Reinventing retrofit: annex

Energiesprong homes can reduce peak heat demand

In 2010, the coldest winter in 100 years and second coldest December since 1659, a peak of 170GW domestic heat demand was recorded (Watson, *et al*, 2018). This year was used as the baseline for our calculation of how Energiesprong homes could help reduce heat demand and in particular peak heat demand. Our conclusion is that this 170GW peak can be reduced by 41 per cent to 100.3GW, without adding to peak electricity demand. This is due to 41 per cent of the current 27 million UK housing stock being energiesprong compatible, or 11.1mn homes. These homes do not connect to the gas grid, using entirely electricity and high thermal efficiency for heat demand.

Heat pumps deliver residual heat demand more efficiently

Although Energiesprong homes require electricity for heat, this scenario does not result in 69.7GW of peak heat demand being added to electrical demand. Energiesprong homes require 89 per cent less heat on average than a conventional home, lowering this 69.7GW down to 7.7GW. Heat pumps are also efficient at converting electricity to heat, with a Coefficient Of Performance (COP – also known as a Seasonal Performance Factor or SPF) measuring how many kWs of heat will be created by a heat pump for every 1kW of electricity used. COPs vary depending on the outside air temperature, with a COP of 1:3.9 (so 3.9kW of heat for every 1kW of electricity used) achievable in a UK context, where heat pumps are used in an optimised mode.

High thermal inertia can shift electrical load, meaning there is no increase in peak electricity demand

Energiesprong homes have a high thermal inertia, meaning the heat escapes the building much less easily than in a conventional home. This means that an energiesprong home can retain heat for up to 48 hours. Energiesprong specifications require <40kWh/M2/yr thermal demand, and energy costs low enough to introduce a comfort plan, all of which ensure that retrofits end up having high thermal inertia. This allows these homes to shift heat demand away from peak times. This can eliminate the risk that the use of heat pumps will increase peak electricity demand in two steps. The first is that thermal inertia enables the heat pump to be operated only during warmer parts of the day, increasing the COP to the 1:3.9 achieved by hybrid heat pumps retrofitted to conventional properties (Freedom project). This creates more heat with the same amount of electricity. Referring to our 7.7GW figure above, this is therefore reduced to 1.9GW of peak increased electricity demand. Second, by heating homes in advance of the peak heating demand day earlier in the week and away from daily peak electricity demand (both peak demands occur between 16:00 and 19:00 hours) then this 1.9GW of electrical demand is not added to the peak electrical demand at all, but is instead deferred to a non-peak time of day on a previous day, avoiding both peak heat demand days and peak daily electricity demand.

This can save building new peaking capacity

An *Applied Energy* study calculated that if 20 per cent of households installed heat pumps this would result in a 14 per cent increase in electricity peak load of 7.5GW. Adjusting for 41 per cent of households instead, this would result in 15GW of increased electricity peak demand, in a scenario where decarbonisation of heat was achieved via heat pumps only. By shifting demand in the above way, the avoided cost for high carbon, backup peak electrical capacity results in £10 billion (from CCGTs) or £4 billion (from less capital intensive but more polluting reciprocating engines) being saved (Timera Energy).