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Optimization of generation cost in a microgrid

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Abstract

In this paper is determined the optimal power that needs to be generated by the units in a microgrid so that the total generation cost should be minimum at the consumer premises. The optimization is performed for the steady-state condition of the system. A microgrid is a small-scale power grid that can be operated independently or in combination with the area's main electrical grid. A microgrid can comprise multiple renewable energy sources, such as wind turbines, photovoltaic panels, micro-hydro generators, biomass, fuel cells and storage units. The case study is performed for a microgrid that comprises six generating units and one load. The installed capacity of the generating units is 737 kW, while the load demand is 454 kW.

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Keywords: generation costs; steady-state; renewable energy sources; microgrid; power demand.

1. Introduction

The coordinated operation and control of distributed generation (DG) sources and controllable loads is the main concept of Microgrids (MG).[1]

A typical MG architecture consists of distributed energy resources (DER), a communication network, an MG central controller (MGCC) and local loads. The MG has centralized control with the MGCC, which exchanges information with local loads and DERs through the communication network.[1]

In the second section of this paper a Microgrids overview is presented.

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In the third section of this paper is presented the mathematical model which is used for the determination of the optimal power that needs to be generated by the units of a microgrid, so that the total generation cost should be minimum at the load (consumer).

In the fourth section of this paper a case study will be performed for a test system. The test system comprises six generating units and one load. The installed capacity of the generators is 737 kW, while the load demand is 454 kW. The analysis will be performed for the steady-state condition of the system.

In the fifth section of this paper are presented the conclusions.

Other researches were focused on the development of MG using artificial neural network for renewable energy forecast, system control and power dispatch [2,3], optimal management of distributed generators and storage units in a MG [4-9], optimal planning of topology considering the distributed energy resources output and the reliability of the MG [10] or on the optimal operation of the MG in the cases it is islanded or connected to the grid [11-13].

2. Microgrid overview

Microgrids are small-scale, low voltage and medium voltage supply networks. The Microgrids are designed to supply power for loads (for example a small community, a commercial area, an industrial site or a municipal region). Microgrids are essentially an active distribution network because it is the gathers DG systems and loads at distribution voltage level. The generating units that are used in a Microgrid are usually renewable energy sources that are integrated together to generate power at distribution or utilization voltage.[1]

A Microgrid that consists of electrical loads and different types of sources is presented in Fig. 1.

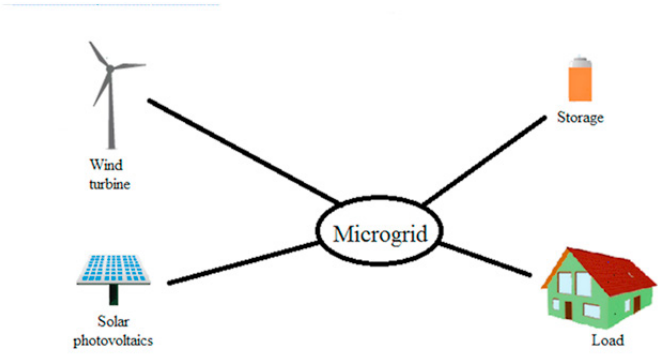

Fig. 1. Microgrid components.

The major differences between a Microgrid and a classic power plant are as follows:

- the sources are installed near to the loads premises so that they can be supplied with satisfactory voltage and frequency profile and negligible line losses.
- the power generated by the sources can be sent directly to the distribution network;
- the sources have a much smaller capacity in comparison with the large generators in classic power plants.[1]

The Microgrid can be operated in two modes:

- connected to the grid;
- isolated from the grid. [1,4,5]

In grid-connected mode, the Microgrid remains connected to the main grid and imports or exports power from or to the main grid. In case of any disturbance in the main grid, the Microgrid switches over to stand-alone mode while still feeding power to the priority loads.[4,5]

The technical features of a Microgrid make it suitable for supplying power to isolated areas of a country where the power supply from the national grid system is difficult due to the topology or frequently disrupted due to severe climatic conditions or due to man-made disturbances.[1,4,5]