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Topic of Research: Investigation and Analysis of Technical and Economic Feasibility of Microgrid based Power System

Keywords: Microgrid, Distributed Energy Resources, SAIFI, SAIDI, CAIDI, ENS, AENS

Findings

The study highlights the technical, economic, and environmental benefits of deploying microgrids in modern distribution systems. First, system loss reduction is demonstrated through the IEEE 33-bus test system, where increasing Distributed Energy Resources (DERs) penetration, including wind, solar PV, and diesel generators, reduced losses by 5.37%, 10.37%, and 14.27% in three successive cases. This confirms that higher DER integration enhances network efficiency.

Second, the application of microgrids in smart cities, specifically Rampur and Aligarh, shows improved reliability indices and reduced system losses. While SAIFI showed minimal change, significant improvements in SAIDI, CAIDI, ENS, and AENS were recorded. For instance, Rampur achieved a 6.93% and 6.76% reduction in real and reactive power losses, respectively, while Aligarh achieved 7.77% and 6.43%. These improvements strengthen the distribution network for continuous, cost-effective electricity supply.

Third, economic feasibility was analyzed using HOMER software for an institutional load at Jamia Millia Islamia. Among five topologies, the Grid-solar PV-wind turbine configuration emerged optimal, offering a 40–50% reduction in OPEX and COE compared to alternatives, despite slightly higher CAPEX and NPC.

Finally, the proposed system reduced CO₂ emissions by over 30% compared to other topologies and nearly 50% versus the conventional grid, cutting the social cost of carbon to INR 0.93 million. Thus, the microgrid configuration proves both economically viable and environmentally sustainable.