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SWOT Analysis for the Current and Future Utilisation of Solar Energy Technologies in Kuwait

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ABSTRACT

Kuwait is a country rich in renewable energy such as solar and wind. The utilisation of renewable energy would lead to reducing the negative impact on the environment and carbon emissions. One of the challenges of utilising renewable energy in Kuwait is the fact that it is rich in fossil fuels, hence making huge investments in renewable energy seems to be immensely unattractive on the short to medium terms. This therefore explains the postponement to effectively strengthen the portfolio of renewable energy projects in Kuwait. This paper presents SWOT analysis to determine the strengths, weaknesses, opportunities and challenges associated with the expansion of solar energy production within Kuwait as part of the renewable energy mix to determine the circumstances that influence adoption and utilisation.

Keywords: Renewable energy, Solar energy, SWOT Analysis, Kuwait.

1. INTRODUCTION

Kuwait seeks to supply 15% of its national demand for energy from renewable sources by 2030. The phased approach adopted by the country entailed a 1% level by 2015, 10% by 2020 and 15% by 2030 [1]. Kuwait currently has a per capita demand for electricity estimated at 14,000 kWh, and this is estimated to double every ten years. Due to this high per capita demand, it is estimated that 40% of the energy produced in the country is consumed locally. Although Kuwait has extensive production potential, it still faces deficits in supply. The growing domestic demand, coupled with extensive demand from its regional partners, both GCC members and non-members such as Iraq, means that any additional energy resources that can be brought into the energy portfolio will offer an advantage to the country.

Currently, Kuwait has solar energy production of 70MW from the Al-Shagaya Solar plant, with plans for energy systems capable of producing 945MW, and this contributes to the total capacity of circa 18.8GW produced by the existing power plants in the country [2]. The integral nature of renewable energy sources in the oil-rich country is evidenced by the future structure of energy systems in Kuwait. Forthcoming plans involve expansion of this productivity, and a multiplicity of benefits are expected from the investment in renewable energy. However, the competition from fossil fuels could play a negative effect on maximising the utilisation of renewable energy.

2. METHEDOLOGY

A mixed approach is implemented using an on-line questionnaire and critical analysis of secondary data. This paper outlines, as shown in (Fig 1), the elements of SWOT analysis (strengths, weaknesses, opportunities, and threats). In this paper, the threats are mainly challenges for the adoption of renewable energy. The SWOT analysis involves a bottom-up review of publications on solar energy in Kuwait, the GCC and at the global level in order to identify the environmental factors in play at both the domestic and international levels.

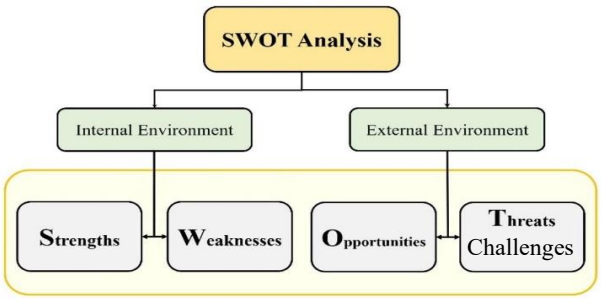

Fig 1 SWOT Analysis Model

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Corroborating evidence is sourced for comparative purposes, especially for the factors that are of a relative nature, such as economic and ecological sustainability. Data collected from the public in Kuwait via an on-line questionnaire (with 1383 respondents), is also used in the analysis. Hence capturing the views of individuals within the community in Kuwait, with a wide range of demographic and psychographic characteristics.

3. THE SWOT ANALYSIS

3.1 Strengths

These are elements that confer advantages to the use of solar energy within Kuwait. They indicate the ways in which solar energy is beneficial and forms a good 'fit' for the country [3].

3.1.1 An Ecologically Sustainable Energy Source

Reference [4] has found that solar energy has a carbon footprint of 6g CO2e/kWh, compared to 109g from coal, 78g from CCS, 98g from bio-energy sources, and 97g from hydroelectric plants. The findings from the questionnaire conducted for this study indicate that all the renewable energy sources preferred by Kuwaiti society have a low carbon footprint, which means that they are viable alternatives to fossil-based energy sources (see Fig 2).

3.1.2 Economically Sustainable in the Long Run

The economic sustainability of solar energy as part of the renewable energy portfolio is represented by the fact that the cost of producing and using fossil fuels in Kuwait is increasing. The growth in population and changes in economic activities, such as manufacturing, are increasing total primary energy demand (TPED) in the region, and this is putting a strain on the national budgets of most GCC countries, including Kuwait. In recognition of this scenario, the questionnaire data reveals that 54.5% of respondents view renewable energy sources as contributing to the preservation of the national economy (see Fig 3).

3.1.3 High Solar Energy Potential Due to Climatic and Weather Patterns

Kuwait has a desert climate and clear skies throughout the year, hence has a high potential for solar thermal energy and solar power. As a recent study revealed [5], Kuwait has global solar radiation at 6.2 kWh/m2/day and direct solar radiation of 6.5 kWh/m2/day; this translates to 2450 kWh/m2/year per year and makes solar power a viable energy source. Another advantage of solar energy is its capacity to match seasonal variations in demand; energy use rises significantly during the hot summer months, which is associated with the high levels of solar irradiation. Solar energy can also introduce high nominal energy capacity, which can be stored to overcome the evening peak. Therefore, during peak seasons, solar energy offers an opportunity for the country to supplement the baseload provided by fossil fuels and meet the increased demand [6]. By investing in renewable energy, specifically solar energy, Kuwait can supply grid-level demands through renewable energy during the peak periods, then scale back to fossil fuel energy systems during the off-peak seasons.

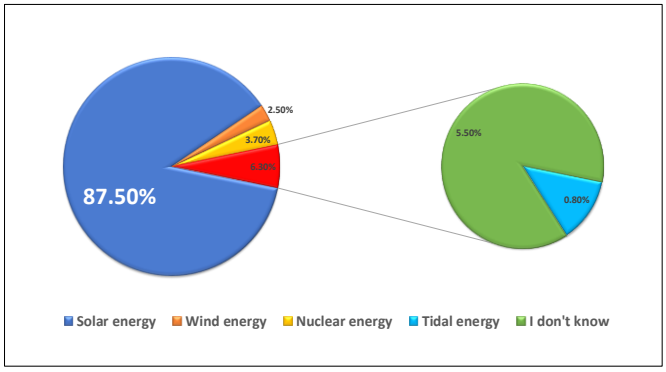

Fig 2 Most suitable energy selected by the public in Kuwait

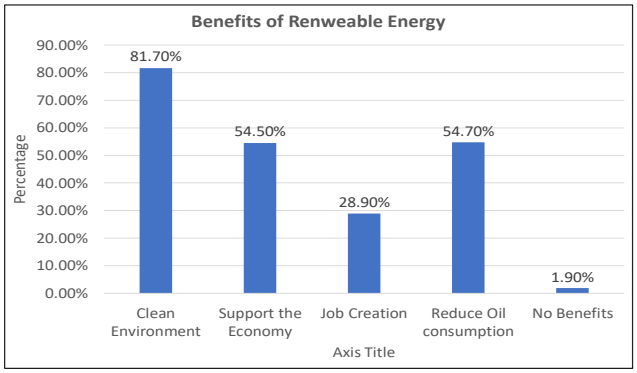

Fig 3 Benefits of renewable energy as seen by people in Kuwait

3.2 Weaknesses

The weaknesses involve aspects of solar energy that make it an unreliable source of energy within Kuwait based on the current status quo. They also represent the circumstances that limit the suitability or viability of solar energy within the country [7]. Most GCC countries, including Kuwait, have long been politically and economically dominated by the exploitation of fossil fuels, and most of their policies and strategies are

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established around these energy systems [8]. Kuwait's propensity and ability to transition to renewable energies is, therefore laced with a multiplicity of challenges, some of which are associated with weaknesses in the solar energy industry in the country.

3.2.1 Flat Learning Curve

The flat learning curve can be attributed to the fact that most renewable energy projects take a long time to move from conceptualisation to completion. This means that by the time a project has been completed both energy demand and technologies have changed. For example, the Al-Shagaya concentrated solar plant was conceptualised as a 50MW plant in 2012, financing agreements were completed in 2015 and commercial operations started in 2018; however, there are reports that Phase 2 will not launch until 2026, a 14-year postponement [1], and final plans have been changed to include an additional phase to boost the production potential from 2GW to 4GW. The fact that the Gulf region is a late adopter of technical innovations exacerbates this problem. The lack of awareness of the applicability and utility of renewable energy systems in Kuwait also affects the learning curve. About 47.8% of the questionnaire's respondents felt that there was not enough information about renewable energy in the educational curricula, and 47.6% expressed the view that the efforts to raise awareness were weak (see Fig 4). This is attributable to the lack of educational programmes aimed at introducing the wider community to renewable energy technologies, and a lack of awareness campaigns spearheaded by the media.

3.2.2 Limited Development in Terms of Technology

Kuwait, similar to most countries in Middle East, still developing in terms of technological advancement in solar energy. China, in comparison, accounted for 45% of global investment in solar energy, while the Middle East accounted for just 4%, among the lowest levels of commitment. Despite the country's oil wealth, the government of Kuwait has dedicated just 0.1% of GDP to research and development, both in absolute and relative terms [9]. By comparison, countries such as the US and China dedicate at least 2.5% of their budgets to research [10], and Qatar, a fellow GCC member, has committed 2.8% of its budgets to research and development.

3.2.3 Preference for Combined Renewable Energy Systems

By combining the different technologies, some argue that the country can take advantage of the various energy resources in place in order to improve the utilisation of renewable energy [5]. For instance, the Shagaya solar energy plant is designed to house 56% concentrated solar energy production technologies, 35% photovoltaic energy production and 9% wind energy technologies. However, the downside to the strategy is the fact that with renewable energy technologies, the economies of scale outweigh those of scope. Solar PV technologies are cheaper; deployment timelines are faster, and, as most companies have the adequate dispatchable capacity, consumers can start utilising the energy from solar sources within shorter time frames.

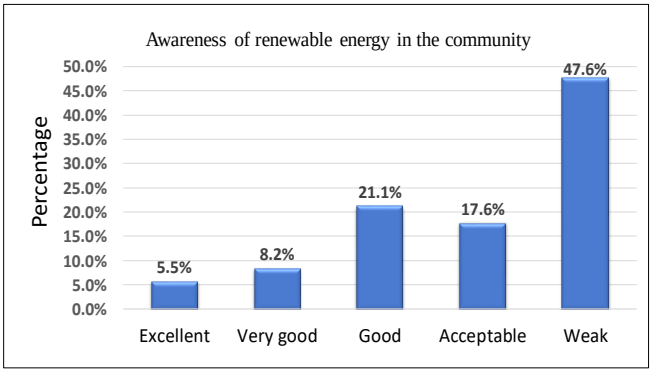

Fig 4 Awareness activities of renewable energy in Kuwait

3.3 *Opportunities*

These are the factors relating to solar energy that can be introduced into the industry in order to increase the utility value of solar energy to stakeholders. They represent the pathway to improvement in current levels of utilisation, efficiency, effectiveness and value to stakeholders [11]. A number of the opportunities identified here are derived from the literature review as well as from the findings of the questionnaire.

3.3.1 Adopting Sustainable Energy Models

The implementation of sustainable energy models depends on the contribution of both consumers and the organisations involved in the generation and distribution of energy resources. However, the findings of this research questionnaire reveal that few consumers in Kuwait currently take steps to use energy in a more sustainable way. For example, less efficient ways of utilising energy include:

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• Most citizens leave lights on in buildings during the daytime.
• It is common for workers to leave appliances on when leaving offices.
• There is a limited propensity for builders to thermally insulate buildings during the design and construction.
• There is a widespread overreliance on fossil fuels in the region, limiting the adoption of emergent innovations such as electric cars.

3.3.2 Exporting Solar Energy to Neighbouring Countries

Based on evidence from the literature review, most countries that generate solar energy have established plans to export a proportion of their energy resources to neighbouring countries. By exporting energy to its neighbours who do not have renewable energy systems, Kuwait has an opportunity to capitalise on the emerging research-driven technology clusters in the region. Although the production potential for the Middle East is expected to double, the installed capacity is still below the existing demand. As a result, as an early regional adopter of solar technologies, Kuwait could generate revenue by exporting solar energy to neighbouring countries.

3.3.3 Introducing Distributed Generation

According to [12], decentralised and distributed ventures are expected to grow in the near future. This is significant for Kuwait because distributed energy production is best suited for off-grid installations, islands and desert regions. The findings of the public questionnaire conducted for this research show that most respondents are aware of the potential for generating different types of renewable energy in different locations across the country. There are numerous opportunities for distributed generation of renewable energy across the country. As the findings of this study indicate, most citizens are aware of the availability of solar irradiation all year round, and their preference for solar energy is founded on achievable goals. Distributed generation also enables the private sector to participate in the generation of solar energy, allowing the government to focus on more complex technologies, such as wind and wave energy.

3.4 Challenges

The challenges relate to the circumstances that limit the potential for utilisation or expansion of solar energy within the country. These might arise now, or in the future, but in either case, they have the potential to effect the entire solar energy industry [13]. The analysis presented here focuses on direct challenges based on the findings from the questionnaire study, as well as challenges identified in literature, and findings from other locations that face similar circumstances to Kuwait.

3.4.1 Changes in Solar Energy Technologies

New developments in solar technologies pose a significant challenge to the viability of the existing solar energy installations in the country. Although the speed with which the technologies for generation and storage of solar energy varies, newer technologies always offer the opportunity for increased productivity per unit. According to a recent analysis of data from global solar systems, the cumulative installed capacity increase from 40GW to 321GW between 2010 and 2016 saw the price per watt at peak productivity drop from US$2 to US$0.56 [14]. This momentous drop suggests that, in light of the long-term payback period and lifespan of the systems, installations that were made in 2010 were four times costlier than those implemented in 2016, without taking into account the economies of scale. For a country such as Kuwait, this has a major impact on the willingness of the government to commit resources to renewable energy, especially at a time when technologies are changing rapidly. This might explain why both the government and private sector investors have largely refrained from investing in this type of energy, at least in the short-term, as they wait to see where the markets go. These assertions are supported by the questionnaire most respondents, 78.7%, of whom indicate that, despite the popular support for investing in renewable energy technologies. The impact of the change in technologies is further magnified by the fact that the initial costs of installation are high. These changes reduce the viability of renewable energy in general since the technologies for wind and wave energy are also changing rapidly.

3.4.2 The Lack of Suitable Policies

The presence of proactive policy management is an integral step in accelerating the deployment of renewable energy systems. Government policies mandating the changeover to renewable energy have the power to motivate and even oblige institutions to utilise renewable energy sources. Indeed, 65.1% of the questionnaire's respondents strongly agreed that the government should require developers to incorporate renewable energy infrastructure in their buildings; and a

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further 48.4% strongly agreed that academic institutions should initiate the use of renewable energy. However, it is not clear whether corporations have begun to initiate the use of renewable energy in their buildings, and this has limited adoption of renewable energies at the household level. The introduction of targeted government policies would reduce the overall costs of solar energy, by establishing a market for solar energy products, and lay the foundations for governmental assistance, in the form of subsidies and other incentives, that are necessary for the changeover to renewable energy.

Based on lessons learned within the GCC and across the globe, it is possible for Kuwait to invest in solar energy as long as the right policies are in place.

The lack of policies and legal frameworks also indicates that there is a limited commitment by the government and the institutions involved in the industry. Although KISR plays the role of the research agency for technologies and projects on renewable energy, it does not possess the mandate to create policy or legal frameworks. The lack of a dedicated agency to develop strategies for the implementation of renewable energy policies limits the viability of this type of energy source in Kuwait [15]. For instance, IRENA [16] indicates that whereas the official target for the generation of electricity from RES in Kuwait is 5% by 2020, the unofficial target is 1% by 2015, rising to just 15% by 2030. These disparities suggest that the country is no well-prepared for the long-term planning necessary for renewable energy technologies and the widespread adoption of solar energies.

4. CONCLOUSION

Renewable energy has proven to be an integral component of the energy portfolio in many countries, and Kuwait is no exception. Due to its geographical and climatic conditions, Kuwait has high levels of solar irradiation across the year and extensive tracts of uninhabited land suitable for the installation of large scale solar farms. While alternatives such as wind and tidal energy are available, solar energy is the preferred option. The need to curb the country's extensive utilisation of fossil fuels, coupled with the fact that the Gulf region is among the worst hit by climate change, further justifies the adoption of solar energy. However, in spite of these advantages, the SWOT analysis reveals that there are more weaknesses than there are strengths to encourage investing in solar energy in Kuwait.

The country currently lacks the necessary infrastructure for the utilisation of renewable energy and the frameworks required to implement effective renewable energy policies. Due to limited educational opportunities, the local population lacks technical knowledge and skills relating to solar energy utilisation and has little awareness of the importance of conserving energy. While foreign expertise can be acquired, the lack of awareness presents a deeper and more immediate challenge. If nothing is done to improve energy efficiency and curb wasteful usage, any measures to introduce renewable energy into the energy portfolio are unlikely to address the energy deficit in the country. One of the reasons these challenges have permeated Kuwaiti society is the lack of specific programs under the Ministry of Energy to regulate energy usage, and this is symptomatic of the wider lack of legislation necessary to implement an energy policy built around renewable sources.

There are a number of potential benefits from the introduction of renewable energy driven by the right policies that take into account the risks and returns on investment. Although the policy framework presented here focuses on the economic dimensions of the investment, it has the potential to orient both public and private institutions towards efficiency and effectiveness in the activities designed to manage the energy sector. The widespread lack of knowledge about renewable energy presents an opportunity to develop academic and professional training programs that will raise awareness across the social structures while establishing a culture of responsibility among the citizens.

Many of the weaknesses identified in the SWOT analysis relate to the fact that the solar energy industry and sector are still underdeveloped, both in Kuwait and within the region. However, while this undoubtedly poses challenges, in the longer term, it also presents a highly significant opportunity. Considering that the GCC region lags behind in terms of technology, Kuwait has a significant advantage as an early adopter in that it can establish itself as the hub from which solar energy resources and technologies spread into the rest of the GCC and the wider MENA region.

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