

Building Energy Usage

Heating and cooling of buildings

This part of the energy supply is responsible for the most CO₂ emissions. The challenge here is really twofold:-

1. Buildings need to be better insulated so as to not get too hot in the summer or too cold in the winter
2. The heating and cooling supplies need to be powered off renewable electricity

Again the challenges vary by country. Countries in the tropics have little need for heating but do need air-conditioning. In the UK, our challenges are:-

1. Houses that pre-date 1920 do not have cavity walls that can be insulated, so need to be retrofitted with external or internal solid wall insulation.
2. Most houses are either heated by natural gas or oil
3. 15% Hydrogen in natural gas supply is still being trialled. 100% Hydrogen necessitates a swap out of existing boilers
4. Tradesmen will need to be re-trained in large numbers in order to facilitate the transition to solar, heat pumps or hydrogen as well as solid wall insulation.
5. Externally insulating houses often needs to be carried out for entire streets, otherwise it does not look good aesthetically. In some cases, external wall insulation will stick out further than the roof eaves, so the roof would need to be adapted.
6. Internally insulating houses is very disruptive to households and would meet a great degree of resistance.

Potential solutions for buildings are a combination of:-

Solar Panels

This will be sufficient to generate electricity during the day from about March through to October. In the UK, these are most suitable in Southern England. If you are out during the day, the spare capacity can be fed back in to the national grid offsetting the costs of using electricity during nighttime hours.

Battery Storage

This can provide a few hours in the evening of electricity from what was generated during the day

Heat Pumps

Heat pumps come in 3 different flavours:- * Air Source - most suitable for city dwellings if district heating is not an option. Challenges at the moment are that they do not provide as much heat as a gas boiler so your house needs to be fully insulated and radiators swapped for larger ones. * Ground Source - requires digging up your garden but makes sense for detached houses in the countryside which currently are reliant on oil for their heating * Water Source - suitable for buildings near lakes or other bodies of water

Heat pumps are 3 times as efficient as gas boilers. They do require electricity to power them but this could be supplied from solar panels/battery storage during the day. Challenges at the moment are that heat pumps do not provide as much heat as a gas boiler so your house needs to be fully insulated and radiators swapped for larger ones.

Hydrogen

Hydrogen is a potential solution as when it burns, it oxidises to H₂O (water).

- A trial has already successfully taken place at [Keele University which replaced 15% of natural gas with hydrogen](#)
- A [further trial is due to take place in Northern England](#) in 2021 in a small area to test the use of Hydrogen in real world conditions using equipment that has been decommissioned.
- Adding 15% H₂ to natural gas supply will be a short term measure which requires no changes to current natural gas boilers. Ultimately, gas boilers will need to be swapped for 100% hydrogen boilers at some point, but this can be done on a specific area with incentives for householders to make the move.

Hydrogen is primarily produced today from the byproduct of producing natural gas for domestic supply. However, another way of creating Hydrogen is to split water by electrolysis. This process isn't currently used due to the costs of electrolysis outweighing the energy supplied. However, one of the issues of solar is that during the middle of the day, it produces more energy than the national grid can accommodate. This excess energy could be used to produce Hydrogen rather than being wasted. This process can be considered as another example of energy storage. Hydrogen can be used not only to heat houses but also to power [ships and planes](#)

External Wall insulation

Houses that have been built post 1920 in the UK, tend to either have cavity walls, or may conform to current building regulations that require thick enough insulation that houses do not lose a lot of heat. 1 of the problems in the UK, however, is that a lot of our housing stock pre-dates 1920 and is solid wall in construction. Internal wall insulation is, of course, an option as well as external, but most people will not relish the disruption or loss of internal space. Note: You do not need to insulate internal walls, so with terraced houses, it's just the walls that face to the front & rear that need to be insulated.

Considerations of external wall insulation include:-

1. Cost - The more effective an insulating material is, the higher the cost is typically
2. Aesthetics - Nobody wants their house to stick out from neighbouring houses - this is clearly less of a concern with detached properties, however.
3. Damp - Any insulation impacts the properties of the walls they're covering, so may trap water vapour which is generated within a home and which would otherwise escape.
4. Skills - Tradesmen need to be trained to understand the properties of wall insulation and hence avoid issues such as damp.

District Heating Schemes

District heating systems refers to a local council (or private company) generating heat centrally to power a local district of a town or city. Examples where this currently operates include Copenhagen, Denmark where burning of municipal waste is used to keep most of the city warm. Clearly, some degree of pollution capture would be necessary to make this option environmentally acceptable, but waste incinerators are already fairly common within city boundaries in the UK.