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DESIGN AND MANAGEMENT OF RENEWABLE SMART ENERGY SYSTEMS: AN OPTIMIZATION MODEL AND ITALIAN CASE STUDY

Francesco Pilati[(1)], Marco Bortolini[(2)], Mauro Gamberi[(2)], Alberto Regattieri[(2)]

[(1)]University of Bologna - Department of Industrial Engineering, Italy
francesco.pilati3@unibo.it

[(2)]Alma Mater Studiorum - University of Bologna, Italy
marco.bortolini3@unibo.it, mauro.gamberi@unibo.it, alberto.regattieri@unibo.it

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Abstract: Smart and distributed energy micro-production is the new pattern for the electric energy supply, joining high service level and sustainability issues. Within such a context, the renewables, i.e. solar photovoltaic (PV), micro-wind, etc., play an increasing role as part of the source mix because of their capillary presence and the decrease of the required initial technology investments. On the contrary, the renewable intermittence is the key weakness to overcome to make a turning point to their final spread. To this purpose, hybrid energy systems join the plus of having renewable modules to the plus of having backup traditional units activated in the case of lack of energy. This study presents and applies to an Italian rural context a linear programming model to best design and manage a local off-grid renewable smart energy system. The power system may include PV and micro-wind technologies together with a battery bank and diesel generator as the backup system. Starting from the expected average load profile, the environmental conditions and the technical features of the energy modules, the model selects the most suitable energy sources, optimizes the power rates of each unit and manages the energy flows within the system. The final goal to achieve is to minimize the levelized cost of the produced electricity (LCOE) making such a system competitive respect to fully fossil fuel based energy systems. The aforementioned case study exemplifies the model application focusing on a remote scientific center requiring electric energy for its daily research activities. The area where the center is located is badly connected to the national grid and, actually, a fossil fuel generator is used, only, to provide electricity. An as-is vs. to-be differential analysis assesses the effect of introducing a dedicated renewable smart energy system finding its economic feasibility over a 15 year lifetime. Evidences show the convenience of exploiting the solar source, while little convenience is for micro-wind installation because of low available wind power and the increasing system complexity. Globally, the LCOE is close to 0.14 €/kWh making competitive the hybrid energy solution, close to the evident environmental benefit.