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Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Dmitry Smirnov

PhD Program: Engineering systems

Title of Thesis: Innovative technological pathway for new commercial applications of Stirling cycle-based systems

Supervisor: Assistant prof. Henni Ouerdane

Name of the Reviewer:

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Signature:**  **Date: 07-10-2019**

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

The Ph.D. candidate Mr. Dmitry Smirnov has worked and proposed an innovative technological pathway for the development of Energy Conversion Systems (ECS) into commercial products. Overall the structure of the dissertation is well organized, the objectives and conclusions of each chapter are clearly explained, and the focus on Stirling refrigerators is well justified. The introduction to the dissertation establishes the relevance of the research project conducted and the intrinsic motivation and previous experience of the Ph.D. candidate. The final chapter summarizes the conclusions and the limitations of the work undertaken and its prospects. There are some minor typos in the manuscript but without an impact on the quality of the overall research work conducted

The topic of the project is relevant because of the expected outcomes in applying the methodology to developing energy conversion technologies that need to reach an appropriate TRL level to become a commercial product. Stirling technologies, and particularly Stirling Engines, do not have a successful development history as a commercial product, and the proposed methodology could help to broadly apply the technology as am ECS for tackle sustainable development goals.

The design methodology proposed in the dissertation using five innovative design methods that includes the literature review using big data technologies, trade studies at the design stage, the influence of designer decision, optimize performance characteristic and scale-up of the Stirling machine.

During his MSc and Ph.D., Dmitry has published a considerable number of papers, which are another clear evidence of his work and quality of his research project. Also, in his dissertation, Dmitry has pointed out several topics for future investigations; those topics could lead to further high impact publications.

In my opinion, Mr. Dmitry Smirnov has done excellent and original research work. He has demonstrated his research capabilities of performing high-quality scientific work focusing on the technical development of commercial applications of ECS. In summary, based on the manuscript revised, I recommend that the Ph.D. candidate should defend the thesis by means of a formal thesis defense.

Some minor editorial corrections and suggestions:

Page 58: In the first paragraph, there is an incomplete sentence “The research activities were…”

Page 63: The Fig.11b caption is the same as Fig.11a.

Page 71: The Fig.18 is not quite easy to see; the colors are quite similar.

Page 95: Typo “Osbourn [29]” must be “Osborne [29]”? Please check.

From Page 99 to 105 (Section II.4): I would suggest presenting the equations used for the calculation of the micro-CHP system to highlight the complexity of the systems studied.

Page 132: The Fig.17 is not quite easy to see; the colors are quite similar.

Chapter V (From Page 145): There are several typo errors, e.g. al-lows, temper-arures, ap-plication, du-ring, co-efficient, be-low, etc. Please correct.

In Chapter V, in section IV Discussion, a table summarizing the results could be useful for explanation and comparison purposes. I would have been interesting in an experimental comparison studied of the gas leakage between the high-tolerance seal and the dry friction piston seal used in the Stirling Refrigeration.

What is the different in operating life between both? How could it affect the lubrication of the thermal Stirling cycle? How could manage different manufacturing tolerances?

In Chapter VI, the heating load was modeling using adapting the equation proposed by Otaka et al. [1]. However, the constant parameter in that equation was not appropriated for scaling of the system, and it couldn't be experimentally obtained (no constant Fig. 5). Could be another approach or model applied (other references)? Maybe another equation or parameter could be proposed based on the experimental data obtained and considering the parameters evaluated.

The pentagon model proposed or presented in the conclusions is a nice visual representation of the methodology; it would be great to integrate the interactions between the different sides of the pentagon if that is possible.

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*