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Heat Pumps Revolutionizing Retrofits: Scaling Up Deployment with Innovative Solutions and Overcoming Barriers

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Topical Article

## Speeding Up the Roll-Out of Heat Pumps With Lessons from Archetypal Outcome-Led Packaged Retrofit Solutions

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***Heat pump deployment in the UK is well behind targets. Energiesprong UK has been exploring deep retrofit with heat pumps in non-traditionally built homes which has been challenging but insightful. We have tested different retrofit packages in several prominent archetypes, which represent 200k properties in the UK. The lessons learned and solutions developed offer the potential for a step-change in scale, helping contribute to a retrofit ecosystem capable of delivering 1m homes a year.***

**UK context**

To meet UK climate change targets, the government set a target in 2021 to install 600,000 low-carbon heat pumps annually by 2028.[1] In 2023, there were 36,799 MCS-certified installations of heat pumps.[2]

[1] UK Government 2023, "Research briefing on heat pumps", https://post.parliament.uk/research-briefings/post-pn-0699/ accessed on 24.10.24.

[2] Carbon Brief, "Analysis: Surge in heat pumps and solar drives record for UK homes in 2023", https://www.carbonbrief.org/analysis-surge-in-heat-pumps-and-solar-drives-record-for-uk-homes-in-2023/, accessed on 24.10.24.

While this is a 20% increase on the previous year, it is still far below what's needed. Yet with the repeated refrains of "retrofitting one home a minute" and "every home is suitable for a heat pump", we could be forgiven for expecting endless graphs of exponential heat pump market growth and deployment. So, what's holding us back?

**The UK's big heat pump challenges**

1. **Affordability**

Despite numerous case studies showing heat pump effectiveness, public opinion remains divided with "heat pumps work" and "heat pumps don't work" articles in equal measure in mainstream media. Many UK homeowners can access a £7,500 subsidy, covering much of the upfront cost for homes requiring minimal new pipework and radiators.

Operational costs are the bigger concern. Properly installed heat pump systems where gas has been removed can deliver savings, but these can quickly be blighted by a cold weather snap or tariff changes. Negative consumer feedback often lacks proper analysis. Poor assumptions about insulation or installation can lead to higher-than-expected costs.

2. **Maximising efficiency requires careful design for different homes**

Homes, even of similar types, can have significantly variable heat pump installations, affecting efficiency by over 20%[3]. Unlike gas boilers, heat pumps are sensitive to temperature and flow control, and cost-saving measures during installation can hurt performance. Accurate heat-loss models are essential, but real-world testing has shown unexpected deviations. Building data sets around the most pertinent factors to successful heat pump retrofit for particular types of homes can reap dividends in terms of outcomes, allowing repeated successful installations and more predictable performance.

3. **The shift to modern methods of construction is not happening quickly enough**

While digital solutions exist, heat pump installation remains craft-based. Kits of parts, modular systems and pre-fabrication are limited, as are the skills for implementing them. Stop-start government funding has left housing providers unable to commit to long-term programmes, meaning the numbers do not stack up for the supply chain to invest. Barriers like fragmented supply chains, skills shortages, financing issues, and planning constraints further slow the adoption of modern retrofit methods.

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[3] https://es.catapult.org.uk/wp-content/uploads/2023/03/EoH-Interim-Heat-Pump-Performance-Data-Analysis-Report-1.pdf accessed on 24.10.24

**A better retrofit market: taking a systemic approach to tackle these challenges together**

So, even with generous upfront subsidies, heat pumps remain a confusing and weak proposition for many. Very few providers can deliver a holistic solution that considers the context of the wider house and energy system, which limits assurances of performance and confidence that outcomes will be sustained.

Our approach has been to create an integrated retrofit approach designed in more detail for particular types of homes. Ongoing performance monitoring provides assurance to funders who can provide finance at better rates, necessary to enable deployment at massive scale.

Energiesprong is an outcome-led retrofit movement with teams across Europe working in their respective countries to create the conditions for a home refurbishment market that delivers comfortable, affordable, and desirable net-zero homes.

It aims to create scale by:

- Allowing a portion of the renovation costs to be repaid through energy bill savings, supported by a long-term performance guarantee
- Ensuring high-quality refurbishments with the use of industrialised components and circular or bio-based materials
- Achieving shorter renovation times through improved processes and techniques
- Developing a product that appeals to people.

Common archetypes have formed the starting point of the first markets in several countries, as shown in Figure 1. We take a technology-agnostic approach but there is a strong focus on using integrated solutions (including a heat pump!) that offer rapid installation and high quality, underpinned by a performance guarantee.

Figure1: Energiesprong retrofits in Arnhem, the Netherlands. Credit: Energiesprong Global Alliance

In the UK, we picked social housing as our starting market as landlords' long-term maintenance plans mean the business case makes the most sense.

It is also populated by several housing archetypes that particularly suit our focus on industrialised whole house retrofit (as shown in Figure 2), including those built after the war under the Emergency Factory Made Housing Programme and solid brick council homes built between 1920 - 1940. These are the homes where deep retrofit has the biggest impact in terms of achieving net-zero emissions, reducing fuel poverty, and achieving much-needed aesthetic regeneration.

Figure 2: 1960s cross-wall homes owned by Nottingham City Council were the first homes in the UK to undergo an Energiesprong retrofit. Credit: Energiesprong UK

**Categorising UK archetypes by age – not all homes need a deep retrofit**

Not all homes need deep retrofits to meet decarbonisation goals. With lower battery costs and better understanding of heat pumps, millions of homes can be rapidly decarbonised, especially if long-term plans are uncertain. In some cases, the embodied carbon and capital costs make deep retrofits impractical.

Categorising homes by archetype helps in selecting the right solutions. Homes built after 1972 have some energy conservation measures, with significant updates in 1984, 1995, and 2002. The 2006 update to Part L introduced the SAP system for energy assessments.

Homes built after 2006 likely only need heat pumps and solar panels without further insulation. Homes built between 1984 and 2006 may need some adjustments but generally won't require solid wall insulation if they have cavities.

What we have learned: common archetypes have many similar traits, but there are common variations.

Countries often have clusters of similar homes or archetypes, typically defined by construction method or period (e.g., solid brick vs. cavity walls, terraced vs. detached) as shown in Table 1. Even within these, sub-archetypes like mid or end terraces may require different retrofitting approaches.

Table 1: Common similarities and common differences table

| Common similarities | Common differences |
|---|---|
| Form/size/layout | Extensions and porches |
| Structure | Plot size/shape/pitch |
| Wall construction | External cladding/insulation |
| Structural condition | Asbestos |
| Defects | Occupants! |
| Services layout | |
| Energy measures and heating system | |

**Similarities**

During construction, pattern books guided designs, offering variants in size or number of bedrooms. Mid and end-of-terrace options could be built, and options to create flats within the same form were often provided. Estate planners would then roll these out to match the local housing needs. Structurally, the homes would be very similar, using concrete or steel structural frames connected to concrete, steel, or brick walls with steel, asbestos, or traditional tile roofs. Table 2 shows these typical non-traditional property characteristics.

These homes perform similarly, except for slight differences due to orientation and solar gain.

Table 2: Typical non-traditional property characteristics

| Structure | Walls | Roof |
|---|---|---|
| Concrete (pre-cast)<br>Concrete (poured in-situ)<br>Steel<br>Timber | Concrete (pre-cast)<br>Concrete (poured in-situ)<br>Steel clad | Steel<br>Asbestos panels<br>Concrete (tile) |

With homes built at similar times, maintenance issues often compound at the same time. Budget cuts in social housing have led to widespread problems – with drainage, rising damp, and electrical compliance issues prevalent in most of our non-traditional schemes. Archetype-related issues, such as structural corrosion or roof replacement, can complicate retrofits, adding high remediation costs. While these are not HP performance issues - and perhaps strengthen the case for a holistic retrofit - they cannot be ignored when designing a retrofit for 15-30 years, and the high capital costs of remediation can often torpedo the best business case.

Originally designed with coal fireplaces and little insulation, many homes have undergone multiple energy efficiency upgrades, including loft and cavity wall insulation, conversion to gas heating, and double glazing. These homes, largely in social ownership, have benefited from subsidised schemes, making their energy standards relatively uniform.

**Differences**

Extensions, ranging from unheated spaces to bathroom pods and porches, vary widely, even on the same street. While non-traditional homes are strikingly similar across London suburbs and northern UK towns, plot sizes and slopes differ, meaning outdoor space for heat pumps is not always available.

Non-traditional homes often have varying cladding, either for aesthetics or insulation. Upgrades usually require removing the old layer to attach new systems. Asbestos, used in roofs and chimneys, frequently poses challenges during retrofits, with unexpected finds causing delays.

While these homes may lack kerb appeal and energy efficiency, they offer larger spaces compared to modern builds. Their size makes them popular with both residents and housing managers, especially for housing larger families. Heating systems must cater to diverse occupants, though social landlords match homes to occupancy.

**How are we putting these lessons into practice?**

**Creating a 'retrofit catalogue'**

We're compiling our archetypal work to date to test 'packaged solutions' that work for each non-traditional archetype. The aim is to bring together what we know about common pitfalls on design and construction, prioritisation of the many trade-offs that are made during the design process (as shown in Figure 3), and learning from real-world monitoring of 200 homes that have been retrofitted (as shown in Figure 4).

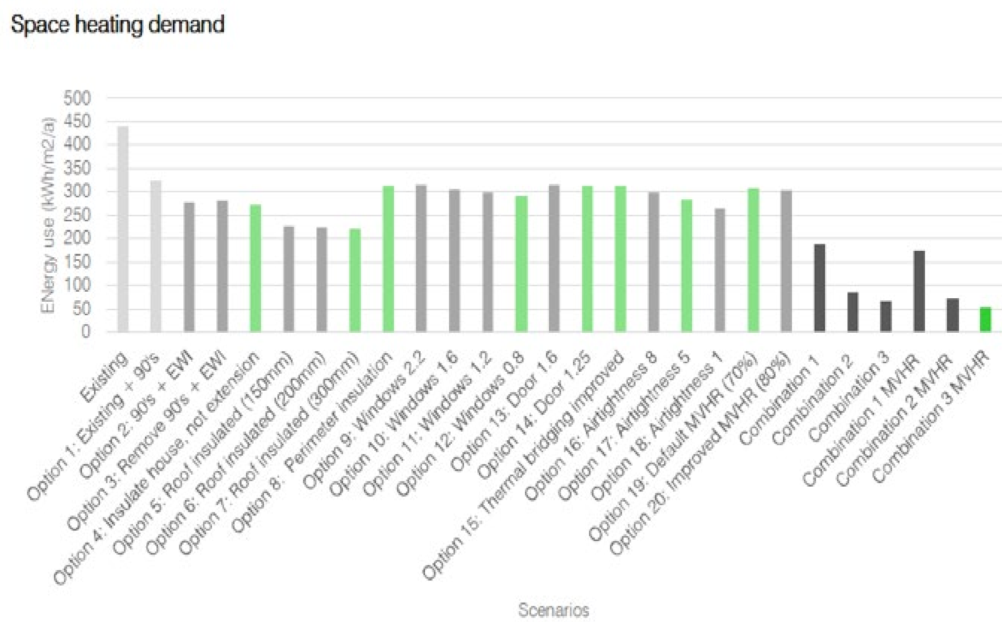


*Figure 3 Modelling different retrofit scenarios in the design process*

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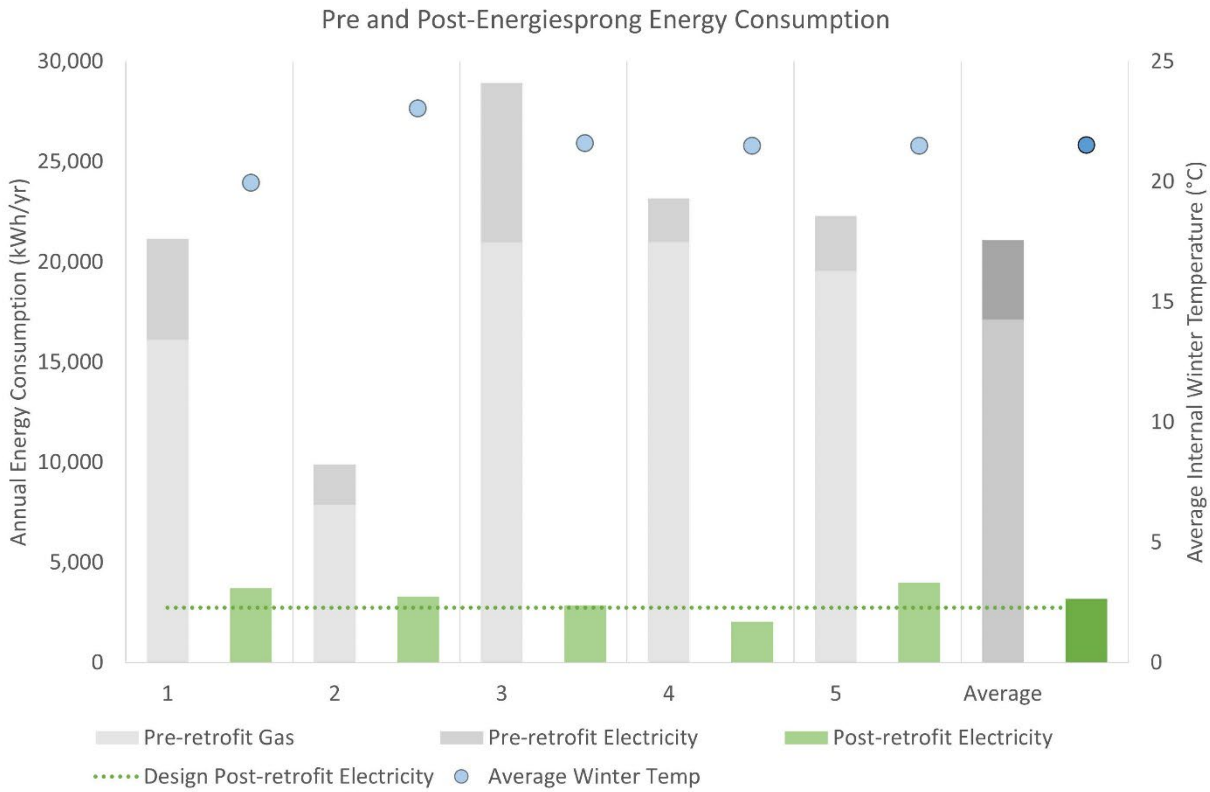


*Figure 4: First cohort of Energiesprong pilot performance.*

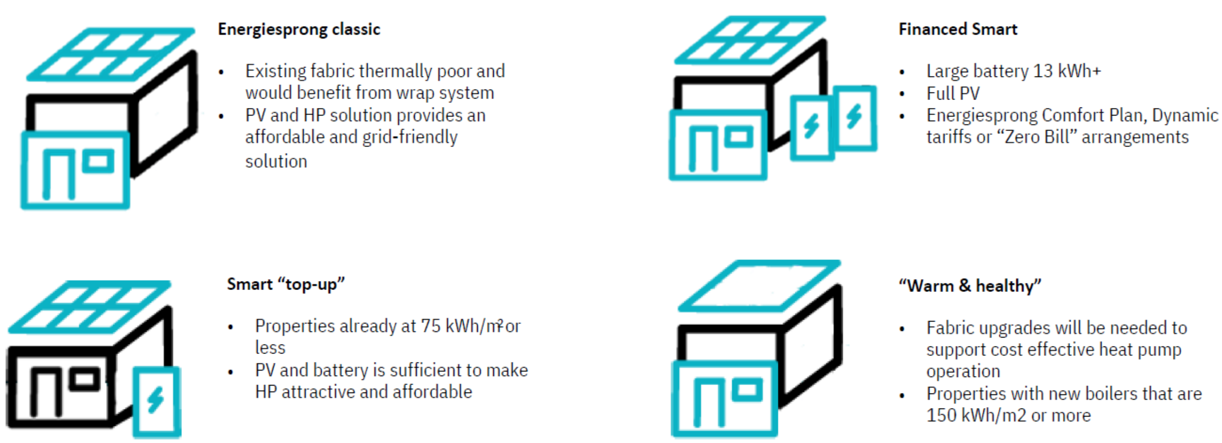


*Figure 5 Packaged solutions under test.*

Our UK Government funded work via the DESNZ Heat Pump Ready project is bringing all this thinking together by exploring the match between packaged solutions (shown in Figure 5) and four key UK archetypes. Designs will be tested at two sites, and further exploration of real-world performance variability and delivery risks will be explored to create design blueprints for four archetypes that represent 200k homes.

Building on this concept, the Transform-ER project expands this approach even further, building a new data platform that will be able to create a net-zero pathway for properties by analysing the best solutions for different archetypes and providing a pre-qualified pipeline. Transform-ER (Transform.Engage.Retrofit) is an Innovate UK-funded project that is tackling retrofit's biggest barriers to scale - enabling one million home upgrades every year by 2030.

Innovative manufacturers are designing and testing new components that will be added to the platform and matched with UK homes. The platform will initially tackle 300,000 homes in alpha/beta phases before scaling up to support a wider retrofit system capable of tackling one million homes per year. New contracting models and finance options will also be developed and rolled out.

We will be sharing insights and resources from these projects, where appropriate, with the wider sector to ensure that lessons are learned and built upon, all with the aim of nurturing a retrofit ecosystem that can deliver home energy refurbishments at the speed and scale we require for the UK's net zero targets.

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