Graduation Plan: Building Technology

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Studio
Theme: Design Technology
Main mentor: Dr. ir. (Martin) M.J. Tenpierik
Chair of Building physics
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Date: 21-6-2013
Argumentation of choice of studio: My choice for graduating in the field of building physics is related to the fact that I find it important to built residences that fulfil the expectations of the users. Realising a successful design with happy users is not only determined by its form, but also by the indoor comfort and experience of the residence. I find it challenging combining this knowledge in search for the right balance between comfort and a sustainability design.

Title
Title of graduation project: Low-energy houses and their users
Predicted energy use vs. actual energy use

Product
Problem statement:
The predicted energy use deviates from the actual energy use in low-energy residences, and houses with an identical EPC show a significant variance in energy use.

Main research question:
What is the share of user behaviour in the difference between the predicted and actual energy use in low-energy residences with an EPC<0,4 and which behaviour is decisive? And how can the variance in energy use in identical residences be explained?

Sub questions:
- What is the difference in the predicted and actual energy use?
- What is the relation between the calculated EPC for the building permission and the EPC of the realised residence. (What caused the deviation)
- Are there technical causes that can explain the difference between the predicted and the actual energy use?
- What is the share of technical factors in the actual energy use?
- What is the share of the type of household in the actual energy use?
- What kind of behaviour can be found in the residences?
- What is the share of user behaviour in the difference of the predicted and actual energy use?
- How large is the variance of the energy use of the identical residences?
- What are the explanatory factors behind this variance?
Research description
My research will consist of monitoring two identical residences with an EPC of 0.31 located in the newly developed area in Almere-poort (Netherlands), to determine the difference in actual energy use and the predicted energy use. I will compare the two identical residences in order to find a relation between the user behaviour and the building performance. The residences will be selected by type of household and the awareness and motivation of the users on saving energy. To find these appropriate residences for monitoring, I will distribute questionnaires to get more insight into the motivation and awareness of the users, types of households and energy use of the residences. The data that is gathered by monitoring, together with the output of the questionnaires, will be analysed to conclude what is the share of user behaviour in the difference between the predicted and actual energy use, and which factors explain the variance in actual energy use of the studied residences.

Goal
The aim of my research is twofold: First goal is to find an explanation for the variance in the energy use in residences with an EPC <0.4. Besides this I want to investigate what the possibilities are to optimize the performance of the residences on a technical and user level. Depending on the results of the analysis, I want to check if conclusions can be made on the robustness of residences with an EPC<0.4, which can lead to design solutions for architects.

In this study, Robustness will be defined as the ability of a building characteristic or system and combinations to live up to the performance described during design stage. Certain building characteristics are robust for they provide lower energy use and higher comfort level. Question is to know what makes a characteristic robust or not.

Process
Method description
After selecting the two appropriate residences from the questionnaire data and determining the willingness of the residents to cooperate, I will monitor the two objects on the physical circumstances, the energy use and the user behaviour for four to eight weeks.

Measurements
To get insight in the indoor physical circumstances, the following measurements will be made (Figure 1).

Location measurements
The measurements will be made in the following areas:
- living area
- 2 bedrooms
- kitchen area

Occupant behaviour
During the period of monitoring I will also give insight in the following occupant behaviour aspects:
- Use of shower
- Presence of users
- Use of thermostat and radiators
- Cooking behaviour
- Use of hot water in kitchen
- Use of washing machine, dryer, dishwasher
- Use of lighting
- Ventilation behaviour
- Use of heaters per area
Analysing data

The obtained data will be analysed in Microsoft excel in the first stages of the research. For more comprehensive analyses, I will use the statistical analysis program SPSS.

Literature


Reflection

Relevance
Reducing the energy use on a world wide scale is a current responsibility for every industry. In 2010, 21.3% of the primary energy in the Netherlands was consumed in Dwellings. The European Energy Efficiency Directive has set the target of 20-20-20 for the year 2020. This means a 20% reduction of greenhouse levels, 20% increase of the share of renewable energy sources, 20% reduction of energy consumption.

One of the tools of the Dutch government for reducing the energy demand and CO2 emissions of houses is the Energy Performance Coefficient (EPC). This instrument consists of minimum norms for new to-be-built buildings. To build a new building, a permit issued by the municipality is required. The expected energy performance of the building must meet the EPC norm.

Current building projects need to meet the requirement of an EPC of 0.6. For 2015, the new target of an EPC<0.4 will be applied, and for 2020 the requirement will be an EPC of approximately 0. In order to meet up with all the energy requirements set by the government, and be able to fulfil the future requirements, we need to learn from successful and unsuccessful realised building project so we can improve the real building performance.

Time Planning