# Reducing fuel bills and environment impact for a listed building

## The brief

A proposal for space heating and hot water generation was requested for a planned large extension to a listed property in Derbyshire.

The owners wanted to keep fuel bills as low as possible and to reduce the impact on the environment by using renewable resources. They specifically wished to use wood as the main heating fuel, because they had easy access to this resource.

High standards of insulation had already been recommended by us previously, thereby reducing the heating demand. Due to the orientation of the property, solar gain would be minimal. A single-phase electricity connection was available at the property, but no gas connection.

## The options

Option 1 – Under-floor heating

Due to the relatively low heating demand, under-floor heating would be the best option. Benefits are that under-floor heating is non-intrusive, provides more thermal comfort than radiators and requires low feed temperatures. A drawback in this case is the slightly higher losses, due to the lack of insulation under the stonework of the floor.

Option 2 – Solid fuel heating

There are various solid fuel heating options, ranging from an open fire to an enclosed fully automated wood chip boiler:

Open fires have such low efficiencies that due to the amount of air drawn through the chimney, they act as a cooling instead of a heating system. We would therefore not recommend this option.

Wood/coal stoves have much better efficiencies. Some come with integrated back boilers to heat up water. The efficiency of these can go up to 75 to 80% (provided adequately seasoned wood is used) and can still have the ambiance as provided with an open fire. Recent market development also provides solid fuel stoves that can regulate the air flow through the fire, hence regulating the output. As combustion without surplus air produces toxic fumes, it is recommended to operate these types of stove nearly at maximum output. If an adequate heat store would be provided to absorb the surplus energy this option would be worth considering.

A third option is a fully automated wood chip or wood pellet stove. These systems look like central heating stoves. Although providing the highest efficiency and precise regulation of the burning process, they lack the ambiance and the radiance heat of a standard wood stove. Usually they are only available in larger outputs and require a three phase power supply which is not available in the property; hence we would not recommend this option.

If a wood fire with back boiler would be used, there would be a number of major benefits:

1. Surplus heat could be stored in a hot water storage tank. This hot water could be withdrawn from the store at any time.
2. The woodstove could be run close to its maximum capacity, thereby increasing the efficiency of the burning process.
3. The woodstove could indirectly heat up the under-floor heating via the storage tank.

The woodstove would only need to be run up to 4 hours per day in January.

Option 3 - Heat pump

In summer it would be a waste of resources to light the woodstove to provide hot water. A small air to water heat pump would provide the hot water during this time at the lowest cost and maximum efficiency.

A heat pump transfers energy in the form of heat from a cooler location to a warmer location. It uses the refrigeration process and transfers low temperature energy to a refrigeration loop, compresses the refrigerant to a high temperature, and transfers this heat to the hot water and heating distribution system.

There are several different kinds of heat pumps available, depending on where the energy is sourced. For this project an air-source heat pump would be most cost-effective.

For whole property heating with heat pumps, a larger system is necessary. These systems need a three phase power supply, which is not available at the property. As retrofitting of a three phase supply would be costly, a larger system would not be recommended. A smaller, single phase heat pump could provide the heat necessary for hot water and, when necessary, under-floor heating in the warmer season.

Option 4 – Solar collectors

To minimize electricity usage to heat up water, solar collectors could be installed. The principle of solar heating is well understood; the sun shines on a collector, and the heat from this collector is then transferred into a storage medium. The better the location of the solar collectors (south facing and at a horizontal inclination of 40° is optimal), the higher the yield.

However, solar heating would not be recommended in this case due to the disadvantageous orientation of the property.

Option 5 – Ventilation with heat recovery

Reducing ventilation losses is possible with forced ventilation with heat recovery.

A heat recovery system extracts air from the kitchen, bathrooms and utility room through a heat exchanger. The system then supplies fresh air to the bedrooms and living rooms through the same heat exchanger with 90% of the heat being transferred.

This would mean that the property would benefit from a constant supply of heated fresh air without the need to open windows.

However, due to space restrictions and the distance between the extraction points and inlets, it would be a very difficult and complicated installation. Although ventilation with heat recovery could be a good solution in other circumstances, we would not recommend using it in this instance.

**Recommendations**

We recommended using a woodstove with back boiler as the main provider of hot water and winter heating. A high efficiency hot water storage tank was recommended as the storage medium.

To prevent having to light the woodstove in summer, a small air to water heat pump was recommended for hot water and, when necessary, under-floor heating in all but the coldest season at the lowest cost and maximum efficiency.

A schematic overview of the heating system was provided, indicating how the central water tank would be linked to the woodstove with back boiler, air to water heat pump, under-floor heating and header tank.

An outside location was recommended for the heat pump, keeping in mind free running of air, avoidance of noise from fans, free discharge of cold coil condensation and short insulated runs to the heat store.

Sizes and types were proposed for the woodstove, heat pump and storage tank based on hot water requirements, lowest design temperature, heat loss and appliance efficiencies.

An estimation of cost for major components was also included.