Microgrid Project: Research, Technologies and Training Courses

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ABSTRACT

The main goal of the considered project is the concept development and creation of flexible and scalable smart University campus microgrid with a two-way data communication. In this case, the power system consists of two subsystems (heat supply subsystem and power supply subsystem). Also, a variant of the construction of the master's program of training specialists in energy management has been considered. The several scientific and educational trajectories are supported by the master's program. One of the key parts of the master's program is interuniversity collaboration due to workshops and joint research projects, both with Russian and foreign universities-partners.

INTRODUCTION

The main advantages of Smart Grid are the possibility of real-time data gathering and analysis so we can better forecasting and planning energy consumption [1].

Proceeding from different Smart Grid concepts reviews and analysis, one can define the following main areas covered today in the concept of Smart Grid [2-4]:

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- Automation systems.
- Smart Metering and Home Energy Management.
- Communication systems for power facilities.
- Sensor and condition monitoring systems.
- Integration of small power sources and electricity storage devices.
- Integration of alternative and renewable energy sources.
- Data management systems.
- Microgrids.

The main goal of this project is concept development and creation of flexible and scalable smart campus microgrid with a two-way data communication. In this case, the power system consists of two subsystems (heat supply subsystem and power supply subsystem).

Increasing energy efficiency in this way is a complicated problem in terms of conceptual design and process engineering [5, 6].

RESEARCH WORK PACKAGE

The existing Perm National Research Polytechnic University (PNRPU) campus energy system can be described as a mini power system with a strong connection by electricity and gas, and the lack of connection by heat and water. It should be said that the existing energy system has only a heat generation source.

Figure 1 shows the general PNRPU campus plan, where we can see energy sources and consumers (academic buildings of PNRPU and Ural branch of Russian Academia of Sciences (UBRAS)).

![Figure 1. General PNRPU campus plan.](image-url)
Electricity is produced by 110/10/6 kV substation and it is distributed to transformer substations by 6 and 10 kV. Transformer substations have from 250 to 1000 kVA transformers. The total connected load of all transformers is 17 740 kVA.

The heating is provided from the PNRPU boiler plant. The main consumers of the heat energy are the heating, ventilation, and hot water systems. The design capacity of the boiler plant is 58 Gcal/h (67.45 MW).

From the University side, one should start the creation of campus Smart Microgrid from the following steps:

- Development of the Smart Microgrid architecture.
- Creation of an automated smart system of accounting and control of the consumption of electricity and heat (Smart Metering).
- Light-emitting diode (LED) street and area lighting.
- Modernization of heating systems (modernization of heating main; boiler plant automation).
- Modernization of electric energy supply (h. e. 110/10/6 kV substation).
- Investigation of the possibility and efficiency of deployment of alternative energy sources (solar panels; gas turbines; heat pumps and etc.).

According to the given scheme, the basic task adds up to taking into account dataflow management, providing data system operation [7, 8].

**AUTOMATED SMART SYSTEM OF ACCOUNTING AND CONTROL OF THE ENERGY CONSUMPTION**

The existing campus electrical power system is equipped with the necessary number of accounting units, but it isn’t automated. Some part of the installed meters has RS-485 interface, which allows the introduction of automation without the additional purchase of new meters [3, 4].

Commercial heat meters are set only on some outside organizations objects of campus.

At the project the following plan of action are proposed:

- Documentation request on the existing power supply system.
- Conducting energy audits.
- Creation of the Smart Microgrid vision.
- Selection of equipment based on analysis of energy audits data and technical documentation.

Also for heat supply subsystem ones should make such requirement as an automatic control of heat supply, which depends on various factors (inside and outside temperature, time of the day and etc.).

It is supposed to use the following solution: methods of genetic modeling [9, 10] and methods on the basis of the subjective estimate of risk factors [11].
EDUCATION WORK PACKAGE

The basis of cooperation between PNRPU and National University of Science and Technology "MISIS" is the joint participation in the development and implementation of a network form the master program "Conceptual design and engineering to improve energy efficiency" [12].

In the course of a regional industrial infrastructure reorganization and formation of essentially new lines of technology development, there was a necessity in preparation of new generation of experts and making of information-methodological support of innovative activity in power branch. The project is aimed at implementation into the universities-partners educational course for preparing of engineering skills, scientific brainpower and administrative bodies in power industry, network companies, and related sectors.

The Master program consists of three directions: engineering (support of devices and installations life cycle), innovative and social. Professional practice (4 months) is provided with industrial partner Envidatec GmbH.

CONCLUSION

At the moment the project is at its development phase. The system engineering is the work for the team not for a single specialist. The components which are realized within the student’s master theses are the structural elements of the system and will be used for its assembly.

The project team has the successful experience of collaboration via developing the software and hardware of Smart Energy Monitoring and Analytic Systems based on SmardGrid and OpenJevis concept are presented.

DISCUSSIONS

The results of the research can be applied in different fields. E.g., knowing the amounts of energy consumption is of great importance for several reasons. First of all, for consumers of electrical energy knowledge about the electric load and the targeted is important for understanding their bills and better controlling their consumption [13]. For organizations, it is also useful to know periods of minimum and maximum of the consumption for planning the technological cycles, for planning budget costs.

Secondly analyzing the data of energy consumption is useful for in energy sales companies to predict probable future consumption and applying the costs for electrical units on the opt market of electrical energy [14].

Thirdly it is useful for power grid companies to regulate and determine the optimal loading of transformer substations [15].
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