LOW EXERGY SYSTEMS IN EXISTING BUILDINGS – LOWEXX

This issue should actually be called LowExx news! The focus in this issue is on Low Exergy systems in the existing building stock. The existing building stock is very important to focus on, the renewal of the building stock is very slow and if we neglect the possibilities for Low Exergy systems in the existing buildings the total effect will not be as big as we hope for. There are special issues to concern when we are talking about applying LowEx systems in existing buildings, these will be reviewed on the following pages. A few examples are also presented, one example is a historical building with a cultural heritage, which means an even greater challenge.

Modern and medieval: heat pumps used in the historic Loevenstein castle in the Netherlands. In this medieval castle floor heating was applied without having to tear up the floor. A "dry mounting system" was used.

WHAT IS LOWEXX?

The first and most important step to use renewable, and energy efficient (low valued) heat sources is to moderate temperatures in energy systems. In buildings this means that emission systems for heating and cooling should be suitable to utilise medium-temperatures, close to room temperature (i.e. relatively low temperatures for heating and relatively high temperatures for cooling)

These so called Low Temperature Heating and High temperature Cooling systems, allow the use of low valued energy and they are very exergy-efficient, from a thermodynamical point of view. For that reason, these systems are often referred to as Low-Exergy systems, or simply LowEx-systems.

When we are talking about the possibilities of LowEx-systems in the existing building stock – we can talk about LowExx (**LowEx**ergy in e**x**isting buildings).

OPPORTUNITIES AND THREATS
FOR LOWEXX SYSTEMS

The age of the building is not such an important issue when considering the possibilities for applying LowEx systems. The important aspects are the degree of protection of the building, the building type, scale of renovation, replacement of installation and the type of LowEx system to be applied.

A good timing is very important when trying to market LowEx systems. When a renovation is done anyway, it is much easier and cheaper to install a new heating/cooling system than if you start a whole renovation just to change the system. In residential houses, it is very common that when the house owner changes, some renovation is done. Therefore some marketing of LowEx systems should be made at the time of the purchase of the house.

Even though the low temperature heating systems are great systems with lots of advantages, we need to keep in mind that when talking about retrofits there are some technical limitations. In old houses the walls aren't always that good, we can be talking about really lousy U-values! If this is the case, floor heating isn't efficient enough to fill the heating demand. The exergy analysis tool developed in the Annex 37 group helps us with this problem. It calculates whether the system is efficient enough to heat the house. Another problem could be that we can't make the floor any higher than it is.
For this problem, there are floor heating solutions with very thin constructions, a bit more than 2cm for the whole construction.

We can see that there is still much research to be done in this area. The potential, however, is huge so it is clear that this effort is worthwile. ■

OPPORTUNITIES AND THREATS

Reasons for applying LowExx:

- Esthetical
- Comfort/improved indoor climate
- Conservation of cultural heritage
- Lower energy use
- Use of renewable energy
- Energy efficiency
- Integration of heating and cooling systems.

Limitations/Threats for applying LowExx:

- Low price of fossil fuels, low electricity prices
- Availability on the market/market price
- No checking of regulations
- Comfort criteria isn't that high in existing houses as in new ones
- Stick to tradition
- Lack of knowledge

Opportunities for applying LowExx:

- Large scale renovation: combination with other measures:
  - acoustic matters
  - upgrading the building or a part of the building
  - more luxury
- Cooling can be added
- Improving indoor climate
- Adjusting office to modern IAQ standards: increased productivity of employees
- Moisture problems-protection of art work, preventive conservation
- Extended use of the building
- Flexibility
  - CO_2 potential
  - uncertainty of energy prices
- Awareness is raising
- Energy Performance Standard (EPS) based on primary energy

Paul Ramsak, Novem, The Netherlands and
Åsa Nystedt, VTT Building and transport, Finland

The Parish church, St. Martin in Teharje, Slovenia.

"Temperisation" heating system. Copper pipes built in the wall around the door.

Most of the buildings, representing cultural heritage are not equipped with technology for temperature or humidity conditioning, according to modern standards. Churches, with its high space, big mass of the walls and intermittent use represent a special case regarding heating system.

The regular visitors require heating of the churches during rituals. Minimum indoor temperatures should not be lower that 8 to 12°C. Sensitive objects of art inside churches require minimum temperature and humidity oscillations, low air velocity and low dust circulation. Relative humidity must be between 60 and 65%. Heat is needed in the lowest two meters of the space. Hot air, which tends to move under the ceiling causes higher energy losses, so the way of energy transport from the source to the people is very essential. Warm air with higher relative humidity and cold walls often cause condensation on the walls and other cold objects causing damage.

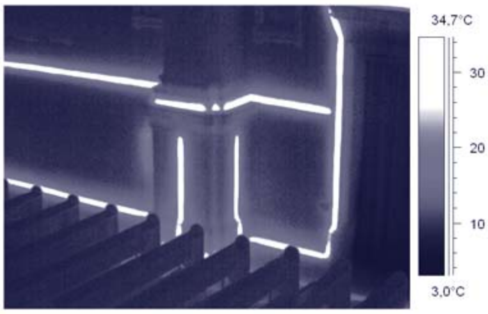
"TEMPERISATION" – A HEATING SYSTEM SUITABLE FOR CULTURAL HERITAGE

The system of temperature control of walls, columns and other parts of the building structure was developed in Germany in the 80s, where it is called "temperierung". It was intended for protection of the walls against ground water and at the same time for maintaining temperatures and humidity in the room constant as much as possible. The system should be simple for installation, cost effective and energy efficient. The system is composed of soft copper pipes built in the walls, main pipes, connecting single heating loops, heat generator, safety appliances and regulation.

The principle of connecting building fabric and heating installation into one unit is known from the Roman times as hypocaustic heating. Heat distributed to the wall from the pipes raises the temperature of the wall, causing radiative heating of the objects in the room without air as a medium of heat transfer. This way circulation of the air and dust is reduced. Wall temperature is in the same range as air temperature, preventing moisture condensation on the surfaces. Temperature of the walls is kept constant during the whole year, reducing the capillary transport of moisture in the wall and causing the walls to dry out.

THE PARISH CHURCH, ST. MARTIN IN TEHARJE, SLOVENIA

The parish church, St. Martin in Teharje, Slovenia was constructed between 1906 and 1907 above the village on the place of an older church from the 17th century. The heated volume of the church is 7700 m^3. The walls inside are painted with ornaments and paintings in fresco. The heating capacity of the boiler is 60kW.



The picture on the right is a thermographic picture, the picture further left is from the same place. In the thermographic picture we see where the copper pipes are installed and what temperatures we have in the surroundings of the pipes.

The boiler house with two boilers is located in the church and is designed for heating the church and the priest's house with classrooms. The boilers are fired with light fueloil. Operating water temperatures are 90/70°C. Control system reduces temperatures for the church heating to 50/43°C. A standard heat meter is installed to measure the heating energy distributed to the church.

1254 m of coated copper pipes were installed inside the walls at three different heights. The lowest level, close to the floor, is most important because of its double role: wall drying and heating. The pipes at other two levels provide only heating.

Measurements were done in the church to get information about the system. The temperature was measured on over 20 locations along with moisture measurements in the wall and humidity of indoor air. The first results of temperatures, humidity and moisture in the walls show that the indoor temperatures were always above 10°C and they vary very slowly regarding the variations of outdoor temperature, the surface temperature of the wall is in the range of the air temperature and in the region where the pipes are built-in it is up to 25°C. The relative air humidity in the cavity in the wall in the height of approx. 50cm was reduced from 88 to 76% after the first heating season while at the ground level it remained 100%. A progressive reduction of these parameters is expected during consecutive heating seasons.

Velocity of the air movement inside the church caused by the heating system is under 0,5 m/s, so there are practically no problems with dust deposit and unpleasant microclimatic conditions, like drought. The energy use is lower compared to buildings of similar type and size with radiator or convective heating system.

In beautiful churches like this any major renovation is out of the question due to a high protection standard.

Matjaz Malovrh, Miha Praznik, Miha Tomsic, Marjana Sijanec Zavrl, OPET Slovenia

Tax office in Arnhem, the Netherlands where a LowEx system is being planned.

This building, owned by the government, is approximately 30 years old and will be renovated. The Dutch Ministry of Housing, Spatial Planning and the Environment has committed itself to realising energy savings in as many government-owned buildings as possible. Also for the renovation of this building, energy saving and sustainable building were important basic principles.

One of the starting points of the renovation of the installation is that, besides heating, also cooling is needed. In the original building there was no cooling, and it turned out that there was very little space to add it. This resulted in the choice of a climate ceiling in which heating and cooling are integrated. A climate ceiling needs no big air supply system but uses water as transport medium.

A climate ceiling is by rule a low temperature heating and a high temperature cooling system. A low temperature in the ceiling while heating is necessary to avoid problems with radiance a-symmetry and temperature stratification. A high temperature of the ceiling while cooling is necessary to avoid condensation problems.

At this moment replacement of the central heating boilers is not planned, but in a few years it will be necessary. Another reason to choose for a low temperature heating system now was to make it possible to change over to the application of renewable energy sources when replacing the boilers. ■

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Novem Netherlands Agency for Energy and the Environment, The Netherlands

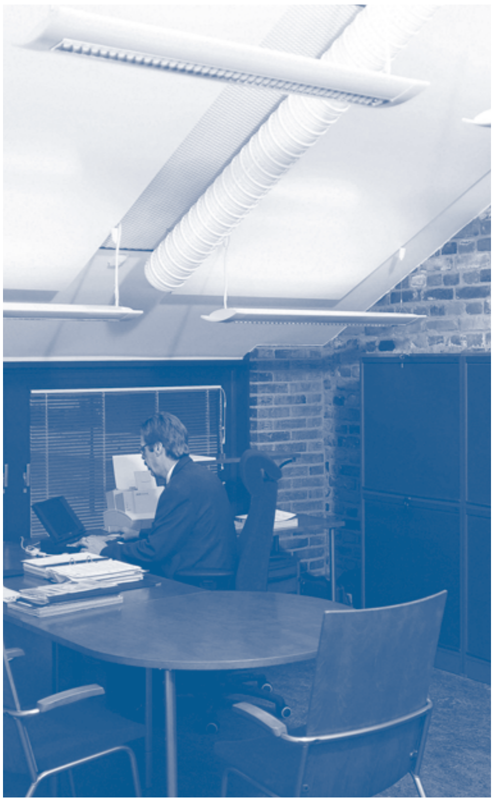
THE BLOMSTEDT HALL
JYVÄSKYLÄ, FINLAND

The Blomstedt hall is an old plywood factory. It was built in 1912 and was renovated in 2000. It is situated in an old industrial area in Jyväskylä, Finland. The building has 2000 m^2 of floor space on 2 storeys. The volume is 2200 m^3. There are 6 businesses on first floor and office space on second. The building has been occupied since November 2000. The only thing that is left of the old plywood factory is the original brick facade of the building with a special rose window and ten steel roof trusses. They are integrated in the new building as a reminder of the old architecture and construction tradition.

Water is circulated in the ceiling panels to heat or cool the rooms in the building. The heat transfers mainly through heat radiation. Each room has individual control for temperature. The panels are also used as a reflecting element for the indirect lighting.

The heating and cooling to the building is supplied by a Sensus® system. Sensus® is the name for an integrated building services product, which includes the design and installation of systems for heating, cooling, ventilation, electricity, lighting, fire protection, water and sewage. The Sensus® system uses primarily the waste heat from the building for heating. When additional heating is needed, it is delivered with a heat exchanger from the district-heating network. Cooling is primarily delivered by free cooling. When this is not enough, the system uses vapour compression chillers to cool the cooling water.

The building automation system plays an important part in energy management of Blomstedt Hall. A LonWorks® based distributed system controls the room temperatures and lighting. There is a demand controlled ventilation system (Nemus®), which maintains the duct pressures at an optimal level. The automation system is controlled by both temperature and occupation sensors. ■



The ceiling panels used for both heating and cooling in an office in Blomstedt Hall.

Åsa Nystedt, VTT Building and Transport, Finland

THE MARKET SITUATION
IN DIFFERENT COUNTRIES

The application of Low Exergy systems is far more common in new buildings than in existing buildings. For example in The Netherlands and in Norway it is more or less common practise to install low temperature heating- or high temperature cooling systems in new residential buildings.

For existing residential buildings it is more of an unknown concept but the trend is, however, positive. In Japan and Canada there can be found hardly no cases with low exergy systems installed in existing residential buildings. The situation is somewhat the same for non-residential buildings. For these types of buildings, LowEx systems don't seem to be as common in the new building stock, as for residential buildings. Table 1 summarises the market situation in 9 different countries. The more crosses, the more common are LowEx systems, a star indicates a positive trend. Please note that information for this table has been collected through discussion with a few people from each country, it should therefore be considered a bit ambivalent. ■

Åsa Nystedt, VTT Building and Transport, Finland

FOLLOWING NEWSLETTERS

LowEx News no 7

The Newsletter no 7 will include technical presentations of different system concepts. It will be published in the spring 2003.

LowEx News no 8

The Newsletter no 8 will be the last newsletter of this Annex. It will be published in the autumn 2003.

NEXT MEETINGS OF ANNEX 37

Seventh Expert meeting

Seventh expert meeting will be held 14–16.4.2003 in Yokohama, Japan.

Eight Expert meeting

Eighth expert meeting will be held 11–13.9.2003 in Kassel, Germany.

Final Meeting

The Final Meeting of Annex 37 will be held in January 2004 in Lappland, Finland.

ANNEX 37 WEBSITE

HTTP://WWW.VTT.FI/RTE/PROJECTS/ANNEX37/

On the Annex 37 website we have collected information about Annex 37: background, objectives and working methods as well as information on participants, meetings and publications. The website is updated continuously, so the latest information will always be found on the website. There you can find the

- Contact information
- Status reports
- Previous issues of LowEx News (in pdf format)
- Technical Presentations about Annex 37 issues in ECBCS ExCo meetings
- Links to other useful sites

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Table 1: Summary of the market situation in different countries. The more crosses, the more common are LowEx systems, a star indicates a positive trend.

	FIN	S	N	NL	D	F	Jp	I	CAN
Residental									
new	XX	X(X)	XXX	XXX	XX*	XX	X*	X*	X*
exist.	X*	X*	X*	X*	X*	(X)*	–*	(X)	–*
Non-Residental									
new	XX..	XX	X	XX	XX	X	X	?	X*
exist.	(X)*	X*	–	X*	(X)	(X)*	X*	X	–*

FIN = Finland, S = Sweden, N = Norway, NL = The Netherlands, D = Germany, F = France, Jp = Japan, I = Italy, CAN = Canada.

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Annex 37

LOW EXERGY SYSTEMS FOR HEATING AND COOLING OF BUILDINGS

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