims to statically investigate the challenges and requirements in the implementation of renewable energy in the UAE. A comprehensive literature review followed by a structured questionnaire was conducted. Eight different factors determined, and then a structured questionnaire was designed and distributed to 94 respondents. The results were analyzed using various statistical methods: one-sample t-test, unpaired two-sample t-test, two-proportion z-test, fisher test, and one-way ANOVA test. 0.98 and 1.000 value of one-sample t-test showed adequate infrastructure and technical skills. The two-sample t-test showed the main difference is in financing renewable energy and infrastructure between professionals and regular community. z-test showed consistent with a two-sample t-test. Fisher test presented positively rate governmental efforts except for the framework for land securement. ANOVA test displayed that the respondents' positions did not affect the perceptions about the availability of the requirements, except for technical skills, where people working on renewable energy projects are more optimistic regarding technical skills. In conclusion, a detailed study needs to be followed in our continuing efforts to analyze the readiness of the UAE to achieve its goals sat for 2050.

Keywords: Renewable Energy, Challenges, Requirements, Barriers, Policies, UAE
JEL Classifications: C120, Q4

1. INTRODUCTION

Renewable energy (RE) is the energy from natural and persistent flows of energy occurring in the immediate environment such as solar, wind, falling water, biomass, and ocean tides. Even though the RE is associated with high uncertainty, but the dependency on traditional energy such as coal, petroleum, natural gas and the fear from draining of this resource makes the dependency of these resources is a risk. On the other side, the other alternative is nuclear energy that has another type of hazard and high-cost investment. However, the barriers and constraints need to be investigated for each specific country. Painuly (2001) claims that the barriers may vary for different countries in the implementation of renewable energy. Therefore, the barriers need to be identified and overcome before this potential can be realized. Based on this, many researchers tried to investigate and determine the success factors and the barriers to the successful implementation of different types of RE in different countries.

Nalan et al. (2009) investigate the market conditions and barriers for the implementation of renewable energy in Turkey. They said that lack of knowledge about renewable energy technologies by most stakeholders has played against renewable energy developments. They assessed the market conditions and barriers to renewable energy use in Turkey. they concluded the reasons behind the frailer of many projects of renewable energy were using premature technologies that are still under-research, the design did not allow sufficient long-term maintenance, many projects were either demonstration projects or not replicated and the limitation of financial resources. Al-Badi et al. (2009) assess and reviewed the potential of renewable resources and their limitations and the future projections energy for Oman. They

found that the solar and wind can play an important role in the future energy in Oman. Fadai et al. (2011) reviewed the potentials of using the RE in Iran. They discussed the current situation of related industries and the barriers and causes of non-achievement objectives of their fourth national development plan. Mey et al. (2016) said that there are about 70 Australian community groups were started to embrace the concept of community renewable energy (CRE) and develop their own projects even though there are unsupportive political conditions for renewable energy (RE) in Australia. Chen and Yamaguchi (2014) reviewed the development policies of renewable energy in Japan, South Korea, and Taiwan. they compare strengths, weaknesses, opportunities, and threats (SWOT). They identify a capacity for additional renewable energy deployment in these countries and highlights the necessity of increased cooperation between the three countries to strengthen their domestic and regional renewable energy sectors. Borhanazad et al. (2013) studied the Malaysian policies of rural electrification by applying renewable sources. The potential renewable energy sources of four different cities were studied: Sabah, Sarawak, Perlis and Kedah. They found that the potential for applying solar energy for electrification is too high in Sabah and Sarawak based on maximum solar radiation. Abdmouleh et al., 2015 conducted an analytic survey attempts to highlight the success factors for successful implementation of RE using different countries experience with different sources and technologies. They found that RE have successful results and it is increasingly becoming a vital component of the energy. The analysis was focused on the following areas: financial, fiscal, legislative, political, technological, and environmental points of view.

Şener et al., 2018 defined and organized the success factors into seven main categories: economic, environmental, political, regulatory, social, technical potential, and technological. Within these categories, economic considerations appeared most frequently across manuscripts, while environmental factors were least represented. Masini and Menichetti (2013) tried to shed new light on RE investment decisions. They found that the role of institutional and behavioral factors in determining the share of renewable energy technologies in energy portfolios with important implications for both investors and policy makers. Barry et al. (2011) analyzed 8 case studies in different countries in Africa: Rwanda, Tanzania and Malawi. The study categorized the factors into 5 main groups: technology factors, site selection factors, economic factors, achievability by performing organization and new identified factors (government support and environmental benefits).

Most of the above studies done in a non-oil producing countries. However, the need and the challenge and the need for the renewable energy is not only for non-oil producing countries this is due to different reasons such as long-term needs for a post-fossil fuel. Lilliestam and Patt (2015) have studied the barriers, risks and policies that faces the implementation of renewables in the Gulf Cooperation Council (GCC). They determined two main obstacles to investments in renewables. The first is the lack of a renewable energy support framework in which consider as barrier. The second is bureaucratic inefficiencies and red tape in which considered as both a barrier and a risk. However, in 2017, the UAE launched 'Energy Strategy 2050'. The strategy aims to increase the contribution of clean energy in the total energy mix from 25% to 50% by 2050. The plan targets an energy mix that combines renewable, nuclear, and clean energy sources to meet the UAE's economics. Though the UAE has policies and strategies that promote renewable energy with the Government considering long term structural reforms in support of renewable energy implementation, the diversification has not been successful. Rooftop solar panels installation has restrictions based upon aesthetics or safety in UAE (Helal et al., 2008). Lack of market and technology awareness is another limitation affecting the renewable energy process in the UAE. Most people in the public are not aware of the emerging technology, which can be used as an alternative source of energy in the UAE. Market strategies have not been laid down to make the public conversant with the principal renewable sources of energy like solar energy, which can be of help to the members of the public. The high investment and operational costs limit the process of installing the machines used to tap renewable energy like solar panels. Experts in the UAE believe that most of the renewable energy projects in the world are successful due to government financial support and the availability of skilled technicians, which the UAE has failed in. The UAE has no government subsidies and no skilled labor, which makes the production cost higher than the conventional power (Helal et al., 2008).

Mezher et al. (2011) stated that the UAE has a program in place to achieve a 7% of power share from renewable energy sources by 2020. He then questioned whether this has been achieved or not and if both the public and the professional sector are aware of the difficulties that could be encountered to achieve this target. However, the review conducted by Mezher et al. was only focused on reviewing the plans of the Abu Dhabi emirate and the Masdar initiative in specific, and not on the whole country initiatives. In the same review, and highlighting the Masdar initiative as part of the Abu Dhabi urban planning, "Plan Abu Dhabi 2030," the authors indicated that the report lacks a comprehensive development plan for the energy demand and critically questioned the ability of the plan to meet the objective of the 7% target due to the gap between the policy expectation and the potential for actual performance of the sought technology. An expert level study on the economic assessment of renewable energy options conducted in 2016 by Jeffrey, (2013), Sgouridis et al. (2016) revealed that an accelerated program for renewable energy can result in a 10% contribution to the UAE total final energy consumption in 2030. The expert study relied on the fact that a cost that is <1 US dollar per gigajoule where the subsidies for current energy resources is avoided.

In recent years, UAE has taken brave steps in converting the strategic plan into real plants on the ground. Several projects are in the execution stages in the Emirates of Dubai and Abu Dhabi. However, the rise of awareness among the professional sector and the community in large is yet to be assessed and investigated as the impact of the renewable energy contribution and the willingness of the public to shift to the renewable energy resources and applications is not well understood. The views of the traditional energy supporters from the professional community are still one of the points that have not been fully investigated. The output of

such an investigation should help to bring awareness and support to the future implementations of renewable energy solutions in the country. Bayomi and Fernandez (2017) conducted a sectorial level demand for renewable energy for four countries, including the UAE. Such expert level studies are still limited in the professional sector but have a lot of merit on the demand and the economics of renewable energy implementation in the country. More of such studies and awareness among the community in large would help faster acceptance and more support of the renewable energy program in the country. Based on the above discussion, the barriers and requirements need to prioritize and analyses to increase the opportunity to take advantage of renewable energy and maximize the output from renewable resources. This research aims to address these barriers that limiting the UAE from shifting its focus from fossil fuel to cleaner and renewable energy sources.

2. RESEARCH METHODOLOGY

An online survey was conducted to investigate the requirements for the successful implementation of renewable energy in the UAE. The respondents were asked to answer the questions on a 5-point Likert scale, where 5 shows strongly agree, and 1 indicates strongly disagree.

A sample from the cities of Dubai and Abu Dhabi has been taken in consideration. The sample was selected randomly from the two cities, 50 people for each city. These people are as follows:

- Employees in International Renewable Energy Agency (IRENA).
- Developers once involved in the renewable energy projects.
- Engineers who worked on the field of renewable energy.
- Data analysts involved in road mapping renewable energy.
- Employees in Dubai Electricity and Water Authority (DEWA).
- Residents of Dubai and Abu Dhabi, some of them have solar panels installed in their homes.

The main questions in the questionnaire were as in Table 1. The questions are written shortly, in the left hand side, to be used later in other tables.

It is worth to mention that some questions might not be clear for some normal citizen such as framework for land securement and infrastructure. The study depends on statistical analysis and five different hypotheses as in Table 2. The table shows also the type of statistical test used. Since 4 and 5 mean "agree" and "strongly agree" respectively, and 3 means "not sure," if the average of the answers is more than 3.5, this will be an enough evidence that the requirement exists according to the view of respondents. Analysis of the hypotheses was done using R software.

Professionals can better estimate the existence of the requirements of successful implementation of renewable energy. This is why the number of professionals in the sample is greater than the number of normal residents. However, the second hypothesis will test if there is a significant difference between both of them regarding their opinions about the requirements for renewable energy.

In the first two hypotheses, the analysis is based on the average value of the Likert scale to differentiate the rate of availability of

Table 1: Questionnaire main questions

Question written shortly	Question (to be rated from 1 to 5 on Likert scale)
Financing renewable energy	The government of UAE is financing renewable energy projects appropriately.
Supporting investment	The policies in UAE are supporting the investment in renewable energy projects.
Policies and strategies	The UAE has policies and strategies that promote renewable energy.
Framework for land securement	The UAE has enough regulatory framework for land securement.
Infrastructure	The UAE has enough infrastructure to accommodate renewable energy projects.
Technical skills	The UAE has enough scientific and technical skills in the renewable energy workforce.
Public awareness	The UAE spread efficient awareness about renewable energy.
Climate conditions	The climate condition of UAE is suited for renewable energy projects.

Table 2: Study's hypotheses and statistical methods used

Number	Hypothesis	Test
1	H_0: UAE has the needed requirement for successful implementation of renewable energy projects H_1: UAE does not have the needed requirement for successful implementation of renewable energy projects (mu>μ)	One sample t-test
2	H_0: There is no difference between the perception of professionals and normal residents about the availability of the needed conditions for success renewable energy implementation H_1: Professionals have different views from normal residents about the availability of the needed conditions for successful renewable energy implementation	Two sample t-test
3	H_0: the difference between the availability level of different requirements for renewable energy, based on percentages of positive (negative) rate, is not significant H_1: There are significant differences among the availability levels of different requirements for renewable energy, based on their positive (negative) rates	Two-proportion z-test
4	H_0: The view of the respondents about the efforts of government has no relationship with their view about other requirements for successful renewable energy implementation H_1: Respondents who positively estimate the government efforts have also positive views about other requirements for successful renewable energy implementation	Fisher test
5	H_0: There is no difference between the perception of different groups of professionals about the availability of the needed conditions for success renewable energy implementation H_1: Professionals have different views about the availability of the needed conditions for success renewable energy implementation	One Way ANOVA

different requirements for renewable energy projects in the UAE. Another way to rank the different requirements is to convert the Likert scale into categorical values, where 4 and 5 mean a positive rate, 3 indicates a neutral rate, and 1, and 2 mean a negative rate. One way to rank these requirements is to compare the proportions of positive rates or negative rates, to check the most available requirements, and the least available requirements based on the percentage of positive rates or negative rates. Hypothesis 3 is about this way.

For hypothesis 4, Fisher test is used to check the dependency between two variables with categorical values. For example, this test can be used to check if the smoking habit has to do with the gender. The categorical values here are smoker/non-smoker and male/female. The result of the test might be that the percentage of male smokers is more than the percentage of female smokers. The same concept can be applied to the respondents' answers, which can have for example positive/neutral/negative values.

For hypothesis 5, One-way ANOVA is used to check if "financing renewable energy" for example has different estimations based on the working place/position. The same thing can be estimated for all the other seven requirements.

Figure 1: Categories of respondents of the questionnaire

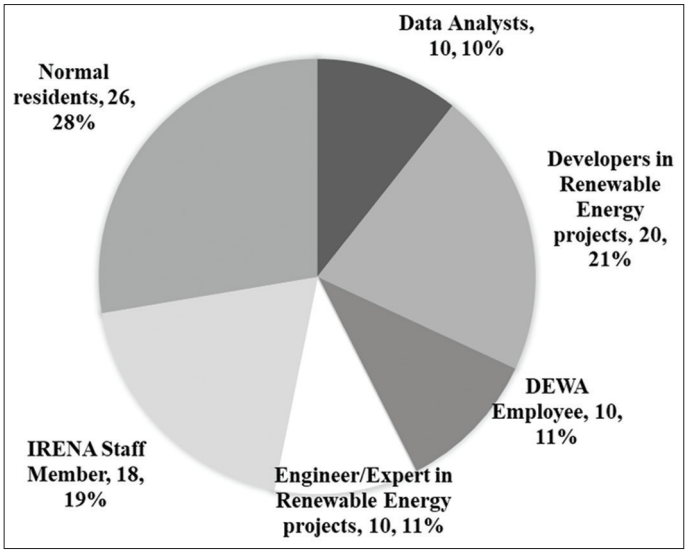
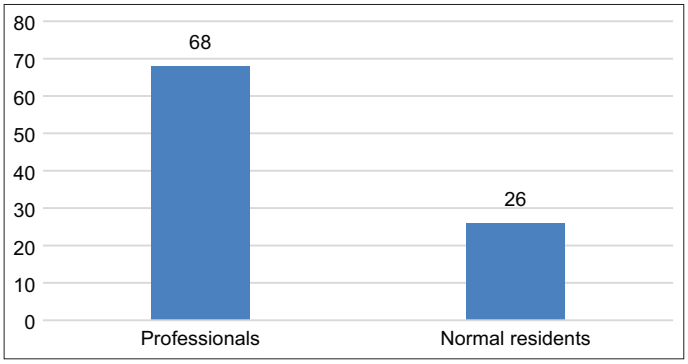


Figure 2: Number of professionals and normal residents in the sample



3. RESULTS AND ANALYSIS

3.1. Descriptive Statistics

Figure 1 shows the respondents' numbers and percentages, where the total number of respondents is 94. Normal residents are only 28% of the sample. Figure 2 shows the number of professionals and normal residents.

Table 3 shows some statistics about the responses which are on a Likert scale. The table shows that the worst performance is for infrastructure and technical skills.

Table 4 shows the results for hypothesis number 1 in Table 2. Table 4 shows that according to the opinion of respondents some of the requirements are not available such as infrastructure and technical skills. The respondents see that governmental efforts are sufficient, except for the opinions of normal residents about financing efforts. That means that professionals are more convinced about the governmental efforts. Combining the responses of all the respondents gives better results for regulatory framework for land securement. Moreover, the normal residents are more convinced about the public awareness.

It is necessary for a subgroup of items to represents the same thing, and to do so, the internal consistency is needed. This internal consistency can be estimated using Cronbach's Alpha, and it must be more than 0.7. Cronbach's Alpha for the Governmental financial support and policies was found to be 0.749, which is >0.7. The same thing was tried for other requirements for renewable energy such as infrastructure and technical skills, but the Cronbach's Alpha was <0.7. Therefore, they are separated, and they do not belong to one subgroup.

Because of the differences in the opinions of professionals and normal residents, hypothesis number 2 in Table 2 was used to check such a difference. Table 5 shows unpaired two-sample

Table 3: Statistics about responses

Requirements	n	Average	Standard deviation	Percentage of positive rating	Percentage of neutral rating	Percentage of negative rating
Financing renewable energy	94	3.89	1.01	81.9	5.3	12.8
Supporting investment	94	4.01	0.90	86.2	4.3	9.6
Policies and strategies	94	3.94	1.06	80.9	4.3	14.9
Framework for land securement	94	3.71	0.96	76.6	9.6	13.8
Infrastructure	94	3.36	1.09	62.8	5.3	31.9
Technical skills	94	2.54	1.40	33.0	7.4	59.6
Public awareness	92	3.76	1.01	75.5	3.2	19.1
Climate conditions	94	3.95	0.86	84.0	7.4	8.5

Table 4: One-sample t-test to check the existence of the renewable energy requirements

Factors	Questions	t-test (all the sample)	t-test (professionals only)	t-test (normal residents only)
Governmental financial support and policies	The government of UAE is financing renewable energy projects appropriately.	0.000	0.000	0.405
	The policies in UAE are supporting the investment in renewable energy projects.	0.000	0.000	0.005
	The UAE has policies and strategies that promote renewable energy.	0.000	0.001	0.004
	The UAE has enough regulatory framework for land securement.	0.017	0.053	0.058
Infrastructure	The UAE has enough infrastructure to accommodate renewable energy projects.	0.890	0.966	0.097
Technical skills	The UAE has enough scientific and technical skills in the renewable energy workforce.	1.000	1.000	1.000
Public awareness	The UAE spread efficient awareness about renewable energy.	0.008	0.054	0.004
Climate conditions	The climate condition of UAE is suited for renewable energy projects.	0.000	0.000	0.000

Table 5: Two-sample t-test to compare opinions of professionals and normal residents

Requirements	Two sample t-test (P-value)	Average for Professionals	Average for normal residents
Financing renewable energy	0.019	4.03	3.54
Supporting investment	0.342	4.06	3.88
Policies and strategies	0.508	3.97	3.85
Framework for land securement	0.896	3.71	3.73
Infrastructure	0.027	3.24	3.69
Technical skills	0.983	2.54	2.54
Public awareness	0.520	3.73	3.85
Climate conditions	0.391	3.91	4.04

Table 6: Ranking of availability levels of requirements for renewable energy in UAE

Number	Ranking based on percentage of positive rating	Ranking based on percentage of negative rating
1	Supporting investment (86.2%)	Climate conditions (8.5%)
2	Climate conditions (84.0%)	Supporting investment (9.6%)
3	Financing renewable energy (81.9%)	Financing renewable energy (12.8%)
4	Policies and strategies (80.9%)	Framework for land securement (13.8%)
5	Framework for land securement (76.6%)	Policies and strategies (14.9%)
6	Public awareness (75.5%)	Public awareness (19.1%)
7	Infrastructure (62.8%)	Infrastructure (31.9%)
8	Technical skills (33.0%)	Technical skills (59.6%)

t-test to check if the averages on a Likert scale for both groups of respondents have the same values or not.

Table 5 shows that the main difference is in financing renewable energy and infrastructure, where professionals are more convinced about the first one, but less convinced about the last one. For the other requirements, there are no significant evidences that they are different.

Table 6 shows the sequence from the highest available requirements to the lowest one according to the percentage of agree/strongly agree (positive rating), and according to the percentage of disagree/strongly disagree (negative rating) found in Table 3. The difference between proportions of two requirements might be insignificant such as the difference between proportions of supporting investment (86.2%) and climate conditions (84%). To check that with more details, hypothesis number 3 is used.

Table 7 shows two-proportion z-test to check the differences between the requirements according to the rank found in Table 6. The rank here is based on the percentage of positive rating. The numbers in Table 7 are consistent with those numbers found in Table 6. For example, number "R 1" is for supporting investment. Table 7 shows that the differences between the first 5 requirements are not significant. However, the difference between the first and the sixth requirement is significant. These are supporting investment and public awareness with a P-value of 0.048. The seventh requirement, which is infrastructure, is significantly different from all the six requirements before it. The same behavior is for "technical skills", which is significantly less than all the other requirements. Table 8 shows the same idea of Table 7, but it is based on the percentage of negative rating. However, the numbers mean something else. For example, number 1 here means climate conditions according to Table 6 in the last column. Therefore, "R′ 1" is used to recognize it. The results show almost the same behavior of Table 7, giving the fact that the numbers 6, 7, and 8 in the two tables mean the same requirements, which are public awareness, infrastructure, and technical skills respectively. The main conclusions here is that according to the respondents, the availability of infrastructure and technical skills was again found much less than the availability of other requirements (Table 8).

Figure 3: The perception of different groups about the availability of technical skills

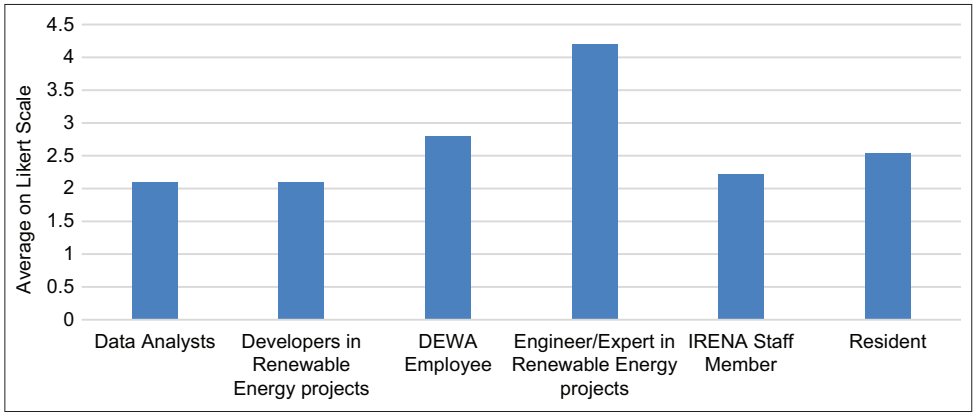


Table 7: Two-proportion z-test to check the difference between requirements based on percentage of positive rating

	R 1	R 2	R 3	R 4	R 5	R 6	R 7
R 1							
R 2	0.419						
R 3	0.275	0.423					
R 4	0.216	0.351	0.500				
R 5	0.067	0.136	0.236	0.296			
R 6	0.048	0.102	0.186	0.240	0.500		
R 7	0.000	0.001	0.003	0.005	0.028	0.041	
R 8	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 8: Two-proportion z-test to check the difference between requirements based on percentage of negative rating

	R′ 1	R′ 2	R′ 3	R′ 4	R′ 5	R′ 6	R′ 7
R′ 1							
R′ 2	0.50						
R′ 3	0.24	0.32					
R′ 4	0.18	0.25	0.50				
R′ 5	0.13	0.19	0.42	0.50			
R′ 6	0.03	0.05	0.16	0.22	0.28		
R′ 7	0.00	0.00	0.00	0.00	0.00	0.03	
R′ 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Hypothesis number 4 in Table 2 is used to check if the perception of respondents who are satisfied about the governmental efforts regarding supporting renewable energy is affecting their perception about the other requirements. In other words, to check if people who positively rate the governmental efforts will also positively rate the other requirements. To do that, several types of tests can be used. One of them is fisher test, which is especially used when some numbers of respondents in at least one category is expected to be <10. For example, only four respondents negatively rated "framework for land securement," but positively rated "climate conditions." Table 9 shows the fisher test.

From Table 9, it is obvious that people who positively rate governmental efforts, tend to positively rate the other requirements, except for the framework for land securement. For example, Table 10 shows that most of the respondents who have positive perception about the governmental financial support have also positive perception about enough infrastructure to accommodate renewable energy projects. For example, about 69% of the people who positively rate financial efforts also positively rate

Table 9: Fisher test to check dependency between governmental efforts and the other requirements

Factors	Infrastructure	Technical skills	Public awareness	Climate conditions
Financing renewable energy	0.006	0.002	0.012	0.007
Supporting investment	0.000	0.002	0.000	0.000
Policies and strategies	0.000	0.030	0.000	0.001
Framework for land securement	0.004	0.088	0.001	0.000

Table 10: The dependency between financing renewable energy efforts and infrastructure

Factors		Enough infrastructure (%)		
		Positive rating	Neutral rating	Negative rating
Financing renewable energy	Positive rating	68.8	2.6	28.6
	Neutral rating	33.3	8.3	58.3
	Negative rating	40.0	40.0	20.0

Table 11: One-way ANOVA to check the effect of working place/position

Requirements for renewable energy	P-value
Financing renewable energy	0.513
Supporting investment	0.277
Policies and strategies	0.075
Framework for land securement	0.181
Infrastructure	0.722
Technical skills	0.003
Public awareness	0.073
Climate conditions	0.055

the infrastructure. This might be because some people tend to positively rate general requirements as a whole package.

The last hypothesis is about the effect of the position or working place of the respondents on their opinions about the different requirements. Table 11 shows the p-values of one-way ANOVA test for each one of the requirements. The positions of the respondents

did not affect their perceptions about the availability of the requirements, except for technical skills, where people working on renewable energy projects are more optimistic regarding the availability of technical skills as in Figure 3.

4. CONCLUSION

In this study, the requirements for successful implementation of renewable energy projects in the UAE are investigated. Some of these requirements are considered a government responsibility. The first four of them are grouped together in one subgroup, related to the efforts of the government. A questionnaire was designed, and then filled by 94 people from two cities in UAE. Statistical analysis was conducted, using different statistical methods such as one-sample and two-sample t-tests, fisher test, two proportion z-test, and ANOVA test. Generally, six requirements including the governmental efforts are positively rated by respondents. However, professionals in the field of renewable energy are more convinced about governmental efforts. On the other hand, the normal residents are more convinced about infrastructure, than the professionals are. The availability level of the six available requirements are with similar positive rates, except for the public awareness, which is lower rated than the others are. Moreover, the respondents who positively rate the governmental efforts tend to positively rate the other requirements, except for the relationship between framework for land securement and technical skills, where they are independent of each other. Moreover, except for technical skills, the professional position has no significant effect on the perception of availability of the different requirements.

The current study is the basis for a more in depth and detailed study to follow in our continuing efforts to analyze the readiness of the UAE to achieve its goals sat for 2050. A thorough investigation could follow, to evaluate and rate the preparation within the sector, from professionals, who are deeply involved in renewable energy project. In specific, questionnaires that are more technical can be drafted to evaluate the level of readiness and availability of resources.

5. ACKNOWLEDGMENT

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