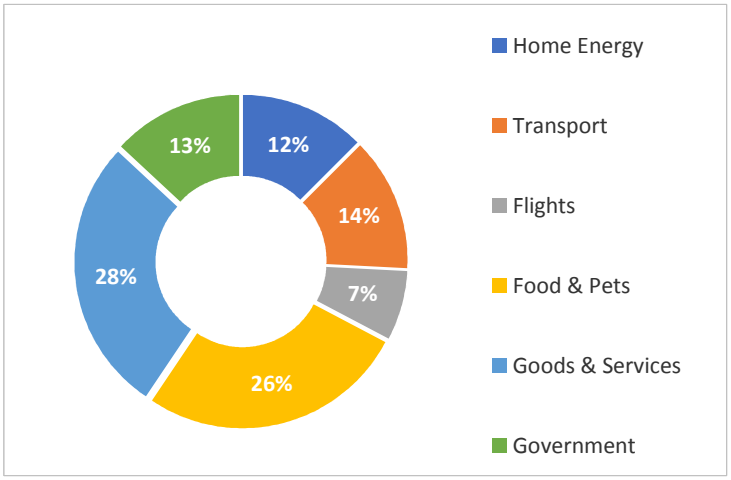
REDUCING HOUSEHOLD CARBON FOOTPRINTS - A BRIEF SUMMARY

This summary is intended as an overview, and contains little detail. I have also written a longer article, with the same headings, which you can dive in to for more information and more explanations.

THE STARTING POINT:
Carbon Dioxide (CO_2) in the atmosphere has been increasing very substantially since the Industrial Revolution, largely due to burning of fossil fuels. Increased CO_2, combined with other effects, causes more of the sun's heat to be trapped in the atmosphere, this is usually called the "greenhouse effect". The scientific view is that we must drastically cut CO_2 emissions (and other damaging emissions) if we are to avoid serious and damaging climate change. The phrase "carbon footprint" refers to the amount of CO_2 emissions associated with each person.



Household carbon emissions for an average home with 3 occupants, 2021 estimates. Assumes one holiday trip by plane, and use of two small/medium cars, 7000 miles each.

The typical carbon footprint in UK is currently about 10 tonnes per person, including the embedded carbon in imported goods. An average 3 person household has a footprint of roughly 30 tonnes (www.carbonindependent.org). This figure is purely for CO_2 emissions, and does not include other "greenhouse gases" which also have a climate warming effect.

Household annual CO_2 consumption from home energy and travel

	Consumption	Cost	CO_2 emissions
Central Heating (Gas) – average semi-detached house, 3 occupants.	15,000 kWh	£750 (in 2021)	2.7 tonnes (Oil heating 3.6 tonnes)
Electricity – average semi-detached house, 3 occupants	4400 kWh	£900 (in 2021)	1.0 tonnes
Car (small-medium) – 10,000 miles per year, 45 mpg average (petrol)	1000 litres (225 gallons)	£1400	2.2 tonnes
Air travel – 3 people, trips to: • Spain – say 2000 miles • USA – say 7500 miles.	 330 litres 1100 litres		 1.0 tonnes 3.6 tonnes

CENTRAL HEATING & HOT WATER: (2.7 tonnes CO_2 average)
Improvements are worthwhile in the following areas:

Loft insulation is a high priority and good value for money, i.e. quick pay-back. The current recommended figure for loft insulation is 270 to 300mm thickness. If your loft has less than 200 mm (8"), then it's a high priority to top it up to 300mm (or more).

Cavity Wall insulation is also a priority and good value if your property is suitable. Cavity insulation can reduce heat losses through the walls by a factor of 2.

Double-glazing does save CO_2, but its payback in pure energy terms is likely to be a lot longer than 5 years. However, it will also enhance the value of the house.

Even with double glazing thick thermal lined (and close fitting) curtains make a substantial difference to heat loss at night, reducing heat loss by up to 50%.

On the same subject, if you have a conservatory attached to your house, consider the heat loss through this large area of window, and keep the interconnecting door closed.

Draught-sealing is important, particularly in older properties, with a very quick pay-back. Draughts are a major loss of heat, though of course one should not eliminate all ventilation.

Open fireplaces with chimneys, unless they are being used frequently, should be stopped up to avoid major heat loss.

Improving the controls on central heating is easy and cost-effective. Fit a "programmable thermostat", and you can set different temperatures for different times of day. And radiators should be fitted with thermostatic radiator valves, turned well down in rooms that are not in use.

The hot-water tank (if you have one) should be insulated to a high standard.

Boiler type has an important effect on efficiency. If a boiler is an older type, say 20 years old or more, it will probably have a much lower efficiency than modern boilers.

A lot of small improvements as described above could add up to a substantial saving. (In the full article I describe the improvements we made to the heat usage in our home). Unless your house is unusually poorly insulated at present, the saving is unlikely to reach 50%. But 25% plus may be easily achievable, and that's a worthwhile gain.

ELECTRICITY: (1.0 tonnes CO_2 average)
The amount of CO_2 produced per kWh of electricity has reduced dramatically (by 2/3rds) in the UK in the last 10 years. This was achieved by phasing out coal fired power stations, reducing usage of gas fired power stations, and increasing the renewable sources of power.

Also, the average household consumption has reduced substantially over the same period, from 5500 kWh to 4400 kWh, a reduction of around 20%.

Low-energy lighting: The early CFL low energy bulbs were disliked by some, due to the quality of the light. Modern LED bulbs give far better light quality, and are now low cost and adequately powerful. These give a very quick pay back, usually less than 1 year.

Domestic appliances: These have been improving substantially over the last 15 years or so. For fridges and freezers, you need to not only consider the energy rating, but also the size, as a large unit will consume more electricity than a small unit with the same nominal

energy efficiency rating. Luckily, nearly all suppliers publish the annual electricity usage in kWh, and this should be used as the comparator when choosing your appliance.

The information available on the internet is diffuse and over-complicated. In the full article I show a list of my estimates of annual energy consumption of various domestic devices, showing typical new versions and 15 year old versions for comparison.

As with home heating, a number of small improvements can add up to a substantial gain. Low energy lighting is a particularly big saver with a very quick payback.

CAR TRAVEL: (2.3 tonnes CO_2 per 10,000 miles average)
The figures in the table are for a 45-mpg (petrol) small family car. If you have a Diesel car, then a 50-mpg Diesel gives roughly the same CO_2 as a 45-mpg petrol car. (The Diesel is however much more polluting in other respects.)

Before you do a long (or short) journey by car, think whether you could combine two or more journeys to save mileage, or share cars, walk, cycle, or take public transport.

Hybrid cars using an electric motor in conjunction with a petrol engine (Toyota Prius for example) have improved fuel consumption and CO_2 at low speeds, but currently only limited benefits at motorway speeds.

The PHEV (Plug-In Hybrid Electric Vehicle) is an interesting option if you do mostly short journeys, less than 40 miles a day, as you can charge it overnight and run it just on electricity most of the time.

Electric cars (EVs) are getting better and cheaper year by year. And the recharging infrastructure is also improving. This is by far the best car option in terms of CO_2 reduction. Current models produce less than 1/3 of the CO_2 of a small petrol car.

Public transport, trains and buses. Train travel (in UK) has a very low carbon footprint, about 1/5 of a single occupant car. Urban bus travel is less good, but long distance coach travel is claimed to be lower CO_2 than train travel.

AIR TRAVEL: (???? tonnes CO_2)
A trip for 2 to Spain plus a trip for 2 to USA creates about 3 tonnes of CO_2. This figure is purely the CO_2 emissions, and the additional effects of the CO_2 being injected directly into the high atmosphere magnifies the global warming effect by a factor of between 2 and 3. So the effective figure might be **6 to 9 tonnes** equivalent. Compare that with the energy savings you are likely to be able to make per year in your house!

Every time you take a plane ride, think whether there is an alternative? For domestic and near-Europe trips take the train instead of the plane. Even car travel (single occupancy) is lower CO_2 than plane travel. And can the reason for the travel be achieved equally effectively by video meetings?

OTHER ECO-IMPROVEMENTS:
Not many people are in a position to build (or have built) a new high efficiency eco-house, which can reduce energy consumption to almost zero. However there are various add-on technologies which can be used with existing buildings, which go some way towards this.

The starting point for most home owners is gas (or oil or LPG) central heating, producing typically 2.7 tonnes of CO_2 per year. Oil fired central heating generates approximately 30% more CO_2, and propane (LPG) systems are about half way between.

The cost aspect is difficult to predict. At the time of writing this (2021, 2022) there is a UK energy "crisis" caused by various supply side factors, and prices for gas and electricity are unusually high. Whether and when they will settle back to more affordable levels is unclear. The expected default domestic tariff cap level (as at April 2022) is approx 7.5p/kWh for gas and 31p/kWh for electricity. Allowing for the 80% efficiency of gas boilers and central heating systems, the electricity cost per kWh is effectively about 3.2x the gas cost. The figures below are based on this 3.2x ratio, which may change in future.

Technology	Cost (allowing for grants)	Running cost difference per year	CO_2 saving per year (average 2020 to 2030)	Financial payback period
Solar Photovoltaic (PV) cells 4 kW	£6000	£400 - £500 saving (Apr 2022 £0.31/kWh price cap assumed)	0.5 tonnes (see notes)	12+ years
Solar panel water heating	£4000	£100 saving (assuming gas central heating)	0.3 tonnes	40 years
Ground source heat pump 10 kW unit. (Assumes £6000 grant)	£25000 to £30000	Running cost saving approx 10% (without added insulation)	2.2 tonnes	??
Air source heat pump 10 kW unit. (assumes £5000 grant)	£7000 to £13000	Running cost **increases** approx 15% (without added insulation)	2.1 tonnes	??
100 kWh Thermal store using low carbon off-peak electricity	£12000 (no grant)	Cost depends on future overnight electricity tariff, currently not known.	1.1 tonnes	??
Wood burning stove	£3000	No saving (if paying for wood)	0.2 tonnes	??

Solar PV Panels: Currently (2022), the majority of the financial benefit comes from the avoided cost of household electricity imported from the grid, and only a small proportion comes from the electricity exported to the grid.

Solar panels for water heating were once heavily promoted, but are not seen much now in UK (though very popular in more sunny countries). They are of little use in winter.

Ground-source heat pumps are expensive, because installation typically involves laying pipes in a deep hole in the ground, or over a large area of shallow excavation. Based on current (2020) electricity supply, the CO_2 saving compared to a gas boiler is 75%, rising to about 88% by 2030.

Note that the articles claiming lower running costs for a heat pump generally include a major insulation upgrade applied at the same time. The insulation delivers the lower running costs, the addition of the heat pump at present does not of itself make much difference to the running costs. At the expected April 2022 electricity and gas prices, the running cost saving from a ground source heat pump will be of the order of 10%.

Air-source heat pumps avoid underground works and are considerably cheaper to install. The efficiency (COP) is somewhat less than a ground-source heat pump, particularly when outside air temperatures are very low. Based on current (2020) electricity supply, the CO_2 saving compared to a gas boiler is 69%, rising to about 85% by 2030.

Due to the lower efficiency (compared to a ground source heat pump) the air source heat pump will (at anticipated April 2022 prices) cost about 15% more to run than a gas boiler, for the same amount of heat delivered.

Underfloor heating: In order to get high efficiency from a heat pump system, one requires very large area "radiators". Underfloor heating is the classical way to achieve this, though one can use over-sized wall mounted radiators, or fan-assisted convector radiators.

Thermal storage systems: Various options exist or are under development. One interesting new device is the "Warmstone" which is in effect a whole-house electrical storage heater with 100 kWh capacity, enough to provide a full day's winter heating in many homes. See <www.caldera.co.uk>. Smaller units are available from Tepeo.com (currently 40 kWh capacity), and from Sunamp (12 kWh capacity).

Running costs depend on the future availability of overnight off-peak electricity at low prices. The "break even" on running cost occurs when the price of off-peak electricity is around the same as gas, currently (from April 2022 onwards) around 7.5p/kWh

Wood Burning Stoves were discussed earlier in this article. The CO_2 reduction is a bit controversial, in that it assumes the wood burned is replaced by new trees, which of course take years to grow..

Summarising all of the above, it appears that at current energy prices, none of the alternative heating/energy options listed will substantially reduce operating costs (compared to gas central heating). Future energy prices are difficult to predict, but if one assumes that fossil fuels will in general increase more than electricity prices (either by natural market forces or by government incentives, green taxes etc), then changing your heating system may yield a good financial return.

ALTERNATIVE OPTIONS:
Rather than fitting a small solar PV panel or water heating panel to your house, you could put your money into larger schemes, which can have better impact per pound invested.

One example is investing (buying shares) in windfarms or other renewable energy systems. There are currently (in the UK) only a small number of opportunities to invest in pure renewable energy companies, some of these are described in the full article.

Please see the full article for more information, including a few topics barely mentioned here.

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