mountEE: Energy efficient and sustainable building
in European municipalities in mountain regions
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D 4.5: MONITORING AND EVALUATION REPORT FOR MOUNTEE PILOTS

Name of pilot project:

Ecologic and sustainable kindergarten/preschool Hedlunda, Umeå municipality

Region / local area where the pilot is situated:

Västerbotten County, Sweden

Monitoring and evaluation report submitted by:

Nenet Norrbotten Energy Agency

Type of building:	Kind of public use: All-day preschool/kindergarten/ daycare center for the age of 1-7 years. Total effective area: BBR (Swedish system to count the area) 1580 m2 PHI (for the Passive House certificate) 1323 m2 Number of levels above earth: 2 levels preschool, 1 level restaurant and kitchen Source of energy for heating: District heating with renewable fuel, with only use of returning district heat water. Type of heating system: Under floor heating system Type of water heating system: Energy from the district heating system (returning water) and from the energy recovery of the food cooling- and freezing units of the restaurant and kitchen. Type of ventilation system: Passive House certified central ventilation systems with heat recovery system and an effective heat recovery rate of 86%. Exhausted air from the kitchen will be cleaned with Ozone to reduce cooking odors and grease before the heat recovery is possible in a normal ventilation unit.
Owner of the building:	Name of owner: Umeå municipality Date of construction: 2013/2014 Total cost:41.000.000 SEK (4,3 mill.€), project costs, building included all fixed equipment and furniture for preschool, kitchen and restaurant Financing resources: Public funding by the municipality of Umeå

1) Short description of the pilot project

In 2020, Umeå region aims at being world leading in sustainable building in cold climate. This and the EPBD were driving factors for the City of Umeå for developing a lighthouse project in building the northernmost certified passive house. The building is in addition BREEAM-certified, a unique combination so far in Sweden. The project was developed together with the municipal operator to suit for their Reggio Emilia inspired education. The use of ecological, nonpoisonous building materials was decisive as well as long-living building and easy to change appliances. Resource-efficiency was highly prioritized and the target was to create a building with a negative CO_2-balance in a 50-year-lifecycle. 4 options of building design have been tested with LCC method, resulting in a concept which meets the following criteria:

- Specific space heating demand ≤ 15 kWh/(m2,a)
- Total specific primary energy demand ≤ 120 kWh/(m^2a)
- -87% reduction of heating demand and -80% of total energy demand compared to building code
- Airtightness Pressure test result, n50≤ 0.3 h^{-1} or 0,15 l/(sec, m^2)

Expected lessons to be learned

- How to implement political decision on sustainability in reality.
- Giving input to a process in defining national criteria and rating systems for sustainable buildings, not at least linked to possible funding mechanism.

The building was completed in September 2014 and is in regular use since that.

2) Quality of location and facilities (new buildings only)

Hedlunda preschool is situated on a municipal lot, distance to the city center about 1km. The new building is replacing an old one, thereby not leading to additional soil sealing. The area is well connected and easily accessible by sustainable transport modes (cycling, public transport).

3) Process and planning quality

a) The process started with a 2-step architect competition in 2011, in which one part was about planning a certified passive house. No more environmental targets and goals have been set in the competition.
The winning SWECO concept included already the use of renewable nonpoisonous building materials, meeting sustainable certification criteria and a zero-energy-concept.
The concept has been optimized in a step-by-step process together with the responsible municipal departments which resulted in a decision to go for a flagship project and the use well-known international certification systems.

b) Objectives for energetic measures
Accordingly to the Passive House Certification criteria for

- Specific space heating demand ≤ 15 kWh/(m^2/a)
- Total specific primary energy demand ≤ 120 kWh/(m^2/a)
- Airtightness Pressure test result, n50≤ 0.6 h^{-1} (here n50≤ 0.3 h^{-1} or 0,15 l/(sec, m^2)

All energy calculations have been done using the Passive House Planning Package (PHPP) which is the key design tool used when planning a Passive House and as such, serves as the basis of verification for the Passive House Standard.

c) Standardized calculation of economic efficiency

4 different types of buildings, from standard/building code going to the most ambitious passive house design have been calculated with LCC method, while using the following basic parameter:

- Price district heating: 0,5 SEK/kWh
- Price electricity: 0,8 SEK/kWh
- Increase energy price per year 5%
- Interest rate 4%
- Timeline 50 years

The calculation showed that the international passive house design had the lowest lifecycle costs.

d) Product management - use of low emission products
All building materials have to fulfill the following limits for emissions to air:
TVOC according to EN 16000-5/6/9 < 300 µg/m3
VOCaccording to EN 16000-5/6/9 < 100 µg/m3
Formaldehyd according to EN 16000-2 < 48 µg/m3 = 0,048 mg/m3 = 0,04 ppm
Radon < 50 Bq/m3
CO_2 < 900 ppm
All building material is documented in a digital register including type, name, producer, content, delivery note and where used. Beyond, a complementing list of which materials are not allowed has been developed and was in use during the whole building process.

e) Planning support for energetic optimization
All energy calculations have been done with the Passive House Planning Package (PHPP).
There was a space allocation plan for the project (which also was used as tabulation for all building materials).
Part of PHPP is to take into account of all internal heat gains, passive solar gains, thermal bridges and more.
Part of the planning process was to develop an air tightness concept with detailed drawings and material recommendations. There was also a training of construction workers carried out as the airtight layer was practiced. Two Blower Door tests together with infrared thermography were carried out.

f) Information for users
Under the whole planning process every two weeks meetings were held with the project-, building- and the kindergarten management. All of them have been involved in the process concrete regarding the overall concept, the floor plans, the function of the building and the selection of materials and equipment.
A large display in the entrance area shows the current and the average annual energy consumption. An alarm bell sounds in the school kitchen when the present power consumption of the kitchen appliances exceed the calculated power consumption.
One part of the BREEAM certification was the creation of a user manual for all of the users.

4) Energy and Utilities

a) Specific heating demand:
Accordingly to the Passive House Certification Criteria:

- Specific space heating demand ≤ 15 kWh/(m^2/a)
- Total specific primary energy demand ≤ 120 kWh/(m^2/a)
- Airtightness Pressure test result, n50≤ 0.6 h^{-1} (here n50≤ 0.3 h^{-1} or 0,15 l/(sec, m^2)

b) Specific cooling demand
There is no cooling demand because of the temporary exterior sun protection with external venetian blinds. As a heat shield in the summer and additional insulation in the winter, the external venetian blinds improve the energy balance of building.
The adapted automated slat control ensures that external venetian blinds meet the requirements for energy efficiency class A.
Additionally, there is a bus-system that coordinates the sun shading systems, ventilation, heating, with each other to be able to react effectively to external weather influences. An ice and a direction depending wind monitoring system exists as well.

c) Specific lighting demand
Demand controlled LED lights with daylight- and occupancy sensors which are cooperating with the exterior venetian blinds with concave light control slats.

d) Primary energy demand
Total specific primary energy demand ≤ 120 kWh/(m^2/a)
Reduced primary energy demand through following measures:

1. Heating demand max. 15 kWh/(m^2/a) = international Passive House standard.
2. Controlled ventilation units with sensors for humidity, VOC, CO_2 and temperature.
3. Avoidance of cooling demand through temporary sunshade systems, naturally night ventilation concept.
4. Reduced use of electricity for artificial light, pumps and fans.
5. Reduced use of hot water and losses from the hot water circuit.
6. Use of the return water from the district heating grid.
7. Connection to the district heating grid using a CHP system (combined heat and power system), PEF between 0,8 (personal research) and 0,26 (data from Umeå Energy).
8. District heating system uses 48% biomass and 38% waste as fuel.
9. Energy-saving trough professional low-energy kitchen equipment and reuse of the waste heat from fridge and freeze storage rooms.

e) Renewable energy
District heating from renewable fuel in combination with use of return district heat water.
In addition waste energy from the food cooling and freezing units of the restaurant and kitchen is used.

5) Health and Comfort

a) Thermal comfort in summer
Good thermal comfort in summer is guaranteed by

- Use of exterior temporary sunshade systems.
- The ventilation system sucks in fresh air on the cool north side.
- A naturally ventilation system strategy to cool the building by night in summertime.

b) Ventilation – non energetic aspects
Part of the sustainability and quality program of the project are these sound pressure levels (a control of the system was carried out before the building was handed over to the users):
LA,eq < 30 dB (A) Kindergarten group rooms
LA,eq < 25 dB (A) Rest rooms
LA,eq = effective sound pressure.

6) Building materials and constructions

All building materials have to fulfill the following limits for emissions to air:
TVOC according to EN 16000-5/6/9 < 300 µg/m3
VOC according to EN 16000-5/6/9 < 100 µg/m3
Formaldehyd according to EN 16000-2 < 48 µg/m3 = 0,048 mg/m3 = 0,04 ppm
Radon < 50 Bq/m3
CO_2 < 900 ppm

All building material is documented in a digital register incl. type, name, producer, content, delivery note and where used. Beyond, a complementing list of which materials are not allowed has been developed and was in use.
Furthermore it was not allowed:
To use HFC´s in the production process of XPS insolation under the ground slap.
To use insolation panels with brominated flame retardants.
To use PVC pipes for wastewater and conduits.
To use refrigerants with ODP > 0 and GWP > 5 in cold storage systems.
All chiller, freezer, cooler in the professional kitchen use as an environmentally friendly refrigerant CO2.

a) Avoidance of PVC

- It was not allowed to use PVC pipes for wastewater and conduits.
- No floor coverings were used. Instead use of linoleum, wood parquet and tiles.
- Certified Passive House windows, doors and curtain walls are made of wooden frames with aluminum cladding.
- The exterior venetian blinds are made of aluminum.
- Ventilation pipes are made of galvanized sheet metal.

b) Ecological optimization of building materials

All materials needed an EPD, a sustainable certificate and a report of emissions. The variety and numbers of materials has been reduced and renewable, emission free building provisions produced as near as possible to the building site were preferred. The results of comparative LCA lead to the use of:

- Wooden beams
- Cellulose insulation (without Borax)
- OSB 3 panels without Formaldehyde
- Wood fiber insulation boards
- Ceilings with glued laminated timber
- Glued laminated timber for bearing construction
- Linoleum floors
- Wooden parquet
- Wooden panels
- Wooden frames for doors and windows
- Paintings with very low emissions

7) Test of special methods (renovation only, if applicable)

N.A.

8) Service Package

Nenet was cooperating with the responsible architect Thomas Greindl and offering service and support following the structure of the service package. This means in practice that the standard was more or less the same as in the service package regarding moduls 2-5. Certification as Miljöbyggnad Guld and passive house following PHI criteria secured a high level of quality.

9) Deviations from implementation plan

No deviations from the implementation plan occurred.
The building construction outclasses all MountEE-criteria for MountEE pilot buildings: energy performance, building materials etc.

10) Lessons learned and proposed improvements

1) It is possible to build certified Passive Houses in the cold climate of North Sweden. This is of high importance for the ongoing discussion in Sweden how to implement the EU building directive in Sweden. E.g. the national Swedish building authority Boverket is arguing that the current building standard in Sweden (e.g. 130 kWh/m2/a for Northern Sweden) is in fact already what should be seen as NZEB standard for (North) Sweden.

2) The use of the LCC method was crucial for the success of the project. The cooperation between the architect and Umeå municipality was very fruitful and even the involvement of stakeholders and future users was an essential part of the project work.

3) A lot of communication and information activities were carried out from the very beginning of the planning work. The project was seen as a lighthouse project for Umeå municipality from a very early stage of the planning process.

4) The procurement of ecological and low-energy building materials was decisive for the success of the project and sometimes a real challenge.

11) Next step and follow up

The project is together with other pilot projects of high importance for the ongoing discussion in Sweden how to implement the EU building directive in Sweden and as a consequence for how NZEB building criteria will be defined in Sweden.
A follow-up project on how to on a broad scale introduce a support and consulting structure which is based on Vorarlberg´s Service Package" is under preparation.
The network of Swedish regional Energy Agencies is going to strengthen the position as leading expert group and capacity building structure for sustainable building in Sweden.

Further support for the pilot project:
1) Sharing information with County Council building team, e.g. from WP2 Best Practice examples and other lighthouse constructions;
2) Facilitating continuously exchange of information with MountEE Regional Cooperation Committee;
3) Further capacity building for staff, building company and project leaders following concrete demands from the pilot;
4) Coaching and consultancy on concrete questions and problems
5) Offering contact and network for discussion questions and experience exchange with international experts;
6) Evaluation of actual project and compiling lessons learnt;
7) Documentation of building process in terms of sustainable building and publishing of results.

Evaluation process:
According to the joint evaluation guidelines and using interviews with the involved parties in the project as well as the continuous discussion of the project by the RCC.

9) Contact project owner

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Umeå municipality property management
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10) Add Logo and 2-3 pictures or diagrams if appropriate!

Umeå kommun

Umeå municipality