CONTRIBUTING TO A FLAGSHIP PROJECT OF THE STRATEGY

Baltic Sea Region
Programme 2007-2013

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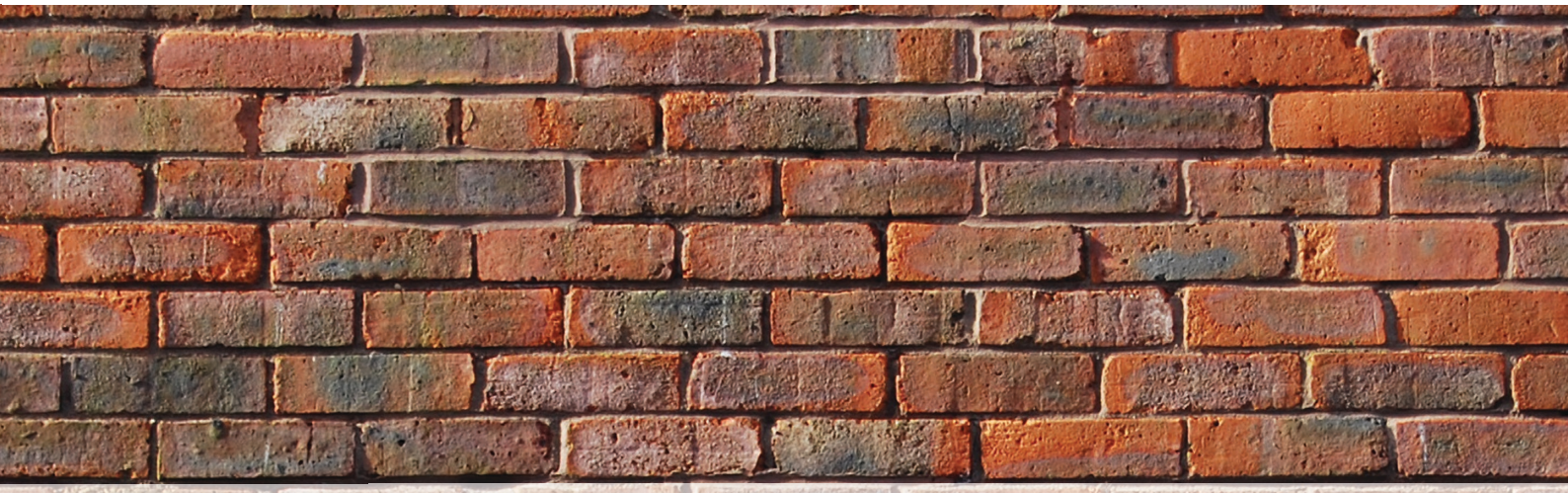
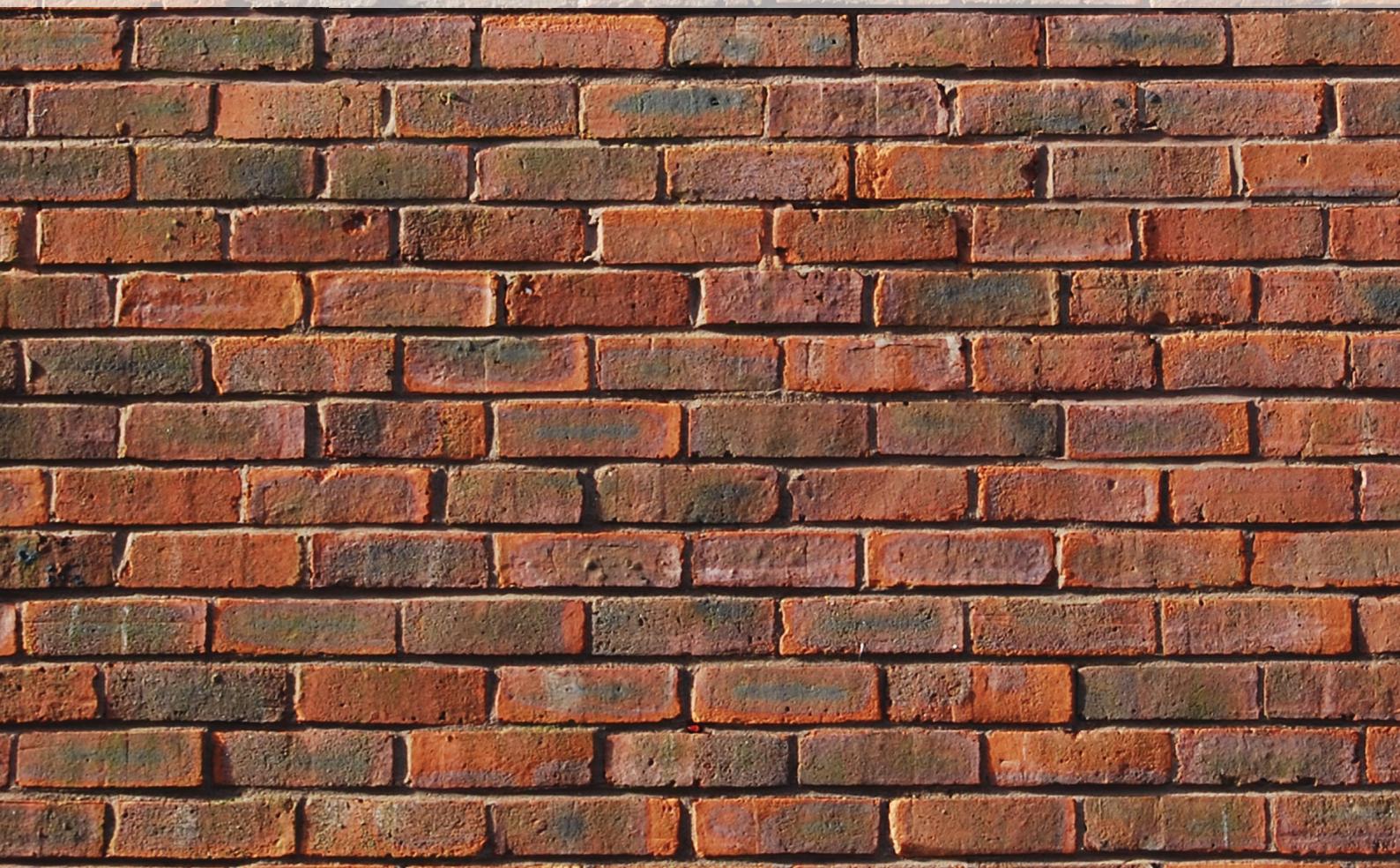
CO2olBricks



WP5 Education and Economic Promotion

Heat pumps

Educational product: New lecture material for training modules dealing with knowledge and skills how to apply suitable methods of energy efficient refurbishment of historic constructions and how innovation can be combined with cultural heritage



Heat pumps

Target group: architecture, construction, energy audit students

Educational objectives: To explain the principle of heat pump, possible sources and construction solutions.
This measure can help to save up to 15% of total energy used in building

Lecture course: 2 academic hours

References:

Boait, Peter John, D. Fan, and A. Stafford. "Performance and control of domestic ground-source heat pumps in retrofit installations." *Energy and Buildings* 43.8 (2011): 1968-1976.

Brenn, J., P. Soltic, and Ch Bach. "Comparison of natural gas driven heat pumps and electrically driven heat pumps with conventional systems for building heating purposes." *Energy and Buildings* 42.6 (2010): 904-908.

Chua, K. J., S. K. Chou, and W. M. Yang. "Advances in heat pump systems: A review." *Applied Energy* 87.12 (2010): 3611-3624.

Wood, Christopher J., Hao Liu, and Saffa B. Riffat. "An investigation of the heat pump performance and ground temperature of a piled foundation heat exchanger system for a residential building." *Energy* 35.12 (2010): 4932-4940.

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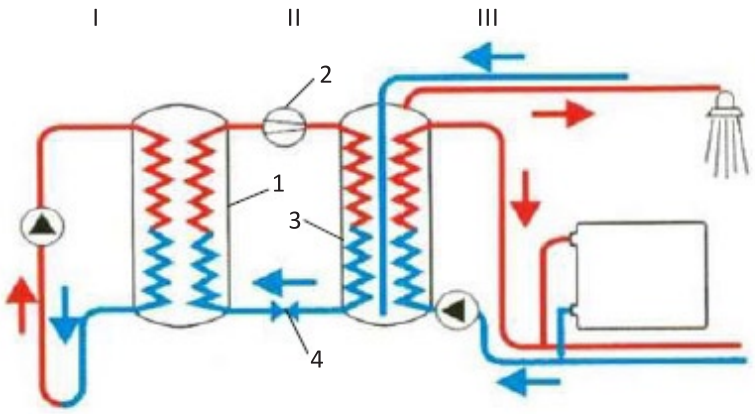
Introduction

In Historical buildings a widely used energy source is heat pump; it uses environment heat for heating and water heating, providing a stable, well-adjustable and automatically controllable heating system that works all year round. Heat Pump is a compact device without gas ducts and chimney. Heat pump operation requires solar energy and electricity, which is used for the operation of compressor and circulation pump.

Definition. Heat pump is an environmentally friendly engine that uses energy from the environment - solar energy accumulated by soil, land formations, water storage, borehole water and air.

Regardless of whether it comes to the outdoor air, ventilation air, surface or deep layers, ground water or sewage, everywhere there's heat energy, which is ready to be transported and converted into to energy of higher value. However, now only a small part of the excess energy released into the environment can be used.



1 - evapotator , 2 - compressor, 3 - condenser, 4 - throttle.

Fig.1 Heat pump principle scheme

Space heating with heat pump has a big advantage over the wood, peat or coal-fired boiler, due to the lack combustion process:

• Heating takes place automatically by the program entered in machine, it depends on the outdoor temperature changes.

• From the comfort point of view heat pump heating system is comparable to the centralized heating system.

• Heat Pump provides the ability to install environmentally clean space heating, during the operation of which no harmful emissions (CO, SO_2, NO_x, CO_2), harming the environment and human health and causing the greenhouse effect, which are locally produced, it also allows to save rapidly shrinking land resources and at the same time considerably reduce heating costs.

Principal scheme of heat pump is illustrated in Figure 4.8. It includes 3 independent and interconnected loops:

I – Loop, which extracts heat from the surrounding environment;

II – Heat pump installation loop;

III – Heating system loop.

Heat Pump not only looks like a refrigerator, but its operation is a reversal of the refrigerator operation, the house is heated from the inside, but cooled on the outside. According to the second law of thermodynamics, heat naturally flows from a higher temperature to lower.

The heat pump consists of four key elements (See Fig. 4.8., II loop):

• Evaporator, which receives the heat from the collector and regulating the evaporator pressure with the expansion valve, it shall be ensured that in the desired temperature cooling agent starts to boil.

• Compressor, which increases the pressure in the system by raising the temperature of the liquid vapor.

• Condenser, where the cooling agent gives heat to the internal heating system, which is usually water circulation system of heat supply to the radiators or warm floor system, as well as the system providing hot water.

• Throttle, which lowers the pressure and removes cooling agent back to the evaporator, completely transforming it into a liquid state so that it can once again pick up the heat.

All these four parts are connected through a closed piping system. Most popular cooling agent liquid is on ethanol and propylene glycol base, which does not harm to the environment. Despite of the similarities of heat pump elements, they differ have varying operation cycles, working environment and heat sources.

Heat pump operation cycles

Almost all currently offered heat pumps for buildings heat supply are based on either the vapor compression (compression heat pumps) or the absorption cycle (absorption heat pumps).

• Compression heat pumps. They operate on the vapor compression cycle principle. The main components of heat pumps are a compressor, an expansion tank, and two heat exchangers designed to vaporize and condense.

• Absorption heat pumps. Absorption heat pumps are powered thermally, which means that it is more advantageous to convey heat for the operation of cycle not mechanical energy. Absorption heat pumps for space conditioning are often powered by burning gas.

Heat pump working fluids

Heat pumps after the principle of work fluid interaction can be combined into two main groups:

• With open cycle, in which the liquid is removed from the external environment and returned to it.

• With closed cycle, in which the liquid circulates in closed circuit, interacting with a heat source and heat consumers with a help of heat transfer processes.

Heat sources of heat pumps

Heat pump types by the used kind of heat source are divided into three main groups. They

use either air or ground heat:
• Outdoor air heat pumps;
• Exhaust air heat pumps;
• Geothermal pumps.

In this way, heat from outside is pumped into the house. Since a large amount of heat is accumulated in soil layer or outer air volume, then giving some of the heat ground or outside air the temperature does not change, but with this amount of heat the area can be heated to the required temperature. An example of heat pump installed in historical building is illustrated in figure 2.

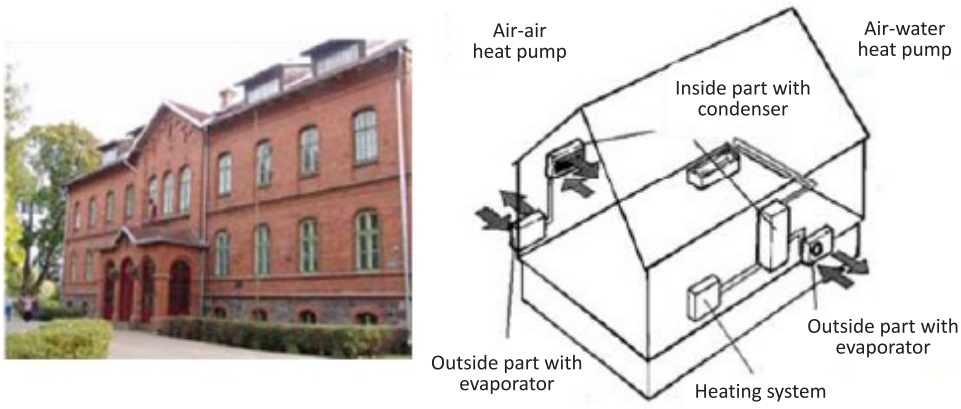


Fig. 2. An example of heat pump installed in historical building