Kuwait city solar energy research and development

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Since 1960, Kuwait’s electrical power demand has increased from around 380 GW.hrs [1] to 66,356 GW.hrs in 2020 [2]. Although this rise is mostly driven by population growth, the per capita consumption has also seen rapid growth until the stricter implementation of efficient building codes in 2005 caused it to moderately decline [3,4].

In 2015, local electricity consumption per capita was 14.95 MWh which was amongst the highest in the world [4]; almost double that of OECD countries (8 MWh) and considerably higher than the average in GCC countries (11 MWh, excluding Kuwait) [3].

Only 0.3% of the energy demand in Kuwait is being met through renewable energy resources [2] which, in combination with the high per capita demand, results in a substantial carbon footprint. Kuwait’s emissions per capita in 2015 were 21.1 tonnes of CO2-eq, which is tremendously higher than the average in the Middle East (8 tonnes of CO2- eq) and the global average (4.5 tonnes of CO2-eq) [3]. This situation necessitates a careful reevaluation of the country’s energy policies.

Although Kuwait is only responsible for 0.23% of global carbon emissions (83 million tonnes of CO2-eq emitted locally out of 35,000 million tonnes of CO2-eq globally in 2015) [3,5-8], the country might be especially vulnerable to the perilous effects of global warming. Extended draughts, sea level rise, and average temperature increase are some of the adverse phenomena that have been linked to global warming [6] all of which could be exceptionally detrimental to an arid coastal country like Kuwait where over 90% of potable water demand is being met through seawater desalination [7].

Furthermore, the Intergovernmental Panel on Cli-mate Change (IPCC) forecasts global sea levels to rise by one to three meters during this century. This is catastrophic to Kuwait’s low-lying coast of which 1.4%-3% could be inundated with a sea level rise of 0.5 m-2 m. This has the capacity to affect up to 5% of Kuwait’s GDP and 174,000 individuals [8].

In 2016, The Paris Agreement urged the reduction of global carbon emissions by 50% in an effort to lower the average global temperature by 1.5°C-2°C. Kuwait signed this accord pledging to mitigate 7.4% of its projected carbon emissions in 2035 under “business-as-usual” parameters.

The country aims to achieve this goal through a number of projects that would reduce emissions as well as sequestrate and reuse carbon. These projects are shown below in Table 1 which is quoted directly from Kuwait’s second “Nationally Determined Contributions” document submitted to the United Nations in ratification of the Paris Agreement in October 2021 [8].

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Economic feasibility of utilizing renewables is directly dependent on the capital and operating costs of renewable technologies compared to fossil fuels. In the 1980s, renewables were considered unsuitable for Kuwait because of their high costs compared to the cost of using fossil fuels [9-28]. However, technological advancements have started shifting the balance with renewable energy costs rapidly declining over the past decade. Photovoltaics in particular have seen significant drops of 82% as seen in Table 2.

Although the cost of oil production is low in Kuwait, its high selling price makes it more economically incentivizing to rely on energy generation methods that don’t consume oil. Under this light, domestic oil consumption is associated with implicit losses in the form of foregone revenue from selling oil internationally. This consideration makes renewable energy technologies more economically competitive with conventional fossil fuels.

This paper aims to give a general overview of some of the potential opportunities available for Kuwait to utilize towards further incorporation of renewable energy within its energy portfolio, as well as some of the technical, economic, and legislative obstacles that could hinder such expansion. The paper also briefly mentions notable recent developments in the field that could aid in overcoming the technical obstacles. Specifically, the paper will focus on photovoltaic solar panels, concentrated solar power technology, and wind energy as some potential sources of renewable energy.

With the goal of assessing Kuwait’s opportunities for renewable energy expansion and relevant challenges, research was conducted over existing material in the literature in order to obtain relevant data and formulate a concise elementary evaluation.

Current energy production and consumption: In 2020, the total electricity demand in Kuwait was 66 TW.hrs with a peak load of 14,960 MW. With a population of more than 4.6 million this corresponds to a per capita consumption of 14,207 kWh/year or 38.8 kWh/day. This demand is amongst the highest in the world [9]. Furthermore, total demand is ex-pected to grow to 100 TW.hrs (around 50% increase) with a peak load of 20 GW in 2028 [2].