Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Tatiana Chernova

PhD Program: Engineering Systems

Title of Thesis: Specific aspects of peer-to-peer energy market design and operation

Supervisor: Assistant Professor Elena Gryazina, Skoltech

Name of the Reviewer: Yanli Liu

I confirm the absence of any conflict of interest	**Date: 18-11-2024**

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications

The summary of issues to be addressed before/during the thesis defense

- Brief Evaluation of the Thesis Quality and Overall Structure

The doctoral dissertation by Tatiana Chernova is a well-structured and comprehensive work that addresses the critical issue of designing and operating peer-to-peer (P2P) energy markets. The thesis is divided into logical sections, starting with an introduction that provides a clear context and motivation for the research. The literature review is thorough, covering various aspects of P2P energy markets, including historical developments, existing challenges, and recent advancements. The methodology section is detailed and well-explained, providing a solid foundation for the subsequent analysis and results. The results are presented clearly, supported by appropriate simulations and case studies. The conclusion summarizes the key findings and suggests future directions for research.

- Relevance of the Topic to the Actual Content

The topic of P2P energy markets is highly relevant to the current trends in the energy sector, particularly the shift towards decentralized, digitalized, and decarbonized solutions. The dissertation aligns well with this theme, focusing on the integration of prosumers, the use of advanced technologies, and the design of market mechanisms that support consumer preferences and network constraints. The content is consistent with the stated objectives and addresses the identified challenges effectively.

- Relevance of the Methods Used in the Dissertation

The methods used in the dissertation are appropriate and state-of-the-art. The author employs optimization-based approaches to design P2P market schemes for both meshed and radial networks. The use of chance constraints to handle uncertainty in renewable energy sources is innovative and well-justified. The development of a distributed algorithm for implementing the proposed market designs demonstrates practical applicability. The comparison with correction-based algorithms provides valuable insights and highlights the strengths and limitations of different approaches.

- Scientific Significance of the Results Obtained and Their Compliance with International Standards

The results obtained in this dissertation are scientifically significant and contribute to the advancement of knowledge in the field of P2P energy markets. The proposed methodologies for incorporating user preferences, handling network constraints, and managing uncertainty are novel and robust. The use of chance constraints to internalize the stochasticity of renewable energy sources is particularly noteworthy, as it addresses a critical challenge in the operation of P2P markets. The results are consistent with the current state of the art and meet international standards, as evidenced by the author's contributions to peer-reviewed journals and conferences.

- Relevance of the Obtained Results to Applications

The results of this dissertation have significant practical implications for the design and operation of P2P energy markets. The proposed market architectures and algorithms can be applied to real-world scenarios, providing benefits such as improved reliability, cost savings, and better integration of renewable energy sources. The inclusion of trade-independent network fees ensures that the grid remains financially sustainable while supporting the transition to a more decentralized energy system. The methodologies developed in this work can be adapted for various network configurations, making them versatile and widely applicable.

- Quality of Publications

The author has published several high-quality papers related to the dissertation, including contributions to conferences and journals. These publications demonstrate the author's ability to communicate complex ideas effectively and contribute to the scientific community. The papers cover a range of topics, from the design of P2P market architectures to the stability analysis of decentralized control systems, showcasing the breadth and depth of the research.

- Summary of Issues to be Addressed Before/During the Thesis Defense

1) Further Validation of Models: While the proposed models and algorithms are well-supported by simulations, additional validation using real-world data would strengthen the credibility of the results.

2) Discussion of Scalability: The dissertation could benefit from a more detailed discussion on the scalability of the proposed methodologies, particularly for larger and more complex networks.

3) Economic Impact Analysis: A more comprehensive analysis of the economic impacts of the proposed P2P market designs, including long-term financial sustainability and cost-benefit analysis, would provide valuable insights.

4) Comparative Study with Other Market Designs: Although the dissertation compares the proposed methods with correction-based algorithms, a more extensive comparative study with other market designs (e.g., centralized markets, virtual power plants) would enhance the understanding of the relative advantages and disadvantages.

5) Addressing Security and Privacy Concerns: Given the increasing importance of security and privacy in P2P energy markets, a dedicated section discussing these concerns and potential solutions would be beneficial.

Overall, the dissertation by Tatiana Chernova is a high-quality piece of research that makes significant contributions to the field of P2P energy markets. With minor improvements, it is well-prepared for successful defense.

Provisional Recommendation

☐ *I recommend that the candidate should defend the thesis by means of a formal thesis defense*

☒ *I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report*

☐ *The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense*