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REDUCING EMISSIONS IN UTTARAKHAND VILLAGES THROUGH HYBRID ENERGY SYSTEMS: A CASE STUDY ON REPLACING FUEL OF SECONDARY GENERATOR

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Abstract

The present study introduces a scalable hybrid power generation framework integrating wind, solar, biomass, and a generator. The initial phase involves pinpointing a specific geographical area and collating meteorological data as primary research steps. Through a meticulous analytical evaluation of each constituent within the system, a cost-reduction-oriented objective function is formulated to optimize the hybrid power system configuration. Comprehensive planning and simulations encompass various scenarios incorporating backup batteries, solar and wind power, biomass, and secondary generators. Furthermore, a pivotal study supports the concept of amalgamating wind and solar energies in locations where their complementary cycles intersect. To achieve this, a system design targeting an optimal levelized cost of energy for off-grid deployment, set at $0.158 per kWh, is devised. Innovatively, the incorporation of co-fired generators and fuel substitution strategies are introduced into the analysis. Remarkably, substituting conventional diesel with a blend of biomass co-fired diesel, alongside a 20% biodiesel blend, results in a reduced cost of electricity to $0.132 per kilowatt-hour. This substitution not only lowers expenses but also significantly curtails emissions. The utilization of co-fired generators exhibits a remarkable environmental impact, manifesting as a 34.5% decline in particulate matter emissions, an 85% reduction in SO_2 emissions, a 91% reduction in NO_X emissions, and a 37% decrease in CO_2 emissions, as per the study's findings.

Key words: cofired generator, emission reduction, hybrid energy systems, technoeconomic analysis biodiesel

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