Abstract No: PO-40

Optimising energy efficiency in a PV-enabled base transceiver station

J. A. T. D. Jayasooriya[1], P. L. A. K. Piyumal[2*], and A. L. A. K. Ranaweera[2]

[1]Department of Electrical and Electronics Engineering, CINEC Campus, Sri Lanka.
[2]Department of Physics and Electronics, University of Kelaniya, Sri Lanka.
kasunp@kln.ac.lk*

The need for green energy sources has become paramount in the modern world due to the environmental hazards of non-green alternatives. Essential services, including the telecommunication industry, must also align with this goal. As foundational elements of the telecommunications network, base transceiver stations offer a ripe opportunity to integrate green energy solutions. However, the prevalent scenario reveals that many of these stations continue to rely on conventional grid-based power sources, with only a limited fraction equipped with standalone photovoltaic (PV) systems. This study addresses a pressing challenge in integrating standalone PV systems with base transceiver stations. Central to this challenge is the conundrum of power generation backups, specifically during the morning hours, when the battery reserves charged by the PV systems are frequently depleted. This operational gap necessitates the deployment of supplementary power generators, imposing substantial operational costs that diminish the cost-efficiency advantages anticipated with the introduction of PV systems. The methodology involved a detailed analysis of the selected base transceiver station's total DC power consumption patterns from 15th May 2023 to 21st May 2023. These insights guided the design of an efficient energy harvesting system enriched with a supercapacitor-battery hybrid energy storage arrangement. A Maximum Power Point Tracking (MPPT) controller was acquired to optimise system performance; its effectiveness was verified through efficiency calculations and PV array emulator Irradiance Profiles, and its efficiency exceeded 90%. An intelligent power management strategy was implemented, automatically switching to consume supercapacitor (SC) energy when the voltage level exceeds a threshold, conserving battery bank energy, ensuring uninterrupted operation, and extending battery lifespan. The prototype's operational modes, including neutral, SC charge recovery, and SC bypass, have been successfully demonstrated. Results indicate that the suggested photovoltaic system prototype effectively tracks the PV array's maximum power point (MPP), comparable to standard systems using traditional MPPT algorithms. This novel system promises to not only obviate the need for extensive generator backups but also potentially reduce their capacity compared to conventional configurations. Realising a green energy-powered telecom network is a vast and complex process, demanding guaranteed performance and cost-effectiveness for a period of at least about 15 years. This research marks a significant milestone in advancing green energy solutions and highlights the crucial role of base transceiver stations in establishing a sustainable telecommunication infrastructure. Embracing eco-friendly technologies is essential in safeguarding our planet and ensuring a brighter future for generations to come.

Keywords: Base Transceiver Station, Energy Harvesting, PV Systems, Supercapacitors

Acknowledgment
This work was supported by the internal research grant of the University of Kelaniya, Sri Lanka, under the research grant no. (RP/03/02/05/01/2023).