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MODELLING OF A STAND-ALONE H2-BASED ENERGY STORAGE SYSTEMS FOR ELECTRICITY PRODUCTION AND H_2 MOBILITY

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ABSTRACT

The application of renewable energy sources (RES) during the last decades is increasing, with the aim to reduce carbon dioxide emissions and develop more sustainable energy systems. Referring to isolated microgrids and off-grid remote applications, because of the non-continuous RES production, energy storage systems (ESSs) are necessary to make the energy supply reliable and reach the energy self-sufficiency. Among the possible EESs, hydrogen-based storage solutions integrating electrolysers to produce hydrogen from surplus renewable energy and fuel cells to generate power from the stored hydrogen (called Power-to-Power systems) can represent a promising solution. The present study has the aim to analyse, from a technical and an economical point of view, a hybrid Power-to-Power and Power-to-Hydrogen system for a mountain off-grid village. The hydrogen is utilized in fuel cells for power generation to provide the electrical load of the site and also for mobility for fuelling a FCEV minibus line. The aim of this work is to find the optimal system configuration, with the minimum Net Present Value (NPV) at the end of system lifetime. The Levelized Cost Of Energy (LCOE) and the Levelized Cost Of Hydrogen (LCOH) are also computed, to understand the economic viability for electricity and mobility loads, respectively. These values were derived using cost inputs from literature, and a comparative analysis is performed for different system configurations. Results from the energy simulations revealed that the need for an external source is significantly reduced thanks to RES together with the hydrogen-based storage system, with zero emission respect to diesel solution and a cost of electricity slightly higher. Moreover, considering also a biomass-based CHP system as energy source, the cost is reduced more than three times. The cost of hydrogen for mobility instead, is still highly influenced by the lower development status of hydrogen technologies in the mobility sector.

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