Optimizing Load Distribution in Power Transmission Networks through Demographic and Geographical Analysis

Networks and Complex System

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1. Introduction

- Efficient power distribution is vital for modern lifestyles and economic growth.
- Conventional systems encounter challenges like load imbalances and transmission losses.
- Observations of a specific power network reveal opportunities for load optimization.
- Leveraging demographic data and geographical proximity can enhance distribution efficiency.
- This study addresses load forecasting, transmission capacity optimization, and renewable integration.
- The aim is to advance power system engineering and bolster energy infrastructure resilience.

2. Overview of research

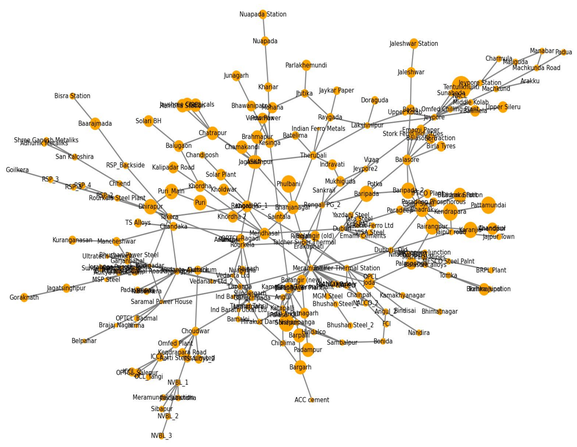

Fig 1: Overview of the research.

3. Scientific questions

- How can we integrate **renewable energy sources** such as solar and wind power into the network while maintaining stable load distribution and grid reliability, considering their intermittency and variability?
- **Optimal placement of new nodes** to minimize load imbalances and transmission losses while maximizing power distribution efficiency?
- Developing accurate load forecasting models to anticipate **future distribution needs** considering population growth and economic development.

4. Optimization Framework for Efficient Load Distribution and Infrastructure Planning in Power Networks

Objective: To optimize load distribution in power transmission networks through demographic and geographical analysis for enhanced efficiency and reliability.

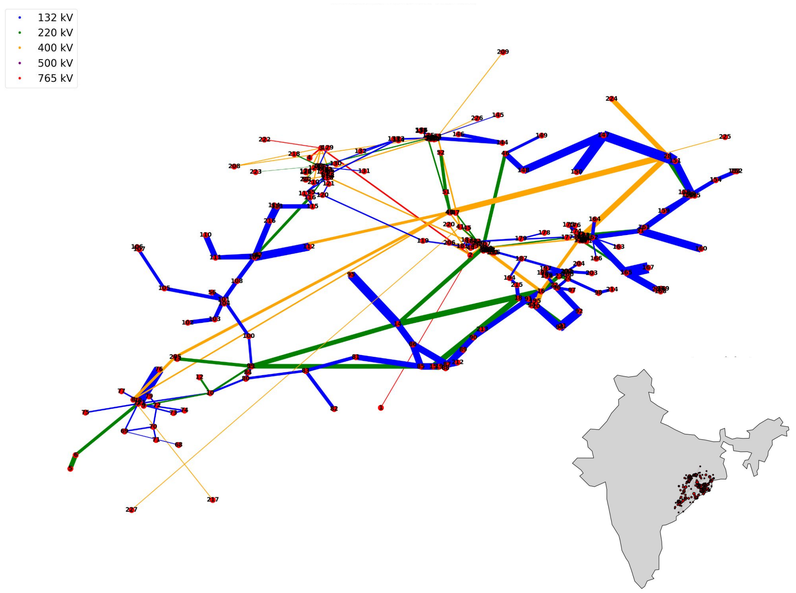

Fig 2: network graph illustrating nodes and edges annotated with power ratings and population weights.

5. Utilizing Lower Population Nodes and Strategic Placement of new node for Improved Power Grid Efficiency

Objective: To optimize power distribution networks by redistributing load from high population-weighted nodes to comparable lower population-weighted nodes or strategically establishing new nodes, thereby enhancing overall network efficiency and reliability.

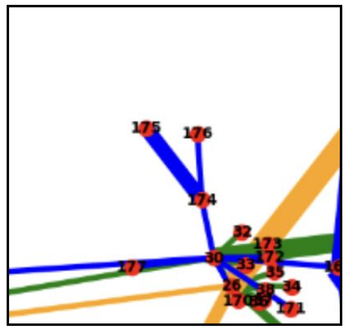

Fig 3: Load Distribution from Brahmanipal (175) to Tomka Junction (176) Power House Ensuring Short Distance (5km)

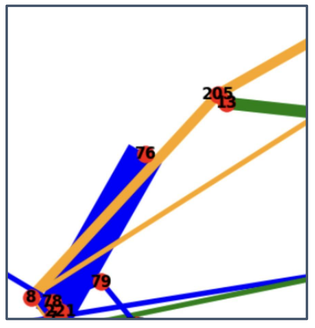

Fig 4: Load Distribution from Tentulikhunti (76) to Indravati (13) Power House Via Generating a New Node

6. Emerging Technologies and Innovations in Power Distribution Networks

Objective: Investigate how emerging technologies, such as smart grids and renewable energy integration, can improve efficiency and reliability in power distribution networks.

- **Renewable Energy Integration**
  - Incorporate solar, wind, and other renewable sources into traditional power grids.
  - Promote sustainability and reduce reliance on fossil fuels for energy generation.
- **Promoting Network Sustainability**
  - Reduce carbon emissions and environmental impact by increasing the share of renewable energy sources.
  - Support long-term energy sustainability goals and contribute to climate change mitigation efforts.
- **Improving Network Efficiency**
  - Enhance grid stability and load balancing capabilities.
  - Enable dynamic pricing schemes and demand response strategies for efficient resource utilization.
- **Enhancing Network Reliability**
  - Mitigate risks of outages and disruptions through proactive monitoring and fault detection.
  - Facilitate rapid restoration of services through automated control systems.

7. Research Outcomes

- Investigate **optimal load sharing** strategies among powerhouses based on population weight and geographical proximity, aiming to minimize overload and optimize energy distribution.
- Investigate innovative techniques for strategically placing new nodes in the distribution network to enhance load sharing efficiency and overall network performance.
- Evaluate infrastructure changes and new node positioning for their effects on load distribution, and environmental compliance.

Future work: Exploring the integration of renewable energy sources to enhance network flexibility and sustainability.

8. References

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- [2] E. U. Oleka, S. N. Ndubisi, and G. K. Ijemaru, "Electric Power Transmission Enhancement: A Case of Nigerian Electric Power Grid," IEEE Transactions on Power Systems, vol. 32, no. 4, pp. 2789-2797, Jul. 2017. [Online]. Available: link

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