IJARSCT



International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Volume 5, Issue 13, April 2025



A Multi-Agent AI-Driven, Blockchain-Secured, IoT-Enabled Smart Grid Framework for Autonomous Energy Management and Resilience Enhancement

Vishal Yadav¹, Rahul Singh², Mahtabul Haque³ ¹²B. Tech Students, Department of Electrical Engineering ³Assistant Professor, Department of Electrical Engineering R. R. Institute of Modern Technology, Lucknow, India

Abstract: The accelerating evolution of modern energy systems requires a transformative shift from centralized, rigid power grids to intelligent, decentralized, and adaptive infrastructures. This paper proposes a next-generation smart grid architecture that integrates four foundational technologies— Multi-Agent Systems (MAS), Artificial Intelligence (AI), Blockchain, and the Internet of Things (IoT) into a unified, resilient framework for autonomous energy management. The proposed system leverages the decentralized intelligence of MAS to enable distributed decision-making among dynamic grid entities such as prosumers, distributed energy resources, and grid operators. AI algorithms, embedded within these agents, empower real-time forecasting, optimization, and anomaly detection, allowing for predictive and self-healing grid operations.

A layered architecture is adopted, where the IoT layer acts as the sensory and actuation interface, collecting real-time data from the physical environment. The AI and MAS layers collaborate to process this data and execute control strategies autonomously. To ensure secure and tamper-proof communication and transactions, a blockchain layer is implemented to maintain data integrity, facilitate peer-to-peer energy trading, and enforce smart contracts transparently.

The framework is evaluated using IEEE standard test systems under diverse operating scenarios, including peak demand, renewable intermittency, and cyber-physical attacks. The results demonstrate substantial improvements in grid efficiency, operational resilience, scalability, and cybersecurity. This research offers a comprehensive blueprint for future-proof, autonomous, and intelligent energy systems.

Keywords: Artificial Intelligence

Copyright to IJARSCT www.ijarsct.co.in



DOI: 10.48175/IJARSCT-26025



155