Graduation plan

Revitalization of the gallery apartment building

Mark Evertzen
Content

1 General information
   1.1 Personal information
   1.2 Graduation Studio
   1.3 Graduation project
   1.4 Location
   1.5 Time

2 Problems and objectives
   2.1 Current situation
   2.2 The main problem
   2.3 Sub-problems
   2.4 Opportunities
   2.5 Main objective
   2.6 Sub-objectives

3 Research questions
   3.1 Main Research question
   3.2 Sub-questions
   3.3 Background questions

4 The anticipated result

5 Approach
   5.1 Process
   5.2 Method description sub-question 1
   5.3 Method description sub-question 2
   5.4 Method description sub-question 3

6 Literature
   6.1 Literature that has already been consulted
   6.2 Literature that is intended to consult
   6.3 Non-written sources

7 Relevance
   7.1 Social relevance
   7.2 Environmental relevance
   7.3 Scientific relevance

8 Time planning
1 General information

1.1 Personal information
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1.2 Graduation Studio
Name / Theme: Zero Energy Refurbishment
1st Supervisor: Prof. Dr. Ir. A.A.J.F. (Andy) van den Dobbelsteen  
2nd Supervisor: Ir. L.G.K. (Lidwine) Spoormans  
Delegate examiner: Ir. F.D. (Frits) van Loon

Argumentation for the choice of the studio: I think it’s terrible if good buildings or good parts of them get demolished, the demolition and processing of the waste as well as the building of a new structure has a high negative influence on our earth. I’m willing to show alternatives in which these buildings or parts of them will be prepared for the future. I also like the technical challenges of these type of assignments and the difference these transformations can make to the residents. I’m convinced that with transformation it is possible to increase the quality of life of the residents more than what a new building would do and on top of that with a lower impact on the environment.

1.3 Graduation project
The working title of the graduation project is: Revitalization of the gallery apartment building

1.4 location
Several big building systems where used to build Dutch pre 1975 gallery apartment buildings. To make the project manageable the design is based solely on buildings according to the the Eesteren Rationele Aanpak building system also know as ERA. The final product should be modular or easily portable to all buildings of this system. Several locations will be analyzed but one just one specific location is picked for the case study.

1.5 Time
At this moment the building regulations have strict rules on the operational energy but there is not much place for embodied energy. As one of the tree pillars of this project is embodied energy and the reduction of it, the case study is not a project that is likely to be build tomorrow but my hope is that the building regulations take embodied energy better into account in the near future. So in a way the case study will become more of a future vision. Designing a future vision has some consequences for the project, for instance the current building regulations concerning sustainability and energy don’t have to be taken into account as this design will exceed the sustainability demanded by the current regulations. And there is more freedom to propose unique whole new design solutions. Although the design is a future vision and this will be propagated in the design, the design should be technically possible today and if a social housing association is willing to be a frontrunner they should be able to build the case study with the techniques currently available.
2 Problems and objectives

2.1 Current situation
Dutch gallery apartment buildings served well for years but are not up to today's standards anymore, both climate technically as well in terms of living quality. Nowadays a few different things happen to these buildings:

- The gallery flats are demolished and new buildings are build, this option seems to be quite bad for the environment but due to the high dwelling demand this is luckily quite rare in The Netherlands.
- The buildings are updated technically in a really simple way when maintenance is needed, when a façade needs maintenance it is replaced by a better insulating one. Sometimes additional some other adjustments or additions are done, like the placement of solar panels. When the façade is upgrade but the inside of the building remains untouched, sound problems occur.
- It doesn’t happen much yet but there are cases in which added value for the user is created for instance by adding a winter garden to the building, to me these are the most successful transformations but again if these transformations are done without adjusting the interior sound problems will occur.
- The buildings remain in use as they are, resulting in a lower quality life than the inhabitants deserve and lots of energy gets wasted, as the operational energy of the gallery flats is extremely high.
- In some cases the buildings are stripped to the bearing structure and a complete new building is made of it. In this case there is a lot of added value for the dwellers of the building, but in most cases the dwellers are not the same as lived in the building before. These types of projects are extremely expensive the ones I’ve found where a lot more expensive than building a completely new apartment building. And in these types of projects the gallery apartment building becomes completely unrecognizable and it seems like the designers didn’t look at the values of the gallery apartment building at all, or they just valued them extremely low.

What most of these approaches have in common is that they didn’t seem to have looked at the values of the gallery apartment building in terms of architecture and living quality. And none of the projects I’ve found seems to use the unique climate technical opportunities of the gallery apartment building to the fullest.
2.2 The main problem
Pre 1975 Dutch gallery apartment are not up to today's standards anymore. The buildings consume a lot of energy and the inhabitants deserve a better quality of dwell. But destroying the buildings might have a big environmental impact. And when these buildings are renovated the quality of life of the inhabitant seems often to be treated as a side issue.

2.3 Sub-problems
- Most transformations solely take the operational energy into account and don’t consider the embodied energy or other bad influences the material usage has on the environment. When the operational energy of a building gets lower the embodied energy gets more influential, therefore to me making an energy neutral building is not enough. The total of the embodied and operational energy should be as low as possible over the rest of the lifetime of the building.

- I wasn’t able to find one single transformation of a gallery apartment building that made good use of the unique characteristics and potentials of gallery apartment buildings considering climate design.

- The user of the building has a huge influence on the actual energy consumption of the building, yet a lot of gallery apartment buildings use climate systems some of the residents don’t even understand, and that are not intuitive to use. This results in a lower quality of life and a higher energy bill.
2.4 Opportunities
The thesis from O. Guerra Santín from the TUDelft shows that the user has more influence on the energy usage of a dwelling than the actual building has. In the picture below you can see that the average energy usage of insulated buildings is always lower than that of not insulated buildings, but due to the effect of the user the worst scoring uninsulated buildings score better than the worst scoring insulated buildings. So the influence of the user on the operational energy is not to be underestimated and therefore there is lot of opportunity for a system that is easy to understand and operate.

![Figure 2.2 Mean and standard deviation for energy use (MJ/year) per insulation degree category](image)

2.5 The main objective
Make a case study project of a transformation of a gallery apartment building that improves the quality of life of dweller, has a low total energy usage over the lifetime of the building and is significantly more sustainable than the status quo. The project should be a showcase of how we could build in the near future especially considering the total energy usage, the use of potential and opportunities in the climate design and putting the dweller central in the climate design.

2.6 Sub objectives
- Investigate the possibilities to get the total of operational and embodied energy as low as possible over the lifetime of the gallery apartment building. Different options should be investigated from making the building sustainable by hardly touching it to tearing the building down and rebuild a whole new building.

- Investigate the unique characteristics of the gallery apartment building and the close area and what climatological possibilities these characteristics might bring. Design several climate schemes that use the unique qualities of the gallery apartment building to the fullest.

- Create several sketch designs of climate systems that are intuitive to use and designed with the user as the center of the climate system. This to improve the quality of life and reduce the operational energy usage.
3 Research questions

3.1 Main Research question:
How can Dutch gallery apartment buildings built with the “Eesteren Rationele Aanpak” building system be transformed in such a way that the total of the operational and embodied energy will be as low as possible over the rest of the lifetime of the building, while the quality of life of the residents increases?

3.2 Sub-questions:
1. How can the embodied energy of the building materials be as low as possible in comparison to the operational energy of the building over the rest of the lifetime of the gallery apartment building?
2. How can the typical characteristics and potentials of gallery apartment buildings be used optimally in the climate design?
3. How can the climate system of a building be designed in such a way it becomes intuitive to use?

3.3 Background questions
1. What is the technical condition of gallery apartment buildings build with the ERA building system?
2. What are the architectural qualities of Dutch pre 1975 gallery apartment buildings?
4. The anticipated result
The result will be a design based on one case study but easily portable to all ERA gallery flats. The design should increase the quality of life of the dweller significantly and be based on the existing qualities of the gallery apartment building both in terms of architecture as well in terms of climate solutions. The final design takes the answers to all sub questions into account. The project is a technical project above all, however because the user and the ease of operation of the climate system stand central and because the design of the whole building will be based on the existing qualities of the gallery apartment building the project has a big architectural influence, on top of that the architectural quality is also extremely important from a climatological point of view, the easiest way to reduce the embodied energy of a building over it’s lifetime is by extending the life of the building, architecture can do so.
5. Approach
The main research question will be answered by research by design. To do so, first the three sub-questions need to be answered and the design will be based largely on the answers of the three questions and some general research. The design will be based on those three sub-question but other parts of sustainability should also be taken into account, for instance: water, materials, waste, flora and fauna and health, as the design is a future vision. I hope these aspects of sustainability will be more integrated in the building code in the future.

5.1 Process
The scheme below shows the process that needs to be followed to come to a good end product and the relationships between tasks. To be able to show the relationships clearly the tasks are grouped per question they answer to. The blue area shows the tasks that need to be done to answer the main question generally and the other colors are tasks that can be specifically related to the corresponding sub-questions.

[1] Main research question: How can the embodied energy of the building materials be as low as possible in comparison to the operational energy of the building over the rest of the lifetime of the gallery apartment building?

[2] Sub-question 1: How can the embodied energy of the building materials be as low as possible in comparison to the operational energy of the building over the rest of the lifetime of the building?
[3] Sub-question 2: How can the typical characteristics and potentials of gallery apartment buildings be used optimally in the climate design?

[4] Sub-question 3: How can the climate system of a building be designed in such a way it becomes intuitive to use?

[5] The scheme only shows the main books or documents that will be used in that specific part of the literature research, there is a bunch more literature study related to every research question.

[6] The separated analyses are done mostly simultaneously, on location. Because different parts of the analyses are needed for different research questions they are separated in the scheme and placed under the sub-question that actually requires that specific part of the analyses. The analyses of the dimensions is placed under the header of the main-research question as the analyses of the dimensions are needed to answer both the main research question as well the first and second sub-questions.

[7] The current solutions of transforming a gallery apartment building are calculated considering the total of embodied and operational energy as well as some possible future solutions. The results of these calculations will integrated in the final design, on it’s turn the total of embodied and operational energy over the lifetime of the final design that is based on all the three sub-questions will also be calculated.

[8] In this step the results from the three sub-questions and the general research will be integrated in several sketch designs, from here the project will be a ‘normal’ design project.
5.2 Method description of Sub-question 1
How can the embodied energy of the building materials be as low as possible in comparison to the operational energy of the building over the rest of the lifetime of the building?

Several digital models are made based on existing and possible solutions, the operational energy demand and the embodied energy of these models will be calculated. The results of these calculations are used to make schemes with the time on the x-axis and energy on the y-axis, these schemes can be used to compare the total energy consumption of different scenarios over the lifetime of the building.

Scale: This question will be answered on the scale of one unit, as most units are the same in a gallery apartment building, so the approach is quite accurate. If a new foundation is needed, this is included in the models, for instance if the gallery apartment building consists of 500 flats, 1/500th of the needed foundation is added in the calculations.

Which climate systems purify the air and heats the building is used will not be taken into account, only the heat, cool and air refreshing demand the building with the calculated façade would have.

The end façade is completely excluded in the calculation, as these could be designed completely separate of the rest of the façade so it would only blur the results.

Energy yield of the building will be subtracted from the operational energy, probably multiplied by a factor below 1. This is because energy that is put on the power grid will have some transportation losses before it can be used or even bigger losses occur if the power needs to be stored. On top of that the power grid also needs to be maintained what will cost some energy and environmental damage.

These three different approaches that are currently done will be modelled and calculated:
- The conservative approach: When the gallery apartment building is ready for big maintenance, the façade (the walls, windows and window sills) will be upgraded in the most simple way, to get a B-label according to the Dutch energy label system.
- The building will be upgraded to an energy zero building in the most common way currently done.
- Transformation of a gallery apartment building that improved the quality of living by adding a greenhouse façade, for instance the Noordwachter in Poelenburg, Zaandam.

At least these four possible designs/scenarios will be modeled and calculated:
- The building is stripped to the structure and will be finalized completely out of wood.
- The building is stripped to the structure and finalized with a focus on lightweight materials with a low embodied energy. For instance, by the use of a ETFE foil or polycarbonate panel façade.
- The gallery apartment building will be completely torn down and rebuild according to the most common building techniques.
- The gallery apartment building will be completely torn down and a zero energy building with low embodied energy will be rebuild.
5.3 Method description of sub-question 2

*How can the typical characteristics and potentials of gallery apartment buildings be used optimally in the climate design?*

Gallery apartment buildings and the direct area will be analyzed to find the unique characteristics and potentials. Based on these characteristics and literature such as ‘Architecture as a climate machine’ several climate schemes will be sketched, climate schemes that use the potentials of gallery apartment buildings optimally.

Scale: This sub-question will be answered on the scale of the entire building including the close surroundings of the building.

Examples of possible sketch designs:
- Use the height of the gallery apartment building to make a solar chimney
- Use the height of the gallery apartment building for wind harvesting
- Change the blind end façade of the gallery apartment building into a Trombe wall
- Use the structure of the building to heat and cool with concrete core activation.
- Use newly introduced greenhouses for food production and to heat the building.

5.4 Method description sub-question 3

*How can the climate system of a building be designed in such a way it becomes intuitive to use?*

Literature is assessed and based on this several climate designs are sketched. De sketches are based on an intuitive to use climate system from the perspective of the user.

Scale: The design is from a user perspective so the scale is mostly just the inside of the apartment, if from a user perspective more of the building is needed to operate the climate system this is added, for instance if the balcony is needed in the climate design.

Examples of possible sketch designs:
- A completely manually solution with natural ventilation in which the user can change everything manually. When a user is in control of the climate he/she tolerates a lot more temperature differences and yet feels more comfortable.

- A system based on home automation, the user just gives the personal temperature he or she wants and the systems gives that temperature on the place in the building the user is. This should be possible for multiple users, so every user has the conditions that suits him or her best. By having a system like this it becomes unnecessary to heat the whole building, you just heat the spot where the person is.
6 Literature

6.1 Literature that has already been consulted

6.2 Literature that is intended to consult

6.3 Non-written sources
- Interview with Arne Steeneken, development manager at social housing association Woonbron
7 Relevance

7.1 Social relevance
At the moment lots of people live in gallery appartment buildings that are outdated and do not meet the living standards of today, it will have a big influence on the lives of these people if their homes will be upgraded to todays or even tomorrows standards.

7.2 Environmental relevance
At the moment gallery apartment building spill a lot of energy, reducing the total off embodied and operational energy over the rest of the lifetime of these buildings will significantly help to reduce the energy usage of the building and if this approach is applied more; of the entire country.

7.3 Scientific relevance
Lots of studies and projects have been done to transform gallery apartment buildings, but I was not able to find one transformation that seemed to truly use used the potential of the unique characteristics of the gallery apartment buildings in the climate design.
8 Time planning
The time planning is added in appendix 1
### Main Research Question

**Sub-question 1 (Embodied Energy)**

**Sub-question 2 (Potentials for the Climate Design)**

**Sub-question 3 (User Central)**

### Background Questions

- Literature research on building systems and ERA
- Literature research on transformations in general
- Literature research on embodied energy
- Tabletop research on different ERA apartment buildings
- Field analyses of ERA apartment buildings
- Make a computer model of an ERA apartment building
- Analyze and draw currently done transformations considering material usage
- Design and draw several possible interventions considering material usage
- Calculate the embodied and operational energy for the modeled interventions
- Analyze the potentials of gallery apartment buildings and the area
- Sketch different climate designs that optimally use the potentials
- Literature research on the effect of the user on the operational energy of a building
- Tabletop research on how to put the user in the center of the climate design
- Create sketch designs for climate systems that are intuitive to operate
- Analyze the architectural qualities of ERA apartment buildings
- Make small sketches of solutions that improve the living quality
- Create several sketch designs that integrate the sketch designs of the sub-questions
- Calculate the embodied energy of the integrated designs
- Elaborate on one design
- Improve the design and make presentable products

### Time Planning

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