ABSTRACT/SUMMARY

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The worldwide endeavour to tackle climate change is generating an increasing interest in adopting clean energies as a feasible alternative to fossil fuels. Challenges arise in small communities without dependable energy supplies due to uncertainties around renewable energies. Hydrogen exhibits considerable potential as a viable alternative owing to its inherent dependability and capacity for long-term energy storage. Nevertheless, there are lingering inquiries regarding the inclusion of hydrogen in renewable energy supply chains and whether it results in an ideal arrangement and equilibrium between yearly expenses, environmental consequences, and societal effects, all aiming to satisfy a small community's energy requirements. The most effective technologies, as determined through tri-objective optimization, are wind turbines (WT), Combined Heat and Power (CHP), Organic Rankine Cycles (ORC), and grid. The optimal approach results in a cumulative yearly expenditure of $6.14 million, an ecological footprint of 0.2 species annually, and a societal impact of 1256 utility resources. By integrating the likelihood of power disruptions, the model demonstrates a 2.2% reduction in social consequences compared to having complete grid connectivity, which increases to 15.4% in an off-grid situation. According to projections, hydrogen technologies are expected to create 22 MW of energy by the year 2030 as they continue to advance and develop. In this scenario, there is a notable decrease of 63% in environmental impact and a 4% gain in social effect despite a substantial 143% increase in total annual expenses.

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