Advisors Toolkit
Factsheet No 6.g
Revised 16 Jan 2020

Water Source Heat Pumps

Water source heat pumps (WSHP) absorb heat from a source of groundwater to heat buildings. There are two types of WSHP, water-to-air systems provide warm air, which is circulated to heat a home and water-to-water systems heat water to provide heating to a home through radiators or an underfloor system.

A water source heat pump system extracts heat from a local water source and usually operates exactly like ground source heat pumps within a 'closed loop' system. In a closed loop system, the pipe work will simply be sunk to the bottom of a water course. However in some instances a water source heat pump can operate using an 'open loop' system. This involves water being abstracted from a borehole and discharged via a heat exchanger to a river or sewer. These systems can be very efficient because of consistent water temperatures.

The Coefficient of Performance (the units of heat generated for each unit of electricity used) – CoP - of water-to-air heat pumps will depend on the temperature of the source water, but typically lies between 2.8 and 3.7. The CoP of water-to-water heat pumps will depend on the source water temperature and the temperature to which it is being raised, but is typically in the range of 3 and 5.

Possible water heat sources are:

- **Ground water** is available with stable temperatures (4-10°C) in many regions. Open or closed systems are used to tap into this heat source. In open systems the ground water is pumped up, cooled and then re-injected in a separate well or returned to surface water. Open systems should be carefully designed to avoid problems such as freezing, corrosion and fouling. Closed systems can either be direct expansion systems, with the working fluid evaporating in underground heat exchanger pipes, or brine loop systems. Due to the extra internal temperature difference, heat pump brine systems generally have a lower performance, but are easier to maintain. A major disadvantage of ground water heat pumps is the cost of installing the heat source. Additionally, local regulations may impose severe constraints regarding interference with the water table and the possibility of soil pollution.

- **River and loch water** is in principle a very good heat source, but has the disadvantage of low temperatures in winter (close to 0°C). Great care has to be taken in system design to avoid freezing of the evaporator.

- **Waste water and effluent** are characterised by a relatively high and constant temperature throughout the year. Examples of possible heat sources in this category are effluent from sewers (treated and untreated sewage water), industrial effluent, cooling water from industrial processes or electricity generation, condenser heat from refrigeration plants. The major constraints for

use in residential and commercial buildings are, in general, the distance to the user, and the variable availability of the waste heat flow. The heat is then delivered to either radiators or fan-coil units within the indoor space.

- WSHP needs electricity to run, but it should use less electrical energy than the heat it produces.
- Water source heat pumps are ideal for new builds, highly insulated renovated houses and houses with underfloor heating.
- Installation costs can be slightly higher than other types of heat pumps. The pipes require space and good depth and some flow of water to refresh the heat collection. Lake source heat pumps have lower running costs and can capture better temperatures from "refreshed" water.
- A heat pump consists of three main elements; the evaporator, the compressor and the condenser. A heat pump uses its ‘evaporator’ to pump energy from outside to inside, raising the internal temperature through releasing heat via an internal ‘condenser’. The diagram below shows how this works.

In essence heat pumps work on the same principle as a refrigerator or freezer. A freezer will extract heat from a food item, even when it is cold, and disperse it through the panels at the back. A heat pump does the same thing.