Temperature requirements

Safe temperatures of domestic hot water are quite narrowly defined by two different health risks: the risk of scalding with overly high temperatures and the risk of bacterial growth in water with overly low temperatures. The latter risk mainly concerns legionella, which are bacteria that can grow in the biofilm inside the pipes and can cause pneumonia when inhaled through aerosols (small droplets). As legionella grows in temperatures between 25 °C and 45 °C, minimum DHW temperature levels of 50-65 °C are usually required. Table 1 shows the required temperature in a few countries.

In its guidelines for DH substations, Euroheat & Power recommends that there should not be any connection of equipment to the system that could force the temperature below 50°C in any part of the system. Consequently, the outgoing water temperature from the heat exchanger/ storage tank should never be below 50 °C in single-family houses and 55 °C in multi-family houses. Taking distribution losses and temperature drop in the heat exchanger into account, this results in a minimum DH supply temperature of about 55 °C, which is also the level used in several existing low-temperature DH systems. To reach the requirement in multi-family buildings, the temperature may have to be slightly higher, or flat substations may be used.

*** There is no regulatory requirement to achieve a specific temperature. The figures cited are 'custom and practice' for commercial systems with hot water recirculation. (Real world domestic systems are more like 45C and 50C)'*

Table 1. DHW temperature requirements in some European countries. **Country**	**DHW temperature at the tap (°C)**	**DHW production temperature**
Belgium	≥55	≥60
Denmark	≥50*	≥60
Finland	≥55	≥60-65
France	≤50	≥60
Germany (large systems)	≥45	≥60
Italy	45-48	≥60
The Netherlands	-	≥60
Spain	≥50	≥55
Sweden	≥50	≥60 (in tank)
United Kingdom**	≥50 (45)	≥60 (50)

There are various ways of controlling legionella in the DHW system such as disinfection methods which kill or remove the bacteria and/or the biofilm, pipes with antibacterial properties that inhibit the establishment of the biofilm and the small volume approach which minimizes the time the bacteria can grow (discussed below). The disinfection methods are currently mostly used in larger

buildings such as hospitals, nursing homes or public baths. Pipes with antibacterial properties are still in the development phase.

Small DHW volume approach

The main barrier to reduce the DHW temperature below 50 °C is the risk of legionella, as mentioned above. Apart from nutrients and favorable temperatures, legionella bacteria need time to grow. In a building with hot-water circulation, the water is constantly circulating, which means that it is very important that the temperature is kept sufficiently high, as otherwise the legionella will grow in the biofilm. In order to minimize the time, the legionella is in the range of temperatures in which it grows, it is important to have DHW only when needed and minimize its volume, i.e. the volume from the heat exchanger and the tap.

For single-family houses this can be achieved by limiting the volume from the house substation and for a multi-family house this can, in practice, be achieved by using flat substations. This approach has been used in some low-temperature systems in Denmark, where the DHW temperature has been set to approximately 45 °C and its volume limited to 3 litres (Ottoson, 2013; Christiansen, 2012; Rosa, 2012). Analyses from case in Lystrup have shown that DHW can be prepared at 46 °C from a DH supply temperature of 50 °C in these systems, with acceptable waiting times.

The Danish initiative is based upon an earlier German rule, which did not put any explicit limits on the DHW temperature for “small” systems. A system is considered” small” if the hot water tank has a total volume less than 400 litres and if the total volume between the heat source and the furthermost tap is less than 3 litres. In a later version of the rule, the temperature restriction was included for small systems, and now the lowest temperature is set to 50 °C. However, the efficiency of controlling the levels of legionella by limiting the volume of the DHW has not been scientifically verified. Low-temperature DH case studies using this technology: Aarhus (Lystrup), Denmark, Høje Taastrup (Sønderby), Denmark, Stavanger (Østre Hageby), Norway.