Geospatial solutions for Smart (Power) Grid Implementation

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INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY

H Y D E R A B A D

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Status of Smart Grids in India

1. India's Energy Landscape:

India is the world's third-largest electricity producer and consumer, with increasing demand driven by industrialization and population growth.

As of 2021, India's renewable energy capacity was 150.54 GW, with significant contributions from solar, wind, and hydroelectric sources. The goal is to achieve 500 GW by 2030.

With the intensification of global warming and fossil fuel supplies becoming scarcer, this objective intends to restructure the energy system via infrastructure development to incorporate renewable energy sources and enable a green energy transition. Due to inefficiencies and operational issues, India's power system suffers substantial transmission and distribution losses.

The Indian electrical industry has a lot of untapped potential. Government authorities and leaders from the energy sector have stressed the importance of Smart Grid and Micro-grid for the nation, resulting in a lucrative commercial prospect. India's principal objective is to electrify all houses, supply enough electricity for agriculture, and provide 24×7 power access to every resident by 2019.

2. Challenges in the Power Grid:

- Significant transmission and distribution losses.
- Frequent electricity theft and blackouts due to inefficiencies.
- Lack of automation and one-way communication in traditional grids (includes routing problem).
- Lack of security and difficulty in management because of Radial network (centralized)

3. Smart Grid Initiatives:

Smart grids integrate renewable energy, advanced communication technologies, and sensors for real-time data exchange, outage detection, and load management.

Multiple pilot projects have been completed across cities like Guwahati, Mysore, and Puducherry, incorporating advanced metering, load management, and outage management.

The Government of India's Department of Science and Technology (DST) has committed around US$ 46.5 million to the research and development of smart grids. Academic institutions in India and private industry, have been doing research and development on smart grids.

4. Emerging Technologies:
- Use of AI for demand prediction, load optimization, and fault detection.
- Deployment of advanced metering infrastructure (AMI) and distribution automation (DA).
- Integration of distributed energy resources and energy storage systems.
- In general, the artificial neural network (ANN), reinforcement learning (RL), genetic algorithm (GA), and multi-agent systems are well-known AI techniques to solve the problems of classification, forecasting, networking, optimization, and control strategies.

Problem Statement

The evolution of India's power grid into a smart grid has been promising, but significant gaps remain in achieving full-scale implementation. These include: Lack of comprehensive visualization tools to evaluate the historical and future impact of smart grids in specific regions. Insufficient use of spatial analysis and AI for optimizing grid operations. Limited public understanding of smart grid benefits and their role in energy sustainability.

Proposed Project Focus

Develop a web-based application to:

1. *Visualize Smart Grid Evolution*: Focus on a specific Indian city, showcasing data on renewable energy integration, grid upgrades, and performance improvements. Incorporate historical trends and real-time data wherever possible.

2. *Leverage Spatial Analysis and AI*: Analyze geographic and energy consumption patterns to highlight critical areas for improvement. Simulate AI-based solutions for fault prediction, load balancing, and demand management.

3. *Promote Awareness:* Provide user-friendly interfaces to educate stakeholders about smart grid functionalities and their role in India's energy transition.

4. *Analysis* : Involves calculating the carbon footprint, which quantifies the total greenhouse gas emissions associated with a project, and the cost of implementation, which covers the financial expenses required to execute the project

Thank you