MSc Projects of the Class of 2010-2012

MSc in Sustainable Architecture
Faculty of Architecture and Fine Art
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Sustainable residential ventilation

In Norway, balanced ventilation with heat recovery is the most recommended solution for a low-emission building. However, a minority claims that a naturally ventilated house can be equally sustainable. To find out more about which concept is more sustainable, a model building with natural ventilation is compared to the same building with balanced ventilation in several cases. These are calculated in the computer-program SIMIEN, with a CO2-factor 355 g/kWh.

In a real assessment of recovered heat in a balanced ventilation system, latent heat supplied to the indoor air should be included.

The calculations indicate that the total greenhouse gas emissions in a lifetime perspective from a house with natural ventilation can be as low as from a house with balanced ventilation. A typical Norwegian passive house heated with electricity seems to have higher greenhouse gas emissions than a naturally ventilated house with 50% of the space heating covered by biofuel.

A naturally ventilated house with pre-heating of air in a earth heat exchanger, and reduced air change rate at daytime when people are out, can have equally low global warming potential as a typical passive house, when both have electric heating.

This indicates that natural ventilation, especially in a concept with wood-pellets, or district heating, can achieve very low total greenhouse gas emissions.

Fig. Emissions from components in ventilation system included, but not from heating system or envelope. Cases N1-6 all have natural ventilation.
Comparative Analysis of PV Shading Devices for Energy Performance and Daylight

The comfort and energy demand of a building are influenced significantly by glazed area of the facade. The glazed areas in the building are always challenging. Large glazing allows more daylight to get into the room but at the same time cause more heat gain and heat loss through the building envelop. Shading devices are very suitable elements for installing PV panels. The aim of this study is to evaluate the potential impact of different PV shading devices on energy performance and daylight of office buildings in Nordic climate.
Thermal mass activation - PowerHouse

This thesis investigates whether the use of TMA is suitable for and of benefit to the Norwegian building industry.

Power House One plans to use the same heating technology as the Sparebank1 building in Trondheim. This building uses ventilation to distribute thermal energy to the end of activating the thermal mass. The purpose of this thesis was therefore to determine whether it is more efficient to use water rather than air to distribute thermal energy. Water has a higher volumetric heat capacity than air and therefore water-carrying pipes embedded in the thermal mass should be more efficient in distributing thermal energy.

This thesis found that integrating thermal mass activation into building design is a valuable means to improve the thermal comfort of an indoor space. While its performance for improving thermal comfort is better than that of ventilation, there is no clear answer as to whether TMA is also more energy efficient than activating this same thermal mass using ventilation heat. Further research is thus necessary to investigate this issue.

Ref. Sparebank 1, Trondheim
Ref. Powerhouse 1, Snøhetta,
The Potential of Façade-Integrated Ventilation Systems in Nordic Climate

Ventilation is a crucial aspect in super-insulated and airtight buildings. Façade-integrated ventilation systems are a state-of-the-art technology which is considered an energy efficient option. Results of the conducted evaluation in Nordic context show that some aspects need adaptation to local requirements. However, good performance can be expected in fields like indoor comfort and user satisfaction. The technology has enormous potential and might be an alternative if there are high expectations on indoor environment but conventional ventilation system are not applicable. The used tools in this work include ESP-r and Simien for dynamic simulation of building performance.

Transformation of a barn at Camphill Rotvoll

The barn at Rotvoll farm has a history of 140 years. The design project aims to prepare it for future use by reusing the old structures as much as possible while ensuring a good energy performance. The future user of the barn is Camphill movement that creates "life-sharing" communities and schools for adults and children with learning disabilities and other special needs providing services and support for work, learning and daily living. Energy performance of the building, on-site energy supply options and embodied emissions of the new added and reused materials were estimated as part of the design.
Energy Retrofits of Residential Buildings
- impact on architectural quality & occupants' comfort

In order to be successful on the market, energy-saving measures for existing buildings need to be promoted with arguments that are directly relevant to the users. Initial marketing for energy retrofitting has been based on monetary profits from future energy savings. However, for most households in Europe, energy bills for the home account for only 3-4 percent of disposable income, hence are not a major concern. As a result of inappropriate promotion of energy savings for existing buildings, less than 1 percent of over 300,000 projects certified by BREEAM are refurbishments. Apparently, the promotion of energy retrofitting needs to be based on different grounds. It has been shown that people are particularly attracted to the idea of increasing the comfort and appearance of their homes, rather than carbon savings or long-term monetary profits. Therefore, the goal of this research was to analyze the potential of linking energy-efficiency to an increase in housing quality. Once this relation is precisely defined, people will have a clear idea about the benefits of energy retrofits of their homes, thus be more motivated to make the investments.
Architectural Integration of Photovoltaic and Solar Thermal Collector Systems into buildings

Solar technologies in the form of photovoltaics and thermal collectors have not been used to the expectation specially in building sector to replace the use of fossil fuels. The main reason for these technologies not being popular in building integration is the lack of good architectural quality rendered not meeting desired design considerations. Hence, the objective of my thesis is to pave possible ways of integrating these technologies into buildings, both on existing and new constructions to add emphasis on the overall architectural expression in addition to producing energy. Basic focus is on the appearance or aesthetics part of integration as this makes the major impact on the people. PVs and thermal collectors can deliberately be used as architectural design elements in a distinctive way. Integrating these systems into buildings is not only for clean energy but also to use them as multifunctional elements where they replace the conventional building elements.

“How can the Photovoltaic and solar thermal collector systems be integrated into buildings to serve the dual purpose of generating solar energy and enhancing architectural quality?”
The impact of building morphology on energy consumption

Buildings are responsible for 38% of energy use in Norway, about 64% of which is heating energy. Lacking of architectural design at the early design stage has adverse consequences on the climate and environmental efficiency of buildings, which is a burden for reducing the energy consumption of buildings.

This research uses Ådland project as a case study in order to investigates how the building morphology which is one aspect of the architectural quality will impact the heating demand of buildings. The research is based on the design which is ongoing in the Research Center on Zero Emission Buildings (ZEB).

The objective of this research paper is to provide designers with general guidelines at the early design stage for selecting the most energy-efficient building morphologies from the perspective of the heating demand of buildings.
The Impacts on Solar Access and Energy Demand of Different Building Masses in Linear Building Forms
-Feasibility Study of Norwegian Suburb Sustainable Residential Community Project: Åland, Bergen

The main direction of the thesis is analyzing the impact on solar access and energy demand of different building mass in linear building forms. The study model of this work is a current ongoing project - a suburb sustainable residential community design project located in Åland, Bergen, Norway. The work mainly consists of two parts: theory and project analyses. Both two parts are focusing on reducing environmental impact of suburb sustainable residential communities. More specifically, the theory is aiming on finding out the critical design and energy issues for suburb sustainable residential communities. The project is aiming on using the strategies from theory part and analyzing critical design issues of solar access and energy issues of heating demand reduction with different building masses.

Suburb sustainable residential community, Reduction of environmental impact
Ensuring solar access, Reduction of heating demand, Renewable energy supply systems
Emissions Accounting for ZEB Shoebox Office Model:
--Strategies for optimizing the operational energy supply
--Strategies for reducing the embodied carbon from a life cycle perspective

Zero emission building (ZEB) is considered a future-oriented concept for reducing Green house gas emissions in the building sector.

Which aspects should be considered when designing a zero emission building?

The largest potential for decreasing emissions comes from improving energy efficiency, conscious choice of materials and renewable energy supply. The project investigates each aspect providing different design alternatives which give a basis for possible decisions on carbon neutral strategy.
PCM Application- Effect on energy use and Indoor temperature

Thermal comfort is one of the most important factors for the success of design. Many investigations have been made since people realized the importance of energy conservation in a building. PCM is an example of such innovation in building material that helps to maintain the thermal comfort in building and also lessen the energy demand. PCM works on a principle of latent heat storage in which the material is capable of storing the heat while it reaches melting and later releases this heat in useful form. This thesis looks into the behavior of PCM when applied on different building component and in different building criteria. It more over looks into the energy demand and Indoor Air temperature differences when PCM applied to a building. The simulation program WUFI Plus is used to simulate different cases with varied criteria and these cases are compared to discuss more about the topic.
Towards a zero emission built environment

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The MSc programme in Sustainable Architecture lies in the forefront of research, innovation and implementation related to reducing GHG emissions in architecture which the students will be able to transfer into their practice as building professionals. The continuous focus on integrated design methodology will enable the students to perform in any building design team, both as co-worker and leader.

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Annemie.Wyckmans@ntnu.no