

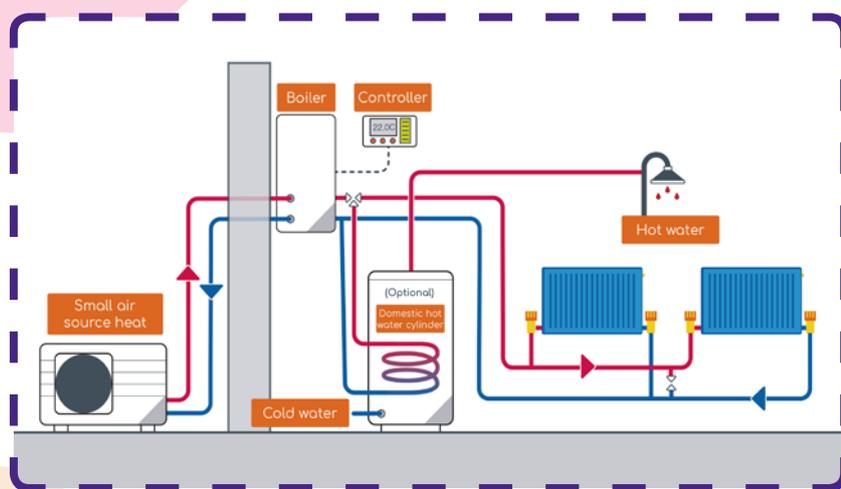
The Freedom Project

Interim results – March 2018

Freedom could deliver a unique future energy system that is affordable, secure and low carbon, while avoiding the need for costly and disruptive electricity network reinforcement, as well as deep in-home insulation retrofits and replacement of existing wet heat delivery systems.

A multi-vector approach to home heating

The Freedom Project is an industry first cross-sector collaboration project seeking to understand the potential role of multi-vector solutions to support the delivery of low cost domestic heating decarbonisation. We're collaborating with Western Power Distribution (WPD) and PassivSystems on this project with other project partners: Delta-ee, Imperial College and City University.



Based in Bridgend, south Wales, the project is investigating the consumer, network and energy system implications of hybrid heating system deployments, where domestic heating systems have the option of operating using a standard gas boiler or an air source heat pump (ASHP).

The 75 systems being tested have the ability to retrofit a small low cost heat pump to an existing central heating system using smart software to control them.

Key learnings so far – Winter 2017/18

- Smart controlled hybrid heating between an air source heat pump and a boiler currently offers lower cost, lower carbon domestic heat, when compared to electrified heat through air source heat pumps alone. The system avoids inefficient, costly and carbon intensive use of peaking or coal generation to power heat pumps. Burning gas in the home at 93% efficiency is more carbon efficient than incurring 6% electricity network transmission losses after burning fossil fuel at coal (34% efficient, 937 gCO₂e/kWh) or gas peaking OCGT (28% efficient, 651 gCO₂e/kWh) power stations.
- Winter testing and future simulations indicate that using renewable wind electricity in a hybrid system could result in 70% carbon reduction, with minimal investment.
- The addition of renewable gases to the network, such as hydrogen blends, biomethane or BioSNG, significantly improves the carbon reduction when the boiler operates and could achieve full decarbonisation of domestic heating.
- The smart control panel successfully demonstrated switching between the two fuel sources and heating appliances driven by cost – supporting the decarbonisation of heat in an affordable way, with limited cost to the customer and limited behaviour change.
- When there is insufficient renewable electricity generation, when it is very cold and/or when there are capacity constraints in the electricity network, the heat load can shift across to the gas network, and vice-versa, to provide uncompromised heat, flexibly using the vast energy storage within the gas network (210TWh seasonally)

- Imperial College's modelling of hybrid heating system adoption indicates that the potential benefits are considerable. Modelling the 2030 energy system, their analysis shows that an increased annual spend of £178 million on the gas system as a substitute to electricity in air source heat pump-only scenarios, the whole system is able to achieve gross savings in total cost of more than £1.3 billion per year.

Customer survey, engagement and future proposition

The project team delivered 75 installations during 2017, with a focus on ensuring the portfolio of residential properties were representative of UK housing stock that will be around in 2050:

- flats, bungalows, terraced, semi-detached and detached properties
- homes with one to five bedrooms
- an age range from pre-1900 to new build
- an almost equal split between privately owned and social tenanted
- three off-gas-grid properties with Calor storage.

The hybrid heating systems installed as part of the project were appealing to participants once they had been explained, with running cost savings viewed as the biggest advantage. Nearly 90% of respondents found the idea of hybrid heating systems appealing or very appealing.

The emerging proposition for heat as a service, which may be achievable to deliver by the mid-2020s, is showing that the potential combined value of fuel arbitrage, domestic demand side response and frequency response services could avoid initial capital outlay. This model requires a demand aggregator role to act on behalf of heat consumers and share the value from the benefit of flexibility of using two vectors and the storage in the gas network, with third party investors owning and maintaining heating assets.

The supply of a hybrid heating system without triallists having to invest their own money in the equipment was also very appealing. Wales & West Utilities' previous research has shown that initial capital cost is the key factor that influences a decision to change to an alternative heating solution, with 80% of consumers not being able or willing to pay.

The value between purchase of fuels and sale of heat could be grown further by reducing heat demand in the home, with the aggregator and investor incentivised to install insulation measures which pay back at no further cost to the consumer. The leakiest homes and those properties with higher occupancy and, therefore, higher heat demand would attract the quickest financial return from lowering demand in a heat service world.

Not only is the evolving customer proposition attractive in the offering of lowest cost heat with minimal disruption, flexibility to smartly and remotely switch vectors on a variety of signals could enable a pathway to full domestic heat decarbonisation, through the balancing of renewable electricity and gas – neither which could achieve on their own.

Next steps

- The solution is suitable for installation and immediate benefit in areas off the gas grid and where the electricity networks are also most constrained, with hybridisation of oil and LPG boilers and replacement of direct electric and solid fuel heating providing financial savings now, as well as being future ready for smart control and heat as a service. With a higher proportion of fuel poor homes located off the gas grid, there is a strong case for this to be implemented now.
- Continue running aggregated controls in all 75 homes using signals to switch between both appliances, using future fuel price ratios, tariffs, frequency response services and electricity network constraints. The hybrid benefit to potential hydrogen cities will also be explored.
- Develop potential follow-on projects, such as deeper exploration of viable pathways to market and use of different appliances and technologies that also offer fuel vector switching benefits, such as using gas heat pumps in non-domestic hybrid systems and smart hybrid heat networks.

Further reading

An interim report detailing early trial results was produced in early 2018 and you can read it at <http://wwutilities.co.uk/media/2662/freedom-project-interim-report-february-2018.pdf>