Supervisor's statement of a final thesis

Supervisor:	doc. Ing. Robert Pergl, Ph.D.
Student:	Wanaka Mannaert
Thesis title:	Evolvability of the grid; An investigation of mechanisms to minimize the ripple effects due to increased use of distributed energy sources
Branch / specialization:	Digital Business Engineering
Created:	November 18, 2023

Evaluation Critera

1. Fulfilment of the assignment

▶ [1] **assignment fulfilled**

[2] assignment fulfilled with minor objections

[3] assigment fulfilled with major objections

[4] assignment not fulfilled

This thesis is a result of the Double-degree study programme with the University of Antwerp. The assignment consists generally of two main parts:

1. Analytical and design part: application of the Normalised Systems Theory for analysis of evolvability of electricity grids in the face of increasing integration of renewable Distributed Energy Resources (DERs) causing significant design challenges because of ripple effects. The result here is a novel perspective on the design of the electricity grid.

2. Software-engineering part where the proposed mechanisms are evaluated through a design and implementation of an analytical software tool.

The assignment is challenging in its complexity and I consider it fully completed.

2. Main written part   99/100 (A)

The size of the thesis is above average given the implementation part, all parts are relevant and information-packed. The methodology is rooted in the established Design Science methodology, as explained in the beginning of Chapter 3. Although the details on the substantiation of the methodology is present further in the text, an complete overview of the three cycles and their substantiation in the work done may be beneficial for the reader to be present also here.

The text is logically structured, it systematically addresses the problem, relevant design challenges, and proposed solutions, culminating in the design and implementation of an analytical tool for assessing dynamic pricing's impact on grid stability. The research is grounded in a comprehensive understanding of the challenges facing the electricity grid, including issues of physical structure, economics, and grid intelligence, explored through both literature review and collaboration with professionals in the field.

The software-engineering part, i.e. requirements analysis, design and implementation description are thoroughly elaborated. Testing is also described in a high detail, I just missed an explicit evaluation of the requirements set in 4.2.3 (Functional requirements) and 4.2.4. (Non-functional requirements).

The thesis demonstrates a high standard of formal quality, including language and grammar and stylistics appropriate for a scientific text. The language used is clear, precise, and appropriate for an academic thesis. Stylistically, the thesis adheres to the conventions of scientific writing, with a formal tone, logical progression, and structured arguments.

The typographical quality exhibits consistent formatting, appropriate use of figures and tables, and a clear layout that aids in the comprehension of the content. My only suggestion for improvement would be to use monospace fonts for technical identifiers.

The thesis contains above-average number of quality resources that are properly used in the text. The bibliography items are properly structured according to one of the common formats in scientific literature, the only comment is missing date of accessing for the online resources.

3. Non-written part, attachments   100/100 (A)

An analytical software tool was developed to evaluate the proposed design mechanisms. It extracts data through an API and converts them to an appropriate format to prepare it for further processing. The core of the artefact is a grid simulation (microgrid), where dynamic prices and their behaviour are implemented. The data are manipulated according to this behaviour and the changes are observed.

The solution is implemented in the Python programming language. The code is well structured, commented and appropriately tested using unit tests.

The evaluation (Section 4.6 Findings - discussion) demonstrates the practical validity of the developed tool.

4. Evaluation of results, publication outputs and awards   100/100 (A)

Given the high practical relevance and close collaboration with the experts in the field, I am highly confident that the deliverables have a high potential of practical use: both the design focused on evolvability and the software tool.

5. Activity of the student

▶ [1] **excellent activity**

   [2] very good activity

   [3] average activity

   [4] weaker, but still sufficient

   [5] insufficient activity

Wanaka proved herself as a hard-working student oriented on delivering excellent results.

6. Self-reliance of the student

▶ [1] **excellent activity**

   [2] very good activity

   [3] average activity

   [4] below average activity, but still sufficient

   [5] insufficient activity

Wanaka was able to address all the domain and technical challenges by herself, my guidance was rather at the methodological and formal levels of the thesis.

The overall evaluation   100/100 (A)

An excellent diploma thesis showing a high maturity of the student in respect to addressing a complex multi-faceted engineering task. I would dare say that in several respects the thesis reaches doctoral-level work, especially in deep work with many resources, excellent scientific language quality and stylistics. As such, the thesis deserves the highest evaluation.