Make use of that waste heat

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In a squash and badminton centre called CROSSI in Vantaa, Finland, space heating takes advantage of cheaper night-time electricity. Also a heat recovery system recovers the heat which appliances and players emit. Due to careful HVAC planning the total electricity cost has been kept to less than FIM 2 per player.

Ventilation heating with cheaper electricity

The centre has a central air-conditioning system, which can also be used as a heat delivery system due to the great need for air flow (in total 4.8 m³/s).

A 40 kW electrical heater was installed in the inlet air duct of the squash section. The centre is heated from 3 am to 7 am, when the price of electricity is cheaper. The heater is able to supply heat for storing in the structures of the building by increasing the indoor temperature by up to 20°C overnight. The system then circulates and heats indoor air only.

In the squash hall, the temperature is regulated by the thermostats in the inlet air duct and in the ceiling of the hall. The night-time storage heating is controlled by a separate thermostat and a time switch. Heat is so well accumulated in the building that additional heating during the following day is only necessary when the outdoor temperature falls below -20°C.

A squash player needs warm fresh air and good lighting.

During playing hours fresh outdoor air is taken into the ventilation system. Indoor air is exhausted but its heat content is recovered through an efficient heat recovery unit; the average efficiency being 80%. This high figure means that the need for heating power of over 100 kW can be avoided. The combination of the heat exchanger and the electric heater in the inlet air duct have given sufficient heating in the playing halls even during the coldest days in the last few years.

Ventilation air volume according to need

The need for daytime heating is also diminished by halving the ventilation air volume from 7 am to 5 pm. In the evenings, when the number of players emitting heat and the need for fresh air increases, the ventilation is fully activated.

The badminton court must have an 8 m high free space allowing for upward hits. Air flows must be kept at minimum to avoid disturbances in the trajectory of the shuttlecock. Therefore, a supplementary heating was realized by 18 separate 1.4 kW electrical radiant heaters in the ceiling. Heat is effectively radiated down, thus warming the floor and the players.

Storage tank in water heating

Players use a lot of warm water in the saunas. Although the showers are equipped with timers allowing for 30 seconds of waterflow at a time, the amount of warm (38°C) water used, is still 10,000 litres on busy days (250 players per day).

Due to the high consumption peaks, an ordinary heating coil placed inside a hot water storage tank would not have been efficient enough. Therefore, a separate hot water storage tank of 5 m³ connected to a 60 kW electric boiler was installed. The maximum

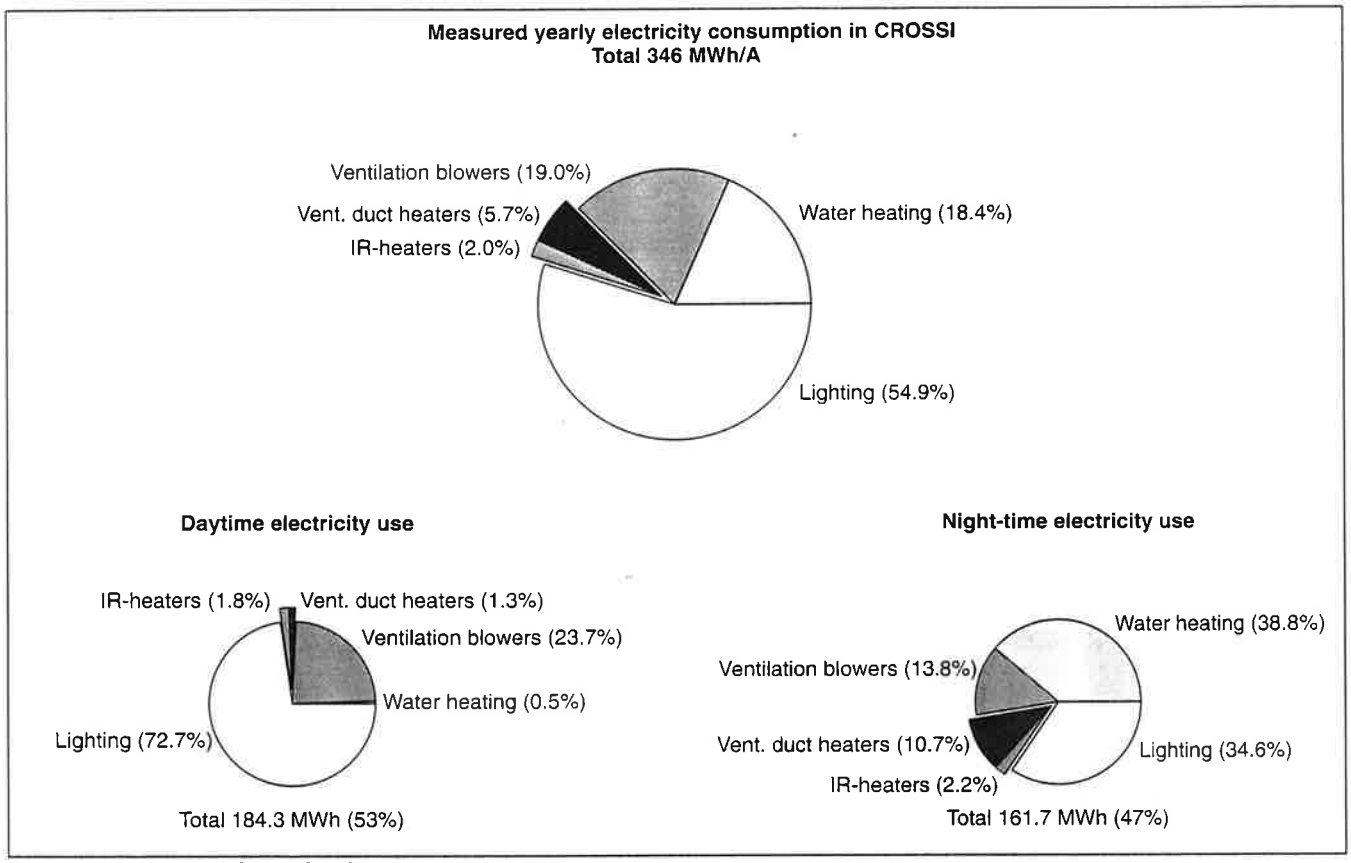

Figure 1: Measured yearly electricity consumption in CROSSI sports centre.

electrical power of this boiler is used during the night to heat up the water of the storage tank. Not only because the electricity is cheaper but also because the total electrical power demand is low during the night. A small part (6 kW) of the power of the boiler can be used any time to heat up the water temperature in the top part of the storage tank (for instance for possible daytime hot water peaks).

The hot water in the storage tank is not consumed, but stays permanently in the tank. Instead the heat is transferred to fresh water in a place heat exchanger, which can provide warm water for 16 showers at once. The temperature in the storage tank is regulated according to water consumption. In the autumn, when the number of players increases, the temperature will be raised to 90°C and in the spring, when less players are attending, the temperature will be lowered to 70°C.

Keep heat circulating

It was noticed in the preliminary calculations that the need for electrical power for lighting was great. When added to the electrical demand of saunas and ventilation equipment it already totalled 75 kW. Although electrical power is also needed for space heating and hot water heating, the total peak power has not exceeded 100 kW. This has been achieved by using an efficient power control and power sequencer device. Instead of simultaneous use of high power electrical appliances, their use can be managed in sequential order when possible.

The heating of the supplied air benefits from almost all the waste heat from lighting and other electrical systems. The waste heat is transferred via the heat recovery unit to the ventilation air flow. The sportsmen bouncing small squash balls emit considerable amounts of heat at the very time when electricity is expensive. All this emitted heat moves up to the ceiling where it is sucked into the ventilation system.

With the return air's temperature of 18°C and a temperature efficiency coefficient of 0.8 in the heat recovery unit, the incoming fresh air can be heated up to 15°C without using heating energy. This balance is sufficient for most of the year. Only during a few of the coldest days is some extra peaking heat needed and this is controlled with a thermostat in the inlet air duct.

In badminton there is less need for ventilation and the air volume is thus not sufficient for heat transfer

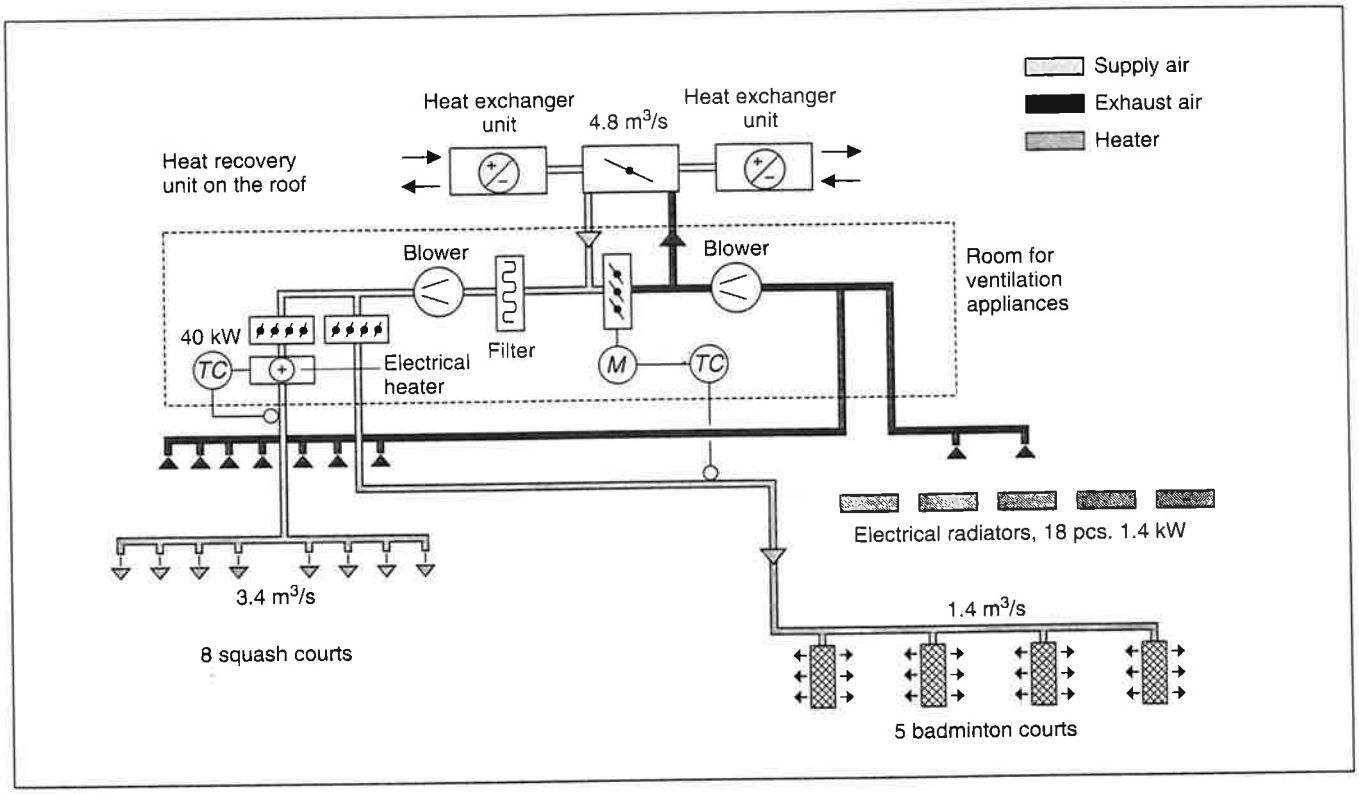

Figure 2: The schematic diagram of the HVAC system in CROSSI.

purposes. Furthermore, in order to guarantee stable conditions for the players, the incoming air flow is conducted slowly to the surface of the floor. The incoming air temperature is slightly cooler than the room temperature.

A reasonable electricity bill

Total electricity consumption was measured and found to be 346 MWh over a one year period, which costs FIM 110,000. Divided by the number of players, the total cost is only FIM 2 for each player, representing a small fraction of the fee, and can be considered reasonable.

The specific electricity consumption is 30.9 kWh/m³ from which only 2.4 kWh/m³ is used for space heating and 78% of that is cheaper night-time electricity.

These figures show that this type of a building, equipped with good lighting and powerful saunas, needs practically no extra energy for space heating purposes, provided that these "no cost" waste heat sources are taken into consideration during the energy planning and are accordingly utilized.

Technical notes

The squash hall:
- floor area 1130 m²
- volume 6140 m³

The badminton hall:
- floor area 660 m²
- volume 5140 m³

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