IEA ECBCS ANNEX 37

LOWEX NEWS NO 3 WITH CASE EXAMPLES

This is the third issue of LowEx News, the biannual newsletter of Annex 37 'Low Exergy Systems for Heating and Cooling of Buildings'.

During Annex 37 the participants are trying to promote the rational use of energy by means of facilitating and accelerating the use of low valued and environmentally sustainable energy sources for heating and cooling of buildings. There are participants from ten countries (see last page).

The main product of the Annex will be a Design Guidebook for designers and architects. Other products will include technical reports and conference papers, national and international industrial seminars and a website with all the information about the Annex.

In this issue of LowEx News we will introduce some of the demonstration buildings of Annex 37. These examples will show how the wide variety of available low temperature heating and high temperature cooling techniques can be compiled as systems. The examples also demonstrate the flexibility of low exergy systems with respect to the energy source. There are systems that use waste heat from industry, solar heat, ground heat and cold, district heat as well as electricity or gas.

Sibelius Hall in Lahti, Finland, one of the demonstration buildings of Annex 37. See more on page 4.

CENTRE FOR SUSTAINABLE BUILDING (ZUB)

The Centre for Sustainable Building in Kassel, Germany.

This office building is situated at the University of Kassel in an urban neighbourhood. The ZUB (Zentrum für Umweltbewusstes Bauen) office building is attached to an existing preserved building and consists mainly of three different parts: One for exhibitions and events, one for offices and an experimental part for different kinds of research in building technologies and services concepts.

Location:	Kassel, Germany
Building type:	Commercial
Floor area:	1000 m²
Emission system:	Floor heating/cooling
Heat source:	District heating
Cold source:	Ground cooling

ENERGY CONCEPT

Major aims in the planning and construction process in the energy field were:

- Annual heating energy consumption less than 20 kWh/m².
- Extensive natural ventilation and natural lighting of the rooms.
- Good thermal and indoor comfort. Utilisation of passive solar gains.

The energy demand is reduced by using energy efficient building materials. The U-value of the exterior walls is 0.13 W/m²K and the U-value of the triple-glazed windows, which mainly face south, is 0.7 W/m²K. A minimal frame-fraction on the total window area helps to reduce heat losses.

To monitor the aims and to verify the concepts and achievements an intensive research and measurement project is currently running.

HEATING AND COOLING

To achieve heating and cooling of the offices with one system only, a hydronic conditioning system with embedded pipes was chosen. For the heating case, the system works with low inlet temperatures. The building is connected to a district heating system. If cooling is necessary, coils in the floor slab construction of the cellar will cool the water. Ground cooling is utilised and mechanical cooling equipment is not needed.

The concrete floor slabs are thermally activated and, in addition, a conventional floor heating system is installed on top of them. Since each room has its own heating circuit, individual regulation of the thermal conditions is provided. Normally the systems are operated with a low constant inlet temperature, using the self-regulation effect of the system.

VENTILATION

To reduce ventilation heat losses, mechanical balanced ventilation with heat recovery is installed. The air flows are regulated via indoor air quality sensors. Natural ventilation of the office rooms is also possible.

CLIMATE WALL

There is a clay wall, made from massive clay bricks, in the centre of the building, which extends over all storeys. This wall with its great heat capacity and with its capability to damp fluctuations in humidity can be seen as a climate wall.

BUILDING MANAGEMENT

The building is equipped with a building management system. All building service functions are controlled and the components like ventilation equipment are regulated. Furthermore, energy management systems for buildings are going to be developed and tested.

INTEGRAL PLANNING

For the ZUB building, all planning was done with participation of designers from all related fields. Already in the first planning stages, design decisions could be optimised with regard to the energy demand of the building and the total environmental impact of the building. Through that integral planning process, a well balanced building design with respect to architectural, technical, economical and energy aspects was achieved. ■

Dietrich Schmidt
KTH – The Royal Institute of Technology, Sweden

ART MUSEUM

This four storey building has a double skin external envelope with an outer opened glass wall. The cooling system had to be designed to bear the load of 250 people that were assumed to attend an art opening and occupy one room (floor) for the first hour and then be distributed on all floors for the next two hours.

Location:	Bregenz, Germany
Building type:	Commercial
Floor area:	2800 m²
Emission system:	Wall and ceiling heating and cooling
Heat source:	Gas boiler
Cold source:	Ground cooling

SPECIAL REQUIREMENTS

For protection of art, other indoor requirements are needed for a museum than for an office. Especially the rate of temperature and humidity changes may cause damage to art. The design values for room temperature and humidity are: summer 22-26 °C/ 52-58 % and winter 18-22 °C / 48-54 %.

COOLING CONCEPT

The main objective of this project was not the phase shift of the cooling into the night hours. On the contrary, as the freely available cooling potential of the groundwater is always accessible and the phase shifting would cause temperature swings with too large amplitudes, therefore the cooling is applied over the entire day. The cooling medium is a water circuit embedded in 24 posts 18 m deep into the ground with large layers of groundwater.

VENTILATION

All the exterior walls of the building are equipped with plastic pipes and exterior insulation to completely cut the connection with the exterior climate. The only connection is through the outdoor air supply. The incoming air will be supplied to the building at a constant temperature and humidity through displacement ventilation slits. During the year, the concrete core temperature can be controlled according to the seasons. However, during peak times such as exhibition openings, it is planned to switch the supply air set points to a lower level.

The art museum in Bregenz, Germany.

HEATING AND COOLING

Important for the design of the heating/ cooling system and the air system was an accepted room temperature of 18 °C in winter and that the temperature in summer during an art opening may increase up to 28 °C. The first control concept is to control the water temperature at 22 °C, summer and winter. If the room temperature in winter drops below 22 °C the system heats and when in summer the room temperature increases above 22 °C the systems cools. In zone 1 the heat from people is removed by the pipes embedded in the walls and in the concrete slabs (floors). The energy for cooling is supplied alone by the heat exchange between the pipes embedded in the foundation pillars/walls and the ground. The heating is provided by a gas boiler.

HUMIDITY

Significant for the control of the relative humidity was the split into two zones and the low air change rate (750 m³/h). The sensible heat from the sun and the artificial lighting is removed by the cooled slab and the exhaust air in zone 2. In this way it will not dry out the air in zone 1 where the art exhibition is. The low air change rate in zone 1 would in wintertime, with the dry outside air, only have a small effect on the relative humidity in the building. Also the fact that people do not only heat up a space by their sensible heat loss, they also increase the absolute humidity by the latent heat loss, which will result in only minor variations of the relative humidity. ■

Bjarne Olesen
Wirsbo-VELTA GmbH & Co. KG, Germany

SIBELIUS HALL

The concert hall of Sibelius Hall in Lahti, Finland.

Location:	Lahti, Finland
Building type:	Commercial
Volume:	90 000 m^3
Emission system:	Air heating and cooling
Heat source:	District heating
Cold source:	Waste heat from industry via district cooling system

Sibelius Hall is the largest wooden building constructed in Finland for over one hundred years. The large complex (nearly 90 000 m^3) is a congress and concert centre and includes the main hall (1250 seats), forest hall (1000 m^2 lobby), a renovated carpentry factory (1400 m^2 for exhibitions and meetings) and lecture rooms.

WOODEN BUILDING

Wood has always been a popular building material in Finland, both inside and outside. The Sibelius Hall was however a big effort to develop the timber construction technology even further. The building contains many special wooden elements and new solutions. For example the facades of the congress and concert hall are made of sand filled wooden elements and glass (see front page). Recent research in Finland has shown that wooden materials have a positive effect on indoor climate and comfort.

THE BUILDING SITE

The Sibelius Hall was built at exactly the same location, where industrial woodworking originally started in Lahti, in the neighbourhood of the harbour by Lake Vesijärvi. It is here the first steam sawmill was established in 1869. In the harbour there is also a railway station. After more than 100 years of serving the industry, the harbour has now been transformed into a leisure resort.

HEATING AND COOLING

The building is cooled and heated with a ThermoNet® system, which is an integrated system concept for air handling, heating and cooling. It operates at low temperatures for heating and high temperatures for cooling. The energy to the Sibelius Hall is delivered by district heating and district cooling networks. The energy source for cooling is the local industry process water via absorption chillers. Waste heat from the system is recovered to the district heating return.

ACOUSTICS

A lot of attention is paid to the acoustics of the main hall. The materials and even the furniture are chosen bearing in mind their effect on the acoustic qualities of the hall. In this kind of environment it is also very important that the cooling system is silent. The echo chambers at the sides of the hall with their doors and curtains make the acoustics of the hall adjustable. ■

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BLOMSTEDT HALL

This plywood factory was built in 1912 and was renovated in 2000. It is situated in an old industrial area. The building has 2000 m^2 of floor space on 2 storeys. There are 6 businesses on first floor and office space on second. The building has been occupied since November 2000.

THE OLD BUILDING

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.

CEILING PANELS

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

The interior of the second floor of Blomstedt Hall in Jyväskylä, Finland.

Location:	Jyväskylä, Finland
Building type:	Commercial
Floor area:	2000 m^2
Emission system:	Ceiling panels
Heat source:	District heating
Cold source:	Electricity

HEATING AND COOLING

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.

BUILDING AUTOMATION

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.

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KIINTEISTÖ OY KÄRRYKARTANO

The idea in this case example is the combination of solar collectors and ground heat for heating a group of attached houses. There are 15 dwellings in four single-storey buildings. The houses have been inhabited since August 2000.

The Kärrykartano residential dwellings in Kurikka, Finland.

Solar and ground heat sources are combined to heat the Kärrykartano area.

HEATING

Heat is extracted from five wells that are 80-100 m deep in the ground and 32 solar collectors situated on the roof of one of the buildings and distributed in the dwellings by floor heating. Between these two circuits, there is a group of heat pumps. The system is controlled with different strategies depending on the time of the year. With this system, the efficiency of the solar collectors and the coefficient of performance of the heat pumps will be higher than normal.

SOLAR HEAT IN FINLAND

There is a lot of solar heat available in Finland during the summer, when the heating load is not so large. During the spring and autumn there is a lot of radiation, but the heat losses of the traditional solar heating systems are substantial due to the large temperature difference between the collector and ambient air. The efficiency of the solar collectors will improve, if they can be operated at a lower temperature level. This is why the Hot&cold system concept in the Kärrykartano area will increase the efficiency of the solar collectors during spring and autumn.

TEMPERATURE LEVELS

Since a high temperature level is only needed for DHW, it is unnecessary to heat all of the water to the same temperature. The water needed for the floor heating can be distributed at lower temperature level.

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Location:	Kurikka, Finland
Building type:	Residential
Floor area:	825 m^2
Emission system:	Floor heating
Heat source:	Ground heat pumps and solar

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THIRD EXPERT MEETING OF ANNEX 37
HAMBURG, 26TH-27TH MARCH

The Third Expert Meeting of Annex 37 was held in Hamburg, Germany on March 26th to 27th, 2001. It was hosted by Wirsbo-VELTA GmbH & Co. KG. It was attended by participants from Canada, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Sweden and Switzerland. The meeting consisted of technical presentations and working sessions to review the work of the Annex.

At the meeting Carey Simonson reported of the general status of the Annex. Official participation of Denmark is likely not possible, but they hope for close contact. At the Tokyo meeting the ExCo members had approved the Finnish suggestion, that Carey Simonson would act as the Operating Agent. Annex 37 was presented in the joint meeting of ECBCS and ECES (Energy Conservation by Energy Storage) implementing agreements. Several ECES Annexes expressed their interest in Annex 37 work. As a result the "Low Exergy Concepts and Technologies" database was sent for comments to ECES OA's and also to OA of HPP Annex 25 "Year-round residential space conditioning systems using heat pumps".

The end of the first day as well as the second day of the meeting were used to review the work and to decide upon the actions to be done in order to be able to reach the objectives in due time.

In the evening of the second day, the group visited two buildings with slab heating and cooling. One of the buildings was still under construction, which helped the group to see the structure very clearly.

At the end of the meeting, actions for the next six months were agreed upon, and the group created an action list of over 50 items. The times and places for the rest of the meetings were also decided.

NEXT MEETINGS OF ANNEX 37

Fourth Expert Meeting
The Fourth Expert Meeting will be held on 13th to 14th September 2001 in Rome, Italy. The Clima 2000 conference will take place right after the meeting on 15th to 18th September. There will be an Annex 37 related workshop during the conference.

Fifth Expert Meeting
The 5th Expert Meeting will be held in April 2002 in Sophie-Antipolis, France. An international seminar on low temperature heating and high temperature cooling will take place in Sophie Antipolis right after the meeting. One day of the seminar will be organised by the Annex 37 working group.

Sixth Expert Meeting
Sixth Expert Meeting will be held in September 2002 in Norway.

Seventh Expert meeting
Seventh Expert meeting will be held in April 2003 in Japan.

Final Meeting
The Final Meeting of Annex 37 will be held in October-November 2003 in Finland.

ANNEX 37 WEBSITE
HTTP://WWW.VTT.FI/RTE/PROJECTS/ANNEX37/

All the information about Annex 37 will be found on our website. It is updated continuously. There you can find the

- Status Reports
- Information about the meetings and publications
- Contact information
- Links to other useful sites etc.

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LowEx

Annex 37

LOW EXERGY SYSTEMS FOR HEATING AND COOLING OF BUILDINGS

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