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Feasibility of Small Autonomous Solar-Powered Water Desalination Units for Arid Regions

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Abstract : The shortage of fresh water is a major problem in several areas of the world such as arid regions and coastal zones in several countries of Arabian Gulf. Fortunately, arid regions are exposed to high levels of solar irradiation most the year, which makes the utilization of solar energy a promising solution to such problem with zero harmful emission (Green System). The main objective of this work is to conduct a feasibility study of utilizing small autonomous water desalination units powered by photovoltaic modules as a green renewable energy resource to be employed in different isolated zones as a source of drinking water for some scattered societies where the installation of huge desalination stations are discarded owing to the unavailability of electric grid. Yanbu City is chosen as a case study where the Renewable Energy Center exists and equipped with all sensors to assess the availability of solar energy all over the year. The study included two types of available water: the first type is brackish well water and the second type is seawater of coastal regions. In the case of well water, two versions of desalination units are involved in the study: the first version is based on day operation only. While the second version takes into consideration night operation also, which requires energy storage system as batteries to provide the necessary electric power at night. According to the feasibility study results, it is found that utilization of small autonomous desalinations unit is applicable and economically accepted in the case of brackish well water. While in the case of seawater the capital costs are extremely high and the cost of desalinated water will not be economically feasible unless governmental subsidies are provided. In addition, the study indicated that, for the same water production, the utilization of energy storage version (day-night) adds additional capital cost for batteries, and extra running cost for their replacement, which makes the unit price not only incompetent with day-only unit but also with conventional units powered by diesel generator (fossil fuel) owing to the low prices of fuel in the kingdom. However, the cost analysis shows that the price of the produced water per cubic meter of day-night unit is similar to that produced from the day-only unit provided that the day-night unit operates theoretically for a longer period of 50%.

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