REVIEW

for dissertation work for the degree of Doctor of Science in the professional field 5.2. Electrical Engineering, Electronics and Automation with the title "Optimization of electrical energy efficiency in reduced load mode and improvement of the quality and reliability of power supply systems" with author Assoc. Prof. Dr. Eng. Iliyan Hristov Iliev

Reviewer: Acad. Chavdar Rumenin, Institute of Robotics at the Bulgarian Academy of Sciences

1. Relevance of the research

The power system of any country is one of the key priorities of its national security. However, among a significant part of the people, this topic is unreasonably associated with the price of consumed electricity and the unmotivated shutdown of power supply in the event of natural disasters. The lack of understanding of this key element of management, related to the reliable functioning of power distribution and its efficiency, was one of the factors that led to the tragic consequences for the Chaira hydroelectric power plant. This is one of the examples in which the non-optimized frequency operating mode of the national power system with that of the Chaira generator, including the incompetent management, led to an extremely serious accident. To this day, certain circles in the "Energy" sector are delaying making a competent decision for the rapid restoration of this important power facility. The efficiency of electricity generation in a reduced load mode is an important prerequisite for the operation of the entire power system of the country. It is believed that the quality of electricity is a long-standing problem and does not contain scientific challenges. I will pay special attention that in this case the most important thing is to achieve a minimum specific consumption of electricity, especially for industrial consumers in critical load mode. The issue of different energy mixes from wind generators, solar panels, nuclear power plants, thermal power plants, hydroelectric power plants, etc. has also been opened, as well as their final frequency coordination in the national grid. It is unnecessary to give an example of what happened a few weeks ago with the electricity supply in Spain, Portugal and southern France. In its synergy, this issue motivates the importance of the research topic of Assoc. Prof. Iliev, which is necessary, in my opinion, especially in an applied aspect for Bulgaria. All this gives me reason to define the topic of the dissertation as very relevant.

2. For the dissertation candidate

Iliyan Hristov Iliev graduated from the Technical University of Gabrovo in 2001 with a degree in Electrical Engineering and Electrical Equipment. In 2016, he obtained PhD with a dissertation titled: "Research, analysis and quantitative assessment of the real contribution to the deterioration of the quality of electrical energy by industrial consumers and the municipal sector". In 2019, he was elected as an associate professor and head of the "ESEO" department at the "St. Ivan Rilski" University. Since 2024, he has been an associate professor and head of the Laboratory "Robotic Systems in Energy" at the Institute of Robotics- Bulgarian Academy of Sciences.

3. About the dissertation research

The submitted dissertation has a total volume of over 400 pages and contains an introduction, four chapters, a conclusion, an appendix and a bibliography of 296 sources. The introduction justifies the significance and relevance of the research problems and presents the conceptual framework of the complex study - subject area, subject, scope, thesis and working hypotheses, goals and objectives, methods and conclusions. The abstract follows the narrative of the dissertation work and does not contain information, suggestions and conclusions that have not been the subject of analysis and consideration in the main material. It correctly reflects the scientific contribution results. The research is divided into four sections: a. A general energy analysis of the factors influencing electrical energy efficiency is presented; b. Research on electrical power losses; c. Establishing the dependence of energy consumption related to voltage and load regimes; d. Development of a regulatory framework for lighting as an ergonomic factor with an electrical energy focus. The main goal of the study is to create a methodology for optimizing electricity consumption in the country.

To implement the milestones defined in this way, the following more significant topics have been formulated: Analysis of the relationship between the power system and its main characteristics, including power losses; The quality of power efficiency and the reliability of power supply; Assessment of the regulatory framework in our country and in the EU for power efficiency; Application of classical and modern theoretical approaches for the purposes of power efficiency; Derivation of the balance equations for the individual energy categories; Establishment of optimal operating modes and their relationship with the power efficiency of the system; Analysis of the reliability of power supply and the relationship with the power efficiency of the national system; Assessment of the various energy processes in the power system, analyzing the

elements of the power balance in the multifactor space; Determination of the operating modes of multi-transformer substations, etc.
From the review of the presented table for the minimum requirements for the right to defense, according to the Requirements of the Bulgarian Academy of Sciences, it is seen that Assoc. Prof. I. Iliev covers the necessary indicators. This gives grounds for opening a procedure for the defense of a dissertation for the scientific degree "Doctor of Technical Sciences". His name appears in the List of the NACID.

4. About contributions

The dissertation contains scientific and applied scientific contributions that are logically well formulated, motivated and consistently proven. My interpretation of the results is as follows:

4.1. Scientific contributions

1. A methodology has been formulated in virtual space, substantiating mathematical models containing various output energy parameters and their optimization. 2. A model has been proposed for determining the power balance at a point in the power supply system. On its basis, the so-called "power balance equation" has been determined, representing a set of various energy indicators. The model makes it possible, by combining the functions of quantities of different nature, to obtain a positive trend in the energy impact. 3. An original approach has been proposed, based on the theory of instantaneous power for vector representation of voltage and current. Three strategies have been developed for the application of active filters for compensating for imbalance and nonlinearity in the power industry. The simulation has been carried out in the Matlab-Simulink environment of the studied processes. 4. Mathematical models have been developed, which allow for a more precise assessment when determining power losses from all indicators of electricity efficiency.

4.2. Scientific and applied contributions

1. The need for the power supply system to operate at lower voltage levels than the nominal ones regulated in the standard has been proven. The result is an improvement in the electrical energy efficiency of the system, an increase in the reliability of the power supply in the reduced load mode. 2. A new approach for determining the partial power losses has been proposed, which is based on the theory of instantaneous active power in the reduced load mode. 3. An original concept for determining the asymmetric and non-sinusoidal modes has been developed, reflecting the energy impact of the load on the quality indicators. 4. To suppress the resonance phenomena in the power system, parameters have been developed for their assessment, taking into account the influence of the

load, which increases the reliability and stability of the power supply. 5. The correlation between the reliability of the power supply and the mode characteristics of the reactive loads has been determined. 6. Optimization criteria procedures have been formulated, including a complex multi-factor approach to achieve higher power efficiency of the system.

My reading of his research on the current topic is a demonstration by new means of substantially new aspects of existing scientific problems and theories by formulating original research methods, new constructions, technological solutions, and obtaining numerous confirmatory facts.

5. Some other questions on dissertation

I am not aware of any intellectual and industrial property issues or claims from third parties to the contributions. I declare that I have no influence or any other dependencies on the doctoral student. During my initial acquaintance with the dissertation research (I was assigned to give a Review) I found inaccuracies, repetitions, absence of some of the standard attributes for this type of work, grammatical errors, tautologies, etc. In their dominant entirety, they were subsequently removed by the doctoral student. However, even in this form, the work is too voluminous, and could be further shortened. I would recommend that I. Iliev summarize the main ideas and results of the dissertation and direct them for publication in prestigious journals with an impact factor, and to form some of the engineering solutions as applications for utility models.

6. Final conclusion

The presented dissertation has undeniable merits. It is well structured, the presentation is consistent and logically motivated, demonstrating the competence and commitment of the dissertation candidate Assoc. Prof. Dr. Iliyan Hristov Iliev to the researched problems. The motives and conclusions I have presented give me reason to believe that the dissertation "Optimization of electrical energy efficiency in reduced load mode and improvement of the quality and reliability of power supply systems" has the necessary qualities for this type of scientific work. All this gives me the conviction to propose to the esteemed scientific Jury to award Assoc. Prof. Dr. Eng. Iliyan Hristov Iliev the scientific degree "Doctor of Sciences" ("Doctor of Technical Sciences") in professional field 5.2. "Electrical Engineering, Electronics and Automation".

Sofia, 29.05.2025 Chavdar Roumenin