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ABSTRACT

MODELLING FACILITY ENERGY SYSTEMS FOR ENHANCED CLIMATE RESILIENCE AND SECURITY OF SUPPLY

Extreme weather and climate events, interacting with exposed and vulnerable human and natural systems, can lead to disasters. The character and severity of impacts from climate extremes depend not only on the extremes themselves but also on exposure and vulnerability[1]. This work will explore the scenarios to incorporate climate-resilience into energy infrastructure. The underlying model in this work is built using OSeMOSYS[2], the open-source energy modelling system. By virtue of its modular nature, OSeMOSYS is ideally suited to include the assessment of some factors such as demand response, which are often overlooked by traditional long-term energy modelling tools. Furthermore, scenarios with the inclusion of renewable energy and other rapidly developing technologies, such as desalination, is also studied.

The output of renewable energy fluctuates significantly depending on weather conditions. In this work, a unit commitment model is developed using the forward dynamic programming approach, to analyse the effect of integrating wind energy on the micro-grid system operation. The model obtains the time series for the operational state of generators that would maximize the profits of an electric power utility by taking into account both the forecast of output for the wind energy as well as the demand response of consumers. To validate the model, a micro-grid on the island of Corvo in the Portuguese archipelago Açores is considered as a case study. This system consists of diesel generators with a plan to integrate wind energy into the system as well implement a Demand Response strategy to utilise the wind energy during hours of excess. The study suggests

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[1] IPCC, 2012: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.

[2] www.osemosys.org

a power generation schedule for the existing power system on the island in order to lower the cost of operation. The viability of integrating wind energy was also confirmed and a generation schedule was produced. A demand response strategy was integrated into the model, using the water heating demand as a "shiftable" load. The water heater load-shifting was carried out using a real-time-pricing strategy to incentivize the utilization of electricity during hours of excess wind production. Several scenarios were studied and the impact of the demand response strategy was found to be significant. Finally, the effect of limiting the instantaneous wind penetration was studied. It was found that the total wind penetration is affected significantly by the restrictions on the instantaneous wind penetration only during days of high average wind speeds.

The results of this work can be used to gain a better understanding of the climate vulnerabilities in energy systems. A study of representative climate futures will provide insights towards the best approaches to enhance the resilience of an energy system.