

# OPINION

on a dissertation for the degree of "Doctor of Science"

Area 5. Technical Sciences

Professional field 5.2. "Electrical Engineering, Electronics and Automatics",

**Author of the dissertation. Associate Professor PhD Ilian Hristov Iliev**

**Dissertation Topic: Optimization of power efficiency in reduced load mode and improvement of quality and reliability of power supply systems**

By Prof. PhD. Eng. August Yordanov Ivanov, Institute of Robotics - BAS.

## **1. Description of the dissertation and the materials**

The dissertation consists of 4 chapters, a statement of main contributions, a list of publications, a list of citations related to the dissertation and a list of references used from 294 sources (104 in Latin; 190 in Cyrillic). The text is 430 pages long, contains 229 figures and 102 tables;

Twelve publications on the dissertation, five in English and seven in Cyrillic;

The abstract is 56 pages and adequately reflects the dissertation.

I believe that the materials presented give a clear picture of the development of Assoc.Prof. Iliev and his creative achievements.

## **2.Relevance of the dissertation, aim and objectives**

The dissertation work was created on topical problems of finding an approach to optimize the electricity consumption in the Republic of Bulgaria, namely, to analyze the relative relationship between the power system and its main energy characteristics, including power and electricity losses, power quality, power supply reliability; to evaluate classical and modern theoretical approaches in relation to power efficiency, by establishing the balance equations of the different energy

**The aim of this dissertation** is to investigate, systematize and analyze the theoretical propositions related to the concept of achieving Electrical Energy Efficiency (EEf), identifying the factors influencing this energy category, to be implanted in practical-applied research conducted under different criteria with the objective function of rationalizing and optimizing the electricity consumption in the sectoral structure of the country. In order to achieve the objective, the following **tasks** are defined:

1. To study the literature related to the factors influencing EEf. To look for a relational relationship between EEf and some energy characteristics such as power and energy losses, power quality (PQ), Reactive Load Compensation (RLC), reliability of power supply, etc., and establish the mutual influence of these indicators.
- 2.To study the legislation in the field of EEf - regulations, directives, standards at national and European level.
- 3.To investigate classical and modern theoretical approaches in relation to EEef. To analyse power theories, methods for determining power and energy losses in the Electricity Supply System (ESS), in Power Transformers (PT), etc. Power facilities, to define and analyze Static Characteristics of

the Load (SCL), power balance equation, dispersion component of losses, etc. concepts and power categories.

4. To clarify theoretically and in practical-applied terms the basic concepts related to economically feasible modes of operation of PTs, optimum modes in PT, quality characteristics of EE and their relative relationship with Electromagnetic Interference (EMI), and to investigate its impact on EEf.
5. To study the characteristics of reliability of power supply, distribution laws, different types of coupling and Mathematical Models (MM) and establish the relationship of this parameter with EEf.
6. To carry out practical studies on various power processes in ESS in the sectoral structure of the country. To determine the power losses, SCL and power balance in multifactor space
7. To investigate the operating modes of multi transformer substations and to determine the Economically Viable Operating Mode (EVOM). To propose criteria for optimal operation of PT.

### **3. Degree of knowledge of the state of the art and creative interpretation of the literature.**

The high degree of knowledge of the state of the problems to be solved as well as the good creative interpretation of the literature review material is remarkable.

### **4. Correspondence of the chosen research methodology and the set aim and objectives of the dissertation with the achieved contributions.**

I believe that the aim and objectives formulated in this way are fully consistent with the scientific and applied contributions achieved.

### **5. Activities and Contributions of the Dissertation.**

The contributions of the dissertation work are in the field of power supply and electrical equipment of industrial enterprises. The majority of them are applicable to rationalize and optimize power efficiency by minimizing power losses, compensating reactive loads and improving the quality and reliability of power supply systems.

The contributions and creative achievements can be classified and summarized in the following areas:

- Power efficiency in electricity supply and electrical equipment;
- Electromagnetic compatibility in power supply and electrical equipment;
- Electrical power quality;
- Optimum operating modes of electrical equipment in power supply systems and minimum power losses;
- Application of a dualistic approach to reactive load compensation and voltage regulation to improve the energy efficiency of power systems;
- Enhance electrical energy efficiency by optimizing electrical load schedules in power supply systems of industrial sites;

In nature, the contributions in this work can be defined as:

#### *Scientific:*

- A methodology has been developed in multifactor space for the determination of the MM of various output parameters (IP) and their optimization, which has been created with the



main purpose of serving as a basic criterion in the definition and formulation of the energy category "Electrical Energy Efficiency"

- A theoretical model for determining the power balance at a given point in the power system is proposed.

*Scientific and applied:*

- ✓ The appropriateness of electrical equipment in the electricity supply system (ESS) to operate at voltage levels lower than the nominal ones regulated in the standard is proved.
- ✓ Static Load Characteristics (SLC) MMs have been developed for nine industry sectors to enable a more accurate assessment in determining conventional power losses from all Power Quality Indicators (PQIs).
- ✓ An approach for the determination of partial power losses is proposed, and the theoretical basis of the methodology is based on the instantaneous active power theory.
- ✓ A new concept for the determination of the asymmetric and nonsinusoidal modes is developed, and they are evaluated using power-weighted unbalance and nonlinearity coefficients.
- ✓ Approaches for suppressing resonance phenomena in the power system (ESS) and their evaluation with consideration of load effects are developed.
- ✓ The correlation of power supply reliability with power supply mode characteristics and specifically with reactive load compensation (RLC) and EE quality is scientifically substantiated.
- ✓ Predictive results for reliability performance in 9 industry sectors are obtained. It is shown what laws are obeyed by some reliability characteristics and is justified on the active application of synchronous motors (SM) to improve reliability and RLC.

In terms of their significance, the contributions are central to the implementation of specific approaches for the analysis and optimization of decision-making processes or the support of these decisions in the field of power supply and electrical equipment for industrial plants.

I accept the contributions formulated in the thesis.

**6. Assessment of the publications on the dissertation.** Twelve papers have been submitted on the dissertation, of which one is independent, eleven co-authored, in four of them the dissertant is the first author. Considering the volume and comprehensiveness of the material, I believe that these publications are not sufficient, but adequately reflect the results of the work. Thus, the main ideas in the dissertation are also defended.

Fifteen citations to eleven of the author's publications are also provided.

I declare that I have no joint publications with the author and I am not a related person within the meaning of paragraph 1(5) of the Supplementary Provisions of the Act for the Development of the Academic Staff in the Republic of Bulgaria ADASRB.

I have not detected any elements of plagiarism in the thesis.

**7. Opinions, recommendations and comments.** Some comments and recommendations can be made to the thesis:

- Some abbreviations used in the dissertation are not adequately explained on page 5.
- The Field and Professional Area is stated but the Research Specialty of the dissertation is not defined.
- I recommend that in future research on the topic by the author, the results should be reflected in publications referenced and indexed in world-renowned databases of scientific information.

- Repetitions in the text and spelling errors have been made, which in my opinion are of a purely technical nature. Compared to the entire volume of material, these inaccuracies are a negligible amount. A list has been submitted and the author has promptly corrected them, for which I thank him.

These remarks and recommendations in no way detract from the achievements of the thesis.

The abstract is entirely on the dissertation, and there are no suggestions or data not treated or discussed in the dissertation. The contributions and conclusions in the abstract are the same as those in the main body of the paper.

**8. IN CONCLUSION**, I believe that the dissertation under review can be highly commended, which in the significance of its proposed scientific and applied contributions, ranks in a place of honor in the effort to implement rationalization and optimization of power efficiency by minimizing power losses, compensating reactive loads, and improving the quality and reliability of power supply systems. On this basis, I am convinced that the work fully satisfies the requirements for a Ph.D. dissertation in Area 5. Technical Sciences, Professional Field 5.2. "Electrical, Electronic and Automation Engineering" and I recommend to the esteemed Scientific Jury of the IR-BAS to award this degree to **Assoc. Prof. PhD Ilian Hristov Iliev**. I vote positively for this.

Date: 09.06.2025

Opinion:

/Prof. PhD Eng. August Ivanov /