1 Introduction
This report presents an overview about Low Temperature Heating systems in Finland. Some cases of Low Temperature Heating systems applied in existing buildings in Finland are presented. The possibilities and limitation of LTH systems are also reviewed.

2 The LTH systems
Two LTH systems will be described; the ThermoNet® system developed by ABB and the Sensus® system developed by Are Oy.

2.1 The ThermoNet® system
ThermoNet® is an integrated, flexible energy- management system (Today the name of the commercial product is ECONET). A conventional system has different circuits for heat recovery, heating and cooling. The different batteries are used for different purposes. A conventional system needs a higher liquid temperature than the ThermoNet® system. From figure 1 the difference between the air handling of a conventional heating system and a ThermoNet® system can be seen.

Figure 1 A conventional heating system and a ThermoNet® system

2.1.1 ThermoNet® technique
With ThermoNet®, buildings and properties can be constructed and managed more efficiently and their energy consumption reduced. The system requires an extremely low liquid temperature and the fan pump and air-conditioning systems have a low energy consumption. ThermoNet® is adapted to use environment-friendly techniques for heat production and air conditioning. Specially designed control functions and
integrated components are used for distributing available thermal and electrical energy in an intelligent way to the hot water-, heating- and climate systems.

2.1.2 System benefits

Benefits for the user:

• Reduced access fees and costs for district heating and electricity services.
• Reduced energy consumption.
• Reduced electricity consumption.
• Utilisation of waste and excess energies.
• Fewer components in the ventilation, piping, electricity and control systems.
• Freeze-proof system.
• Efficient use of machine rooms.
• Ability to use renewable energy sources.
• Ability to implement district cooling.

Benefits for energy production:

• Improved fuel consumption in electricity production.
• District heating capacity can be obtained from a smaller water flow.
• Reduced heat losses in primary circuit.
• Reduced peak loads in production resulting from improved system properties and mechanical improvements.
• Accessible to additional users.
• Reduced investment costs for district heating network.
• Improved competitiveness of district heating.
• Reduced fuel consumption (approx. 15%) resulting from the use of bio energy.

Benefit for society and the environment:

• Efficient energy production means.
• Reductions in emissions.
• Improved competitiveness of bio energy.
• Possibility to utilise waste energy and other renewable energy sources.
• Minimal use of harmful CFC and HCFC compounds.
• ThermoNet production materials are recycled.

2.2 The ARE Sensus® system

ARE Sensus® is a building services product that offers a total integrated solution for building services. The Sensus® building services solution is a product that has been planned and made for high quality office and business premises. The ARE Sensus® product comprises:

• Water and sewage systems
• Heating system
• Fire extinguishing system
• Ventilation system
• Cooling system
• Electrical system
• Building automation
• System dimensioning and modelling for the premises
Customer-specific product plans
Installation and control
Project management
Operating and maintenance manuals
Warranty period liabilities

In the Sensus® concept, the components cannot be planned or implemented separately, because the benefits and properties of Sensus are based on integrating the systems with information technology and on the joint operation of the systems and the building automation bus. ARE Sensus® can be flexibly implemented with low current systems of the building and the user, including:

- Data processing systems
- Access control
- Burglar alarms
- Work time monitoring
- Video monitoring
- Electrical and telecommunications systems for fixtures
- Life cycle maintenance agreements

Sensus® is also available with an open interface solution for Internet data transfer. ARE Sensus® can be applied to both new buildings and renovations of older buildings. ARE Sensus® can also be tailored, where appropriate, for the needs of educational and residential buildings. The main commercialised components of the ARE Sensus® product are:

- The ARE Sensus® ventilation machine (low temperature technology, high-efficiency heat recovery, frequency transformer control, if necessary as a package or room unit solution)
- The Sensus ceiling panel which acts as a heating and cooling system unit for the room
- Sensus room regulators
- Sensus room sensors
- A variable-air-flow, LON-based, ventilation control system that takes the occupancy of the premises into account
- High-tech-based heat recovery and free cooling technology
- A LON building automation system with the most open architecture on the market
- A PC user interface
- Glare-free direct/indirect lighting
- The design methodology of ARE Sensus®
- Operating and maintenance manuals
- Product modelling
- Product Life Cycle Assessment (LCA)
- Life Cycle Costs (LCC)
4 Cases

Four different cases are presented. They are different kinds of buildings with two different kinds of LTH systems, the ARE Sensus® and the ThermoNet®.

3.1 The Blomstedt hall

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 m² of floor space on 2 storeys. The volume is 2200 m³. 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. 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 system.
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.

![Figure 3. The ceiling panel (the right figure).](image)

### 3.2 AaltoAlvari

The “AaltoAlvari” is a water sport centre originally designed by Alvar Aalto. It offers great opportunities for traditional swimming and water exercise and modern spa services. The total volume is 64.900 m³.

In 1998–2000 a major reconstruction and renovation was made. A ThermoNet low temperature system was installed. After the renovation, the heat energy demand has reduced by a fifth and the indoor conditions have improved considerably.

Due to the special conditions in indoor swimming pools and spas, the heating energy, electricity and water consumption is much greater than in other building types. A great deal of the energy consumption is caused by evaporation of the water in the pools. An essential task for the building service system is to manage the moisture load.
The ThermoNet-Indoor swimming hall system is an integrated system, where

- the different demands of pool areas, dressing rooms and washrooms has been taken into account
- a low temperature level is used
- the system is flexible and functions according to users’ needs
- lifecycle costs are optimised
- a fast building and renovation schedule is possible
- environmental impact is minimised
- pleasant indoor climate is achieved during all seasons.

3.3 The Sibelius hall

Sibelius Hall is the largest wooden building constructed in Finland for over one hundred years. The large complex (nearly 90 000 m³) is a congress and concert centre and includes the main hall (1250 seats), forest hall (1000 m² lobby), a renovated carpentry factory (1400 m² for exhibitions) and meetings and lecture rooms.
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. Recent research in Finland has shown that wooden materials have a positive effect on indoor climate and comfort.

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.

The building is cooled and heated with a ThermoNet® system. District heating and district cooling networks deliver the energy to the Sibelius Hall. 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.

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.

3.4 Are Oy - Branch Office, Lahti, Finland
This office building has a floor area of 230 m² and was built in the 1970's. As a retrofit, eleven cubicles have been equipped with Sensus heating and cooling panels, which cover about 30% of the ceiling area. The indoor climate and air quality was measured in the space equipped with ceiling panels and with traditional radiators. The results show that the indoor conditions were significantly better in the office space with ceiling panels.

Figure 4. The ceiling panels which also reflect the indirect lighting in Are Oy-Branch office, Lahti, Finland.
3.5 The Sipoo church
The church in Sipoo was built in 1885. In the summer 2001 a renovation was made. The church was previously heated with oil and the heat distribution system was conventional high temperature radiators. The floor was renewed and floor heating was installed. The floor area is 868 m² and the annual energy consumption is about 300 MWh. The energy source is ground heat.

4 Possibilities and limitations

4.1 Opportunities
Energy efficiency is today an important thesis in Finnish politics. Much is being done in this sector. Qualitative aspects of the built environment are also becoming more important. More attention is paid to thermal comfort and healthy indoor climate all the time.

The use of renewable energy sources is being pursued quite heavily. The Kyoto agreement is one reason for this, but also the ecological awareness is becoming better in the building sector. The importance of the role of existing building stock in energy consumption and emission reduction is slowly being recognised. Because the new construction production is slow, it is therefore important what can be done in the existing building stock.

4.2 Threats and barriers
A lack of knowledge of Low Exergy systems is a fact in Finland. One problem is the problem of understanding the concept "exergy". With an increasing number of case studies the concept will however be more known. There has been quite much writing in the newspapers about some cases, which naturally helps in making the concept more known.

There is no mention at all about Low Exergy systems in the Finnish energy policies. The quality aspect of energy seems to be an unknown concept for the politicians.

The extremely low prices of energy might be an obstacle for the concept since energy saving becomes less interesting.