

Section 2: Energy Efficient Buildings

2.1 [Assessing Heat Loss & Insulation Requirements](#)

2.2 [What is the Heat Loss of a Building?](#)

2.3 [Defining Options](#)

2.4 [Options an Initial Guide](#)

2.5 [Planning Applications & Building Regulations](#)

2. Energy efficient buildings

This section deals with energy efficiency issues and will help communities understand how best to tackle inefficient buildings or practices. It covers some technical detail which could be useful if a community is looking at improving building performance and energy usage.

2.1 Assessing Heat Loss and Insulation Requirements

Immediate savings on energy can be obtained by applying simple energy efficiency measures. These include:

- Draft proofing
- Adding new or more insulation into walls, ceilings and under the floor
- Installing double glazing
- Using low-energy light bulbs
- Blocking off unused chimneys
- Installing white goods with high ratings for energy efficiency
- Raising the awareness of those that use the facility as to best practice regarding energy efficiency.

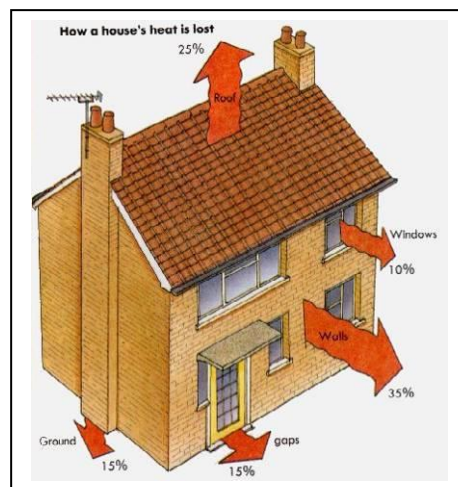
Buildings built before 2002 will not be as energy efficient as more modern buildings. Therefore, where possible, it would be advised to have the building improved to at least current day building standards so that maximum benefit can be gained from renewable technologies. Planning the installation of any renewable energy heating system will require consideration of *heat load, heat loss and insulation*.

A good source of advice and information on energy efficiency measures, and current building standards is Scottish Building Standards <http://www.sbsa.gov.uk>. They also have a useful guide available at <http://www.sbsa.gov.uk/homeimprovements.html>.

Further information on energy efficiency measures and funding is available at <http://www.energysavingtrust.org.uk/What-can-I-do-today> and <http://www.energysavingtrust.org.uk/scotland/Scotland/Consumers>

2.1.1 What is Heat Loss?

Heat Loss is the amount of heat that transmits from the inside to the outside of a building through walls, windows, roof and other building surfaces. Heat loss is expressed as Watts per metre squared (W/m^2). The rate at which heat is lost from a building is determined by many factors. Understanding how to minimise these factors can help to save money and carbon emissions.



2.1.2 How do we assess heat loss?

Heat loss can be estimated using the following equation:

$$\text{Total building heat loss} = \text{Fabric Heat Loss} + \text{Ventilation Heat Loss.}$$

The use of an infrared *thermal imaging camera* can also give a visual indication of where heat is being lost from a building. Thermal imaging involves measuring long-wave infrared radiation (heat) and displaying it as a visible picture. Thermal imaging can detect defects in insulation, air leakage, dampness, hidden objects such as flues and air ducts, damaged areas of insulation and blocked heating distribution pipes, locating central heating pipes.



Infra red photo of a building – brightest colours indicate highest heat loss

2.1.3 How can we minimise heat loss?

Get a survey carried out for the building to see where the levels of insulation can be improved to current building standards. The following measures can all help improve energy efficiency of buildings and reduce heat loss.

Draught Proofing

Draught proofing is an inexpensive measure which can be used to increase the insulating values of windows and external doors in buildings. Draught proofing can be fitted to letter boxes, access hatches and loft hatches.

Improving building fabric

Walls, windows, doors and other materials that make up a building envelope all have different levels of insulating properties. Older buildings can have higher ceilings and minimal or no insulation which requires a lot of energy to heat. New buildings are designed to meet specific building regulations on insulation levels to prevent heat loss. If the date of construction of the building is known, the minimum levels of thermal performance it should comply with can be found out. Further information is available on the Scottish Building Standards website <http://www.sbsa.gov.uk/homeimprovements.html>.

Insulation

Insulation is any material used to reduce heat loss. When insulation is placed in walls, ceilings or floors it reduces the loss or gain of heat from outside sources. The ability of material to retain heat or reduce loss is expressed as its **U-value**.

U -value is a measure of the amount of energy that will pass through an area of material when there is a 1°C difference in temperature between inside and out. U-values are expressed in W/m²K. Lower U-value materials are better at preventing heat loss.

Floor Insulation

Insulation can be fitted between suspended floor joists or under raised access floors to help prevent heat escaping through the floor. This should be standard where under floor heating has been fitted.

Loft/Ceiling Insulation

Current building regulations state the insulation in these areas should be of a depth of at least 270mm. It is essential that water tanks and pipe work present in the loft space are insulated also, but taking care not to insulate underneath the water tank as this could cause the water to freeze.



Typical loft insulation and pipe lagging

Photo from CES library

Solid Wall Insulation

For walls there are options to insulate both externally and internally. Internal wall insulation comes in the form of insulated plasterboard. The most common form of external insulation is external render or cladding.

Cavity Wall insulation

Cavity wall insulation can result in up to an 85% improvement in wall performance. Check that the building has a cavity wall structure – if there are no building plans and it is not possible to tell from the appearance, a local insulation company can assess the building free of charge by drilling a small hole in the wall to determine whether it is a solid or cavity wall. Cavity wall insulation is usually installed by drilling holes in the outer membrane of the wall and blowing in the insulation.

Glazing

Heat loss from the most thermally efficient window is still ten times more than the most thermally efficient wall. For this reason secondary, double or triple glazing will provide a beneficial increase to the thermal performance of windows. Conversion to Double or Triple Glazing windows can be expensive. The addition of a secondary layer of Perspex can prove less expensive but can still provide benefits.

Air tightness

A leaky building will allow heat to escape through poorly fitted windows, doors, and wall joints. Sealing the building envelope will prevent heat from escaping. Air tightness or pressure testing of a building can test for leakage. Air tightness testing is a legal requirement for community buildings with a usable floor area greater than 500m².

Note that with the addition of any energy efficiency measures it is extremely important to allow for adequate controlled ventilation, otherwise damp and condensation can build up.

2.2 What is the Heat Load of a Building?

The *Heat Load* of a building is the amount of energy required to raise and maintain the temperature of the structure to the desired level. Heat Load is usually expressed in kW. This value is used to determine the size of heating system required for the building. This is usually calculated on a room by room basis then scaling up to give a total heat requirement

for the building. Sizing the heating plant correctly is important as an incorrectly sized plant will result in inefficient operation.

A heating plant is sized to overcome the heat losses of a building. The calculation also takes into consideration the internal and external design temperatures.

The Internal Design temperature will depend on what temperature is required for the specific uses of the building. The External Design temperature will depend on your location in the country. For example the typical Scottish External Design temperature is -4°C . However if you are in a more extreme location such as Aviemore this can be -10°C . The actual external temperature can go below the design temperature but it is not practical or economic to design for heating system for 100% of the time.

The size and shape of a building will influence the amount of heat that is lost through the building envelope. The larger the building the larger the external surface area the more heat is lost through the building. Conversely the smaller the building the less opportunity there is for heat to escape. A south facing building will also benefit from solar gain ensuring that maximum daylight is absorbed by the building.

The number of air changes required in your building will differ depending on the specific usage of your building. Fresh air from the outside will be cooler so will require energy to heat up.

When designing a new building speak to your architect about designing an energy efficient building, minimising heat loss and maximising solar gain.

2.3 Defining options

For a group about to explore whether renewable technologies can bring benefit to a local community and have identified the key needs of the community, the next important step is to define options. This will require analysis of the local resources and an assessment of what the most efficient and beneficial technology would be. In some cases it may be necessary to gain expert advice and commission a report or a feasibility study by a specialist. Studies which may need to be undertaken include:

- Energy Audits
- Option Studies
- Feasibility Studies

Potential Gains from these studies include:

- Increased knowledge of how the building operates from an energy perspective.
- An indication of possible improvements to the building.
- An indication of whether renewables are feasible in the local area.
- An understanding of which renewables are feasible for the project.
- A strengthened application to funding bodies.

Carrying out a study can add additional time to a project. However, it can also give a community group better knowledge and understanding of what options are available.

If a study is necessary, it's a good idea to ensure that it also covers practical design requirements for the best option.

For more information on how to approach a feasibility study, see Annex 1. See [the Scottish Renewables Forum](#) website for a list of consultants active in Scotland.

2.4 Options – an initial guide

For groups initially assessing options, the following table will help guide the reader through this toolkit.

If not already considered, the first statement on this table needs to be addressed if dealing with an existing building. Once completed, choose one or more of the subsequent statements which most reflects the position of the group, then go to the relevant option identified for more information.

| State of building | Option | Section |
|---|--|---|
| We have not assessed heat demand, heat loss, or insulation requirements. There is little/no insulation in our building. | Get some help in assessing heat demand and heat loss to help scale your heat requirements. Assess scope for insulation before doing anything else | 2: heat loss and insulation |
| It has a sunny/open aspect | If you need hot water, solar water panels may be an option | 3: Solar Water Heating |
| It is in a windy location and has land nearby | A wind turbine to power heaters (direct heating from wind) may be an option | 3: Direct heating from wind |
| We have a river nearby | A hydro-electric plant may be an option | 6: Hydropower basics |
| We have a daily demand for heat and hot water and a local supply of wood | A boiler burning logs, woodchip or pellets may be an option | 3: Biomass heating 4: District heating |
| We need a reasonably constant background warmth | A heat pump may be an option | 3: Heat pumps |
| We are planning a new building | Careful design could significantly reduce energy requirements | SBSA website |

2.5 Planning applications and Building Regulations

In almost all projects involving installations on or adjacent to buildings, planning consent and a building warrant are likely to be required. It is essential to check first with local

authority planning and building control departments. The Scottish Government has brought to Parliament the conclusion of the General Permitted Development Rights (GPDR) consultation. This brings solar panels, ground source heat pumps and biomass boilers (specifically flues) into permitted development (PD), so for most circumstances planning permission will not be required for such installations. There are restrictions in areas of conservation status. Further information on this can be found at:

[The Town and Country Planning \(General Permitted Development\) \(Domestic Microgeneration\) \(Scotland\) Amendment Order 2009.](#)