

Reflection

Integration to Personal Interest and Relevance

Sustainability technologies and zero energy in buildings focus has been my personal interest for a long period. Within the graduation topic I have been able to combine my interest with the research topics to deliver an adequate approach to creating a Zero Energy Building cluster with effective technologies on energy consumption and generation. It must be stated that zero energy refurbishments must be integrated with the indoor comfort conditions for delivering user satisfaction. Therefore comfort in space is added in the graduation research to deliver a complete improved conditions package.

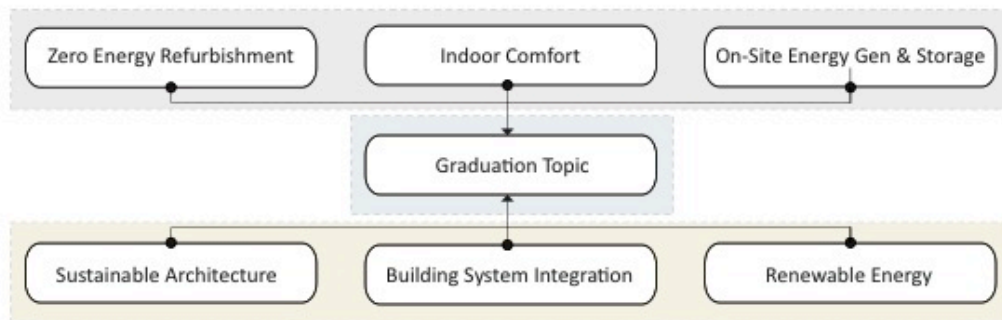


Figure 1: Integration of personal interest and research focuses

The graduation topic can be acknowledged as a necessity for Europe and the Netherlands as we are facing fossil resources depletion and global warming threat. The set target by the Netherlands for 2050 to completely transform all the building stock into energy neutral buildings is a bold challenge and the graduation topic integrates with the national aim as it is focusing on the refurbishment of an existing building cluster in Ramplaankwartier, Haarlem under SUI (smart urban isles) project.

Approach, Research and Design

The research is structured with the framework given in *figure 1-1* in chapter 1.3 *Research Methodology*. Division of the graduation into four sub topics has increased the effective progression and the coherence between introduction, literature study, case study design and the conclusions. First two sections of graduation process were done before the P2, to clarify the follow up steps of case study design. The envelope refurbishment strategies were derived from the conclusions in literature research.

Within literature study; certain boundary conditions, criteria's are defined and possible refurbishment measures are gathered along with background research on row-houses refurbishment cases in the Netherlands to highlight real-time applications and measures for refurbishment. During the case study design additional frameworks are added for different application and refurbishment measures to clarify, enhance and strengthen the connection between boundary conditions, simulations and conclusions in each step.

The fractionized approach for refurbishing made it possible to give enough attention to every subject to improve energy performance and the comfort conditions in both of the refurbishments.

The architectural design variations within the research haven't been the primary objective, however it has been taken into account not to provide irrelevant end product architecture wise. It is always possible to increase the variations of the façade appearance for refurbished row houses, though appearance of the envelope hasn't been stated as a research objective nor it has been included as a research question.

Product

Large portion of the research has been simulation for every input thought for as a design data and the conclusions derived from the end results of simulations. The approach has made it possible to increase the control over inputs and the driven conclusions from the steps, where the conclusions from each step formed the final design of the Zero Energy Building cluster.

Conclusions have been generated regarding the criteria's defined for each step and assessed within simulations in DesignBuilder software for energy consumption reduction, human comfort in closed spaces. Energy generation inputs were calculated over excel and to increase the accuracy of the calculations data from DesignBuilder is used for certain variables. Inputs for every step were quantified to highlight the possible result for different applications on the state of the building as well on human comfort. Among the simulations inputs suitable with defined criteria's and arguments are selected to form the final design of the buildings.

Assessment of different building services options has been simplified to reduce complexity on the process. Simulation inputs have been extensive and out of context if detailed HVAC is to be used for building services due to requirement of total control over every component regarding connections, efficiencies, heating loops and provisions.

Less emphasis was put on an energy neutral building cluster formation rather than individual condition of the building due to low numbers of the similar typologies of case study building in the vicinity. Due to time planning as well as the energy type of the building services in use only one type of energy generation system is used to offset the energy consumption in the cluster. It would be interesting to see options with higher integration and varieties for the energy generation part of the process.

Time Planning

Time planning given in figure... hasn't been altered since and after P2 due to flexible research focus. Most time consuming section has been the integration of inputs into simulations and how could they be shaped in the software along with the calibration and optimization of comfort in space. Zone based comfort optimization has taken a bit more time than expected due to extensive calibration requirements per zone for both of the refurbishments, where different strategies of ventilation are followed.

Initially it was expected to work longer on the energy generation and its integration to available space. However due to constraints in the number of the buildings and the followed generation strategy, it has been shortened. Thou the time lost during comfort optimization have been compensated in energy balance portion of the research.

Ideally it is important to focus on the conclusions from the calculations conducted and not on the detailing of the envelope components or sizing of the elements used in the simulations. However the focus on sizing and detailing of components have helped to create a healthy and relevant design and it will be included in the report after P4.