https://doi.org/10.46335/IJIES.2025.10.8.7 **e-ISSN: 2456-3463**
Vol. 10, No. 8, 2025, PP. 35-38

International Journal of Innovations in Engineering and Science, www.ijies.net

Overview of Smart Grid Prospects in India - A Review

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Received on*: 09 May,2025* ***Revised on****: 15 June,2025* ***Published on****: 17 June,2025*

Abstract *–The Indian economy has consistently grown at a significant rate, which has increased demand for energy. The need for electrical energy has created challenges for both its delivery and production. India's electricity grid has expanded to 250 GW from 1362 MW. Since achieving independence, India has faced several power-related issues, such as transmission and distribution losses, electricity theft, and environmental issues. Presently, India ranks third globally in terms of both power production and consumption. To compensate these issues there is an emerging need of 'Smart- Grid'. This study discusses the components that might help India implement a smart grid. Additionally, it emphasizes technology that increase the grid's security, sustainability, and efficiency and this paper gives a glance at some initiatives taken by government of India to boost Smart Grid in country. This paper's goal is to talk about the role of policy frameworks, advancement in technology and collaboration of stakeholders in driving. India's smart grid journey. By embracing smart grid technology, India can create a more sustainable, efficient and consumer centric ecosystem of the electricity by supporting its economic growth and satisfying the environmental norms. Unlike in the past, the increasing demand from consumers is no longer being met by the electricity supply. It is anticipated that by 2040, India's proportion of the world's primary energy consumption will rise from 6% to 11%. and Implementing a smart grid, an enhanced electric grid that incorporates renewable resources, communication technologies, and various sensors to make the grid more responsive, is a potential answer in today's circumstances.*

Keywords*- smart grid, scope smart meter, electricity*

INTRODUCTION

Over the past ten years, there have been major global changes to the distribution, transmission, and generating aspects of the power system's value chain. The way the power sector is seen has changed significantly. With renewable power accounting for 43% of installed capacity in 2022–2023 (up from 31% in 2014–2015), India has seen tremendous progress in the green energy sector during the past decade. India wants to use renewable energy to generate 500 GW of installed capacity by 2030. In terms of physical infrastructure 1, 23,577 ckt.km of transmission lines and 7, 22,940 MVA of transformation capacity have been targeted to add up in the 2022-23 to 2026- 2027. Consumers today seek digital-grade power supplies that are safe, dependable, high-quality, and reasonably priced. This draws a clear roadmap for the power grid development and transformation to become a smart grid Due to inefficiencies and operational issues, India's power system suffers substantial transmission and distribution losses (Jadhav and Dharme, 2012). Also the increasing global warming worldwide and the scarcity of fossil fuels becomes a subject of big concern for power sector.

What exactly a smart grid is?

An electrical network that is digitally based and delivers power to consumers via two-way digital communication is known as a smart grid. The use of systems that continuously supply and consume data from an energy network is one example of a smart grid application, as are demand management, smart energy integration,

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storage and renewable resource administration, and smart gauge integration. In this paper we have discussed about the technological advancements which integrates to form a smart grid system by providing information, achieving environmental norms and fulfilling customers demand.

1.1 Smart grid Objectives:

The goals are to reduce operating costs, maintenance costs, and system planning; to improve power system performance and security; to controllability of assets; and to offer grid observability.

- To support a broad range of dispatchable, sporadic, and dispersed generation.
- To interact with smart building energy management systems to let users control their energy consumption and save energy costs.
- To give consumers better electricity quality.
- To provide real-time information, lower operational costs, and make power available to all.
- To anticipate system issues and act quickly to prevent power outages and poor power quality.
- To achieve energy independence for the country.
- To generate employment, Smart grids are

believed to be essential for consumer participation in order to improve overall system efficiency, meet peak demand without investing in generation, and implement variable pricing, in addition to being required for the integration of distributed generation, renewable energy sources, and plug-in (hybrid) vehicles into the electrical grid.

II. LITERATURE REVIEW

Vijaypriya and Kothari (2011) explore the "Energy for all and Energy forever" goals of former President Dr. A.P.J. Abdul Kalam.

Jha et. al. (2014) examined the Puducherry Smart Grid Pilot Project as a case study to apply smart grid technology to the Indian power system.

Kumar et. al. (2015) evaluations of the most recent developments in physical security technology, with an emphasis on

system dependability and protective mechanism failure

Deshmukh and Upasani (2016) examined the smart grid's potential and protection mechanism failures.

Akhil et. al. (2019) reviewed with the role of smart grid technology.

Farmanbar et.al. (2019) studied about ***mart*** devices optimize energy use in smart cities by integrating renewable and non-

renewable resources, reducing costs and environmental impact

Butt et.al. (2021) presents a brief evaluate of ‘‘smart Grids” with its capabilities and its one of a kind components on power distribution enterprise has been offered. It's also explained that how these technologies alternate and have extra ability to evolve and energy the distribution machine.

Archana et.al (2022) studied to prominent academicians, researchers and industry professionals in the power sector participated in questionnaire surveys, interviews, and workshops to examine the many parts of the smart grid.

III. COMPONENTS OF SMART GRID

The main components of smart grid include:

- Smart appliance;
- Electrical vehicles (EVs);
- Smart meter;
- Smart substation
- Distributed generation
- Phasor measure units
- Integrated communications
- Sensing and measurement

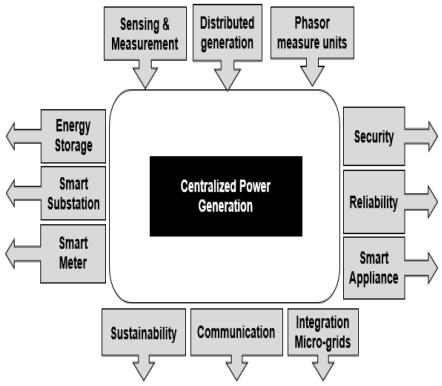

Fig. 1 Components of Smart Grid

3.1Smart Appliance

Smart appliances make use of modern computer and communication technologies to carry out tasks more quickly, more affordably, and with greater energy efficiency. These appliances can benefit from an energy smart grid that is created nationally by the utilities. The smart-grid technology may be used to generate

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electricity for appliances like toasters, dishwashers, washing machines, refrigerators, and electric cars.

3.2 Electrical Vehicles (EVs)

A vehicle that uses one or more traction or electric motors for propulsion is called an electric vehicle (EV). There are several techniques used to reenergize EVs. Some of them are as follows:

- System of collectors that provides power from sources other than vehicles.
- Self-contained battery system;
- Solar panels; and
- An electric generator that produces power from fuel.

3.3 Smart Meter

Smart meter technology offers two-way communication as a means of creating a channel for communication between power providers and end consumers. This communication system is developed using a secure wireless network. Smart meter technology offers several benefits, including the ability to gather billing data quickly, identify system faults, and notify the maintenance team much more quickly than a manual system since utilities are instantly notified of any outage.

3.4 Smart Substation

The various substation components have been improved, enriched, and supplemented by integrating digital technology, resulting in improved performance at higher ratings and increased dependability over the previous version. The primary difficulty is in combining all of these parts into a fully digital substation and enabling them to function in a demanding environment.

3.5 Distributed Generation

Distributed generation is the use of low-level energy generating methods at the consumer level.
It can save expenses, improve dependability, limit pollutants, and increase the number of power options.

3.6 Phasor Measurement Units

Phasor measurement units (PMUs), also known as synchrophasors, are devices that use the global positioning system (GPS) radio clock to synchronise their measurements of voltages and currents at specific locations within the utility grid. PMUs can be complex devices that are frequently incorporated into other electrical devices, including protective relays.

3.7 Integrated Communications

The integrated communication system is the part of the power system that links various technologies. Integrated communication technologies include wireless mesh networks, fibre optics, and supervisory control and data acquisition (SCADA) systems.

3.8 Sensing and Measurement

The data was collected and modified using sophisticated sensing and measurement technology to enable better power system management. The electrical markets will be supported and energy will be used more efficiently by the developing sensing and measurement technology. This will enable consumers and utilities to make capital savings.

IV. POLICIES MADE BY CENTRAL GOVERNMENT OF INDIA IN VOTE OF SMART GRID

- Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA):
  Empowering households in both rural and urban areas by providing them with inexpensive, dependable electricity.
- Green Energy Corridor (GEC):
  Synchronising grid-connected renewable energy with India's national transmission network.
- National Smart Grid Mission (NSGM) and Smart Meter National Programme (SMNP): Modernising India's power sector into a secure, adaptive, sustainable, and digitally enabled ecosystem

V. CONCLUSIONS

Without electricity, it would have been impossible to establish science or technology. Future electricity consumption is expected to rise even higher, necessitating increased centralized or distributed power generation to meet growing demand while maintaining power quality.
However, a number of issues with the efficient operation of the electrical grids lead to significant power outages and perhaps acute shortages in the future. Additionally, the most recent developments in the production of power from renewable sources call for a way to use them effectively.

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