Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Alvaro Gonzalez

PhD Program: Engineering Systems

Title of Thesis: Flexibility characterization in power systems

Supervisor: Assistant Professor Aldo Bischi, Skoltech

Co-supervisor: Assistant Professor David Pozo, Skoltech

Name of the Reviewer: Assistant Professor Elena Gryazina, Skoltech

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Date: 29-09-2021**

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

The thesis provides a detailed study of flexibility in power systems. Flexibility is a hot topic and there are different ways to understand and quantify flexibility. The Thesis provide a comprehensive overview of the current approaches to flexibility. Besides, the proposed models and algorithms can be applied in different parts of existing power systems including operational and market layers.

The described research is performed at high international level and is consistent with current state-of-the-art in the area of power systems operation.

The structure of the thesis is absolutely reasonable. There are 5 chapters, middle chapters 2-4 contain the majority of the results obtained while the others are devoted to introduction, conclusion and future work. Besides, each of the Chapters 2-4 contains its own small introduction, nomenclature and conclusion which significantly increases readability of the Thesis. In general, the Thesis is very well-written, all the results are deeply investigated and explained with the necessary level of details. The topic and the title of the thesis is relevant to its actual content.

Speaking about the relevance to applications, it's hard to judge at the current state. Power systems give an example of rather conservative industry. The control protocols that Independent System Operators (ISO) and Market Operator follow in their daily routine are mainly based on the methodology developed decades ago. However, in private microgrids or test-bed systems that are not obliged to follow current regulations the proposed methods could be successfully tested. Indeed, these days we witness significant change the whole paradigm and this thesis give an excellent of novel methodology with complete theoretical validation.

The results are published in numerous conference proceeding including 2 journal papers and 1 book chapter published and the other 2 journal articles submitted. The candidate demonstrated outstanding publication productivity and the proposed material could be the source for more than one PhD Thesis. The journal articles are published in the highly reputable journals - IEEE Transactions on Power Systems and International Journal of Electrical Power and Energy Systems – both highly competitive ones.

I have mainly one issue to be addressed before/during the thesis defense. The author emphasizes the convexity of the proposed routines. Most often convexity is needed to speed up the convergence and decrease computational burden but at the same time one may scarify accuracy. When discussing battery models (Chapter 2) the accuracy and computational time is addressed in Table 2.1 and 2.2 with reported number of samples 14 and 20 used to construct the convex envelope. I'm curious in the robustness of the observed accuracy and computational time with respect to the number of samples. What if you use more/less samples? How would it affect the accuracy and computational time?

When presenting convex heat market (Chapter 3) what are (non-convex) alternatives and their computational consequences?

When describing stochastic power market (Chapter 4) how do you propose to derive the prices in OPF-N2N-AB model? Does it simply mean taking x* equal \hat{x}* since it's always feasible?

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*