Intelligent lighting system: Energy management technical measure

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Abstract. The Intelligent lighting System Project is a program at the Northern (Arctic) Federal University named after M. V. Lomonosov that provides research and analysis within the framework of the NArFU digitization. This paper deals with the implementation of the project as an integrated element of the digitization process at the NArFU. Real-life objects of the NArFU are presented to demonstrate performance of the experiment titled "Smart Campus" that is considered as the partial program of the project. The intelligent lighting system is wired and it is based on the SunRise on-line service that results in monitoring and controlling energy consumption providing energy saving. In order to perform the measures the energy service contract as a specific form of agreement between the consumer and the energy service company has to be implemented. The contract implementing aiming at operating costs saving by increasing energy efficiency was analyzed and explained in the present paper.

1. Introduction and Background

It should be noted that today Russia faces such global challenges as the digital economy developing as well as the new technologies implementation and also improving competencies in every sphere of the society etc.

The new version of the Federal law No 261 of 27 December 2018 “On Energy-Saving and Energy Efficiency” as well as amending certain legislative Acts of the Russian Federation has been issued. Moreover, the official version of the international standard ISO 50001 "Energy Management Systems: Specifications and Guidelines for Use" was published the 21st of August.

The aim of the present paper is to provide an analysis of the experiment results of the project "Intelligent lighting system of facilities of the NArFU named after M. V. Lomonosov". The tendency towards self-enhancement makes the project to be a technical measure of great topicality.

The Northern (Arctic) Federal University named after M. V. Lomonosov is growing progressively in the framework of the University Academic Council’s resolution: the University Development Policies: the digitization program at the NArFU named after M. V. Lomonosov issued the 28th of June 2018. According to the resolution four projects were launched including the experiment titled "Smart Campus". The basis of the experiment is the information model support of the "Intelligent Campus ".

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The project "Intelligent lighting system of facilities of the NArFU named after M. V. Lomonosov" formed by example of the Energy Innovations Educational and Scientific Center will become the milestone of the digitization process at the NArFU on the one hand and also the project will be an important stage in the energy management technical measure implementing on the other hand. The latter is the purpose of the project. It is worth remaking that the energy management system forms the basis of energy saving and energy efficiency improvement as well as energy processes digitization [1].

The fact that the energy management system should function at the three levels: state, industry sectoral and intra-organizational has been emphasized by a number of researchers [2, 3].

2. Materials and Methods

At the NArFU named after M. V. Lomonosov the issues related to energy saving and energy efficiency are managed in accordance with the system-integrated approach by means of the intra-organizational energy management system.

The energy management system of the NArFU named after M. V. Lomonosov (NArFU EMS) depends on the cyclical processes of planning, implementing and checking of energy-saving measures that are systemic (Fig.1). On the other hand the complexity of the approach to the energy management provides managing the processes within the organization.

The recurrence of the energy management system of the NArFU named after M. V. Lomonosov are presented in figure 1.

As it is shown in figure 2, the integrity of the energy management system is represented by four major components including: a) the organizational management system, b) technical control management, c) R&D strategies integrated in the energy management system of the NArFU named after M. V. Lomonosov, d) the NArFU formative component (training of staff and the students; energy management, monitoring and environmental energy laboratory).
3. Experimental Section

At the NArFU named after M. V. Lomonosov the energy management system itself is based on the principles of the recent version of the international standard ISO 50001 "Energy Management Systems: Specifications and Guidelines for Use". It cycles a loop of instructions by Deming [4] that identifies the recurrence of the system and its systematicity.

The integrity is reflected in the principal processes of the NArFU named after M. V. Lomonosov Energy Management System in the information system where the software and hardware structure and also the managerial structure interact through the energy information system [5].

At the designing stage the implementation of the energy management system technical measure "Intelligent lighting system" of the building of the Energy Innovations Educational and Scientific Center is an element of the managerial structure of the University.

There are a number of activities that were performed at the current stage of planning: a workgroup had been set up on the draft guide «Intelligent lighting system of an item of the NArFU named after M. V. Lomonosov», working contacts were established with the company-implementer concerning lighting devices replacing, and also with the development - company «smart-light» as well as the company-prospective investor concerning the energy service contract.

The technical aspect of the project is marked by an audit for its compliance with the lighting standards; the lighting design is worked up as well as the cost-effectiveness analysis. A technical design specification is being worked up. Commercial companies’ specialists and the Energy, Oil and Gas Graduate School’ students as well as the NArFU academic staff are required to take part in the process.

The principal objective of the project is to replace the available led lamps with light-emitting diodes fitted out with embedded controllers as it is shown in Fig.3.

The light-emitting diodes fitted out with embedded controllers will be equipped with «SunRise» SROffice controllers that are used to adjusting the brightness of the led lamps depending on the number of people and the intensity of natural light indoors.

The host computer or the lighting control panel will be equipped with the SROffice software. The SRLSOOffice sensors monitoring motion, light intensity as well as indoor temperature will be placed around the campus area. Obtained data will be sent to the SROffice control cabinet.

A data processing platform using provides an opportunity to monitor and control energy consumption resulting in energy saving.
Developing a logical case and loading it into the control cabinet is prerequisite to implement the "smart-system". The logical case is understood as a pre-configured chain of signals or events on the object where the system will be installed. The wireless system will analyze external factors (lighting, movement, office attendance, etc.) that were scripted. Based on the information obtained the system will smoothly adjust the brightness in the specified areas.

The cases for the University’s items will be developed by the undergraduates at the final stage of connecting the "SunRise" system to the lighting equipment that were purchased.

4. Results and Discussion
Having made the necessary cost-benefit analysis, we come to understanding the planned value of financial costs for the implementation of technical measures of the project and also the payment back period of the project - 3 years.

The key benefits of the intelligent lighting system promotion are the following: firstly, energy savings is to be mentioned, secondly, the statistics on the lighting system operation acquisition and storage is vitally important, and finally, the possibility of remote monitoring, which provides safe and comfortable conditions of lamps operation and also the components of the "smart"-system is to be noted.

Having considered the theoretical part of the project and having made the indispensable technical and economic estimate, we come to comprehension of the target value of financial costs for the whole implementation of the project’s technical measures. Due to the need for one-time serious financial investments, we consider the opportunity of operational funds and financing options saving. We consider an energy service contract use makes the most sense for the implementation of the project.

The energy service contract represent a special form of contract aimed at saving operating costs by improving energy efficiency and introducing technologies that provide energy saving [6].
5. Summary and Conclusion

Thus, it is worth mentioning the advantages of energy service contracts.

1) The energy service company involvement in maximizing savings through a long-term contract under budget constraints;

2) Financial risks absence for the customer (The energy service company guarantees financial savings and assumes all project risks);

3) The energy service company does not require financial investments from the customer — the project is financed by a third party (mostly banking institution). As for the recompense it is provided by "guaranteed savings". The energy service contract constitutes one of the main mechanisms for improving energy efficiency all over the world.

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