

**Heat pumps transform renewable energy from air, ground and water to useful heat.** Additionally they can utilize waste energy from industrial processes (creating potential for cascading energy use) and households (i.e. exhaust air).

**Heat pumps use a renewable energy source and contribute to total energy efficiency.** A heat pump system consists of a heat source, the heat pump unit and a distribution system to heat/cool the building.

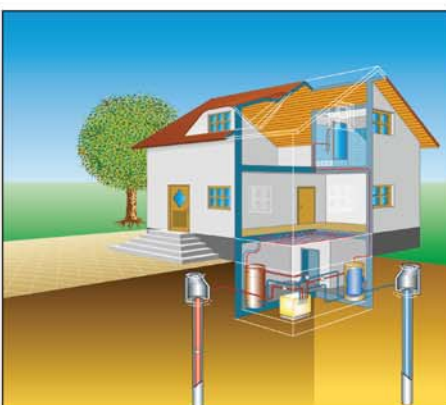
A transfer fluid transports the heat from a low-energy source to a higher energy sink. Auxiliary energy is needed to run the compressor and the pumps. **It is possible to switch the direction of this cycle to use the same machine for heating and cooling.** In heating mode, the heat source is outside the building envelope (heat from air, water, ground), in cooling mode, the cycle is reversed: the building itself is the heat source while air, water or ground is used as the heat sink.



### Air source heat pumps

Air source heat pumps use the ambient energy in outside or exhaust air for heating, cooling and preparation of hot water. They can be installed as compact units entirely inside or outside the house. Split systems consist of one unit inside the building and one outside.

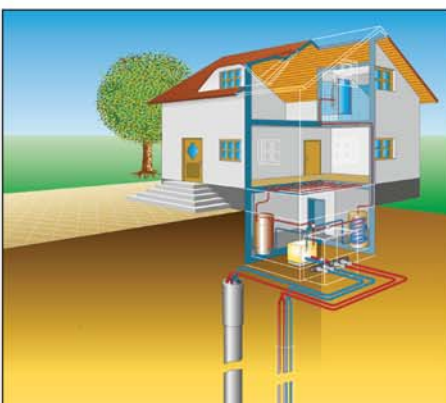
Heat is commonly distributed inside the house by a hydronic distribution system or by air using fan coils or a ducted ventilation system. Recent technical developments allow for efficient use in almost all climatic regions.



### Water source heat pumps

Water source heat pumps use energy stored in ground, surface or sea water. Where ground water is easily available it is accessed by two drillings. One is used as a water source, the second is used to reinject the water into the ground. The heat pump extracts heat from the water and makes it available for heating, cooling and preparation of

hot water. Heat is commonly distributed inside the house by a hydronic distribution system or by air using fan coils or a ducted ventilation system. Water source heat pumps profit from particularly high efficiency due to excellent temperature characteristics of water as energy carrier.



### Ground source heat pumps

Ground source heat pumps use energy stored in the ground for heating, cooling and preparation of hot water. They extract heat from the ground either by a vertical or horizontal collector. Heat is commonly distributed by a hydronic distribution system or by air. Ground source heat pumps can be operated efficiently by employing the consistent temperature level of the ground.

