


کد سند: RO-S-F-28-04	معاونت پژوهشی	
تاریخ صدور: ۱۳۹۹/۴/۲۲		
تاریخ ویرایش: ۱۴۰۰/۰۳/۲۵	فرم خلاصه انگلیسی طرح/پروژه	

Project Title: Determining the specifications and configuring the subsection of load and generation forecasting in the software of the microgrid control center.

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Project/Program Manager:	Seyed Mohamad Mehdi Abasi	Executor:	Mahdieh Alibakhshi
Project Financial Code:	398001	Project Quality Code:	pdpn33
Type of Project/Program:	Practical and developmental	Assistant:	Research

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Keywords: Microgrid, load forecasting, generation forecasting, smart grid, control center, automation.

Project Necessity:

The entry of various elements, including distributed renewable energy sources, energy storage systems, voltage control systems, etc., into the power system has created numerous challenges alongside multiple benefits in the power distribution system. In general, the introduction of these components makes the inherently extensive and interconnected distribution system more complex, making it more challenging to incorporate new elements into the system. One proposed solution in this regard is the simplification of the system through the use of microgrids. Microgrids are collections of loads, distributed energy generation units, and storage facilities that, along with control centers, form a network within a geographically close area.

Project Goals:

Some of the most important objectives of this project include:

- Investigating active microgrids worldwide and investigating their practical applications.
- Investigating microgrid control centers and their hardware and software structures.
- Studying load and generation forecasting methods within microgrids and categorizing them based on the long-term and short-term perspectives.
- Providing an overall structure for the control center and the subsection of load and generation forecasting.

Abstract:

In the microgrid control center, there are various subsections, and one of the important subsections is related to load and generation forecasting. This subsection must provide accurate predictions of future microgrid load consumption and energy generation using methods such as artificial intelligence and information sources like weather data, network status, and real-time energy prices. These predictions are crucial for the stability of the

network and energy management. The goal of this project is to define the specifications and configure the subsection of load and generation forecasting in the microgrid control center software.

Steps and Methodologies:

Among the advantages of using microgrids, we can mention improved network reliability and local resilience, reduced capital investment costs, pollution reduction, enhanced power quality, and decreased electrical losses. Microgrids are utilized in various segments of the network and can operate in two modes, connected to the main grid or independently.

The control and monitoring of communications and information exchange in a central controller of a microgrid can be examined at three levels:

1. With the subsystems of the microgrid (internal).
2. With the upper-level control center.
3. With other microgrids.

Control subsystems of a microgrid include:

1. Smart homes (residential homes, commercial complexes, shopping centers).
2. Intelligent transportation (cars, motorcycles, electric bicycles, and traffic control).
3. Electric power generation sources (solar cells, wind energy, combined cooling, heating, and power systems, etc.).
4. Smart low-voltage automation (water, electricity, and gas meters, network optimization for increased customer satisfaction, blackout management system, distribution management system, load response system).

While each of these subsystems requires local control, they also require a higher-level control center that oversees and manages the overall performance of the microgrid.

The information obtained from various sections of the microgrid is analyzed and, depending on defined scenarios, decisions are sent to different parts of the microgrid. The overall structure of the microgrid consists of three levels as follows:

1. **Primary Level:** This level is used for initial control of voltage, current, and local power, and reference values at this level are sent from higher levels.
2. **Secondary Level:** The secondary level is responsible for voltage imbalance compensation and harmonic compensation in the microgrid. It handles synchronization and power exchange with the main grid and other microgrids.
3. **Tertiary Level:** The third level aims to intelligently manage the entire microgrid based on economic and environmental criteria. Therefore, having awareness of the microgrid's status and accurate predictions of production and consumption in the microgrid are crucial. To achieve the defined objectives, the collected information in the microgrid is analyzed using decision-making algorithms. Control commands are then sent to different parts of the microgrid.

The goal of this project is to determine the specifications and configure the load and generation forecasting subsection in the microgrid control center software. To achieve this goal, the following project phases are outlined:

1. In the first phase, the project involves an examination of the microgrid control center, software, and hardware components.
2. In the second phase, the project investigates intelligent load and generation forecasting models in smart microgrids and their simulation environments.

3. In the third phase, the project focuses on extracting the software and hardware requirements of the load and generation forecasting subsection and its interactions with other subsections in the microgrid control center

Main Results (technical outputs, patents, papers, books, reports, etc.):

- "Investigation of Microgrid Control Center and Software and Hardware Components," ICT Research Group, Niroo Research Institute, 2022.
- "Study of Load and Generation Prediction Models in Smart Microgrids and Their Simulation Environments," ICT Research Group, Niroo Research Institute, 2022.
- "Extraction of Software and Hardware Requirements for the Load and Generation Forecasting Subsection and Its Communication with Other Subsections of the Microgrid Control Center," ICT Research Group, Niroo Research Institute, 2023.