LOWTE AB – Ground Source Heat Pump technology

- Supported by industrial developing funds and Swedish Energy Agency

RTD sheet

Innovative Technology
- Heat pump technology
- Low energy heating/cooling system

General information:

- Technology developer: LOWTE AB
- Location: Tilskogsvägen 15 , 193 40 Sigtuna , Sweden.
- Date of issue (year): 1994

Aims and Objectives

The objective of the LOWTE AB technology is to offer Zero Energy Houses technology **"Free Energy Houses"** involving a patent next generation GSHP (Ground Source Heat Pump) technology and low temperature distribution system in the buildings. The developed technology should allow buildings to reduce bought energy with 90 % and at the same time increase indoor comfort. The technology offer both space cooling as well as space heating. The technology concept cross several discipline and existing business models and is difficult to fit into existing business concept and it is therefore planned to set up a new company that is based on a new business models that can exploit the technology and economical potential.

A Short Description of the Technology Free Energy Houses

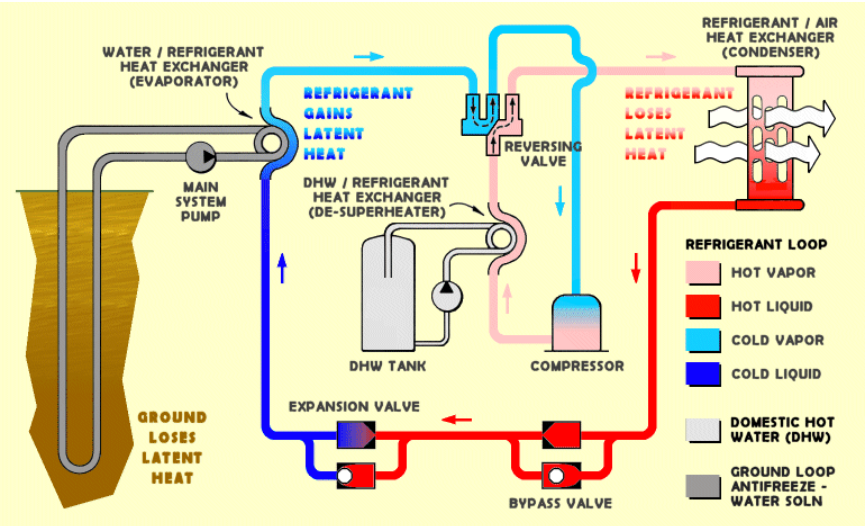
There are several possible technologies that can be possible when they come to harness the solar and wind energy that is freely flowing around a building as;

- Thermal solar collector
- PV Photovoltaic
- Wind turbine

However all these sources are intermittent and diluted, and need some surfaces to be captured and need large energy storage volume.

A building needs also different types of energy qualities, or Exergy as it is called within the thermodynamics. For instance there is a need of high quality energy as electricity to run water pumps, fans and computer. There is also a need of energy to provide a comfortable indoor climate, but in this last case it is sufficient with heat energy at low temperatures. There is a need for heat energy at higher temperature as well for tapping warm water. Furthermore, there is a need of low temperature for the refrigerator and the freezer.

All these energy supplies of different energy qualities are going to be created in an environment of approximately 0-20 °C in the most part of the world. Some countries have a marked inland climate where temperatures vary highly between summer and winter periods. Such countries have a big need of energy for providing a comfortable indoor climate.



Ground Source Heat Pump Heating
(*source:* www.geo4va.vt.edu/A3/A3.htm)

However, the average temperature in the ground is pretty close to the desired indoor temperature (+20°C) everywhere in the world. By upgrading the temperature source from the ground to the HVAC system temperature with a heat pump about 3 times more heat energy can be supplied to space heating than the used electricity that was used to propel the heat pump. However, when the electricity is generated on average with efficiency with about 30 % in the large centralised power plant it is not an energy efficient approach.

But with several appropriate designed ground heat exchangers (the ground loop) configured in a

European Project "Eco-Building International Club for advanced European sustainable energy technology dissemination in Europe and China"

Project partners:
ENEA (IT), ISNOVA (IT), FINCO (IT), ADEME (FR), AIMCC (FR), DTI (DK), DI (DK), CRES (GR), EBHE(GR), GPREC (GR), SEC(B), ZERI (CN), CBEEA (CN)

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The Free Energy Houses is very Exergy aware and don't use overqualified energy for the different applications.

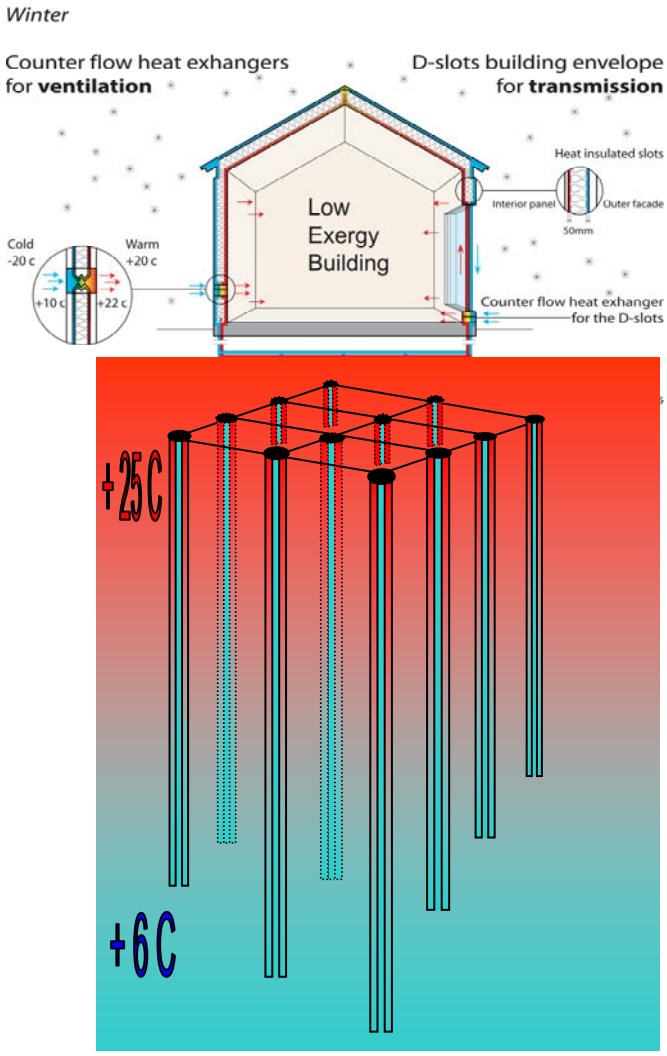

Figure 1 Free Energy Houses winter time

certain way it is possible to employee the ground as storage for sensible heat. Trying to store temperature much higher than the natural ground temperature implies biglosses and make no sense from economical point of view. However, creating a big volume in the ground with a temperature gradient with 20-25 ° C at the top of the ground storage and 5-15 ºC at he bottom of the ground storage means considerably higher efficient (COP = 4-8) for heat pumps.

The heat pump efficiency can be further increased by adopting so-called Low Exergy Cooling and Heating of the buildings (www.lowex.net). A Low Exergy approach means that the supplied energy qualities (temperature) is very close to the desired temperature (the room temperature), which in turn implies the heat supply is just some degrees above room temperature for heating purpose and just some degrees below room temperature for cooling purpose. In Figure 1 is a house illustrated where low exergy approach has been stressed far.

The Low Exergy Building in Figure 1 needs only small amounts of high exergy energy for pumps circulation the water in the ground heat exchangers and fans for the double slot building envelope. Big temperature difference between supply and return flows means also low pump power. There is hardly any need for additional energy to provide all energy that is needed for a comfortable indoor climate including dehumidifying in almost all part of the world.

However, there is a need of higher temperature for tap warm water. With the heat sources (15-25 ºC) in the ground the COP will be very high for a heat pump producing tap warm water. Also lower temperature as refrigeration and deep freezing could be obtained with a high COP because there is a heat sink with low temperature in the ground, and hence only low temperature lift is needed for cooling processes.

Besides low temperature energy needs according to the above examples there is a need of high quality energy (Exergy) as electricity for electric motors, computers and bulbs.

The Free Energy Houses generates it's own electricity and combined heat and power is of course used. In order to realise an attractive local on-site CHP, some important characteristic have to be addressed. The CHP has to be able to provide electricity and heat independent from each other because the need of electricity and heat not coincide with each other. Further more, the CHP should have the very best efficiency at part load rather than full load. When considering a local CHP the average power need is very small compared to the required peak power that can occur. Peak power is about tem times higher than average power needs.

Today micro gas turbine and internal combustion engine are the most common types of technology when implementing small-scale local on site power. As a future power cycles the fuel cell is highlighted. However, modern high performance small-scale steam engine system seams to have a great chance to offer all the desired qualities that local CHP is demanding.

The project aims at promoting and widespread disseminating EU innovative Research and Technology Development and Demonstration results, as well as eco-sustainability criteria in building sector, which include:
- energy efficient building materials, components and systems not yet introduced into the building market or in their first market phase;
- innovative applications of heating/cooling and power supply technologies, combined with the use of renewable energy sources, in building sector;
- best EU demonstration eco-building projects.

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First of all, the external combustion at pretty low temperature unfolds the possibility to use any local fuel. A steam engine could be adapted with different types of burners adapted for local available primary energy resources as bio-fuel.

Furthermore, a steam engine system can make use of solar energy when it is available. Today only large-scale solar thermal power plants exist. But such a technology could be downsized where concentrator (parabolic trough) is integrated into the building envelope. When the sun is failing the steam engine is powered with local available fuel. In summer, when space heating is not needed but there is still need for electricity generation, the ground acts as a heat sink where surplus heat is stored until winter time. This means good matching of electricity and heat need during the whole year and giving low capital cost. When the ground acting as a long-term storage to make use of renewable a device called steam buffer act as a short high temperature energy storage. Such as steam buffer can store solar energy for short periods at high temperature. From the steam buffer, steam can be directly extracted for higher temperature applications as cooking, sterilization, tap warm water etc. or for expanding through the steam engine to produce electricity and low-grade heat (80-130 ºC).

The steam buffer and the ground will together act as storage system, which unfolds the possibilities to obtain a flexible energy system realising the Free Energy Houses with very low vulnerability. Other solar energy technology as PV can also preferably be implemented into the Free Energy Houses. Today PV electricity is very expensive but when integrated into the building a slightly more cost efficient energy system can be realised. But when integrated into the double slot-building envelope as illustrated in Figure 1 and 2 further synergies will emerge.

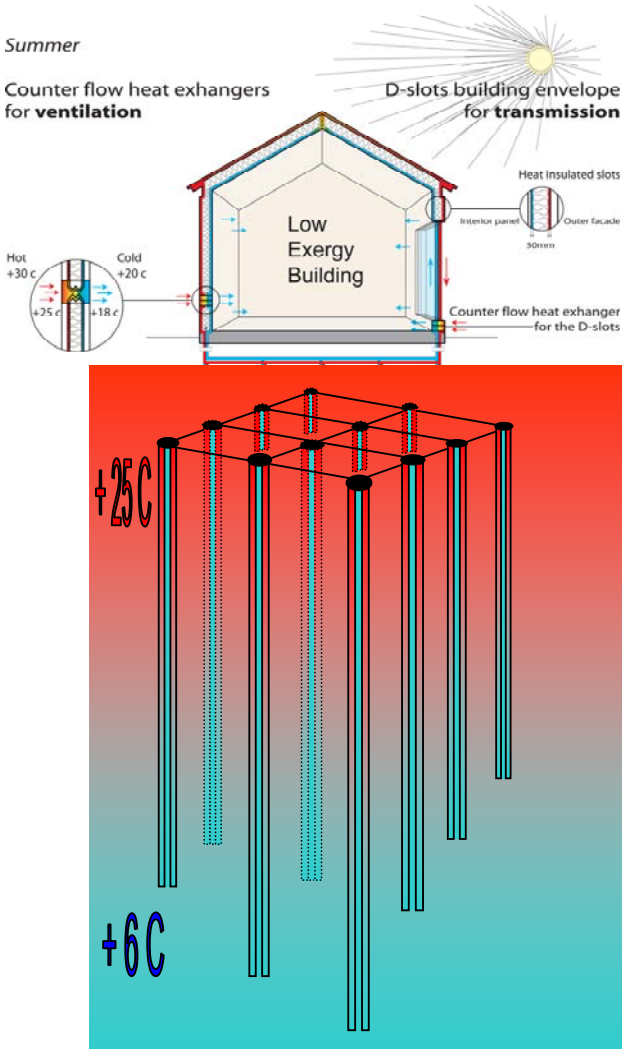

Figure 2 Free Energy Houses summer time

During summer time cool is extracted from the ground, keeping the inside of the building envelope some degrees below desired indoor temperature. In the outer slot of the building envelope is the PV integrated which will be kept at lower temperature with the cooling from the ground. When the PV is kept at approximately + 25 °C it will produce more electricity than it normally do if not cooled. The cooling flow from the ground will both keep the building as well as the PV cool. The cooling flow from the ground is heat up to approximately about + 25 °C when it is feed into the ground again where upon the solar heat, indeed low temperature, but still valuable solar heat is charging the ground which can be stored until winter period. The electricity generated in the PV should be used directly for cooling purpose as refrigeration and deep freezing but not for space cooling and dehumidification because the ground provides mostly necessary cooling qualities (temperature).

Results and Achievements

The project has been going on and off since the oil crises during the 70 ‘s and several public reports have been issued at that time. However, it is not until the last years that the interest has took off and more concrete demonstration hardware has been built and tested. The concept is a system with several different components which indeed can be used as self-contained commercial products but it is as a system the most attractive

Eco-Building Club: an innovative RTD&D results' promotion approach

Different from common market promotion approaches, where market operators are only simple message receivers, the project proposes an innovative approach: Eco-Building Club is a virtual round table, around which building market operators will be main actors for market penetration of research and demonstration results, through the following actions:

- determining what are more appropriated innovative RTD&D results for local market transferring;
- demonstrating the feasibilities of the research and demonstration results on real cases.

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performance/cost can be obtained. Very briefly the system can save as much as 90% of the energy used for space heating and space cooling. To obtain this strong reduction of bought energy an investment that means 1- 3 years pay back time.

Possible application area:

LOWTE technology is an attractive energy system in most part of the world but is of particular interest in climate with both space cooling as well as space heating. The more ventilation and window in the building the more energy savings

Reference:

The Low Exergy Building concepts have been developed on and off during many years with financing from the owner and industrial developing funds and Swedish Energy Agency and several projects and references are available. Below are some of the important references:

- Ref 1. High efficiency ground energy storage and low exergy HVAC systems, New height in net zero energy buildings, P. Platell, B Kilkis, ASHRAE winter meeting 2008, New York
- Ref 2. Zero Energy Houses, P Platell, Dennis Dudzik, Energy Sustainability, June 2007, Long Beach, California
- Ref 3 Peter Platell , Developing work on Ground Heat Exchangers, ECOSTOCK 2006 Thermal Energy Storage, New Jersey
- Ref 4 GEOEXCHANGE & LOW EXERGY BUILDINGS, P Platell, D Schmidt, G Jóhannesson, IndoorAir, Monterey,2002
- Ref 5 Platell O, Low Temperature Energy, Statens Energiverk, (Swedish National Energy Department), Report nr. 656052-1, 1988
- Ref 6 Sunstore-projektet 1977-1980 Swedish Building Council Research report R100:1981

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