A novel approach to frequency control in an islanded microgrid by load shedding scheduling

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Abstract. A microgrid is composed of distributed power generation systems (DGs), distributed energy storage devices (DSs), and loads. To maintain a specific frequency in the island mode as an important requirement, the control of DGs output and charge action of DGs are used in supply surplus conditions and load-shedding and discharge action of DGs are used in supply shortage conditions. Recently, multiagent systems (MAS) for autonomous microgrid operation have been studied. Especially, load-shedding, which is intentional reduction of electricity use, is a critical problem in islanded microgrid operation based on the MAS. Therefore, effective schemes for load-shedding are required. A novel optimization algorithm called ICA has been used to optimize this load shedding procedure.

Key words

Microgrid, Load Shedding, Multi-Agent system (MAS), frequency stability

1. Introduction

The interconnection of small modular generation system such as photovoltaic (PV), fuel cells, micro turbines (MT), small wind turbines (WT) and storage devices (Fly wheels, super capacitors, batteries,...) to LV distribution system, as shown in Fig.1, will lead to a new energy system paradigm, usually referred as the Microgrid (MG) [1]-[5]. Depending on the primary energy source used, the MS dimension and the type of power interface, they can be considered as noncontrollable, partially controllable (e.g. renewable sources that can reduce the power output only) and controllable (e.g. small co-generation units and storage units). A MG can be an extremely flexible cell of the electrical power system if properly controlled through management and control systems. Two different modes of operation can be envisaged [4]:

-Normal Interconnected Mode: the MG is connected to the medium voltage (MV) grid, being either partially supplied from it or injecting some amount of power into it;

-Emergency Mode: the MG operates autonomously when the disconnection from the upstream MV network occurs due to planned or unplanned events (e.g. maintenance actions or faults in the MV network, respectively).

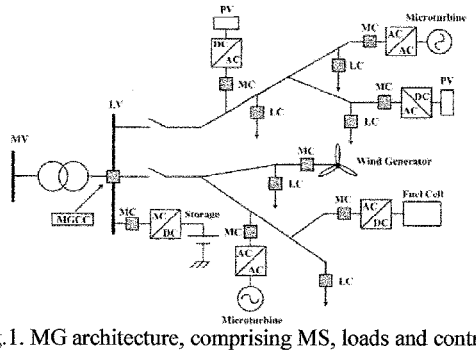

Fig.1. MG architecture, comprising MS, loads and control devices

The MG operation philosophy has been developed based on a hierarchical type control approach headed by the MG Central Controller (MGCC) [3]-[4]. However, frequency control problems arise during islanded operation due to the slow response of MS to control signals and due the inexistence of rotating masses directly connected to the grid (inertia less system). Sudden islanding of the MG due to faults occurring in the MV network may cause high unbalances between local load and generation which must be compensated by local MS and through a very efficient use of storage devices and load shedding mechanisms [4].

A critical security trait for MG operation is to ensure they can run into islanded operation following an unexpected event without collapse due to imbalance of loads and generations. Depending on the MG operating conditions, such as local load, local generation profile and MS availability for active power/frequency regulation, high amounts of power may be required to be injected or absorbed in the MG in the first moments subsequent to islanding. one of the normal method that is applied in a islanding MG,