

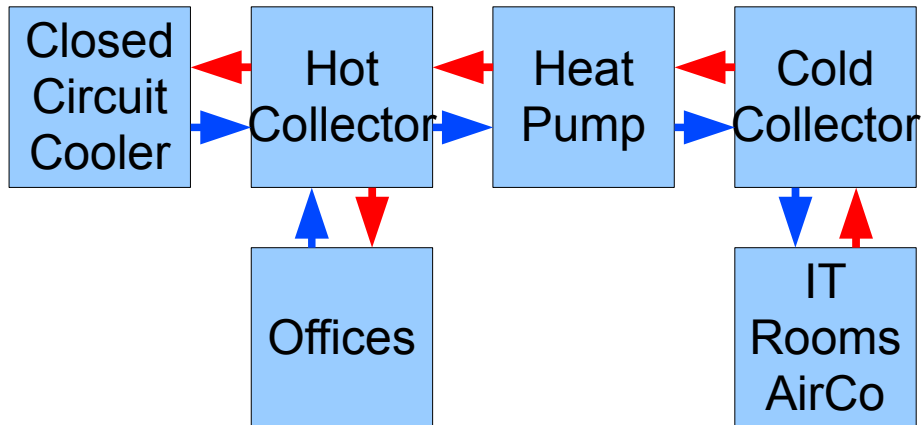
Shared and Local Heat Exchange Networks

November 27th 2013 - Etienne BAYENET, Luxembourg

Why a Heat Exchange Network ?

The idea of a heat exchange network comes from a building with a computer room that heats the offices with a heat pump. A closed circuit cooler insures that the systems doesn't overheat.

Cold water for air conditioning is also produced for the offices during the summer.



The limitation of this configuration are :

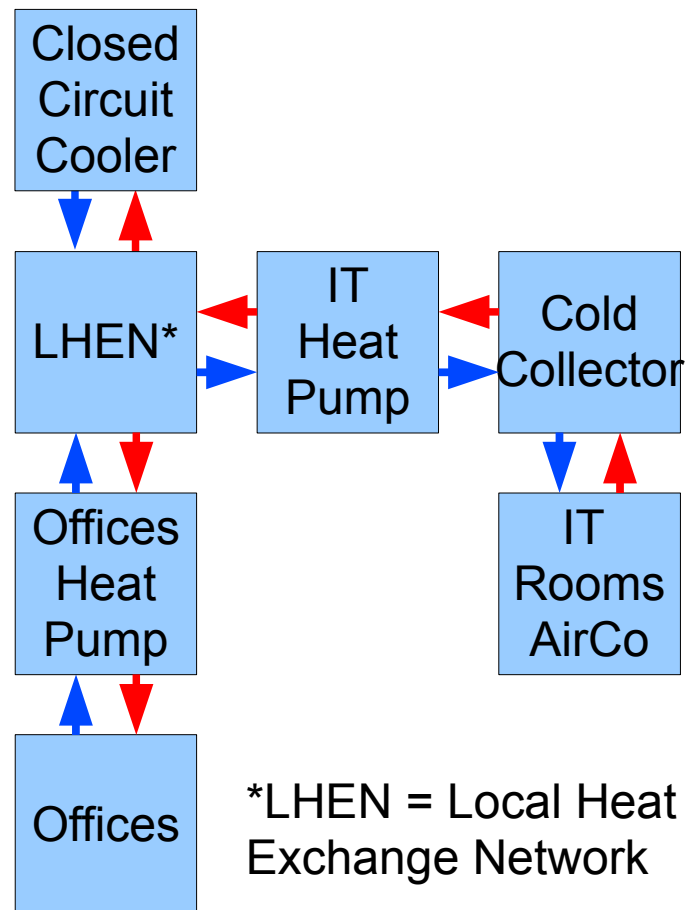
- You can't do free cooling during the winter. Free cooling is a bypass around the heat pump that goes directly from the cold collector to the closed circuit cooler.
- Only between 10% and 60% of the heat coming from the IT room is needed to heat the offices.
 - Since free cooling is not possible, all the heat has to go trough the heat pump.
 - Since a higher temperature is needed to heat the offices than for the closed circuit cooler, the heat pump has to work at a higher temperature (lower efficiency) than required for 40% to 90% of the IT rooms heat.
- The offices are heated with heat pump having the IT required redundancy and maintenance. A single machine would be enough to heat the offices.

Even with these limitations, the described solution is very efficient because the offices are heated at a very low cost.

Solution level 1 : Local Heat Exchange Network

The idea is to replace the hot collector by an intermediary level called “Local Heat Exchange Network” of LHEN that has just the needed temperature for the closed circuit cooler.

Since the temperature of the LHEN is not high enough to heat the offices, another heat pump is connected to the LHEN to heat them.



This solution has many advantages :

- Instead of 1 reduced efficiency heat pump, you have 2 high efficiency heat pumps, each one working only when needed.
- Only the needed water is brought to the needed temperature.
- Redundancy and maintenance is only where it is needed.
- Any other cold or hot system can be connected to the LHEN (hot water, refrigerators, dryers...). If there are just two systems connected like in the example above, the LHEN does not bring much savings compared to the extra costs.
- Since LHEN pipes are at a middle range temperature (10°C to 30°C – 50°F to 90°F), they almost don't need to be insulated when running inside an office area or a temperate storage area.

The temperature and configuration of the LHEN has to be adapted to the facilities :

- If the heat comes from a high temperature system (for example electrical cogeneration), you won't need a heat pump to heat the offices.
- In the described case, there is no need for a different heat pump for the air conditioning in the offices because the air conditioning temperature range is similar with the requirements of the IT rooms. Facilities have to be designed according to the needs.

Solution level 2 : interconnecting LHENs inside a Shared Heat Exchange Network

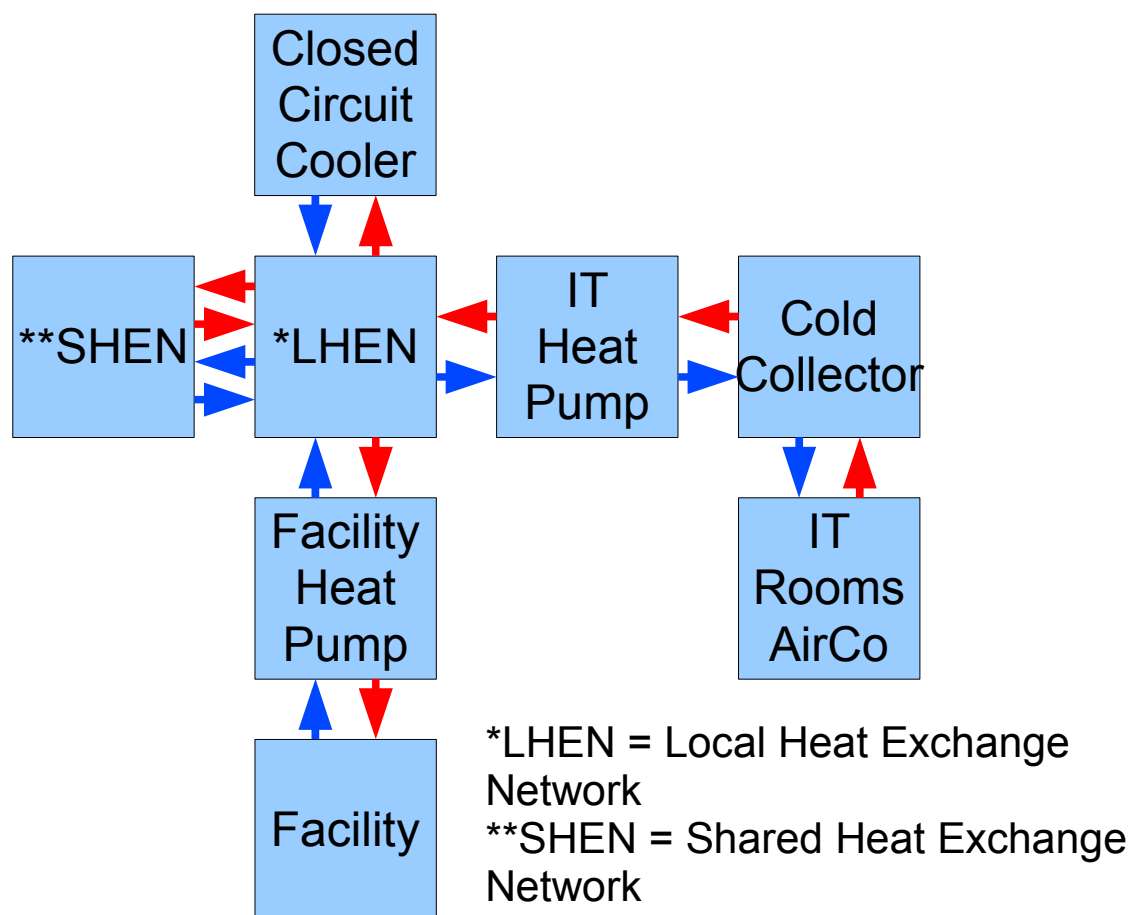
Since the IT heat pump puts too much heat in the LHEN, it would be nice to forward this heat to other facilities built in a short distance.

A “shared heat exchange network” or SHEN can be built to connect different facilities, each one having the possibility to put or take heat in it.

The closed circuit cooler only runs when the SHEN is not able anymore to absorb the extra heat.

If IT rooms have a temporary reduced heat output, it is always possible to get heat out of the SHEN.

A heater can be connected to the SHEN by the SHEN manager to provide extra heat during the winter. This would allow to have no other heating system than a heat pump in the connected facilities but makes cost calculation much more complicated.



Since the SHEN is a **low temperature heat distribution system**,

- Heat can easily come from solar panels, the cooling system of cold storage or any other heat producing system.
- Insulation is not an issue like in normal urban heating systems since temperature are much

lower.

- Any building can connect itself to the SHEN to get heat during the winter. The regulation of the heat pump will bring the water at the needed temperature (40°C-100°F for a well insulated building, 80°C-170°F for a non insulated building). Of course, higher temperature means lower efficiency.

The SHEN can not easily give any warranty regarding the availability of cold :

- Cold is much more complicated to store, produce and manage than heat, and is often produced with a higher efficiency in small or medium sized units.
- A problem in the cold production creates real damage (thawed food, overheated computers...).

The SHEN could give a warranty regarding the availability of heat, but this means that heat can have very different values. It is sometimes the left over of an industrial process, and sometimes a high valuable product.

The SHEN management is somehow complicated and easy :

- It is complicated because everybody can put or take heat out of it, which means that flows and temperatures are not stable. Furthermore there is no link between heat availability which depends of industrial processes and need for heat which depends of the outside temperature. Many industrial processes stop at night, during the non working days, during monthly or yearly maintenance... or when orders are completed.
- It is easy because you don't need a precise temperature, the facilities heat pumps' regulations insure that everybody has the needed temperature.
- Billing is difficult because :
 - Heat at 20°C-70°F doesn't have the same value than heat at 40°C-100°F.
 - The value of heat depends of the need for heat and of the heat available.
- Usual urban heating works with temperature differences around 40°C-80°F. Heat pumps need a temperature difference around 8°C-16°F. This increases a lot the needed water to move heat in a SHEN compared to usual solutions. This means that a SHEN can not easily be used for long distances.

Heat pump systems work with a very high efficiency when there is a good and stable source of heat. Technical improvements of heat pumps during the last 15 years really could make the SHEN a good heating solution in areas with industrial heat available.