Greener Home Heating

Cost and carbon footprint illustrations for a number of options for reducing the carbon footprint from home heating

Over following pages we provide 6 illustrations of the options that are being promoted as ways for reducing the carbon footprint of your home hot water and space heating.

The carbon footprint from heating our homes is far from insignificant. A typical Victorian mid-terrace house will use around 12,000kWh of energy for space heating and 2,500kWh for hot water every year. This is even with a well-insulated loft and a modern gas-fired boiler. This will produce around 2.75 tonnes of greenhouse gases, which is the same carbon footprint as driving 11,770 miles a year in an average car, or flying 11 round trips to and from Rome.

To produce the illustrations we have brought together a number of official data-sets. These are:

- Government data on energy consumption for a range of housing types.
- Data provided to the government by consultancy Delta EE on the costs of installing a range of new heating options. The data they provided including a range of costs (low, central, high). These are illustrative costs only - the actual costs will vary depending on how easy the installation is or not, and costs of labour vary across the UK.
- Data from the National Grid on the carbon intensity of the electricity grid now, including at different times of year and different times of day. Carbon intensity is the carbon footprint from producing a unit of electricity. For example, if the electricity at a given time is largely produced by renewable energy the carbon intensity will be low whereas if the electricity is largely produced by gas-fired power stations the carbon intensity will be high.
- Government projections of the carbon intensity of the electricity grid in future years. The carbon intensity is projected to decline as more renewable power is produced.
- Estimates on how much subsidy some of the options may be eligible for under the governments Renewable Heat Incentive. This data is from a 2018 Fact Sheet published by the regulator Ofgem, but is provided as a guide only.

For the heat-pump option we have used reasonable estimates on how much energy they can capture from the surrounding environment. Heat pumps work like fridges in reverse. Rather than cooling the inside and dissipating the heat outside of the fridge the heat pumps capture heat from the environment outside the house (air or land) and transfer the heat into the house. They work even when the temperature outside is as low as minus 20°C, but they operate more efficiently at higher temperatures. For our modelling we have used a factor of 2.8 for air-source heat pumps (for every unit of electricity consumed they provide 2.8 units of warmth), 3.0 for air-air heat pump, and 3.2 for ground source heat pumps.

For the energy costs we have used current costs from one supplier. The costs will differ dependent on your supplier. Our choice of this supplier does not imply endorsement of the company or its practices.

We have also added an additional example of one type of micro fuel-cell CHP. The data the government requested from Delta-EE did not include costs from this new technology which has just come to market in the UK (200,000 units are already installed in Japan). The cost data we are using for this comes from the manufacturer.

Over following pages we provide the following illustrations for all of the UK except Northern Ireland[1]:

- **An end of terrace house using an air-source heat pump for space heating and hot water**.
- **A mid-terrace house using an air-source heat pump for space heating but keeping a gas-fired boiler for hot water.** This is possibly a configuration where a house does not have space for a hot water tank.
- **A semi-detached house using a ground-source heat pump for space heating and hot water with underfloor heating installed.** The house would need a garden for the heat to be extracted from the soil (with pipework either buried in trenches or a borehole). In this example underfloor heating is also fitted downstairs which operates better than radiators, although radiators can be used and are a cheaper option.
- **A bungalow using a ground-source heat pump for space heating and hot water using radiators –** as above, but without the added expense and disruption of fitting underfloor heating.
- **A bottom floor flat using air-air heat pumps for space heating and gas-fired boiler for water heating** – in our example 3 heat pumps are fitted but the number needed will depend on flat size and configuration.
- **A mid-floor flat with modern high retention storage heaters** – we provide this example even though in the very short term it is unlikely to reduce the carbon footprint from space heating, but it is likely to do so over the next few years as the proportion of renewable energy supplying the electricity grid increases. For this

[1] Northern Ireland has a much greater carbon footprint for the electricity supplied to householders (carbon intensity) which makes these calculations different. The Northern Ireland government also doesn't produce future projections of grid carbon intensity. In addition, the subsidy available is different to the UK (the RHI in Northern Ireland has been suspended). But in summary, heat pumps and fuel-cell micro-CHP will cut your carbon footprint in Northern Ireland (around 10% for heat pumps and around 25% for fuel-cell micro-CHP) whereas electric heaters and storage heaters will substantially increase your carbon footprint.

example we have used data on the carbon footprint of the electricity grid at the times it uses electricity (the Economy 7 period).

There are a number of heating options for which we have not been able to provide illustrations, or chosen not to. These are:

- **Hybrid heat pumps** - we have not been able to provide an illustration for a hybrid heat pumps. These operate as a normal air-source heat pump except when it is very cold outside (e.g. 3 degrees) when they are supported by a gas-fired boiler. They are suitable for homes which can't easily be well-insulated or where it is not practical to replace existing radiators with larger radiators. The reason for not being able to provide an estimate is that we do not have access to data on the carbon implications of these, although they will be much better than gas-fired boilers but more carbon intensive than a normal air-source heat pump.
- **Infrared heaters -** Pretty new to the market are 'far infrared' heaters. These provide warmth by heating objects rather than heating the air. So much like sitting in the sun on a winter's day, you can still feel warm even though the air is cold around you. That doesn't mean your house will be cold, because as your household belongings and the fabric of the house (e.g. sofas, floors, walls, etc.) warm-up they will radiate the heat back out. One leading company selling these heaters – Herschel Infrared Heaters - provided us with data that suggested for a couple of the housing types we have modelled their heaters would reduce heating bills and the carbon footprint by a third or more compared to conventional electric radiators, while providing the same degree of warmth. These therefore look a promising new technology and better than electric radiators and storage heaters. But without independent data we decided we were unable to provide an illustration on this technology.
- **Micro fuel-cell CHP** – this is a relatively new and expensive technology coming to market in the UK. It's fitted in the house and uses your gas supply to provide both heat and electricity. The one example we've looked at - made by Veismann UK - occupies about the same space as a large fridge-freezer. Right now it will reduce your carbon footprint by a tiny bit but only because the electricity grid right now still uses lots of inefficient gas-fired power stations. As the grid gets cleaner with more renewable power this way of producing electricity will be more polluting than using grid electricity and therefore increase your carbon footprint. For this reason we haven't provided an illustration. That said, In Northern Ireland this option is one of the best of all options right now because the carbon footprint of the electricity grid in Northern Ireland is so high. However it isn't a cheap option, costing around £12,000.
- **Electric radiators** - we have chosen not to provide an illustration for electric radiators as they are likely to have a larger carbon footprint than even a gas-fired boiler for at least five years. These radiators use grid electricity when the heat is needed, unlike the storage heaters that use electricity overnight when demand is low. These radiators therefore typically use electricity at peak demand times. These are the periods when the electricity grid has the highest carbon footprint as lots of gas-fired power stations are fired-up to meet the peak in demand.
- **Biomass boilers** - We have also chosen not to provide examples of biomass boilers even though they are financially supported by the government under its Renewable Heat Incentive. The carbon footprint of a biomass boiler or wood-burning stove depends very much on the source of the wood, so we are unable to model the carbon

footprint. In addition, in urban areas wood burning is coming under the spotlight due to the contribution to air pollution.

Most of the illustrations below demonstrate significant reductions in the carbon footprint of heating except for the high heat retention storage heaters which will not show carbon footprint savings for a few years yet and not significant savings until 10 years or so. None of the options will save you money over the next 10 years, even those with a government subsidy. The reality is that natural gas is cheap and gas-fired boilers are cheap. But using natural gas for heating is a significant contributor to climate change, which brings enormous costs and hardship already and will increasingly do so for future generations. The price we pay for natural gas does not reflect these costs.

We hope you find these illustrations helpful. But be warned they are only illustrations and particularly the costs will vary, potentially considerable, depending on your property. You can get more detail and try out different options in the home heating calculator we have produced, please contact info@foe.co.uk for a copy.

EXAMPLES

Air-source heat pump #1

<table>
<tr><td colspan="3">House type: End of terrace house</td></tr>
<tr><td colspan="3">Description: Built 1976 - 1982, 3 bedrooms, floor area of 86m^2. Cavity wall (i.e. insulated), with good loft insulation.</td></tr>
<tr><td colspan="2">Existing heating & hot water:
Gas (modern, post 2005)</td><td>Future heating: Air source heat pump
Future hot water: Air source heat pump</td></tr>
<tr><td colspan="3">Description of works needed to fit new system: An Air-Source Heat Pumps located outside the house will provide all the heating and hot water. The radiators will need to be replaced with bigger radiators and if there isn't already a hot water tank one will need to be installed (cost included in the estimates below).</td></tr>
<tr><td>New system cost estimates[a]:
High: £14,300
Central: £11,450
Low: £8,800</td><td>Government subsidy (RHI)
£5,241 total over 7 years</td><td>New running costs[b]:
£143 additional per year</td></tr>
<tr><td colspan="2">Carbon emissions from new system[b,c]:
2018: 1.17 tonnes / year
2025: 0.67 tonnes / year
2030: 0.48 tonnes / year</td><td>Carbon comparison with old system:
2018: 57%
2025: 33%
2030: 24%</td></tr>
<tr><td colspan="3">Notes:

a) New system costs includes installation costs, which may vary considerably. Costs shown exclude VAT - applicable rates can vary according to specific circumstances.

b) Assumes electricity is from the grid. Homes with solar PV panels will reduce electricity from the gird, although most heating demand occurs during winter months when the PVs are less productive. Buying 100% renewable electricity supports and encourages the development of renewable energy but does not change the overall carbon intensity of grid electricity in the short-term. Figure shown is based on costs including VAT.

c) 2018 estimate is based on carbon intensity of the grid during typical heating periods in the winter months of 17/18, which were around 20% higher than the annual average carbon intensity of the grid. Future projections assume that the carbon intensity is similarly higher at these times than the projected annual average.</td></tr>
</table>

Air-source heat pump #2

<table>
<tr><td colspan="3">House type: Mid-terrace</td></tr>
<tr><td colspan="3">Description: Built before 1900, 3 bedrooms, floor area of 86m^2. Solid wall (i.e. not cavity insulated), with good loft insulation.</td></tr>
<tr><td colspan="2">Existing heating & hot water:
Gas (modern, post 2005)</td><td>Future heating: Air-Source Heat Pump
Future hot water: Gas boiler</td></tr>
<tr><td colspan="3">Description of works needed to fit new system: An Air-Source Heat Pump located outside the house will provide all the heating. Hot water will be provided by a gas boiler. The radiators will need to be replaced with bigger radiators (cost included in the estimates below).</td></tr>
<tr><td>New system cost estimates[a]:
High: £10,800
Central: £8,950
Low: £7,300</td><td>Government subsidy (RHI)
£5790 total over 7 years</td><td>New running costs[b]:
£158 additional per year</td></tr>
<tr><td colspan="2">Carbon emissions from new system[b,c]:
2018: 1.78 tonnes / year
2020: 1.23 tonnes / year
2025: 1.02 tonnes / year</td><td>Carbon comparison with old system:
2018: 65%
2020: 45%
2025: 37%</td></tr>
<tr><td colspan="3">Notes:

a) New system costs excludes installation costs, which may vary considerably. Costs shown exclude VAT - applicable rates can vary according to specific circumstances.

b) Assumes electricity is from the grid. Homes with solar PV panels will reduce electricity from the gird, although most heating demand occurs during winter months when the PVs are less productive. Buying 100% renewable electricity supports and encourages the development of renewable energy but does not change the overall carbon intensity of grid electricity in the short-term. Figure shown is based on costs including VAT.

c) 2018 estimate is based on carbon intensity of the grid during typical heating periods in the winter months of 17/18, which were around 20% higher than the annual average carbon intensity of the grid. Future projections assumes that the carbon intensity is similarly higher at these times than the projected annual average.</td></tr>
</table>

Ground-source heat pump #1

<table>
<tr><td colspan="3">House type: Semi-detached</td></tr>
<tr><td colspan="3">Description: Built 1900 - 1929, 3 bedrooms, floor area of 88m^2. Solid wall (i.e. not cavity insulated), with good loft insulation.</td></tr>
<tr><td colspan="2">Existing heating & hot water:
Gas (modern, post 2005)</td><td>Future heating: Ground-Source Heat Pump
Future hot water: Ground-Source Heat Pump</td></tr>
<tr><td colspan="3">Description of works needed to fit new system: A Ground-Source Heat Pump located outside the house with a trench in the garden will provide all the heating and hot water. Underfloor heating will be fitted downstairs. Radiators upstairs will be replaced with bigger radiators and if there isn't already a hot water tank one will need to be installed (cost included in the estimates below).</td></tr>
<tr><td>New system cost estimates[a]:
High: £35,200
Central: £28,500
Low: £22,750</td><td>Government subsidy (RHI)
£ 17,243 total over 7 years</td><td>New running costs[b]:
£135 additional per year</td></tr>
<tr><td colspan="2">Carbon emissions from new system[b,c]:
2018: 1.61 tonnes / year
2025: 0.92 tonnes / year
2030: 0.66 tonnes / year</td><td>Carbon comparison with old system:
2018: 50%
2025: 29%
2030: 21%</td></tr>
<tr><td colspan="3">Notes:

a) New system costs includes installation costs, which may vary considerably. Costs shown exclude VAT - applicable rates can vary according to specific circumstances.

b) Assumes electricity is from the grid. Homes with solar PV panels will reduce electricity from the gird, although most heating demand occurs during winter months when the PVs are less productive. Buying 100% renewable electricity supports and encourages the development of renewable energy but does not change the overall carbon intensity of grid electricity in the short-term. Figure shown is based on costs including VAT.

c) 2018 estimate is based on carbon intensity of the grid during typical heating periods in the winter months of 17/18, which were around 20% higher than the annual average carbon intensity of the grid. Future projections assumes that the carbon intensity is similarly higher at these times than the projected annual average.</td></tr>
</table>

Ground-source heat pump #2

<table>
<tr><td colspan="3">House type: Bungalow</td></tr>
<tr><td colspan="3">Description: Built 1950 - 1966, 3 bedrooms, floor area of 103m^2. Cavity wall (i.e. insulated), with good loft insulation.</td></tr>
<tr><td colspan="2">Existing heating & hot water:
Gas (modern, post 2005)</td><td>Future heating: Ground-Source Heat Pump
Future hot water: Ground-Source Heat Pump</td></tr>
<tr><td colspan="3">Description of works needed to fit new system: A Ground-Source Heat Pump located outside the bungalow with a trench in the garden will provide all the heating and hot water. Radiators will be replaced with bigger radiators and if there isn't already a hot water tank one will need to be installed (cost included in the estimates below).</td></tr>
<tr><td>New system cost estimates[a]:
High: £28,050
Central: £21,850
Low: £16,450</td><td>Government subsidy (RHI)
£15,533 total over 7 years</td><td>New running costs[b]:
£ 122 additional per year</td></tr>
<tr><td colspan="2">Carbon emissions from new system[b,c]:
2018: 1.45 tonnes / year
2025: 0.83 tonnes / year
2030: 0.60 tonnes / year</td><td>Carbon comparison with old system:
2018: 50%
2025: 29%
2030: 21%</td></tr>
<tr><td colspan="3">Notes:
a) New system costs includes installation costs, which may vary considerably. Costs shown exclude VAT - applicable rates can vary according to specific circumstances.
b) Assumes electricity is from the grid. Homes with solar PV panels will reduce electricity from the gird, although most heating demand occurs during winter months when the PVs are less productive. Buying 100% renewable electricity supports and encourages the development of renewable energy but does not change the overall carbon intensity of grid electricity in the short-term. Figure shown is based on costs including VAT.
c) 2018 estimate is based on carbon intensity of the grid during typical heating periods in the winter months of 17/18, which were around 20% higher than the annual average carbon intensity of the grid. Future projections assumes that the carbon intensity is similarly higher at these times than the projected annual average.</td></tr>
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Air to Air heat pump

<table>
<tr><td colspan="3">House type: Bottom-floor flat</td></tr>
<tr><td colspan="3">Description: Built 2003-6, 2 bedrooms, floor area of 74m^2. Cavity wall (i.e. insulated).</td></tr>
<tr><td colspan="2">Existing heating & hot water:
Gas (modern, post 2005)</td><td>Future heating: Air to air heat pumps
Future hot water: Gas boiler</td></tr>
<tr><td colspan="3">Description of works needed to fit new system: Three air to air heat pumps will provide heating. Hot water will be provided by a gas boiler.</td></tr>
<tr><td>New system cost estimates[a]:
High: £5,600
Central: £4,000
Low: £3,050</td><td>Government subsidy (RHI)
£ None</td><td>New running costs[b]:
£41 additional per year</td></tr>
<tr><td colspan="2">Carbon emissions from new system[b,c]:
2018: 0.78 tonnes / year
2025: 0.61 tonnes / year
2030: 0.54 tonnes / year</td><td>Carbon comparison with old system:
2018: 69%
2025: 54%
2030: 48%</td></tr>
<tr><td colspan="3">Notes:

a) New system costs includes installation costs, which may vary considerably. Costs shown exclude VAT - applicable rates can vary according to specific circumstances.

b) Assumes electricity is from the grid. Homes with solar PV panels will reduce electricity from the gird, although most heating demand occurs during winter months when the PVs are less productive. Buying 100% renewable electricity supports and encourages the development of renewable energy but does not change the overall carbon intensity of grid electricity in the short-term. Figure shown is based on costs including VAT.

c) 2018 estimate is based on carbon intensity of the grid during typical heating periods in the winter months of 17/18, which were around 20% higher than the annual average carbon intensity of the grid. Future projections assumes that the carbon intensity is similarly higher at these times than the projected annual average.</td></tr>
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Electric high heat retention storage heaters

House type: Mid floor flat		
Description: Built before 1900, 2 bedrooms, floor area of 74m^2. Solid brick wall (i.e. not insulated).		
Existing heating & hot water: Gas (modern, post 2005)	**Future heating:** Electric - high heat retention storage heaters **Future hot water:** Gas boiler	
Description of works needed to fit new system: Five high heat retention storage heaters will be fitted. The installation will include controls and a circuit breaker upgrade.		
New system cost estimates[a]**:** High: £5,775 Central: £4,729 Low: £3,940	**Government subsidy (RHI)** £ None	**New running costs**[b]**:** £ 280 additional per year
Carbon emissions from new system[b,c]**:** 2018: 1.94 tonnes / year 2025: 1.28 tonnes / year 2030: 1.02 tonnes / year	**Carbon comparison with old system:** 2018: 130% 2025: 85% 2030: 68%	

Notes:

a) New system costs includes installation costs, which may vary considerably. Costs shown exclude VAT - applicable rates can vary according to specific circumstances.

b) Assumes electricity is from the grid. Homes with solar PV panels will reduce electricity from the gird, although most heating demand occurs during winter months when the PVs are less productive. Buying 100% renewable electricity supports and encourages the development of renewable energy but does not change the overall carbon intensity of grid electricity in the short-term. Figure shown is based on costs including VAT.

c) 2018 estimate is based on carbon intensity of the grid during typical heating periods in the winter months of 17/18, which were around 20% higher than the annual average carbon intensity of the grid. Future projections assumes that the carbon intensity is similarly higher at these times than the projected annual average.