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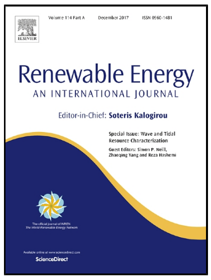

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Integrating desalination with concentrating solar thermal power: A Namibian case study

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ABSTRACT

This paper reports on a feasibility study into the integration of a multi-effect distillation plant with a central receiver plant to generate electricity for the Namibian grid, and fresh water for the community and mining operations at Arandis. Arandis receives on average 2 528 kWh/m^2/year of solar irradiation, is only 48 km from the coast and 580 m above sea level, making it attractive for a cogeneration plant. Desalination is energy intensive, but the required energy is freely available from the waste heat rejected at the condenser of a Rankine cycle. In this study, high level thermodynamic models of a multi-effect distillation and central receiver plant were developed to better understand the economics of such a cogeneration plant. Results indicate that a 100 MW$_e$ central receiver plant combined with a multi-effect distillation plant, is capable of servicing the current water demand in the region. Despite the high capital costs of central receiver plant, as well as pumping seawater inland, the plant is economically viable within the proposed tariff structure for renewable energy in Namibia, and existing water tariffs. Profit parity between a cogeneration plant and a stand-alone, dry-cooled central receiver plant is reached for top brine temperatures above 65 °C. Under these conditions, water sales would subsidize electricity production. However, it is not price competitive with a grid-powered reverse osmosis plant on the coast. The most significant barriers in making cogeneration plant competitive against more conventional desalination methods such as reverse osmosis are the high capital cost of the cogeneration plant, and pumping seawater inland.

Keywords: cogeneration of water and electricity, concentrating solar power, central receiver, desalination, multi-effect distillation, Namibia.

1. Introduction

Namibia is one of the most water stressed countries in sub-Saharan Africa, but it is also blessed with one of the highest solar resources in the world. It is a sparsely populated country, with most people living in the wetter north. South and central Namibia relies largely on underground water resources for potable water, mining and agricultural activities. These aquifers are rapidly depleted, and in coastal regions, seepage from seawater put this resource at risk of salinization. Recharge is sporadic, forcing authorities to cap annual extraction from these aquifers. The United Nations [1] classified Namibia's water resources as currently stressed, and becoming vulnerable by 2025. It is expected that climate change will impact central Namibia severely over the next century, resulting in higher ambient air temperatures, and lower and more erratic rainfall [2]. Water scarcity might put future economic development in the mineral-rich central coastal region at risk.

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