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COMPARISON OF TWO PASSIVE HOUSE SCHOOLS IN NORWAY AND GERMANY

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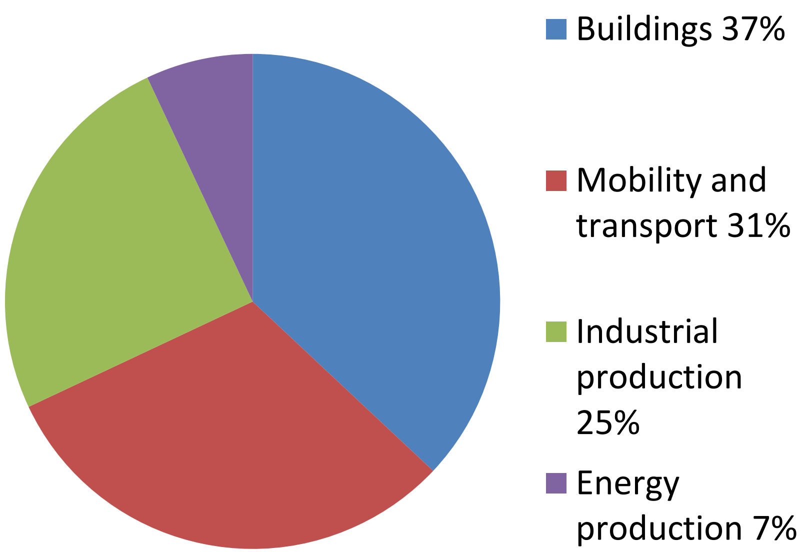
Agenda

1. Introduction energy efficiency of buildings, research questions
2. Passive house definitions in Germany and Norway
3. Development of passive house schools in Europe
4. Comparison of Marienlyst School in Drammen (Norway) and Riedberg School in Frankfurt am Main (Germany)
5. Conclusion and further need for research

Energy-efficiency of buildings

Current situation

Buildings share on total energy consumption



(SSB, Energigbruk i Fastlands-Norge, 2011)

Overall objective

- By 31th December 2020, all new buildings shall be nearly zero-energy consumption buildings. New buildings occupied and owned by public authorities shall comply with the same criteria by 31th December 2018 (EPBD, 2010)

Research questions

1. What impact does the development and implementation of highly energy-efficient buildings and technical infrastructures have on day-to-day energy management and user comfort?
2. What are the benefits and risks of passive house schools from a facilities management and user perspective?
3. What are the similarities and differences between passive house schools in Norway and Germany, which are countries with different climatic conditions?

Passive house definitions

Passive house concept, developed in Germany

"Passive houses have highly insulated building envelopes, including the roof, flooring, exterior walls, and special windows. Ventilation systems with heat recovery supply constant fresh air and recirculate the heat contained in the exhaust air" (PHI, 2012)

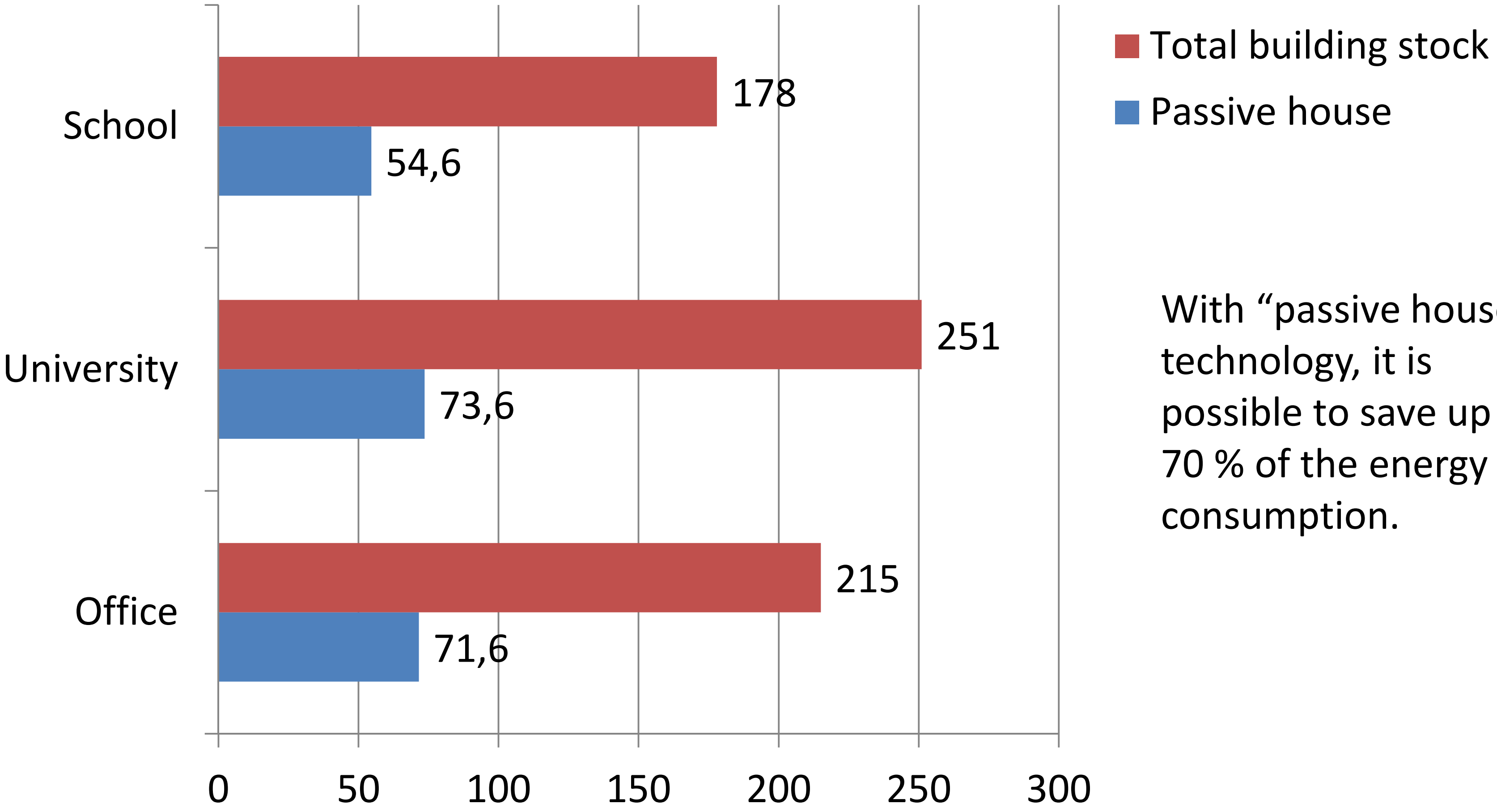
Five basic principles:

1. Thermal insulation
2. Passive house windows
3. Ventilation with heat recovery
4. Airtightness
5. Thermal bridge free design

Norwegian Standard: criteria for passive houses

1. The heat losses for transmission and infiltration < 0.40 $W/m^2/K$
2. The energy supply for cooling is 0 $kWh/m^2/a$.
3. The heating demand for spaces and ventilation is < 20 $kWh/m^2/a$.
4. The passive house must meet requirements for energy supply in accordance with the regulation
5. The minimum requirements of building parts such as U-values for windows and doors < = 0.80 $W/m^2/K$, (NS 3701:2012).

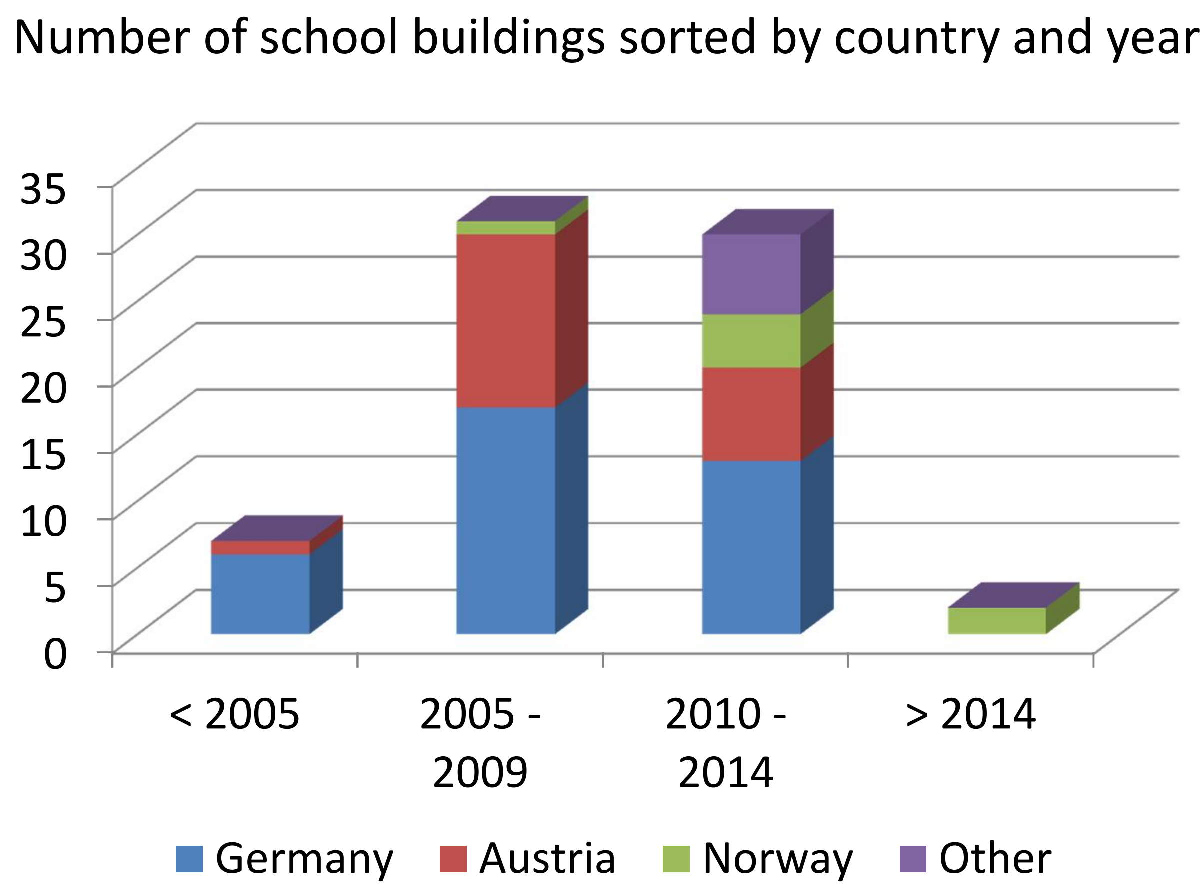
Passive house compared with total stock energy consumption (kWh/m²)



With "passive house" technology, it is possible to save up to 70 % of the energy consumption.

(Dokka et al. 2009, Enova 2011)

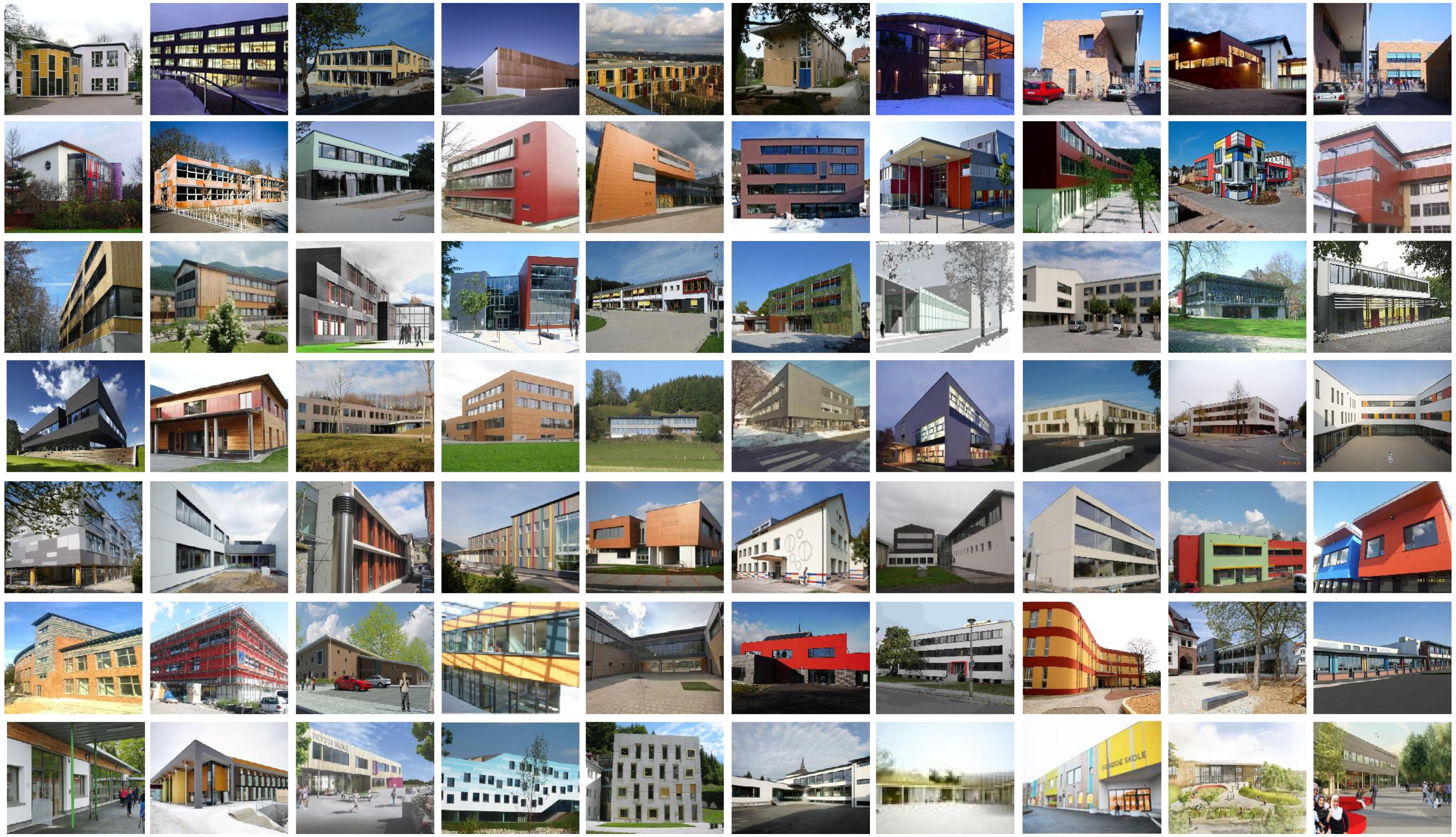
Passive house school development



Based on a sample of 70 school buildings, constructed between 2001-2015, in Germany (36 schools), Austria (22), Norway (6), France (2), UK (2), Belgian (1), and Netherlands (1).

Passive house schools in Europe

Sample of 70 school buildings, constructed between 2001-2015



Comparison of two passive house schools

Marienlyst School (MS)
Drammen, Norway, 2010

Riedberg School (RS)
Frankfurt, Germany, 2004

Categories for the comparison

1. Building history, ownership, management, and use
2. Location and climate conditions
3. Architectural design and heated floor area
4. Energy supply and consumption
5. Challenges for management and use

1 Building history, ownership, management, and use

Similarities

- Result of architectural competition
- Pilot projects
- Public ownership and management
- Similar number of users around 500

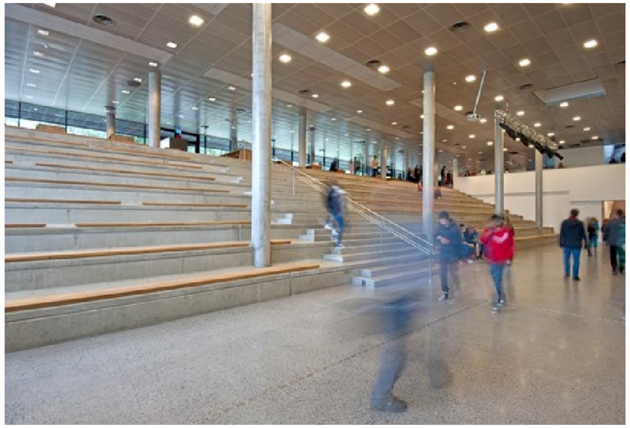
Differences

- Year of construction 2004 (RS) and 2010 (MS)
- Different school types: primary school (RS), lower secondary (MS)

2 Location and climate conditions

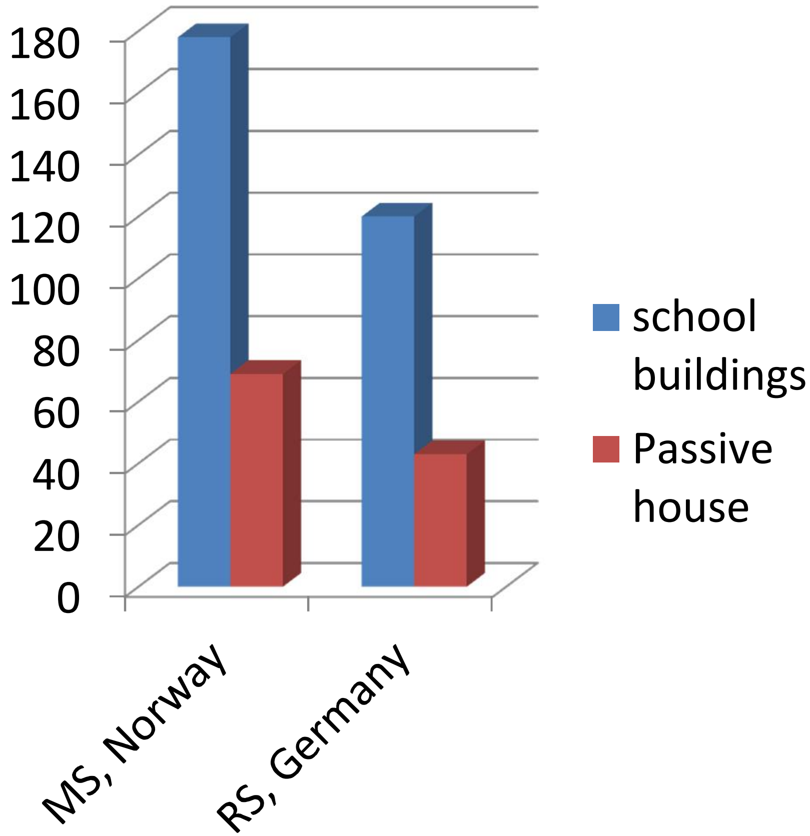
- Both schools are located in urban environments
- Longer heating periods in Drammen (September-May) than in Frankfurt am Main (October-April).
- The annual mean temperature in Drammen (6.3˚C) is lower than in Frankfurt am Main (9.7˚C)

3 Architectural design, heated floor area



- Both buildings have a compact building form
- Marienlyst School has 3 and Riedberg School has 2 stories
- Different heated floor areas MS 6450 / RS 5540 m^2

4 Energy supply and consumption



- Both schools use renewable energy sources: district heating, solar energy (MS), wood pellets (RS)
- Energy demand MS higher than RS: 69 / 43 $kWh/m^2/a$

5 Challenges for management and use

Similarities

- Room heating is provided in addition to ventilation heating
- Good indoor climate ensuring not responsibility of the users
- Provision of good learning and working conditions

Differences

- Intelligent technologies like demand controlled ventilation and automatic blinds implemented (MS)
- Room based controls combined with central time-based controlling system (RS)

Conclusion

1. The studied passive house schools have low energy demand for heating
2. This was achieved by additional efforts in design, construction materials and technical systems
3. Which reduce heat losses and make best possible use of the available natural and user related heat sources
4. The additional energy demand for electricity is relatively high
5. Very good indoor environment quality is achieved.

Further research questions

- Impact of highly energy-efficient insulation and airtightness of building envelope on maintenance costs
- Flexibility of passive houses for adaptation to changing user demands
- Interrelation between high energy-efficient buildings technology and qualification requirement of operational and management staff