

Role of microgrids in ensuring secure electric supply in Nordic rural area distribution networks

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Introduction

The role of reliability and quality of supply is emphasized in the Nordic rural environment. This is due to growing risk of climate change originated storms and weather phenomenon and the fact that existing electricity infrastructure is mostly built with vulnerable overhead line technology in the forest covered areas. In Finland, 56% of the outages experienced by end-customers are caused by trees falling on the lines. Distribution system operators (DSO) are considering different network technologies such as microgrids to renovate the distribution system. The most challenging operating environment is there, where there are long distances, areas are forest covered, networks are built with overhead line technology and there is uncertainty regarding the growth of load (and depopulation).

Research questions

- What is technoeconomic potential and value of microgrids (and distributed generation PV, electric vehicles and energy storages)
- How do they affect the network development needs?
- How microgrids can provide local (DSO) and system level (transmission system operator, TSO) needs?

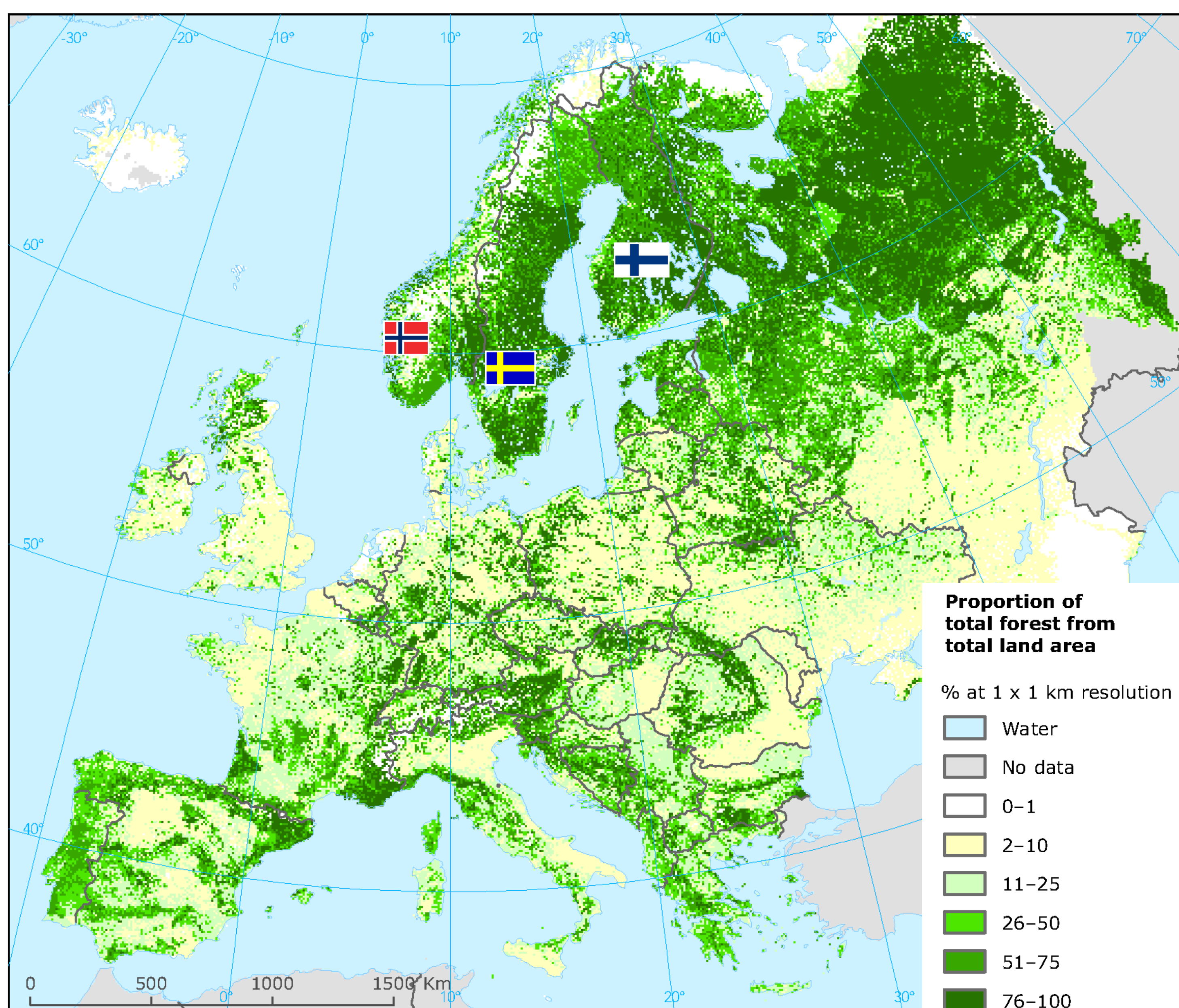


Figure 1 – Forest map of Europe

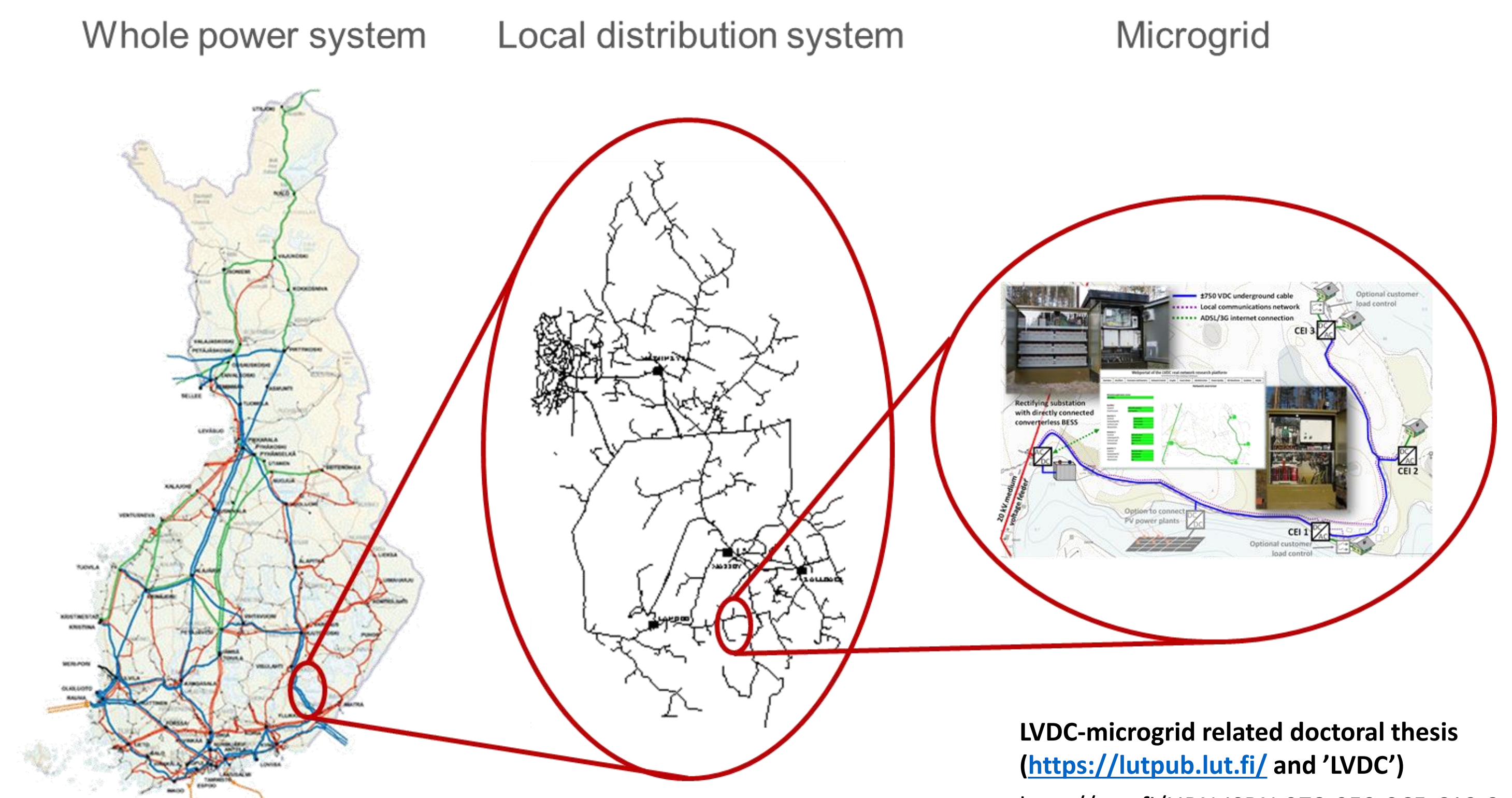


Figure 2 – System of systems. Microgrids providing local and system level services

LVDC-microgrid related doctoral thesis (<https://lutpub.lut.fi/> and 'LVDC')
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Results

The key results are documented in several doctoral theses, scientific publications and research reports. Microgrid technology functions and survives in the challenging Nordic environment. It gives

- **For a DSO** a tool to develop electricity distribution in cost effective way and to provide supportive local mechanisms (reliability of supply, voltage quality, reactive power management)
- **for a TSO** a tool to integrate active resources into the system level services (frequency control, power balance)
- **for customers** a possibility to easier integrate their resources (flexible load, distributed generation and storage) to the electricity markets (for optimization of operation and dimensioning of present and future energy system)

Key facts of rural operation environment

- **Long network lengths** - Sparsely populated country (low customer density)
- **Challenges regarding reliability** - High forest rate and vulnerable network technologies for weather originated storms (overhead line networks in forests), 56% of the outages experienced by end-customers are caused by trees falling on the lines
- **Use of electricity and load profiles well known** - 100% of customers have AMR-meter (customer –specific hourly based numbers from several years)
- **Uncertainty regarding continuity and future demand** – depopulation from rural areas to cities and change of load profile due to electric vehicles, distributed generation and heating system renovations