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Real-Time Distributed Systems Control and Energy Management Using a Multi-Agent Technologies

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Abstract: The microgrids distribution systems are a promising means to broadly the distributed energy resource (DER) systems integration. However, the optimal energy management and control of many energy generators, loads, and local storage units of microgrid present as an important challenge. The concept with multi-agent intelligent control may become a viable solution for smart grid and microgrid architecture. In this paper, the implementation of the distributed energy management and control strategy of a smart microgrid by an intelligent multi-agent system (MAS) approach to achieve multiple objectives in real-time is proposed. The MAS proposed is built with a co-simulation platform which the microgrid model, simulate using MATLAB/Simulink, and controlled by a MAS implemented in JADE through a middleware MACSimJX. The main study is to develop a new approach, to control the microgrid during the fault in the main grid and energy management.

Key words: Smart grid, Microgrid, Multi-agent system (MAS), Distributed Energy Resources (DER), MacsimJX, Renewable energy.

1. Multi-agent framework for microgrid control

The smart grid is an opportunity to use new information and communication technologies (ICTs), represents a transition towards an intelligent and digital technology that is used to supply electricity to consumers via two-way of communication and electric energy [1]. A microgrid is a construction block of smart grid and is a modern type of power system, the low voltage network, usually located at the consumer's side, storage

system, control units, and the distributed generators, including wind power, solar, fuel cells, micro-turbines, and hydroelectric [2].

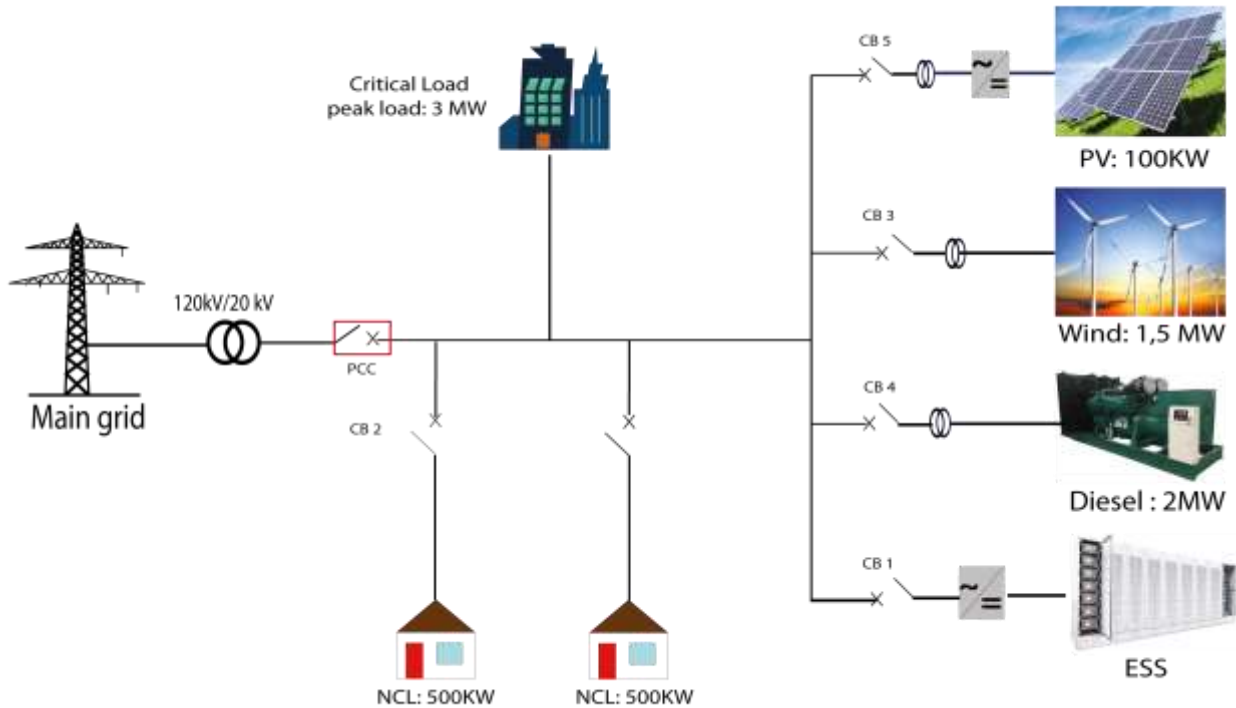


Figure 1. Microgrid architecture.

The studied microgrid is a power system that combines multiple Distributed Energy Sources (DER), critical and non-critical loads, and energy storage system (ESS) (Figure 1). The energy storage systems are assuring the increases of the RES integration issue and are able to provide or to store the difference between generated power and the consumption power. The architecture for microgrid coordinated control and energy management is controlled by MAS. There are four different type of agents: Load Agent, DER Agent, control Agent, and ESS Agent. Every agent has its specific functions, characters, and provides different services, each agent communicated with other agents and manages its assigned asset according to specified objectives (Table 1).

Table 1. Microgrid Agents tasks.

| Agent | Tasks |
|---------------|--|
| Control Agent | <ul style="list-style-type: none"> Is responsible for controlling microgrid operation modes, monitoring, scheduling and managing its subordinate agents |

| | |
|------------|---|
| | <ul style="list-style-type: none"> • Supervising the state of the microgrid, connect or disconnect MG to the main power grid at PCC. • Receives from Simulink the difference signal between the DER production and the loads' consumption |
| DER Agent | <ul style="list-style-type: none"> • Collect information related to the energy source such as availability, connection status, power produced in real time. |
| Load Agent | <ul style="list-style-type: none"> • Receives from Simulink the critical load consumption and the non-sensitive load consumption. • Collect information of power such as load power, voltage, current. • Is responsible to monitor and control load and varying power consumption by load, |
| ESS Agent | <ul style="list-style-type: none"> • Receives the proposal to provide or to store energy from the microgrid control agent. • Collect the state of charge value of storage unit from Simulink. |

Références

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2. Khan, M. W., & Wang, J. (2017). The research on multi-agent system for microgrid control and optimization. Renewable and Sustainable Energy Reviews, 80, 1399-1411.