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:
Renovation Vuollerim 6000 museum

Region / local area where the pilot is situated
Norrbotten County, Sweden

Monitoring and evaluation report submitted by:
Nenet Norrbotten Energy Agency

Type of building:	Kind of public use: Museum with complementing activities in the field of tourism Total effective area: 457 m2 (info-byggnad), 417 m2 (verkstad) Number of levels above earth: 1 Source of energy for heating: Electricity Type of heating system: Heating by electricity Type of water heating system: Electricity Type of ventilation system: Time controlled.
Owner of the building:	Name of owner: Municipality of Jokkmokk, economic association Vuollerim 6000. Date of construction/renovation: 1965, 1990, 1994 Total cost: renovation project, 90 000 € Financing resources: public financing local and regional.

1) Short description of the pilot project

- Voullerim6000 is a local museum, and consists of two buildings. The main museum is built in 1989/1990 and is a freestanding building with one level, but with great ceiling height. The building itself was awarded the Swedish Wood Architecture Prize in 1992 for its outstanding use of wood.
- Due to historically low energy and specifically electricity prizes in Sweden, energy efficiency was not an issue when Voulllerim6000 museum has been built. An inefficient electric heating system, in which radiators are situated right below the roof, has been installed. Even hot water is produced by electricity. The steering system for the electric systems is not working well.

This is a renovation project with the following targets:

- At least -30% less heating demand;
- Heating more than 50% renewable; electricity more than 40% renewable
- Developing of a quality and environmental programme
- Test of special methods (LCC)
- Integration of users and staff, e.g. energy training

The planning process is completed, the construction phase has not started yet, planned to start 2015, completed latest spring 2016.

In what way does the building contribute to the municipality's building/energy strategy?

- The project is contributing to the municipality of Jokkmokk's SEAP (Jokkmokk is a signatory of the Covenant of Mayor and has adopted an energy and climate strategy including a 20% energy efficiency target until 2020.)
- The museum is owned by the municipality of Jokkmokk and the local cooperative is the tenant. The renovation project is a joint effort to develop sustainable tourism linked to the museum and to enable the cooperative to afford rent and operating costs in the long run.

Projected renovation program in detail:
Result of the feasibility study: heat pump using the lake water as heating resource leads to a saving of 90% in costs or from 76 MWh/year to 69 MWh/year for the heating, while at the same time the electricity demand for the pump leads to an increase of 3 MWh/year.
As the rooms are very high, ventilation systems will press down the warm heat so that is in the area where people are.
Other measures for energy efficiency, e.g. insulation, have been evaluated, but could not proof economy due to technical reasons.
LCC calculation methods have been used to proof profitability for the heat pump solution.
Users and staff have been trained on energy efficiency, and have been involved in decision making process.

Time schedule:
The museum was built 1989/90, Swedish Wood Architecture Prize in 1992 for its outstanding use of wood. Museum was taken over by a local non-profit organization in 2012, decision on renovation of building together with new-designing the exhibitions was taken in the beginning of 2013 - at the same time decision that the renovation project should become a MountEE pilot. Potential study including development of 5 different alternatives was completed January 2014. Negotiations with the County Adminstration Board regarding subsidies for the renovation are still ongoing. Implementation is scheduled for 2015-2016.

Expected lessons to be learned
Tourism buildings with high energy demand are still quite usual in Northern Sweden, and Voullerim6000 will be a model project for the whole region.

- Smart renovation of existing public buildings with direct electric heating for owners / tenants with limited budget.
- Agreements between owner and tenants on renovation process, costs and financing models.
- Development of an environmental and energy programme for a tourist building and integration of both staff and visitors

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

The museum building is located in the outskirts of the small village of Vuollerim (650 inhabitants), about 45 kilometers from the centre of Jokkmokk municipality. The distance to the regional capital Luleå is 125 kilometers.
There are bus connections to Luleå and Jokkmokk 3-5 times per day and in addition to the nearest railway station in Murjek. From Murjek there are direct (night)train connections to Stockholm, 2 train pairs per day.
The municipality of Jokkmokk is promoting walking and cycling (even winter time) as a part of SEAP implementation activities.

3) Process and planning quality

a) Decision making and determination of goals
Further development of Jokkmokk as a sustainable tourism destination is one of the key areas for the municipality as described in the long-term strategy document Jokkmokk 2015. The Vuollerim 6000 museum is owned by the municipality and a building worth to preserve due to its outstanding wood construction. However, energy demand and thereby energy costs of the building are high, and this makes it difficult for the tenant, the Vuollerim 6000 cooperative, to operate the building and to become profitable. Beyond, a building with such a high energy demand is in conflict with the targets of being part of a sustainable tourism program.

Therefore, an analysis of energy demand was conducted by consultant Schneider Electric, including:

- Visit of the building and interview of staff;
- Monitoring of ventilation and temperature;
- Analysis of energy / electricity demand over years/months and costs

Based on this analysis, a first set of measures with a payback-time of 5 years has been developed, incl.

- Change from electric heating to air to air heat pump
- Isolation of doors and windows
- Installation of water saving applications, e.g. aerator
- Optimization of monitoring for ventilation, temperature and lightning
- Isolation of roof for 2nd building

According to the preliminary calculation, this would have led to a reduction of energy demand by at least 30%.

A more concrete feasibility study showed, that the preliminary calculation on a reduction of energy demand by at least 30% were too optimistic. Together with the users, the new heat-pump solution based on heat from the nearby lake has been developed.

b) Objectives for energetic measures
s. above

c) Standardized calculation of economic efficiency
LCC was used in the second step of the feasibility study In addition even a simple payback calculation has been done for the different secanrios.

d) Product management - use of low emission products
The actual project is a renovation project with the target to reduce energy demand significantly with a simple set of measures that are economic even in a shorter period of time (5-10 years). According to MountEE pilot projects criteria that have been developed by Nenet and the RCC, the BASTA database was used when choosing building materials to avoid

environmentally hazardous materials. Optimization of ventilation will lead to better indoor-climate.

e) Planning support for energetic optimization

- An experienced consultant (Schneider Electrics) did a comprehensive energy mapping of the building incl. interviews with users/staff;
- MountEE partner Nenet, the regional energy agency, is in an ongoing discussion process with the municipality and the cooperative to plan and adapt energetic optimization measures including follow up and maintenance.
- Information for users and a training program on energy efficient and climate friendly behavior shall lead to the development of an environmental and energy program for Vuollerim6000, ensuring long-lasting effects of energy saving measures by involving users, but even visitors. This process is not completed yet.

f) Information for users

- Involvement of users is an important part of the concept. Users are both staff and visitors of the museum.
- A user manual will be developed, and staff meetings will be held.
- Probably, no detailed information on actual consumption will be given to staff or visitors, but information about the energy and environmental concept, energy efficiency measures and how users can contribute to a better energy performance.
- A monitoring to ensure that predicted values are matched will be in place.

4) Energy and Utilities

a) Specific heating demand

According to the MountEE criteria, the energy demand should be reduced by at least 30%. The following measures were planned, a more ambitious alternative for a higher reduction was added under the second phase of the investigation and planning process:

- Change from electric heating to air to air heat pump
- Isolation of doors and windows
- Installation of water saving applications, e.g. aerator
- Optimization of monitoring for ventilation, temperature and lightning
- Isolation of roof for 2nd building
- Installation of heat pump using water from a lake nearby as heating resource leads to a saving of 90% in costs or from 76 MWh/year to 69 MWh/year for the heating, while at the same time the electricity demand for the pump leads to an increase of 3 MWh/year.
- As the rooms are very high, ventilation systems will press down the warm heat so that is in the area where people are.

b) Specific cooling demand: no cooling demand.

c) Specific lighting demand
A new more efficient lighting system adapted to the museum's needs for a part of the building is a part of the renovation concept-

d) Primary energy demand: under investigation

e) Renewable energy
- Use of heat pump using water from nearby lake.
- Local electricity mix is 100% renewable (hydro).

5) Health and Comfort

a) Thermal comfort in summer
Due to the cold climate, no specific cooling needs even summer time.

b) Ventilation – non energetic aspects
No problems to be expected due to broad experience and market on high-quality heat exchanger.

6) Building materials and constructions

N.A.

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

- LCC method was used for second part of feasibility study.
- An environmental and energy programme was developed together with staff representatives and management.
- Energy efficient behaviour trainings for staff were carried out.

8) Service Package

Nenet is cooperating with Schneider Electric as consultant. The 5 different implementation concepts were developed in cooperation with Schneider Electrics and the local organisation that is responsible for the museum building and during the process some elements of the service package, mainly module 2 was used.
As the construction has not started yet due to ongoing discussions with the County Administration Board regarding subsidies for the renovation other parts of the service package were not used yet.

9) Deviations from implementation plan

It was quite difficult to secure funding for the planned investments. This is due to the fact that the building is owned by the municipality of Jokkmokk which lacks resources for implementing the investment in 2014/2015, while the hirer is a cooperative which just started its activities. The cooperative is planning to access funding for the investments on regional level, but failed in the first attempt. A new proposal was developed and is currently under investigation by the County Administration Board.

10) Lessons learned and proposed improvements

The low electricity price in Sweden which even went down the last year and seems to continue to do so, makes it difficult to show profit of energy efficiency investments without additional funding. There is no general funding scheme for local authorities nor for any other player on energy efficiency in buildings.
The involvement of users and staff has been very helpful, also in terms of choosing ambitious solutions instead of standard. The cooperative involved is focused on sustainable tourism and very interested in an innovative and ambitious solutions, and willing to raise private money.

11) Next step and follow up

Evaluation process:
According to the joint evaluation guidelines and using interviews with the involved parties in the Vuollerim6000 project as well as the continuous discussion of the project by the RCC.

9) Contact project owner

Vuollerim 6000
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10) Add Logo and 2-3 pictures or diagrams if appropriate!

JOKKMOKK

vuolle rim6000

Jokkmokk municipality

Vuollerim6000




Schneider Electric

LCC-analys för bedömning av livscykelkostnader

Grundläggande data	
Kalkylperiod (år)	20
Kalkylränta (procent)	3,0%
Årlig inflation (procent)	1,0%

Investeringsalternativ 1:	Alt1 Luft-VP
Investeringskostnad (kr)	441 799
Energipris (kr/kWh)	0,844
Årlig energiprisökning (procent)	4,0%
Restvärde (kr)	0
Årligt energibehov (kWh)	66 800
Årlig underhållskostnad (kr)	4 000
Övriga årskostnader (kr)	0

Investeringsalternativ 2:	Alt2 Sjö-VP
Investeringskostnad (kr)	810 577
Energipris (kr/kWh)	0,844
Årlig energiprisökning (procent)	4,0%
Restvärde (kr)	160 000
Årligt energibehov (kWh)	39 800
Årlig underhållskostnad (kr)	6 000
Övriga årskostnader (kr)	0

Investeringsalternativ 3:	Alt 2b
Investeringskostnad (kr)	725 696
Energipris (kr/kWh)	0,844
Årlig energiprisökning (procent)	4,0%
Restvärde (kr)	160 000
Årligt energibehov (kWh)	40 800
Årlig underhållskostnad (kr)	6 000
Övriga årskostnader (kr)	0

Investeringsalternativ 4:	Alt3 GSM
Investeringskostnad (kr)	169 695
Energipris (kr/kWh)	0,844
Årlig energiprisökning (procent)	4,0%
Restvärde (kr)	0
Årligt energibehov (kWh)	69 800
Årlig underhållskostnad (kr)	3 000
Övriga årskostnader (kr)	0

Investeringsalternativ 5:	Alt 3b
Investeringskostnad (kr)	70 467
Energipris (kr/kWh)	0,844
Årlig energiprisökning (procent)	4,0%
Restvärde (kr)	0
Årligt energibehov (kWh)	72 800
Årlig underhållskostnad (kr)	3 000
Övriga årskostnader (kr)	0

Befintligt system:	Bef
Energipris (kr/kWh)	0,844
Årlig energiprisökning (procent)	4,0%
Restvärde (kr)	0
Årligt energibehov (kWh)	90 800
Årlig underhållskostnad (kr)	3 000
Övriga årskostnader (kr)	0

Resultat	Alt1 Luft-VP	Alt2 Sjö-VP	Alt 2b	Alt3 GSM	Alt 3b	Bef
LCCenergi	1 403 518 kr	836 228 kr	857 239 kr	1 466 550 kr	1 529 583 kr	1 907 776 kr
LCCunderhåll	65 405 kr	98 109 kr	98 109 kr	49 054 kr	49 054 kr	49 054 kr
LCCtotalt	1 910 123 kr	1 475 294 kr	1 411 424 kr	1 675 274 kr	1 649 124 kr	1 956 830 kr