Academic

Power Grid Densification: Makara Beach Case Study

Project Overview

In response to the planned residential densification at Makara Beach, this project aimed to assess and enhance the existing low-voltage distribution network to accommodate increased load demand. Modeling and simulations were conducted using DIgSILENT PowerFactory to ensure that the network could reliably support the future load growth while maintaining compliance with voltage and thermal performance standards.

My Contributions

- Simulated both current and densified load scenarios to identify system constraints.
- Diagnosed critical network issues including transformer overloads, line congestion, and voltage instability.
- Proposed, modeled, and validated optimization strategies through iterative load flow simulations.
- Evaluated alternative configurations to ensure a balance between performance and cost.

Key Findings

Identified Issues

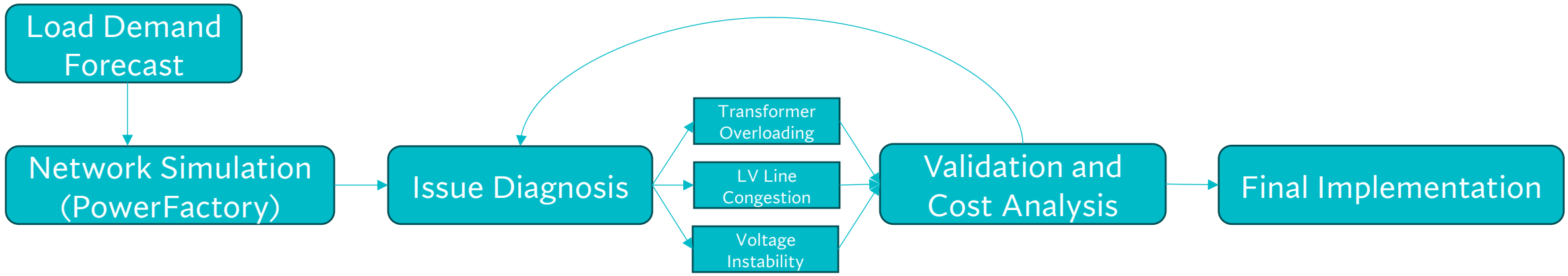
- Severe transformer overloading under full load conditions.
- Overloading of low-voltage distribution lines.
- Voltage drops beyond acceptable thresholds across multiple nodes.

Design Considerations

- **Thermal and Voltage Compliance**: Maintained operating conditions within thermal and voltage thresholds.
- **System Redundancy and Reliability**: Enhanced network robustness to support stable operation under varied load conditions.
- **Cost-Efficiency**: Selected solutions that deliver strong technical performance while minimizing capital expenditure.
- **Scalability**: Ensured the network layout remains simple and scalable for future residential or commercial expansions.

Solutions Implemented

- **Transformer Upgrades**
  Upgraded key transformers at strategic points in the network to accommodate the increased load and eliminate overloading risks.
- **Line Reinforcements**
  Paralleled and restructured low-voltage feeders to redistribute load, reduce congestion, and improve load balancing across the network.
- **Voltage Profile Optimization**
  Improved voltage profiles at all terminal nodes, ensuring that system voltages remained within regulated limits to enhance service quality and reduce losses.



Metric	Before	After
Max Transformer Loading	227.77%	<80%
Max LV Line Loading	>90%	<60%
Lowest Node Voltage	<0.96 p.u.	>0.975 p.u.
Total Upgrade Cost (NZD)		+10.7%

Remark:
All these improvements were achieved with only a **10.7% increase** in the original system cost — ensuring high performance at an optimized budget.