

Popular Science Summary

Many nations have agreed to reduce greenhouse gas emissions. In Sweden, the Swedish government wants to increase renewable energy production and set a target to use 50% more efficient energy by 2030. With the increasing number of renewable-based micro-generations near consumer premises, it is possible to operate the local power system by its own. Such a local power system is called a microgrid, which can be operated either in grid-connected or islanding mode. Many advantages and benefits can be derived from microgrids, but protection strategies should be different from conventional power systems because of the different fault current levels in grid-connected and islanding modes. In microgrids the number of distributed generations is connected, and because of this, it has protection challenges such as bidirectional power flow, blinding operation, and false tripping that need to be considered.

Several microgrid projects have been implemented around the world. In northern Europe, microgrid projects are increasing. In Sweden, E-ön has developed the Simris microgrid project and Vattenfall has developed the Arholma microgrid project. In Finland, the Haiuoto island microgrid project is a working project. This thesis focuses on Simris microgrid project and analyses different protection strategies that consider selective fault detection and disconnection during the fault.

If a fault occurs in the power system it is necessary to disconnect only the faulty part to maintain system reliability. This thesis mainly focuses on the protection strategies of microgrid for the Swedish power system in the medium voltage distribution system and specifically on the three-phase fault and earth fault protection strategies. In the power system, almost 70–80% of the faults are single line-to-ground faults, and 2–5% are three-phase short-circuit faults. Three-phase short circuit faults are the most severe faults that can be addressed as soon as possible. In this thesis, distance protection methods are used for three-phase faults and directional earth fault protection is used for earth faults.

Microgrid can be operated in grid-connected and islanding mode and results show that using a distance protection strategy for a three-phase fault, the fault can be detected on cable in grid-connected and in islanding operations but it creates blinding of the relay in backup protection when the fault location is near the grid side in grid-connected mode and near the distributed generator side in islanding mode. In Sweden medium voltage distribution system uses peterson coil earthing thus fault current is low during earth fault. For selective detection of the earth fault of the system, directional earth fault protection is used. By using this method, the earth fault can be selectively clear during grid connection and islanding operation with low fault resistance value. For high fault resistance values, the fault current is lower than the current transformer rating, so it is not possible to detect earth faults.