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Economic feasibility of grid-connected PV–RO and PV–MVC small desalination units for remote areas in The United Arab Emirates — A comparative study

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ABSTRACT

This work presents a comparative study between grid-connected photovoltaic–mechanical vapor compression (PV–MVC) and photovoltaic–reverse osmosis (PV–RO) seawater desalination units with a desalted water capacity of 100 m^3/d. The two systems are designed to provide water to isolated communities in remote areas in the United Arab Emirates. It is assumed here that transportation of water to those areas is difficult and costly while power from the national grid is available. In this design problem, environmental safety, suitability to demand, simplicity and energy efficiency represent desirable design requirements. Mathematical models are utilized to design the desalination units and produce a preliminary design of the PV array. However, the different design models are not given in this paper. Detailed cost calculations are performed for each one of the suggested systems to assess their feasibility and cost effectiveness. A sensitivity study of water cost to labor cost, cost of electricity, carbon dioxide emission tax and solar panels cost is presented here, together with the computed design characteristics of each one of the two systems. Based on the same cost conditions, the study shows that water cost per cubic meter from the grid connected PV–RO plant is only 51% of the water cost from the grid connected PV–MVC one. The RO plant produced water for a total cost of 3.7 \$/m^3, while water cost from the MVC plant was 7.29 \$/m^3.

Keywords: Hybrid; Vapor compression; MVC; Desalination; Solar; Photovoltaic; PV; Environmental; Reverse osmosis; RO

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