scottish renewables

LOW-CARBON HEAT IN SCOTLAND

RENEWABLE HEAT

The transition to renewable heat is the next big stage of Scotland's net-zero journey, offering enormous economic, environmental and social benefits.

Renewable heat supports healthier communities as it removes the need to burn natural gas in boilers which impacts on our public health. Renewable heat also insulates households against fossil fuel price volatility: a key cause of fuel poverty.

Investing in low-carbon heat and energy efficiency retrofit could create up to 24,000 skilled Scottish jobs over the next decade, providing much needed stimulus as we rebuild our economy from the COVID-19 pandemic.

Heating accounts for approximately 50% of Scotland's energy use, yet currently only 6.5% of Scotland's heat requirements are met from low-carbon sources.

If we are to make progress towards net-zero and realise the benefits of heat decarbonisation, Scotland must move away from heating its homes and buildings with harmful fossil fuels like gas, LPG and oil.

We now need to accelerate the deployment of renewable heat technologies across all of Scotland's communities - city, town, rural and island - ensuring essential progress on decarbonisation is made.

This paper explains the different forms of low-carbon heat technologies which will make this possible.

INVESTING IN LOW-CARBON HEAT AND ENERGY EFFICIENCY RETROFIT COULD CREATE UP TO 24,000 SKILLED SCOTTISH JOBS OVER THE NEXT DECADE

HEAT PUMPS

Heat pumps work on the same technology as fridges and freezers, but in the opposite way: while refrigeration mechanisms pump heat out of an enclosed space and release it into the wider environment, heat pumps gather heat from the wider environment and transfer it into the enclosed space of a building.

Heat pumps run on electricity. For every 1kW of electricity used, heat pumps produce 3kW of heat, making them much more efficient than traditional electric heaters.

Ground source heat pump, Alloway, South Ayrshire.

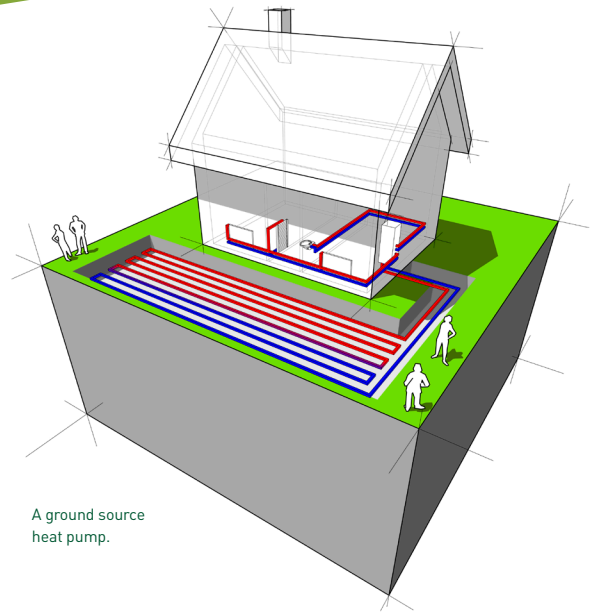
GROUND SOURCE HEAT PUMPS

Ground source heat pumps are attached to either a loop of pipe that runs at least one metre below the ground, or down into a borehole. Fluid is circulated through the pipe to gather heat from the ground.

As the ground is a much more concentrated source of heat than the air, and ground temperatures below one metre stay almost constant year-round, these heat pumps still operate effectively in cold weather.

The installation of a ground loop or bore hole currently makes ground source heat pumps slightly more expensive than other types of heat pump. These devices also require a property with sufficient land to accommodate a loop or borehole.

Ground source heat pumps work in buildings that are less well-insulated than would be required for an air source heat pump, so are often suited to existing homes which have had their insulation and windows upgraded.



A ground source heat pump.

Air source heat pump, social housing, Tarbolton, South Ayrshire.

AIR SOURCE HEAT PUMPS

Air source heat pumps look very similar to air-conditioning units but work in the opposite way - gathering heat from the air outside a building, concentrating it and transferring it into the building.

They are the most straightforward and cheapest heat pump to install, but can struggle to produce enough heat when the air temperature is very low.

Air source heat pumps work best in well-insulated buildings and are a good solution for new-build houses.

WATER SOURCE HEAT PUMPS

Water source heat pumps are very similar to ground source heat pumps but the heat gathering loop is in a water source.

This could be a river, pond or in some cases a disused, flooded mine.

UK's largest water-source heat pumps, Star Renewable Energy, Glasgow.

These are generally cheaper than ground source heat pumps but are only appropriate for locations where there is a suitable water source.

HEAT PUMPS USING WASTE HEAT AND HYBRID SYSTEMS

Air, ground and water source heat pumps can all be adapted to use heat generated by other processes.

For example, water source heat pumps can be used to extract heat from sewage, while air source heat pumps can use heat from industrial processes.

These can be very effective but are limited to locations where a suitable source of waste heat is available, for example a large factory or data centre.

There will always be a small number of buildings – particularly historic ones – which cannot be insulated to the standard needed to make a heat pump-based system viable on its own.

In such properties hybrid systems that have a back-up system fuelled by electricity, biogas or hydrogen will be needed to boost heat levels on the coldest days.

Hybrid systems are more expensive to run but may be necessary in certain hard-to-treat buildings.

Water-source heat pump, Lairds Table Restaurant, Crawfurdland Estate, East Ayrshire.

SCOTLAND HAS A GROWING NUMBER OF HEAT NETWORKS BUT THE LEGISLATION NEEDED TO MAINSTREAM THEM IS NOT YET FULLY OPERATIONAL

DISTRICT HEAT NETWORKS

District heat networks are an alternative to installing an individual heat pump in each home.

They consist of a pipe network that runs between a number of buildings forming a continuous loop. Hot water is generated at a central point – in a low-carbon network this would be done using an industrial-scale heat pump or biomass boiler – and then pumped to the individual buildings through the pipe. As the hot water passes through the radiators in each building it releases its heat and cools down. The cooled water then flows back to the central heat generation point to be reheated and sent around the loop again.

Each building has a meter to monitor the amount of heat it is using, as well as individual thermostats so each user maintains complete control over the heat of their own home or office.

Heat networks require a high density of users, and often an 'anchor load' to make them efficient. The 'anchor load' can come from a large structure such as a university building, office block or hotel that helps maintain a minimum heat demand on the network. These two requirements mean district heat networks work best in densely-populated areas such as city centres.

District heat networks are the norm in major European cities including Copenhagen and Amsterdam, where they have been used for decades and provide heat to the majority of buildings (in Copenhagen the figure is 98%).

Scotland has a growing number of heat networks but the legislation needed to mainstream them is not yet fully operational. It is hoped that the Heat Networks (Scotland) Act and supporting policies will address this issue and make heat networks common in Scotland.

A biomass district heating system which provides 4.5 tonnes of hot water every hour to heat 700 social housing flats in Broomhill, Glasgow.

SOLAR THERMAL SYSTEMS

Solar thermal technologies turn sunlight into heat instead of electricty, and were the first solar energy products to be commercialised in the UK.

Solar thermal units are usually made up of a solar collector, a water distribution system including a pump and a controller, and a thermal store (usually a hot water cylinder). Sunlight falls on a flat plate or an evacuated tube collector and heats up a fluid that transfers the energy to the building's heating or hot water system. Flat plate systems tend to be cheaper, but evacuated tubes are more efficient. These systems can work effectively for 25 years.

Solar thermal systems work best if they are inclined at about 30-40 degrees from horizontal, and when placed on a south-facing roof, however they do still work on south-west or south-east facing roofs. The roof area needs to be of a good size and able to handle the weight of the panels.

Because heat waves carry more energy than sunlight, and because there is no process of transformation into electricity, solar thermal panels are actually more efficient than PV panels.

Solar thermal evacuated tubes (left) and solar PV panels (right), Castle Semple Country Park, Renfrewshire.

Solar thermal evacuated tubes.

A biomass district heating system which provides 4.5 tonnes of hot water every hour to heat 700 social housing flats in Broomhill, Glasgow.

BIOMASS ACCOUNTS FOR 63% OF SCOTLAND'S TOTAL RENEWABLE HEAT GENERATION CAPACITY

BIOMASS

Biomass and biogas (together termed simply biofuels) have been derived from living matter such as wood, forest residues, plant material and animal and agricultural waste which can be used to generate energy.

Biofuels are considered to be carbon-neutral, because the CO2 produced when burning the fuel is offset by the CO2 that has previously been absorbed from the air.

Biomass as a heating fuel is typically used in boilers which run wood pellets or chips, often sawmill waste. Biomass accounts for 63% of Scotland's total renewable heat generation capacity and it is seen as one of the lowest-cost routes to decarbonising heat.

Whilst supporting progress to net-zero, biomass is not a viable solution for the mass decarbonisation of heat due to the limited availability of sustainable fuel sources.

Biomass district heating system, Floors Castle, Scottish Borders.

Biomass combined heat and power, Hevac, East Kilbride.

COMBINED HEAT AND POWER

Combined Heat and Power (CHP) is a highly-efficient technology that generates electricity and simultaneously captures heat from the electricity generation process which would otherwise be wasted. This provides thermal energy that can be used for many heating solutions such as space heating and cooling, domestic hot water and industrial processes.

CHP can be used for individual buildings or as a district heating energy source. CHP is fuel neutral, which means that it can be used with both fossil and renewable fuels. One of its main benefits is that both the electricity and heat which is produces can be used locally (often in the same building), avoiding transmission and distribution energy losses.

ENERGY EFFICIENCY

Energy efficiency means reducing energy demand and cutting down consumption.

Households and businesses can save energy by installing insulation and other measures such as draught-proofing.

Most buildings in Scotland are not particularly well insulated or energy efficient. To compensate for this, gas, LPG or oil-fired heating systems are designed to work at 60-65°C, as much of the heat they produce will be lost. To keep cost down most people only heat their homes at certain times, such as mornings and evenings. These high temperatures, combined with a continuous cycle of heating and cooling, make traditional fossil-fuel heating systems very inefficient.

Heat pumps and district heat networks work much more efficiently at around 40°C, and when buildings are kept at a constant, comfortable temperature.

Due to the difference between the way high and low-carbon heating operates, work to insulate buildings and make them more energy efficient must go hand in hand with the switch to low-carbon heating systems – creating employment and upskilling opportunities.

HOUSEHOLDS AND BUSINESSES CAN SAVE ENERGY BY INSTALLING INSULATION AND OTHER MEASURES SUCH AS DRAUGHT-PROOFING

Installing insulation in a ceiling.

SOURCES

Existing Homes Alliance (2021)

Energy Saving Trust – Renewable Heat in Scotland 2020

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www.scottishrenewables.com