10.0 Fuel Considerations

Due to the geographical area of the highland region not all fuel types are available at all properties. Fuel availability should be checked before carrying out a Fuel Options & Running Costs Appraisal.

10.1 Gas

Gas is often described as the cleanest fossil fuel, producing less carbon dioxide per joule delivered than either coal or oil and far fewer pollutants than other hydrocarbon fuels. However, in absolute terms, it does contribute substantially to global carbon emissions, and this contribution is projected to grow.

The Highland Council has a Gas Safety Management Manual which details the councils Corporate Gas safety Policy, Gas safety Management Policy (No. 014), Gas Safety Management Procedural Document (PCD 017) and Gas Safety Management Operational Instructions (OI-ISC-001 to 013). These documents should be consulted prior to the design and installation of a gas system within Highland Council properties.

Additionally, The Highland Council requires that all gas appliances are serviced every 12 months and no more frequently; this is to ensure a degree of continuity across appliances and to minimise unnecessary costs. No gas appliances which require servicing more frequently shall be acceptable for installation within Highland Council properties.

10.2 Oil

Heating oil is a method for home heating that is used throughout Scotland and the Highlands; it is the rural communities primarily, that rely on oil for heating. In terms of popularity, oil is second only to natural gas.

There is an environmental concern when it comes to the extraction, distribution and storing of heating oil; serious environmental damage. Environmental damage is very expensive to cleanup and it can seriously affect human health and property. It can also pollute water courses, damage plants and wildlife, make soil infertile and ruin habitats.

Additionally, like mains gas, oil prices are on the rise and are likely to remain high as the UK competes with growing demand from other countries. Recently prices of heating oil have gone up sharply and the Office of Fair Trading is now conducting a study of the off-grid energy market in the UK.

As oil is delivered by road there is therefore a possibility that the oil could run out while waiting for your next delivery or the delivery vehicle may be unable to gain access in rural locations during particularly extreme winter weather. These are issues which should be considered when specifying and designing heating systems, particularly in the rural areas throughout the Highland region.

The Highland Council has created an Oil Safety Management manual which details the councils Corporate Oil Safety Policy, Oil safety Management Policy (No. ??), Oil Safety Management Procedural Document (PCD ??) and Oil Safety Management Operational Instructions (OI-???-??? to ???). These documents should be consulted prior to the design and installation of an oil system within Highland Council properties.

The Highland Council requires that all oil appliances are serviced every 12 months and no more frequently; this is to ensure a degree of continuity accross appliances and to minimise unnecessary costs. No oil appliance which requires servicing more frequently shall be acceptable for installation within Highland Council properties.

10.3 Electricity

Electricity is an extremely flexible form of energy, and has been adapted to a huge, and growing, number of uses. Electricity generation is primarily fueled by natural gas and coal which means that emissions of pollutants and greenhouse gases from fossil fuel-based electricity generation account for a significant portion of world greenhouse gas emissions.

However, the increasing use of renewable technologies in the production of electricity means that it is becoming a greener fuel source. There are many possibilities for generating electricity directly from renewable sources of energy based on solar radiation, wind, tides, waves, hydropower and geothermal heat. Scotland and especially the highlands offer an ideal environment for the domestic scale generation of electricity from renewable sources such as solar photovoltaics and wind turbines. These are ideal technologies for reducing national grid electricity use in highland council properties.

The most cost-effective form of electric central heating uses storage heaters; these heaters use electricity supplied at a cheaper 'night-time' rate to heat up and are designed to keep warm for the whole of the following day. Cheap-rate electricity can also be used to provide hot water via an immersion heater in a hot water cylinder.

Electricity tariffs that provide cheap-rate electricity are usually known as Economy 7 or Economy 10. In order for electric storage heating to be cost effective the property must be on one of the electricity tarrifs above.

However, current electricity prices are around three times higher than gas prices per unit of energy. And like gas, electricity prices are also rising and are likely to stay high, as most electricity in the UK is generated in gas-fired power stations any increase in the price of gas will also be reflected in the cost of electricity.

The cost factor is a major consideration when choosing a fuel source for a new heating system within Highland council properties; commercially and domestically.

10.4 Coal

Coal is primarily used as a solid fuel to produce electricity and heat through combustion. World coal consumption was about 6.75 billion short tons in 2006 and is expected to increase 48% to 9.98 billion short tons by 2030.

There are a number of adverse health and environmental effects of coal burning especially in power stations, and of coal mining. These effects include:

- The generation of hundreds of millions of tons of waste products, including fly ash, bottom ash, flue gas desulfurization sludge, that contain mercury, uranium, thorium, arsenic, and other heavy metals
- Acid rain from high sulfur coal
- Interference with groundwater and water table levels
- Subsidence above tunnels, sometimes damaging infrastructure and homes
- Release of carbon dioxide, causing climate change and global warming. Coal is the largest contributor to the human-made increase of CO_2 in the air

Due to the nature of the highland region many properties are remotely located and therefore may only have access to limited fuel sources; coal being one of these.

However, The Highland Council no longer considers coal as a viable fuel source for its domestic properties due to its high carbon footprint. The aim of the council is to phase out the use of coal as a heating fuel and instead use a renewable technology, electric storage or oil heating (in order of preference) where gas is not available.

All properties which are receiving a new heating system and currently have open coal fires will have the coal fire removed and replaced with an electric feature fire and the chimney removed to below roof level and roofed over (where practical).

10.5 Biomass

Biomass is often called 'bioenergy' or 'biofuels'. These biofuels are produced from organic materials, either directly from plants or indirectly from industrial, commercial, domestic or agricultural products.

Biofuels fall into two main categories:

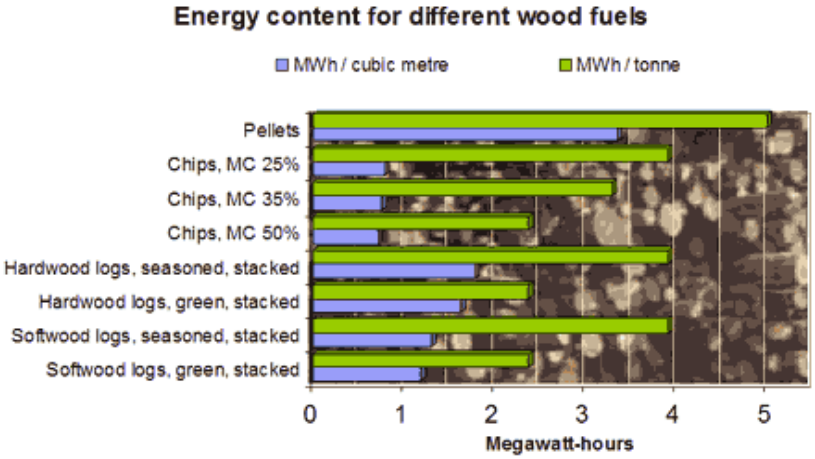
- Wood biomass includes forest products, untreated wood products, energy crops, short rotation coppice (SRC), e.g. willow.
- Non-woody biomass includes animal waste, industrial and biodegradable municipal products from food processing and high energy crops, e.g. rape, sugar cane, maize.

Wood biomass is an attractive fuel for addressing the concerns of the energy crisis and climate change, since the fuel is affordable, widely available, and is carbon neutral and sustainable as long as the crops are allowed to regrow.

The climate impact of biomass is disputed' though biomass fuels, including wood pellets and other wood fuels, produced using best practices from sustainably managed forests, fuel crops, or other forms of biomass waste are generally recognized as having far lower net lifecycle carbon dioxide emissions than fossil fuel equivalents, to the order of 98% fewer emissions. However, if best practices and sustainable biomass management is not instituted, carbon emissions can exceed those of natural gas combustion.

Wood biomass is an attractive fuel for use throughout the Highland region due to it's large areas of forestry and farm land.

The graph below offers an indication of the differing energy content of the main biomass wood fuels which are available throughout the Highland Council region –



Wood Pellets: Wood pellets are a refined, homogenised form of wood fuel produced from byproducts of sawmilling and other wood transformation activities. Their consistent properties make them an ideal fuel for automatic heating systems from small scale to large industrial applications. The pellets are extremely dense and can be produced with a low humidity content (below 10%) that allows them to be burned with very high combustion efficiency.

Emissions such as NO_x, SO_x and volatile organic compounds from pellet burning equipment, are, in general, very low in comparison to other forms of combustion heating, making this one of the less-polluting heating options available.

Pellets take up less storage space than other wood fuels, but require about three times the space needed for heating oil with the same energy content. Storage facilities required will depend on how the pellets are supplied; small systems such as room heating stoves allow pellets to be bought in bags which can be stored anywhere sheltered and out of the rain, however, these is the costlier option.

Pellets are considerably cheaper when bought in bulk and delivered by a truck, however, this requires a hopper, silo or bunker capable of storing at least 5 tonnes of pellets. The final storage solution and capacity is ultimately dependent on the size of the property, the size of the boiler and the availability of fuel, locally.

Wood Chip: Wood chip is a processed form of wood fuel that can be used in automatic equipment without the high degree of processing required to manufacture pellets.

Traditionally woodchips are used as a solid fuel for heating in buildings or in energy plants for generating electric power from renewable energy. The advantage of woodchips is cost while the advantage of wood pellets is the controlled fuel value.

Fuel quality is crucial for reliable operation of a wood chip boiler. The key parameters are material, size and moisture content. Storage facilities for wood chip will also depend on the size of the property, size of the system and the availability of fuel locally.

Wood Logs: Split logs are the traditional wood fuel that has been used for centuries in open fires and more recently in stoves and boilers. For successful burning of wood logs the moisture content should be below 25% so it's advisable to have covered storage facilities for at least one years worth of fuel, to allow for seasoning.

Fuel demand and storage facilities will depend on the size and thermal efficiency of the heated building, however, as a rough indication; a small 1-2 bedroom bungalow might use $8m^3$ of seasoned stacked logs per year, a 2-3 bedroom semi-detached house around $12m^3$ and a 3-4 bedroom detached house about $16m^3$. In terms of storage area this equates to 1.5-1.8m^3 of storage space per $1m^3$ of solid wood when stacked as logs.

Furthermore, with regards to planning permission for such technologies; since 12th March 2009 there is no longer a need to apply for planning permission to add certain "green" energy producing micro generation technology to residential properties. Wood burning boilers and stoves are permitted under the new General Permitted Development (GPD) order, unless:

- The flue exceeds 1m above the roof height
- The appliance is installed on the principal elevation and visible from a road in buildings in Conservation Areas and World Heritage Sites.

Finally, The Highland Council requires that all boilers, stoves etc. are serviced every 12 months and no more frequently; this is to ensure a degree of continuity across appliances and to minimise unnecessary costs. No boiler, stove etc. which require servicing more frequently shall be acceptable for installation within Highland Council properties.

10.6 Air / Ground

A heat pump can be used to provide heating or cooling using the same basic refrigeration cycle to do both. In other words a heat pump can change which coil is the condenser and which the evaporator; this is normally achieved by a reversing valve.

An Air Source Heat Pump uses outside air as a heat source or heat sink. Outside air, at any temperature above absolute zero, contains some heat. An air-source heat pump moves some of this heat to provide hot water or space heating. This can be done in either direction, to cool or heat the interior of a building.

The 'Efficiency' of air source heat pumps (CoP) is limited by the Carnot cycle and will approach 1.0 as the outdoor-to-indoor temperature difference increases (around −18 °C / 0 °F outdoor temperature for air source heat pumps). Within most normal temperature ranges of say -3°C to 10°C heat pump performance and thus the CoP for many machines can be fairly stable at 3-3.5. However, heat pump construction methods that enable use of carbon dioxide refrigerant extend the figure downward to -30 °C (-22 °F).

A Ground Source Heat Pump uses the earth, as opposed to the air, as a heat source (in the winter) or a heat sink (in the summer). This design takes advantage of the moderate temperatures in the ground to boost efficiency and reduce the operational costs of heating and cooling systems, and may be combined with solar heating to form a geosolar system with even greater efficiency. A ground source heat pump has less change in CoP as the ground temperature from which they extract heat is more constant than outdoor air temperature.

The geothermal pump systems can reach fairly high Coefficient of performance (CoP), 3-6, on the coldest of winter nights, compared to 1.75-2.5 for air-source heat pumps on cool days.
The Highland Council favours Air Source Heat Pumps for installation in its domestic properties due to the high cost and logistical issues associated with installing Ground Source Heat Pumps in residential areas. It is easier and more cost effective to install Ground Source Heat Pumps in the council's commercial properties which have adequate external space and higher, individual, heating and hot water demands.

Additionally, Ground Source Heat Pumps are permitted through the General Permitted Development order with no restrictions being placed on this technology. However, Air Source Heat Pumps are not permitted at present due to concerns regarding noise and vibration; ASHP systems must have planning permission before being installed.

Finally, The Highland Council requires that all heat pump appliances are serviced every 12 months and no more frequently; this is to ensure a degree of continuity across appliances and to minimise unnecessary costs. No heat pump appliance which requires servicing more frequently shall be acceptable for installation within Highland Council properties.

10.7 Solar

Both Solar Electric and Solar Hot water systems utilise the suns energy. The highlands are not considered the sunniest location, however, enough energy can still be derived from the sun to generate both hot water and electricity.

Solar Electric: Photovoltaic (PV) systems can be installed on most properties as they utilise daylight as opposed to direct sunlight to generate electricity. PV systems can be installed on a building with a roof or wall that faces within 90 degrees of south, as long as no other buildings or large trees overshadow it. In addition, the roof must be strong enough to take the additional weight, especially if the panels are placed on top of existing roof tiles.

Solar Hot Water: Flat plate collector systems use the heat from direct sunlight to heat water and therefore perform better if installed in properties which have roofs that face up to 45 degrees each way off south (between SW and SE), as long as no other buildings or large trees overshadow it. Furthermore, the structural soundness of the properties roof must also be considered before installing solar hot water systems; as the weight of both the solar panel and the water within it create a large additional loading on the roof.

The Highland Council has various solar electric and solar hot water systems installed in both domestic and commercial properties. These technologies are easily installed in the majority of buildings and can be used to improve energy reduction in any property with any heat & hot water system.

However, there are some conditions for installing solar systems under the new General Permitted Development (GPD) order –

- Solar PV or solar thermal equipment installed on a building shall, so far as practicable, be sited so as to minimise its effect on the external appearance of the building;
- Solar PV or solar thermal equipment shall, so far as practicable, be sited so as to minimise its effect on the amenity of the area; and
- Solar PV or solar thermal equipment no longer needed for micro generation shall be removed as soon as reasonably practicable.

In particular roof mounted solar photovoltaic and solar thermal systems are permitted, in Scotland, unless:

- Panels when installed protrude more than 200mm.
- They would be placed on the principal elevation facing onto and visible from a highway in buildings in Conservation Areas and World Heritage Sites.
- Installed on any part of the external walls of the building if the building contains a flat
- Panels when installed on a flat roof are situated within 1 metre from the edge of the roof or protrude more than 1 metre above the plane of the roof
- Panels when installed project higher than the highest point of the roof

10.8 Wind

In the UK we have 40% of Europe's total wind energy. But it's still largely untapped and only 0.5% of our electricity requirements are currently generated by wind power. With Scotland being the windiest country in Europe, while the Highlands and Islands have Britain's most sustained wind regimes for turbines with significant new investment.

Uses range from very small turbines supplying energy for battery charging systems (e.g. on boats or in homes), to turbines grouped on wind farms supplying electricity to the grid.

Wind speed is one of the most important factors influencing the output of a wind turbine. Wind speed is affected by many factors including height above the ground, presence of obstructions such as trees, houses or other buildings that might disrupt the wind speed and cause turbulence. We recommend that, if you are considering a domestic building mounted installation and electricity generation is your main motivation, then you only consider a wind turbine under the following circumstances:

- The local annual average wind speed is no less than 5 m/s. To check the approximate figure for your location click here.
- There are no significant nearby obstacles such as buildings, trees or hills that are likely to reduce the wind speed or increase turbulence

For more commercial turbines; wind speed increases with height so it's best to have the turbine high on a mast or tower. Generally speaking the ideal siting is a smooth-top hill with a flat, clear exposure, free from excessive turbulence and obstructions such as large trees, houses or other buildings.

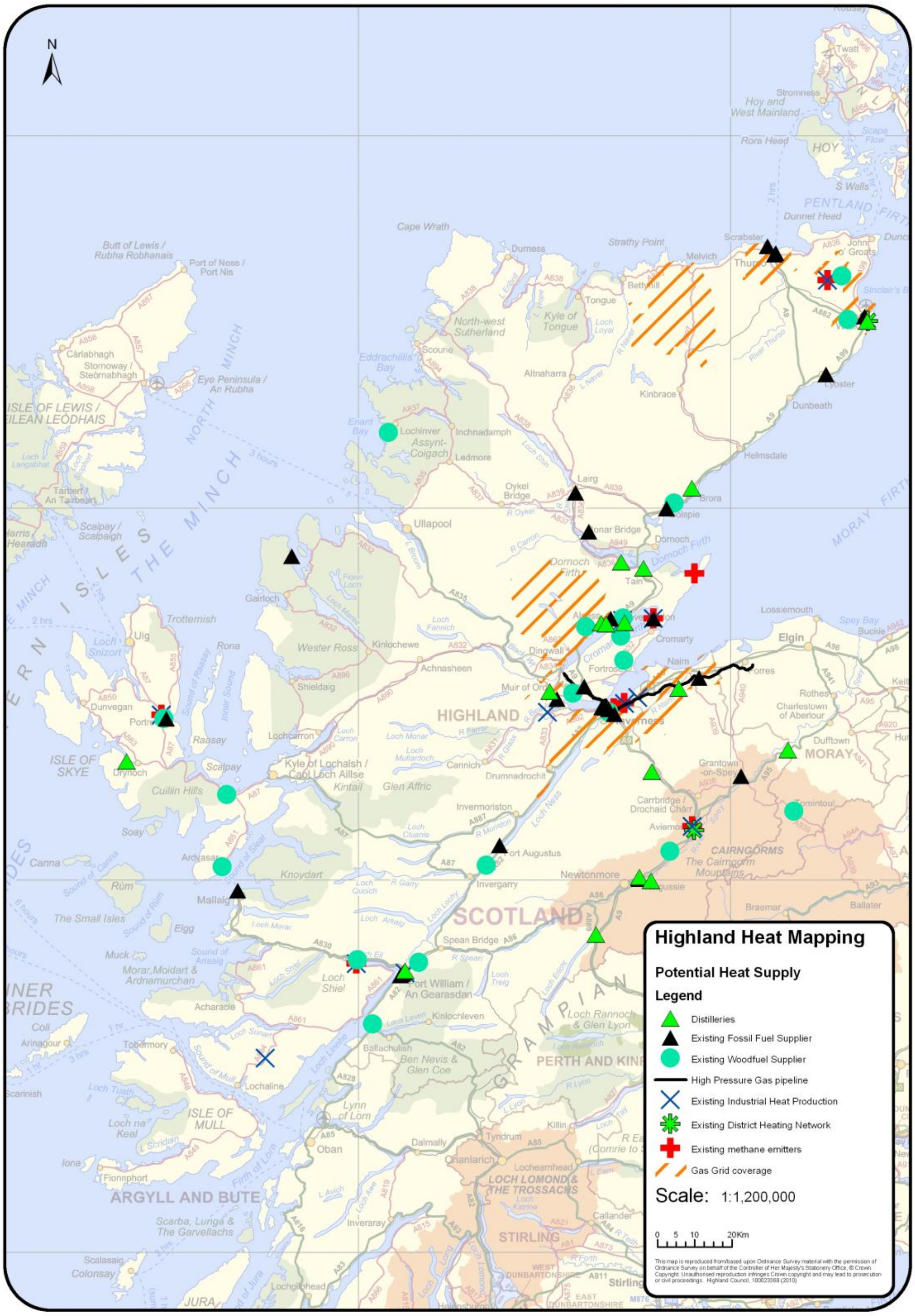
Planning issues such as visual impact, noise, shadow flicker and conservation issues also have to be considered; all wind turbine installations require planning permission from The Highland Council's planning department. Wind turbines do not gain automatic installation permission through the General Permitted Development order.

10.9 Fuel Options & Running Costs Appraisal

The Fuel Options & Running Costs Appraisal spreadsheet which The Highland Council has created will, when completed, clearly show which fuel would be the most cost effective for a particular project.

This allows a clear and concise appraisal to be carried out of the different fuel options available to each design project.

The map of the highland region, below, has been extracted from the Highland Heat Map system and identifies the areas of the Highland region which have gas grid coverage along with identifying fossil fuel suppliers and wood fuel suppliers, allowing quick identification of available fuel sources at project location(s).


N
Highland Heat Mapping
Potential Heat Supply
Legend
Distilleries
Existing Fossil Fuel Supplier
Existing Woodfuel Supplier
High Pressure Gas pipeline
Existing Industrial Heat Production
Existing District Heating Network
Existing methane emitters
Gas Grid coverage
Scale: 1:1,200,000
0 5 10 20Km
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HIGHLAND
SCOTLAND
MORAY
ISLE OF SKYE
ISLE OF MULL
ARGYLL AND BUTE
STIRLING
CAIRNGORMS
HOY