Energies, vol.14, no.23, pp.7881-1-7881-29, .

T.C. González Grandón; F. Cuadra García; J.I. Pérez Arriaga

Abstract-

Renewable-powered “undergrid mini-grids” (UMGs) are instrumental for electrification in developing countries. An UMG can be installed under a—possibly unreliable— main grid to improve the local reliability or the main grid may “arrive” and connect to a previously isolated mini-grid. Minimising costs is key to reducing risks associated with UMG development. This article presents a novel market-logic strategy for the optimal operation of UMGs that can incorporate multiple types of controllable loads, customer smart curtailment based on reliability requirements, storage management, and exports to and imports from a main grid, which is subject to failure. The formulation results in a mixed-integer linear programming model (MILP) and assumes accurate predictions of the following uncertain parameters: grid spot prices, outages of the main grid, solar availability and demand profiles. An AC hybrid solar-battery-diesel UMG configuration from Nigeria is used as a case example, and numerical simulations are presented. The load-following (LF) and cycle-charging (CC) strategies are compared with our predictive strategy and HOMER Pro’s Predictive dispatch. Results prove the generality and adequacy of the market-logic dispatch model and help assess the relevance of outages of the main grid and of spot prices above the other uncertain input factors. Comparison results show that the proposed market-logic operation approach performs better in terms of cost minimisation, higher renewable fraction and lower diesel use with respect to the conventional LF and CC operating strategies.

Index Terms- renewable energy sources (RES); grid-connected micro-grids; unreliable grid; market-logic unit commitment; smart curtailment; reliability; optimisation; load following; cycle charging; predictive strategy

Citation: