Reflection

This document is a reflection of the process and methodology that I follow during my research.
The main aspects than have been assessed are the following:

**The relationship between research and design**

The study focused on exploring the design adaptability and flexibility of the 2ndSkin refurbishment project created by a research team of TU Delft by applying the concept in Germany. The goal of the research was to export the retrofit concept into the Northern European market of residential buildings and specifically to Germany as resulted to be the most potential country for the refurbishment concept. The main research question that the research tries to answer can be formulated as follows: “How can the 2ndSkin design be flexible and adaptable to be applied on a German residential building regarding the building type, the building construction and building services, while exploring design variation of the façade composition?”

The methodology that I follow includes literature study in the beginning of the process in order to get familiar with refurbishment definitions, refurbishment motivations and challenges. Afterwards, I analyzed the residential stock in Europe by focusing on size and age of the residential stock, ownership and tenure, building type and construction and energy performance of housing stock, in order to have an overview of the residential stock of the most potential countries. After analyzing Europe’s market, the research concludes that indeed Germany is the key country for deploying the refurbishment project on a residential building. The analysis of the German housing stock follows the methodology.

After this phase, the methodology continued with the comparative study of the reference buildings in Netherlands as the initial case study of the 2ndSkin concept and in Germany as the current case study of this research. The comparative study enabled the understanding of the retrofit scenario in terms of concept and building technology. The investigation of the case studies was based on key elements like the balcony type of the wall construction that enable the research to create diagram of the characteristics that the design have to deal with and be based for the follow steps of the study.

The design that follows includes the application of the 2ndSkin project on the case study in Germany. The next part is the designing of additional elements that can be applied on
façade construction and offer design flexibility to the concept. The design concepts assess the structure adaptability based on elements such as windows, balcony, cladding materials etc. In the end, there is a design suggestion that combines some of design samples and the 2ndSkin basic concept by adding value at the building.
1. Introduction of research and graduation plan

2. State of the art of Refurbishment in Europe
   - Refurbishment
   - Residential Stock in Europe
   - Characteristics
     - Building typology
     - Energy performance
   - Building Sector
     - Construction type
     - Building services

3. The German housing stock

4. Comparative Study of Reference Buildings in NL & DE
   - 2ndSkin/NL
     - Construction type
     - Building services
     - Details
   - Case study Germany

5. Application of 2ndSkin on case study in DE
   - Design adjustments
   - Design adaptability
   - 2ndSkin limitations

6. Designing additional elements
   - Samples façade constructions
   - Evaluation:
     - Architectural character
     - Design flexibility

7. Conclusions
   - Design catalogue
   - A design suggestion

Recommendations Evaluation
The relationship between the theme of the graduation lab and the subject/case study chosen by the student within this framework (location/object)

The sustainable design graduation studio belongs to the chair of Building Technology. The goal of the studio is to investigate new innovative technologies concerning façade design or structural design or climate design by reflecting a sustainable character.

The case study selected explores and expands an existing refurbishment concept made by a research team of TU Delft that deals with zero energy buildings. The innovative technology behind the 2ndSkin design promotes the energy upgrade of buildings with high energy consumption. The technology applied on the envelope of the building from the exterior offers a renovation scenario that will result in a nearly zero energy building without affecting the residents’ presence. The goal is to have easy installation, to be lightweight, sustainable and scalable. The 2ndSkin finds a way to upgrade the existing building stock and avoids the demolition of poor energy performed buildings.

Therefore it is beneficial to export the 2ndSkin design into the potential German residential market and create design flexibility that could expand the project and improve the process of applying the design on other buildings in Europe. Furthermore, besides applying the retrofit design it is essential to suggest a design concept what could add architectural and functional value at the building. The priority is to make the 2ndSkin design concept flexible to be applied on a German building type in order to create a competitive product for the market.

The relationship between the methodical line of approach of the graduation lab and the method chosen by the student in this framework

The methodical line approach of the graduation lab is scientific-technical study and design research or deployment of a design. The method chose for the purpose of this thesis is scientific-technical study and design research by using 2d or 3d computer software. The methodology aims to find ways for design flexibility and adaptability through computer models and drawings for making the 2ndSkin project flexible and adaptable to be applied
on a typical German case study. Therefore, the methodology used design research to improve the aspects of the project and evaluate the results.

The relationship between the project and the wider social context

The impact of the project to the wider society is the refurbishment market and especially the design behind the concept. The improvement of the existing building stock is an important value that leads the design.

The design adaptability of the 2ndSkin refurbishment concept for zero energy buildings has been explored through the application in Germany. Therefore, the export of the 2ndSkin project into the German market in correlation with energy upgrade of residential buildings has resulted in an efficient and adaptable design. The study concludes in efficient ways to deal with the 2ndSkin design as it proposes design variation and solutions to deal with the drawbacks of the project.

Additionally, the study achieves to improve and advance the façade design of the 2ndSkin refurbishment concept, thus contributing to the existing knowledge about the system and offers a tool to the design team to continue with the research. The study besides the design variation proposes essential elements that would be the key to apply the design in similar building types. Although, the design concept has been studied for two reference buildings, the study proves that it is flexible and adaptable to incorporate more building types and offers a great design variation of the façade. In conclusion, the research suggests continuing applying the 2ndSkin system in Europe in order to tackle the climate change and minimize the CO\textsuperscript{2} emissions of the construction.