Accumulating fireplace integrated with a water-based central heating system

A domestic fireplace of soft-stone construction and integrated heat exchanger for thermal storage

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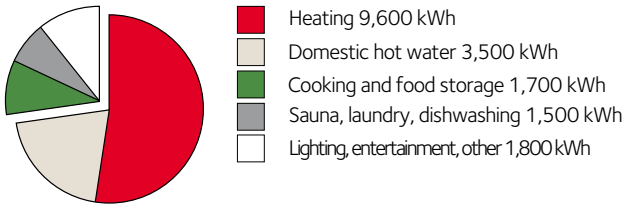
Tulikivi is the world's largest manufacturer of accumulating fireplaces, with net sales of EUR 60 million and 500 employees.

ENERGY CONSUMPTION IN A DETACHED HOUSE *)



Source: Vantaa Energy

Figure 1. Typical delivered energy use in a household of four persons in an electrically heated detached house of 120 m² in southern Finland. Total delivered energy use is 18 300 kWh/year, from which the heating energy use is 13 100 kWh/year.

Space and domestic hot water heating account for about 80% of energy use in European households. Using an accumulating fireplace with integrated heat exchangers and a water-based heating system, a substantial proportion of the heat produced by the fireplace can be used for space and hot water heating. Such fireplaces can easily pay itself back in terms of reduced delivered energy use.

Wood heating – a workable alternative?

New building regulations mean more energy-efficient homes requiring less energy for heating. In low-energy and passive homes, the fireplace and integrated water-heating system can supply a substantial proportion of a household's heating energy needs. The energy generated by a highly efficient (80–85%) accumulating fireplace can be used for heating different areas of the home or for heating of domestic hot water. By having heat exchangers integrated with the massive fireplace, one can make the fireplace part of the heating system, which means fewer overlapping investments. This includes also other important benefits of the fireplace, as it enhances comfort in the home, is an attractive design feature and provides a backup of heating system that is independent of other energy sources in any crisis situation.

For new or renovated homes

An accumulating Tulikivi fireplace with integrated heat exchangers can be used as the heart of the new water-based heating system. Heating energy is transferred from the fireplace to the circulating water, which can then be stored in a hot water tank. The system can be installed in new or renovated homes. In a renovation project, the customer can make use of an existing water tank and the water-circulation heating system. The system is particularly well suited for use in hybrid systems involving a solar collector or a heat pump in buildings where a low-temperature heating system, such as floor heating, is used.

Conventional massive fireplace

To fully heat the fireplace, normally requires about 2 to 3 hours, which means it can be lit in the evening after work, for example. The energy released by the combustion of the wood is storage in the soapstone of the fireplace. The soapstone mass of the heat-storing fireplace is typically 1 000–2 000 kg, which means that the amount of energy stored in the structure from burning at full load of wood can be as much as 30–70 kWh. The energy storage in the soapstone is released gradually over a period of 18–36 hours to the room the fireplace is located. The heat output is in the range of 1–3 kW, as the surface temperature of the fireplace increases during heating and then drops as energy is released. During the time of year when heating is needed, the fireplace should be heated once a day, or even twice on the coldest days.

Fireplace with heat exchangers

In an accumulating fireplace equipped with heat exchangers, between 25 to 50% of the energy stored in the fireplace soapstone is transferred to the water system using an heat exchanger system and then carried

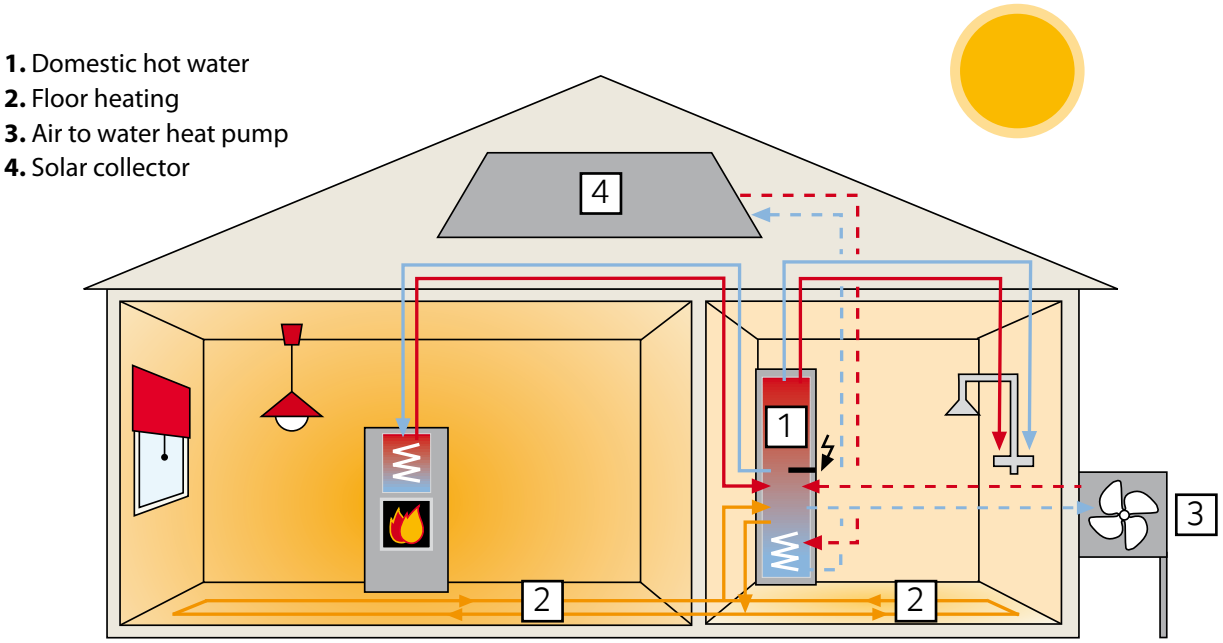


Figure 2. A fireplace with heat exchangers integrated into water-based heating systems.

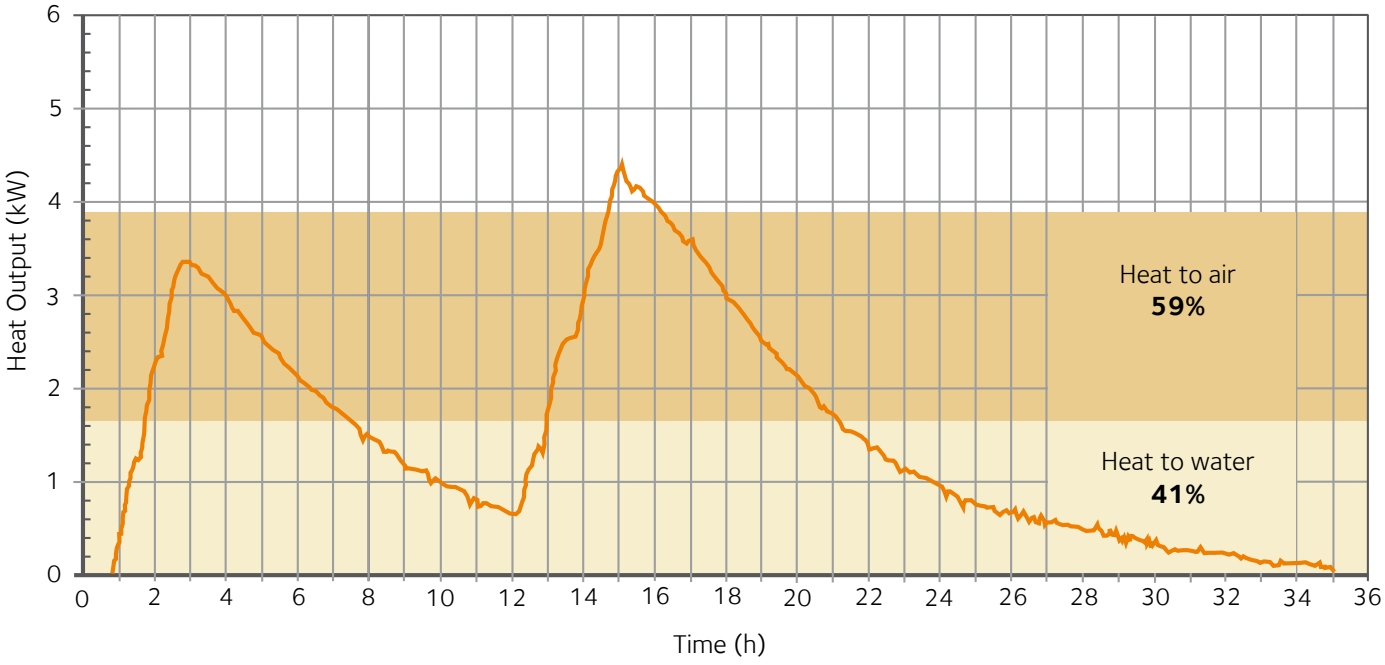


Figure 3. Functioning of an accumulating fireplace with integrated heat exchangers.

by the water for use in the home's heating system. Heat stored in the fireplace during the heating is thus gradually transferred to the hot water tank with the heat output of 1–2 kW. Some of the heat will radiate through the fireplace structure, heating the room. This system does not change the manner in which the fireplace is heated, so one can still use the fireplace as set out in the operating manual. If more heat is needed, the heat output can be increased by heating the fireplace twice a day. This means that one can achieve substantial savings in energy bills as there is no need to purchase energy to cover peak heating needs.

The curve in **Figure 3** shows how an accumulating fireplace with integrated heat exchangers functions in a normal situation. A fireplace with a mass of 2 000 kg

has been heated with 2 x 20 kg of wood. The measurement was carried out during a period of 36 hours. The amount of energy gained from the wood is 141 kWh (η=85%). Of this total, 57.5 kWh (41%) was transferred to the hot water tank using the heat exchangers (curve). The remaining energy output of 84 kWh (59%) was provided to the room as radiated from the surfaces of the fireplace. In average, energy was transferred to the water with 1.5 kW power, while the total average heat output of the fireplace (to the water and directly to the room) was 4 kW.

Easy to use and reliable

The Tulikivi Green W10 water-heating system consists of a double-walled Tulikivi fireplace and a heat exchanger package specifically designed for it. The system can be incorporated in an existing heating system already equipped with a solar collector and/or an air to water heat pump. The heating system should be sized in accordance with the energy needs. The following factors should be taken into account in the design of the heating system: the annual net energy need for space heating and domestic hot water; how much of this need should be met by wood heating; and will the system be used as the main heating system or a backup system.

Safe and maintenance-free

The heat exchangers should be installed on both sides and at the back of the fireplace. If necessary, they can also be installed on the top of structure and on the front side above the door. As the heat exchangers are installed between the inner and outer walls of the fireplace, they do not have any impact on the combustion process. The heat exchangers do not at any stage get into contact with flue gases. The heat is transferred to the heat exchanger elements directly from the soapstone mass storing and transferring the heat. As the heat exchangers lower the surface temperature of the fireplace, the fireplace can also be installed in spaces that are smaller than those typically recommended. One does not need to clean or service the heat exchangers, and because of their simple construction, they can be used for many years.

WOOD AND SOLAR HEATING – RENEWABLE ENERGY ALL YEAR ROUND

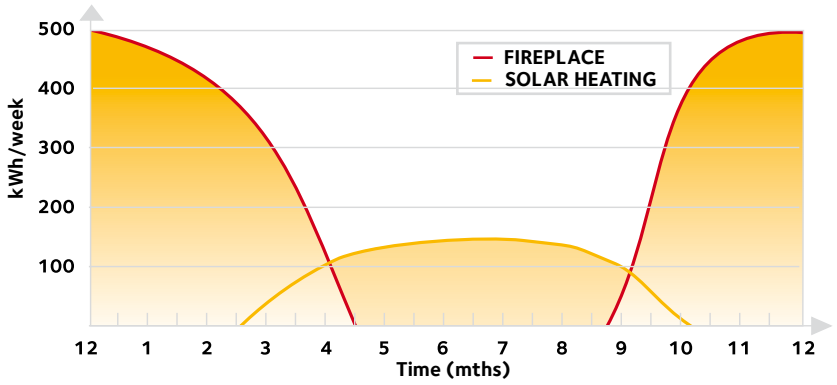


Figure 4. Solar heating and heating generated with a fireplace can complement one another. Regular heating of the fireplace is the natural alternative during the winter months, when the need for heating energy is highest. Solar heating is the most effective in early spring and in summer when the heating energy produced can be used for floor heating in wet rooms and for domestic hot water. Such combination will minimise the delivered electricity use.

Figure 5. The Sonka accumulating soapstone fireplace equipped with heat exchangers.

Accumulating fireplace extends the use of conventional fireplace

Equipping a fireplace with heat exchangers will allow you to extend the period in which the fireplace is used each year, because the combined structure can heat both the room and the water. Using the fireplace will ensure that room temperatures remain at comfortable levels. Such fireplace has a low surface temperature and is safe to use. It also provides a backup system during power failures.