# Review of Welsh Government renewable energy targets

# Evidence from Nesta Cymru

Nesta is the UK's innovation agency for social good. We design, test and scale new solutions to society's biggest problems, changing millions of lives for the better. The aim of Nesta's **A Sustainable Future** mission is to help rapidly accelerate the reduction of household emissions by 2030, and to ensure that policies and conditions are in place to support continued reduction from 2030 onwards.

This submission addresses consultation Question 5 on a Heat Pump target.

**Contents**

**Question 5**

**Proposal 5 states:** That Welsh Government a target of 5.5GW of renewable energy capacity to be produced by heat pumps by 2035, contingent on scaled up support from the UK Government and reductions in the cost of technology.

Do you agree with this proposal?
Please indicate Yes/No
If no, what alternative target or targets would you propose?
Please provide evidence to support your statement.

## Summary

We agree that the Welsh Government should adopt an ambitious heat pump target, as this technology is the most suitable means of decarbonising home heating which is currently available. We outline Nesta's analysis in support of this conclusion below. In our response we are primarily focused on home heating, though we recognise that this only represents around 61% of total heat demand in Wales.

Nesta welcomes the Welsh Government's decision to introduce a heat pump target, and the high level of ambition reflected by the 5.5GW figure.

We have chosen to focus on heat pumps extensively in our decarbonisation mission because:

- they deliver a **greater CO2 saving per pound spent** than any competing green heat technology (or insulation measures)
- they are a **market-ready technology**, already widely used in other EU nations, including many with much colder average temperatures than Wales

- they are **highly efficient,** with average installations delivering **three times as much heat output** per unit of energy as a gas boiler[1], and most other electric heat options. The best installations can deliver four or more times the heat out

However, we do not believe that a target expressed in installed capacity terms is the right approach. We set out an alternative target for **400,000 homes to be heated by heat pump systems by 2035**, which we believe will be more effective in driving and measuring success.

We also believe that a target of such ambition will require new policies targeting the three key barriers to heat pump take up - cost, appeal and skills - as well as targeting other issues such as planning. Nesta has undertaken substantial work on each of these barriers, some of which we summarise and link to below.

To deliver its heat pump target, the Welsh Government should

1. Make the **installation of heat pumps in 'heat pump ready' private homes** a focus for the forthcoming Heat Strategy
2. Support households to **optimise their existing heating systems**
3. Invest in **research into how to scale learning** from the Optimised Retrofit Programme to the private housing sector
4. Ensure **heat electrification workforce / skills are a focus** within wider retrofit skills policy
5. Develop **new finance products for home decarbonisation** in Wales
6. Remove **unnecessary barriers within the planning system** to heat pump uptake, particularly in urban areas

We would be delighted to engage further with the Welsh Government in the ongoing development of its heat strategy, and how our existing and future work might help it develop policies to drive heat pump adoption in Wales - whatever target it may ultimately adopt.

[1] Electrification of Heat - Heat Pump Installation Statistics Report https://es.catapult.org.uk/report/electrification-of-heat-installation-statistics/

**Supplementary information**

We believe the Welsh Government should take a clearer stance on the role of electrification in domestic heating, in order to provide householders and others with clarity, and enable more focused and effective policy development around heat pump take up.

A key role for any government is to send a clear signal to consumers and markets on the direction of travel. Adopting a 'tech agnostic' approach is reasonable when the evidence remains unclear. However Nesta's view is that it is now possible to rule out certain technologies as being unsuitable for domestic heating at scale based on the available evidence. We elaborate on this in Appendix A.

Nesta does not believe that hydrogen boilers are the best technology for use at scale in domestic heat decarbonisation. We also believe the ways in which the uncertainty created at a UK level around the future role of hydrogen in heating risks slowing adoption of better low carbon technologies.

## Assessment of proposed 5.5GW heat pump target

**Framing of the target**

We do not believe that a heat pump target rooted in a total installed capacity figure is the optimal approach.

Instead we would propose that the target should count the *number of homes which are heated by a heat pump system*, and be supported by policies which focus on the distinct challenges of heat pumps in new builds and as retrofits. We expand on this below.

A capacity based target risks creating an unhelpful incentive to install oversized heat pumps in homes which may not need them. There would also then be a tension between the Welsh Government's related policies around improving building fabric and energy efficiency. A more efficient building may well need a smaller capacity heat pump, and therefore success in achieving one target may make it harder to achieve another.

The positive arguments for focusing on the installation of smaller units would be lower costs to individual households, and lower total system costs through lower demand. These benefits would not be achieved by a total installed capacity target which implicitly prioritises the installation of larger units.

A target rooted in 'homes converted' removes any potentially perverse incentives to install oversized heat pumps, and can ensure consistency with the whole house approach the Welsh Government has adopted in other policy areas. We also note that this would be somewhat easier to count and evaluate compared to correctly noting total installed capacity across hundreds of thousands of homes.

It should also contribute to householders retrofitting their property feeling confident that the heat pump unit they install is appropriately sized for their home's circumstances. They should also be free to make decisions about, for example, choosing a larger heat pump unit in order to reduce or avoid the

need for costly upgrades to insulation, or vice versa according to their preferences.

**Targets as a driver of delivery**

Within Nesta's A Sustainable Future mission we have focused on driving heat pump uptake amongst private home-owners. Two of the main barriers we have identified to individuals making the switch are the cost of installations, and what we broadly term 'appeal' - which encompasses trust in the technology, knowledge to use it correctly, and confidence in the quality of installations.

Broadly speaking, the essence of the challenge is to get individual property owners to choose a heat pump, by lowering these barriers. The sizing of individual heat pump units installed only weakly interacts with these challenges from the individual homeowner perspective.

Purchasing a larger air source unit might increase upfront costs by a couple of thousand pounds, but this marginal increase is a relatively small proportion of the total (upfront and lifetime) cost of an installation.

This element of the upfront cost *could* be reduced by insulating to reduce overall heat demand. However, it is worth noting that the Cost-Optimal Domestic Electrification review[2] from BEIS undertook detailed analyses of the trade offs in lifetime (15 years) costs of a new heat pump system.

The review concluded:

> *"Not one of the optimised combinations has any of the more expensive fabric measures: internal or external wall insulation, or floor insulation. This indicates that none of these are justified for purely financial reasons for the boundary of this model."*

This suggests individual homeowners are unlikely to see a net financial benefit by spending on extensive retrofit in order to avoid buying a larger heat pump

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1104051/CODE-Final-Report-WHOLE-FINAL-v20.pdf

unit. This may not even be a consideration in an already well insulated home, and particularly in new build homes.

On trust / appeal, it would of course be problematic if householders felt the sizing of their heat pump was being driven by a government target - rather than what was most appropriate for their home.

We make some recommendations below as to how the Welsh Government could approach removing the barriers to heat pump adoption in Wales.

**Scale of the ambition**

In this section we attempt to answer the question of how many homes in Wales would need to be heated by heat pump systems to achieve the proposed target. The purpose of this analysis is to understand the implicit scale of the ambition the Welsh Government is proposing.

The Welsh Government's Energy Use In Wales 2022 report estimates total heat demand in Wales as being 36.9TWh. Of this, domestic demand (including space heating, hot water and cooking) is 22.4 TWh, or around 61% of the total - with industrial and commercial demand being 31% and 8.4% respectively.

For the purposes of this calculation, we assume that the proposed 5.5GW heat pump capacity target would be achieved in similar ratios to the above. Therefore 61% of the target would equate to 3.3GW of capacity in domestic properties.

Individual air source heat pump units vary in capacity from around 6kW to 15kW. The most appropriate size of unit for a given home will of course depend on the property's characteristics; including its energy efficiency, total floor space, and the needs and preferences of people living in the property.

We also recognise that individual air source units would not necessarily be the most appropriate or desirable technology for every home, ground or water source might be a better option for some, and there will likely be a role for heat networks or direct electric heating.

However, for simplicity, we will assume that a target would be met by individual air source units, and not - at this stage - give any consideration to interactions with individual property or household characteristics.

With these caveats, the figures below indicate the potential range of the number of properties which would need to have a heat pump installed (either as new build or as retrofit) to achieve a 3.3GW target. We also include the percentage of Wales' existing housing stock that this would represent.

**Fig 1**

| Capacity of air source heat pump unit | Total installations needed | Percentage of the 1.35m[3] existing homes in Wales | Average installations per year 2023-2035 *(to nearest 100)* |
|---|---|---|---|
| 6kW | 550,000 | 41% | 45,800 |
| 10kW | 330,000 | 24% | 27,500 |
| 15kW | 220,000 | 16% | 18,300 |

This calculation - simplified and heavily caveated as it is - serves two purposes. Firstly to indicate the sensitivity of a capacity based target to the considerable number of factors which contribute to the sizing of individual units. This further supports our view that such a target is potentially unhelpful.

Secondly it indicates the implicit scale of the Welsh Government's ambition. To achieve a 3.3GW domestic target using 6kW units would require up to

[3] Census 2021 - "There were 1,347,100 households with at least one usual resident in Wales on Census Day" https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/populationandhouseholdestimateswales/census2021

550,000 installations between now and 2035. We keep this scale of ambition in mind when proposing an alternative target.

## Proposing an alternative approach to a heat pump target

Nesta proposes that the Welsh Government's target should be based on the total number of homes in Wales heated by a heat pump system. This also potentially accommodates a wider range of technologies beyond individual air source heat pump units, to shared ground source heat pumps, which can service and decarbonise multiple homes.

We propose that the target figure should be 400,000 homes to be heated by a heat pump system by 2035. We believe this figure is ambitious but achievable through a combination of existing and planned policy, and new policies which could be included in the forthcoming heat strategy (see next section).

A 400,000 heat pump target can be achieved by a combination of:

1. Successfully implementing the Welsh Development Quality Requirement (WDQR) 2021 for no new fossil fuel heating systems in social homes, and assuming these homes will be heated by heat pumps instead (23,000 heat pumps)
2. Delivering on the commitment[4] to introduce the WDQR in private homes from 2025 onwards and making the same assumption (66,600 heat pumps)
3. Implementing a suite of complementary policies focused on driving take up in existing homes, prioritising those which are already 'heat pump ready' (214,000 - 293,000 properties estimated - see below)

This would be comfortably within the envelope implied by the proposed 5.5GW target (see Fig 1 above). It would also broadly in line with the

[4] As set out by the Minister in her 7 April 2022 letter to CCEI committee https://business.senedd.wales/documents/s124308/Response%20from%20the%20Minister%20for%20Climate%20Change%20to%20the%20letter%20from%20the%20Chair%20in%20relation%20to%20decarbonis.pdf

Committee on Climate Change's Balanced Pathway scenario[5]. The Balanced Pathway assumes 8 million heat pumps are deployed in *existing* homes UK wide by 2035. If Wales made a 5% contribution (based on having around 5% of the UK's existing homes) this would also suggest around 400,000 homes.

400,000 heat pumps in homes would deliver annual savings of around 716,000 tonnes of CO2 (see Appendix A), based on the current carbon intensity of the grid. This figure would only increase as grid level generation is further decarbonised.

[5] The CCC: Development of trajectories for residential heat decarbonisation to inform the Sixth Carbon Budget https://www.theccc.org.uk/wp-content/uploads/2020/12/Element-Energy-Trajectories-for-Residential-Heat-Decarbonisation-Executive-Summary.pdf

## Achieving the target

In Wales today we estimate there are between 9,500 (based on EPC records) and 10,500 (according to the Welsh Government's 'Energy Generation in Wales 2022' report) heat pumps installed in domestic properties. This represents around 0.7% of Wales' 1.35m homes today.

We assume a certain proportion of any heat pump target will be delivered by current and planned policy regarding new builds. Specifically, we assume the successful implementation of the WDQR 2021 in social housing would deliver 23,000 new heat pumps if new build rates continue on their current trend of 957 per year on average[6].

We also assume that if the WDQR is adopted in private housing from 2025 as planned[7], this would deliver around 66,600 new heat pumps based if new build rates continue on their current trend of 5217 per year[8].

The existing numbers of heat pumps present in Wales and their rate of adoption have been approximated by combining EPC data for registered new builds with heat pumps with MCS data for certified heat pump retrofits. We acknowledge that there may be some discrepancy between our number and the total number of heat pumps in the EPC database, this can mainly be attributed to not all MCS retrofitted properties having an up-to-date EPC rating.

Existing and planned policy therefore potentially contributes around 78,000 heat pump units to the target by 2035.

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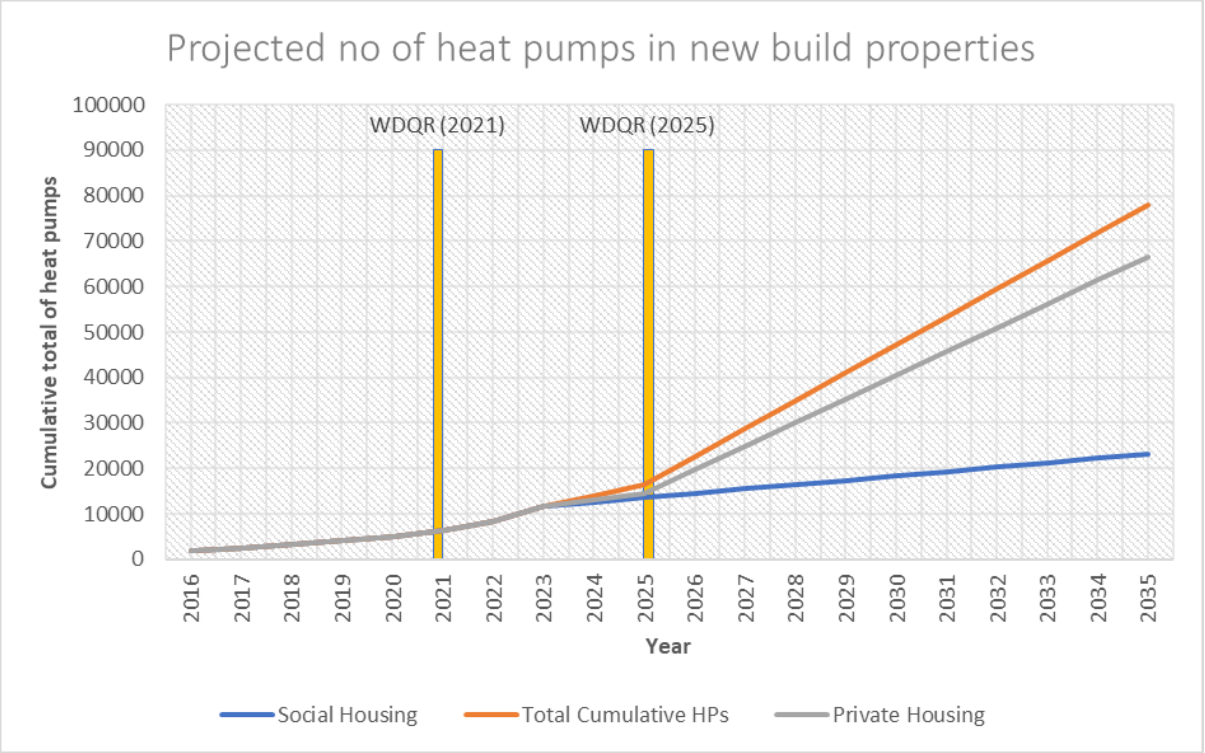
[6] Mean per year since 2007 based on https://statswales.gov.wales/Catalogue/Housing/New-House-Building/newdwellingscompleted-by-period-tenure

[7] As set out by the Minister in her 7 April 2022 letter to CCEI committee https://business.senedd.wales/documents/s124308/Response%20from%20the%20Minister%20for%20Climate%20Change%20to%20the%20letter%20from%20the%20Chair%20in%20relation%20to%20decarbonis.pdf

[8] Mean per year since 2007 based on https://statswales.gov.wales/Catalogue/Housing/New-House-Building/newdwellingscompleted-by-period-tenure




However, it is well understood that retrofitting green heating systems, alongside other energy saving measures, in existing homes is the greatest decarbonisation challenge. We therefore believe that additional policy development will be needed to drive progress to the target.

**Recommendation 1: Make the installation of heat pumps in 'heat pump ready' existing homes a focus for the forthcoming Heat Strategy**

We believe there is a policy opportunity in Wales for a **targeted approach to increasing heat pump adoption in 'heat pump ready' homes** - particularly in the private housing market. This should be a focus for the forthcoming Heat Strategy.

We have argued above that the purpose of an ambitious but achievable heat pump target should be to drive and support the design of effective policy to reduce the barriers to widespread take up. There comes a point at which increased adoption of heat pumps in itself starts to play a role in breaking down the cost and appeal barriers - whether through economies of scale, or increased familiarity with the technology.

We recognise that there is not a universally accepted definition of 'heat pump ready'. The Welsh Government should work towards adopting a definition of what this would mean. Broadly, a heat pump ready should mean 'a home which can successfully be heated with low temperature heating without substantial additional upgrades to its fabric or heating distribution system' (acknowledging that 'successfully' and 'substantial' would themselves need to be defined).

A *perfectly* heat pump ready home would be one which could have a heat pump with no additional retrofit work whatsoever. However, we believe that a more pragmatic definition rooted in low to no additional retrofit being needed would successfully drive supporting policy and achieve decarbonisation at pace.

The Welsh Government should look at homes in Wales in terms of those characteristics which contribute positively to heat pump readiness, rather than a risk averse approach which emphasises deficits in readiness.

We should also not conceive of 'heat pump ready' as being a simple binary, or indeed an absolute condition. Readiness will also be partly about the interaction between the physical characteristics of the property and homeowners' willingness to pay and act.

Physical characteristics most likely to contribute to heat pump readiness would be:

- Fabric energy efficiency
- Current heating system - particularly homes that are off gas or already on electric heating

**How many Welsh homes could be 'heat pump ready' today?**

Heating system design is complex, and homes need individual assessments before green upgrades are made, as well as verification and testing after installation to ensure the new system is working optimally. Any attempt to define 'heat pump ready' should be as an aid to policy targeting, and to shift the message for consumers from one which we fear harms net zero ambitions ('not all homes can have a heat pump') to one which is more nuanced, evidence based, and ultimately more likely to prompt action.

We should not default to assuming deep and extensive fabric retrofits will be necessary to decarbonise all homes. **Some homes will not need any fabric retrofit at all** - and the Welsh Government should prioritise these for heat pump installation in the short term to deliver its target.

With this in mind, we believe that **between a quarter and a third of Welsh homes might be ready to have a heat pump installed** without any upfront fabric retrofit.

Our assumptions here are:

- There are 292,648 Welsh properties in the EPC databases[9] that are **EPC C and above**, and which **also have 'good' or 'very good' wall insulation** (31.7% of all records)
- Of these, 213,737 **also have 'good' or 'very good' roof insulation** (23.1% of all records)
- These properties are likely to be able to be heated effectively with a low-temperature heating system. In practice, some may need upgrades to pipes and/or emitters (radiators), but further reducing heat loss through insulation is unlikely to be cost effective over the lifetime of a heat pump.

Cambridge Architectural Research undertook modelling[10] for Nesta around flow temperatures. They estimated that 72% of homes have radiators suitable for flow temperatures of 60°C, and 53% for 55°C (on a mean winter's day). Of these, roughly 92% would also have suitable pipework for a 55°C flow temperature.

A provisional estimate, which would require further work would be that we might assume that around half of well-insulated homes are also likely to need only minor upgrades to radiators.

[9] To note: not all properties are covered by the EPC database

[10] Free and low-cost energy-saving actions to bring down bills, improve energy security and help the planet (2022) https://www.nesta.org.uk/report/free-and-low-cost-energy-saving-actions-to-bring-down-bills-improve-energy-security-and-help-the-planet/

**Fabric and heat pump readiness**

The fabric efficiency of buildings plays a role in how easily they can accommodate a heat pump as a retrofit without substantial additional changes.

A heat pump needs to be able to produce enough heat to replace heat lost. Therefore the fact that heat pumps run at lower flow temperatures is relevant here, as a lower mean water temperature means lower output for the same radiators. Heat pump readiness will therefore mean understanding how well the home can accommodate low temperature heating. Again, this will at least partly depend on what homeowners choose to prioritise.

Total heat demand impacts the size of heat pump needed (as discussed above), so there might be an absolute constraint if heat demand is too high overall - e.g. some larger homes might need two heat pump units.

However, in a majority of cases it is incorrect to state that a heat pump cannot work in a home. Rather this will be a trade off between upfront costs (insulation, replacement radiators etc) with long term running costs.

For some homes, the amount of additional fabric insulation needed to ensure a heat pump system works well is likely to be minimal. In other cases, the same results could be achieved by resizing radiators. Effective heating controls, which householders know how to use, can also mitigate the need for either insulation or replacement radiators. In some cases, a larger heat pump or a system designed to run at a slightly higher flow temperature will be more cost-effective than a smaller heat pump plus more extensive fabric measures.

In weighing up any of these options, we should also be cautious of overestimating the appetite homeowners or landlords will have for the disruption and cost of multiple rounds of building work. If we want people to act, then the message that they absolutely need to have both fabric insulation and a heat pump may result in some homeowners not doing either.

The Energy Systems Catapult's *Electrification of Heat Demonstration Project* on behalf of DESNZ is evidence that heat pumps can be successfully installed in any housing archetype. The ESC noted that "energy efficiency upgrades

were only made for 15% of properties where a heat pump was installed – in most cases this was loft insulation. The majority of homes where a heat pump was installed had an Energy Performance Certificate rating of C or D." [11]

Sero homes have undertaken analysis of what level of fabric retrofit might be needed to accommodate a heat pump, concluding that:

> "Modelling of the UK suggests that the 'cost optimal' balance from the system perspective is to reduce heat demand by about 10%. This amounts to a pretty 'light' fabric retrofit, such as cavity wall insulation, loft insulation and some window upgrades. This differs from other countries because of the UK's large wind resource, which coincides well with seasonal heat demand."[12]

**Electric heating and heat pump readiness**

Homes which are already on an electric heating source could also be considered a factor in being heat pump ready. Partly because moving such homes onto new gas combi boilers would be incompatible with climate goals, but also because a heat pump is likely to deliver efficiency savings for these homes with few or minimal additional changes.

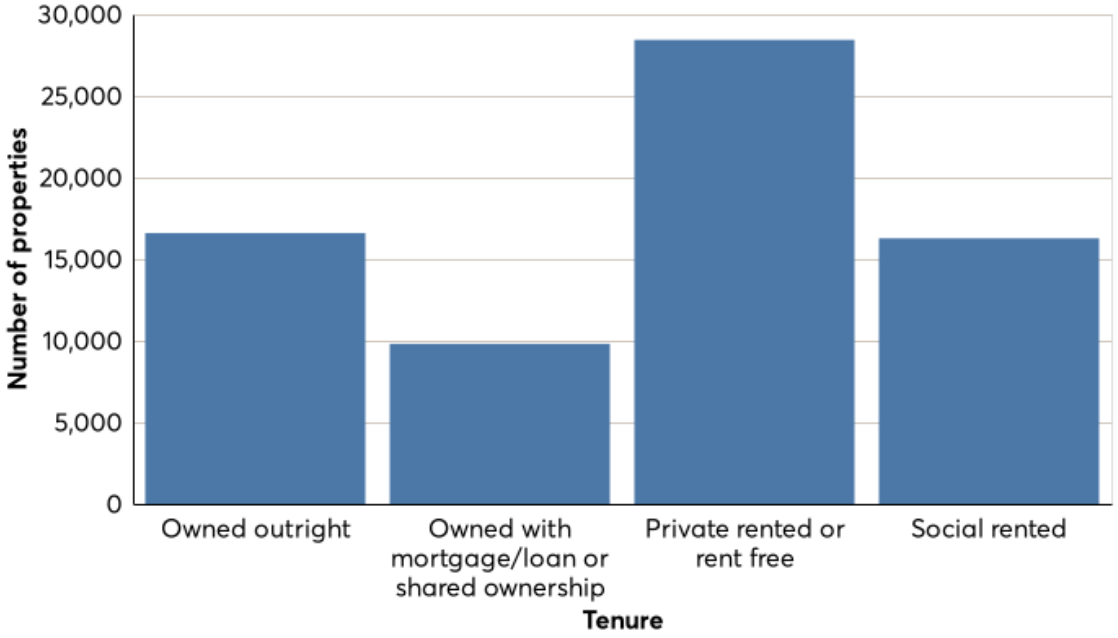
One of the main concerns around heat pump readiness is whether the switch will increase energy bills. Because heat pumps are three times more efficient than most currently available direct electric competitors (see Appendix A), they have the potential to reduce energy demand by two thirds even if we assumed there would be no other changes.

According to 2021 Census data, about 5% of Welsh homes (71,119) are already heated by electricity only.

[11] Energy Systems Catapult Electrification of Heat Demonstrator project https://es.catapult.org.uk/news/mass-rollout-of-heat-pumps-feasible-but-innovation-needed/

[12] Sero: Retrofit: is Fabric First Really the Best Strategy? https://sero.life/energy-advice-support/understanding-energy/retrofit-is-fabric-first-really-the-best-strategy/

**Fig. 2: Properties in Wales with only electric heating, split by tenure (N = 71,119)**



## Other actions to support heat pump adoption in the short, medium and long term

### Short term (12 months)

**Recommendation 2: Support households to optimise their existing heating systems, as a step towards low-temperature heating**

Many households could reduce their carbon emissions and save money through simple, low- and no-cost actions. One of these is to lower the flow temperature of their combi boilers. This has the effect of reducing the temperature of water in radiators, which enables condensing boilers to run more efficiently. While gas heating systems are usually designed to run with flow temperatures of 70-80°C, many homes are able to reach desired room temperatures with lower flow temperatures.

Reducing boiler flow temperatures saves money, gas and carbon in the short term. It also helps households get on the road to a heat pump by normalising low-temperature heating, for example, helping people get used to radiators that are warm rather than hot. Flow temperatures can be lowered manually - Nesta's digital tool shows people how to adjust their own boiler settings and has successfully been used by over 200,000 people - or optimised automatically using controls with weather compensation or load compensation (which adjust flow temperatures depending on outside or inside temperature, respectively).

Heat pumps also use compensating controls to modulate their flow temperatures, so introducing these types of controls would again help households get used to aspects of living with a heat pump, before getting one. As a funder of advice services, the Welsh Government is well-placed to drive increased awareness of boiler optimisation as a simple and quick way to reduce energy usage while helping pave the way for low-temperature heating. It should also mandate the provision of advice on this as part of its future Warm Homes programmes.

**Recommendation 3: Invest in research to map the most plausible paths to scaling learning from the Optimised Retrofit Programme to the private housing sector.**

The Optimised Retrofit Programme is the Welsh Government's flagship 'test and learn' whole house retrofit scheme. Social landlords participating in the programme have an explicit mandate to explore paths to scale outside their own tenure. Nesta believes this has significant potential to increase the pace of decarbonisation, but its success will depend on a proper understanding of how it will be achieved.

Our work on scaling innovation has shown that it requires clarity on:

- The goals of scaling - **what should be achieved** by growing the impact of a specific intervention - in this case, is it about comfort, reducing bills or reducing carbon emissions?
- Whether these goals **align with what users want**
- The key **dependencies** of success - asking 'What made this successful?' and whether this key factor is also scalable / transferable

Only then can we understand which **strategies** are likely to be most effective in scaling.

Scaling also requires that there is sufficient **demand** for the lessons. At present, it isn't clear how much demand there is within the private housing sector for the lessons that ORP is likely to generate, or which sorts of homeowners that demand is most likely to come from. Demand is unlikely to be uniform across the owner occupied and privately rented sectors.

The ORP is multifaceted, but clearly two significant dependencies are the availability of large amounts of public funding, and a set of willing delivery partners who are able to make decisions about large volumes of stock.

By contrast, the private housing sector is unlikely to receive the same volume of grant funding, and is fundamentally different in its decision making structures - with 1.1million individual households in all their diversity requiring a reason to act.

As well as answering the core ORP technical questions like 'What measures

work in what housing archetype?', the wider research into scaling should also ask 'What is most persuasive in getting property owners to take action?'. Reliable information about what works technically is unlikely to be sufficient in itself.

Nesta is currently developing partnerships in Wales which could explore the question of how ORP learning can scale.

Involving homeowners and landlords directly in research around the ORP at the earliest possible opportunity will enable small-scale testing and insight generation on questions like: How might ORP insights be presented? Who is the most trusted organisation to deliver these messages? Have we tested our assumptions about what private owners and landlords are trying to achieve when upgrading their homes? Does this align with what the ORP is learning?

This can be followed by larger scale trials to see which of the important behavioural barriers can (and cannot) be overcome by the ORP's findings.

To be clear - We have made no conclusions about the extent to which ORP learning can scale, and it is likely to be hugely valuable. But it is clear that we must invest directly in understanding and developing clear paths to scale.

**Medium term (2-5 years)**

**Recommendation 4: Ensure heat electrification workforce / skills are a focus within wider retrofit skills policy**

The Optimised Retrofit Programme already has extensive activity around skills for fabric retrofit, and this should be complemented with a specific focus on heat installers in Wales.

As well as supporting heat pump rollout in Wales, this will help ensure Wales' heat engineering sector is not left behind the rest of the UK. The design, installation and maintenance of electric heating systems has the potential to provide skilled, secure local jobs in the foundational economy for decades to come. If Wales moves more slowly, there is a strong possibility that Welsh homes will be upgraded by businesses from over the border.

Nesta has published research[13] exploring the current state of the heat pump market from a skills, training and productivity perspective and suggests ways of increasing the supply chain's capacity to install heat pumps. Based on direct engagement with the sector, we conclude that the UK as a whole needs to train more engineers each year than there are currently in the whole industry.

Our research found that existing training pathways are complex and fragmented. There is currently no single, clear route for someone new to the industry to train as a heat pump engineer. Training offers are fragmented and sometimes inconsistent.

The industry needs to attract both experienced gas engineers and new entrants. Having enough companies and experienced engineers to take on and help train new workers is vital so the heat pump industry can grow. Attracting new entrants via colleges and apprenticeships will also be crucial given the age demographic of the existing gas workforce.

The pathways for new heat engineers and new fabric retrofit installers are unlikely to be identical. So both should be given a specific focus within the Welsh Government's skills programme around the ORP.

**Recommendation 5: Develop new finance products for home decarbonisation in Wales, and target them on wider outcomes**

The Decarbonisation of Homes in Wales Advisory Group's 2019 report[14] and research by the New Economics Foundation on behalf of the Future Generations Commissioner for Wales[15] identified the provision of publicly funded finance products as a way to address the strategic gap in respect of private housing in Wales.

Following this, the Development Bank of Wales has begun to invest in developing products which could be used for green home upgrades /

[13] How to scale a highly skilled heat pump industry (Nesta 2022) https://www.nesta.org.uk/report/how-to-scale-a-highly-skilled-heat-pump-industry/?gclid=Cj0KCQjw3eeXBhD7ARIsAHjssr-LA8BZyQZc3pTQ_nXuDASqK26lRcQFLOIcsfViFTZr4-XJHVNqy-IaApr4EALw_wcB

[14] Better Homes, Better Wales, Better World: Decarbonising existing homes in Wales (2019) https://gov.wales/sites/default/files/publications/2019-07/independent-review-on-decarbonising-welsh-homes-report.pdf

[15] Homes fit for the Future: The Retrofit Challenge (2021) https://www.futuregenerations.wales/resources_posts/homes-fit-for-the-future-the-retrofit-challenge/

retrofit. Nesta has been working in partnership with the Bank to support the development of these potential products, primarily through user testing and insight generation. Our work so far has identified the key needs homeowners[16] have around access to finance, and how to choose the right retrofit measures for their home.

This has informed a large-scale behavioural science experiment to test which of a range of currently hypothetical products might achieve the greatest rate of uptake in Wales. We intend to publish the findings of this work in May 2023.

We hope to see the Development Bank pilot a financial product, informed by our work, in the near future. If this pilot proves successful, the Welsh Government should support the scaling of this product and service offering in the longer term.

However whilst a substantial investment of public funding into retrofit in this market would be welcome, we recognise it is unlikely to be possible to fund works in all 1.1m of Wales' privately owned homes. We therefore believe the Welsh Government should consider what else it can achieve by contributing to the development of this finance offer.

For example, a key insight is that householders perceive a big risk in making the wrong decision about what measures to install in their home. They suspect that if they invest in a technology in 2022, they may find this has been superseded by a better technology in the near future. Whilst understandable, this mindset clearly does not lend itself to rapid progress in this crucial period for climate action.

The Welsh Government could address this by aligning this new finance offering with its heat pump target, sending a clear signal to homeowners that they can have confidence in the technology, and that government finance is available via the Development Bank to help them purchase one. This in turn could also send a message to the wider workforce and supply chains.

[16] Not including private landlords, at this stage

**Recommendation 6: Remove unnecessary barriers within the planning system to heat pump uptake -particularly in urban areas**

Nesta understands, through our engagement with installers, that planning requirements around air source heat pumps can sometimes present a barrier to uptake in Wales., particularly in urban areas with higher population density.

Reasons for planning restrictions include assumptions around the noise an outside heat pump unit makes, as well as considerations around placing units at a fixed distance from windows, and out of the line of sight of neighbouring houses.

However, we believe concerns about the noise of heat pumps are often overstated, especially in the context of other noise sources within densely populated areas which go unregulated.

We intend to look more closely at the impact of planning on uptake in Wales, and properly map which regulations apply and where. Given their importance to reducing carbon emissions over the next ten years, awarding heat pumps permitted development status in planning would be more consistent with the approach the Welsh Government has taken on rooftop solar[17].

**Long term (5 years onwards)**

The actions outlined above should align towards a step change in the rate of heat pump adoption in Wales in the second half of this crucial decade.

Further actions in this period could include scaling the learning from the Optimised Retrofit Programme - based on the pathway mapping described above, as well as an increased investment in government finance.

[17] Gov.wales - Planning permission: solar panels https://gov.wales/planning-permission-solar-panels

# Appendix A

# Why heat pumps should be a priority for domestic heat decarbonisation

Wales currently has around 10,000 heat pump installations recorded on the EPC register. So Wales will need new heat pump-focused policies to increase the pace of installations. These should initially be targeted at the significant proportion of Wales' private housing stock which is already well insulated,

These new policies should complement a continued investment in insulation, as Wales will also need **500,000 properties to install cavity wall, solid wall or floor insulation** to deliver the needed reductions by 2030. Insulation programmes should continue to target households in, or at risk of, fuel poverty or cold related health problems.

Driving the uptake of heat pumps sooner rather than later will also help ensure Wales' **heating sector is not left behind the rest of the UK**.

The Welsh Government should focus on achieving the fastest possible reductions in emissions in the housing sector. A decarbonisation first approach means increasing focus on **replacing gas and oil boilers with electric heating systems** in the short and medium term.

**Objectives and prioritisation**

When advocating a particular approach to upgrading existing homes stakeholders might have different outcomes in mind:

- Reducing the carbon footprint of homes / heating
- Reducing household bills and tackling fuel poverty
- Improving comfort or health outcomes
- Lowering risks to energy bills long term from volatile gas markets

There are clearly both tradeoffs and positive interactions between these outcomes. So policy should be designed on the basis of a clear ranking of these priorities.

We note the conclusions of the Auditor General for Wales' 2021 report[18] into the Welsh Government's Warm Homes programmes Nest and Arbed.

> *"Given its ambitions to achieve net-zero carbon emissions, the Welsh Government will need to rethink the energy efficiency measures offered. Both schemes rely heavily on installing fossil fuel heating, particularly gas boilers. New, efficient boilers may produce less carbon than older ones but are not the most environmentally effective option."*

This clearly demonstrates the tension between fuel poverty first and decarbonisation first approaches. The Warm Homes schemes have understandably prioritised the immediate cash savings of a replacement boiler, but this has had the unfortunate consequence of potentially locking in a decade of additional fossil fuel emissions from those homes.

We believe that the private housing sector is a better space for policies where decarbonisation is the top priority.

## The case for putting low carbon heat first

Our analysis of the costs and carbon benefits of the currently available technologies has led us to focus on rapidly increasing the uptake of electric heat pumps, which we think can be achieved by using innovation to reduce their cost, improve their appeal and increase capacity in the installer workforce. We believe this represents the optimal 'decarbonisation first' approach.

- they deliver a **greater CO2 saving per pound spent** than any competing green heat technology (or insulation measures)
- they are a **market-ready technology**, already widely used in other EU nations, including many with much colder average temperatures than Wales

[18] Audit Wales - The Welsh Government's Warm Homes Programme (2021) https://www.audit.wales/sites/default/files/publications/The%20Welsh%20Governments%20Warm%20Homes%20Programme%20-%20English.pdf

- they are **highly efficient,** with average installations delivering **three times as much heat output** per unit of energy as a gas boiler[19], and most other electric heat options. The best installations can deliver four or more times the heat out

Insulation clearly has an effect on emissions, as well as reducing bills and improving health and comfort. There is clearly a strong argument for continuing and increasing government support for insulation programmes. However, when evaluated from a decarbonisation perspective, **insulation is not the most cost effective way to reduce carbon emissions** when compared to installing heat pumps.

We of course recognise that the current cost of living crisis changes the context for what governments should prioritise, and we return to this below.

## Emissions reductions and costs by intervention

The table below shows the percentage carbon abatement achieved by replacing a gas or oil boiler with a  heat pump.

Heat pumps are highly efficient. Heat pumps currently installed in UK homes produce on average 2.7 units of heat per unit of energy, compared to 0.85 for fossil fuel boilers, and the highest quality installations achieve efficiencies of 3.5 and above. This has a multiplier effect on an already cleaner technology, resulting in an emissions abatement of just over 60%.

| **Emissions per kWh - kg CO2e** | Input - emissions per kWh | Efficiency | Output - emissions per kWh |
|---|---|---|---|
| Gas boiler | 0.1830 | 0.85 | 0.215 |
| Oil boiler | 0.2140 | 0.85 | 0.252 |
| Heat pump | 0.2290 | 2.7 | 0.085 |
| | | | |

[19] Electrification of Heat - Heat Pump Installation Statistics Report https://es.catapult.org.uk/report/electrification-of-heat-installation-statistics/

| | | | |
|---|---|---|---|
| Abatement - Heat Pump vs gas boiler | | | 0.130 |
| Abatement % | | | 60.61% |
| | | | |
| Abatement - Heat Pump vs oil boiler | | | 0.167 |
| Abatement % | | | 66.31% |
| **Source: Greenhouse gas reporting: conversion factors 2021** https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021 | | | |

The table below shows how this translates into actual tonnage of CO2 emissions annually. The 13,700kWh figure represents the mean average gas consumption per UK household[20]. Installing a heat pump delivers a reduction of 1.79 tonnes of CO2 per year. The earlier this abatement is achieved, the greater the cumulative reduction.

| **Annual emissions per 13700 kWh** | Tonnes CO2e |
|---|---|
| Gas boiler (efficiency above) | 2.95 |
| Heat pump (efficiency above) | 1.16 |
| Annual abatement | 1.79 |
| % abatement | 60.61% |

The table below shows the emissions reductions achieved by the most common types of fabric retrofit measures. The greatest reduction achievable comes via solid wall insulation, at around 17% - significantly lower than the 60% reduction from installing a heat pump.

| | **Median energy savings** | **Mean energy savings** |
|---|---|---|

[20] **Subnational Electricity and Gas Consumption (BEIS 2020)** Statisticshttps://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1079141/subnational_electricity_and_gas_consumption_summary_report_2020.pdf

| | | |
|---|---|---|
| Cavity wall insulation | 8.6% | 8.1% |
| Loft insulation | 3.7% | 2.6% |
| Solid wall insulation | 18.0% | 17.0% |
| Cavity wall and loft combined | 13.6% | 12.5% |
| **Source:** National Energy Efficiency Data Framework (NEED) (BEIS 2019: England and Wales data) | | |

**Comparison of costs**

The most recent Boiler Upgrade Scheme statistics show the median cost of an air-source heat pump installation in the UK is £13,000[21]. This upfront cost will clearly remain a barrier for many households in the early part of this decade. However, with policy changes and achievable improvements in installation quality, heat pumps could generate annual running costs savings sufficient to offset the difference in upfront costs within equipment lifetimes.

Solid wall insulation is the most directly comparable in terms of cost to a heat pump installation, with average costs quoted by the EPC register broadly falling between £5-15,000. For a 3-bed semi-detached solid wall home with a gas boiler, solid wall insulation might cost around £13k, and would save just under 1000 kgCO2/year. An air source heat pump costing roughly the same would save 3200 kgCO2/year.

## What do we know about current homes with heat pumps in Wales?[22]

About 10,000 of the 924,000 properties in the Welsh EPC database are

[21] Boiler Upgrade Scheme statistics: February 2023 (DESNZ March 2023) https://www.gov.uk/government/statistics/boiler-upgrade-scheme-statistics-february-2023

[22] This section is based heavily on the Energy Performance Certificate (EPC) database. Only around 924,000 of Wales' 1.35m homes are recorded in the database, and the characteristics of homes not on the register may vary from those that are.

We also acknowledge the shortcomings of the EPC register from a methodological point of view - not least the fact that installing a heat pump can actually reduce the EPC rating of a home whilst improving its carbon footprint. Improving the data available to policymakers around housing decarbonisation would be valuable, until then we continue to make use of the EPC record as the best available data set - which at least enables like-for-like comparisons with other users.

recorded as having a heat pump (1.07%). Since the EPC register only includes data on around 66% of Welsh homes, this is likely to be an underestimate of the true number of heat pumps installed.

Of these, 46% are in owner occupied properties, 18% are in social housing, and 5% are in privately rented homes. The remaining 31% are 'unknown' - suggesting their tenure might not have been certain at the time the EPC was undertaken (most likely if they are new builds).

**Fig. 3: Tenure of Welsh properties with heat pumps (N = 9919)**


**Where are heat pumps in Wales?**

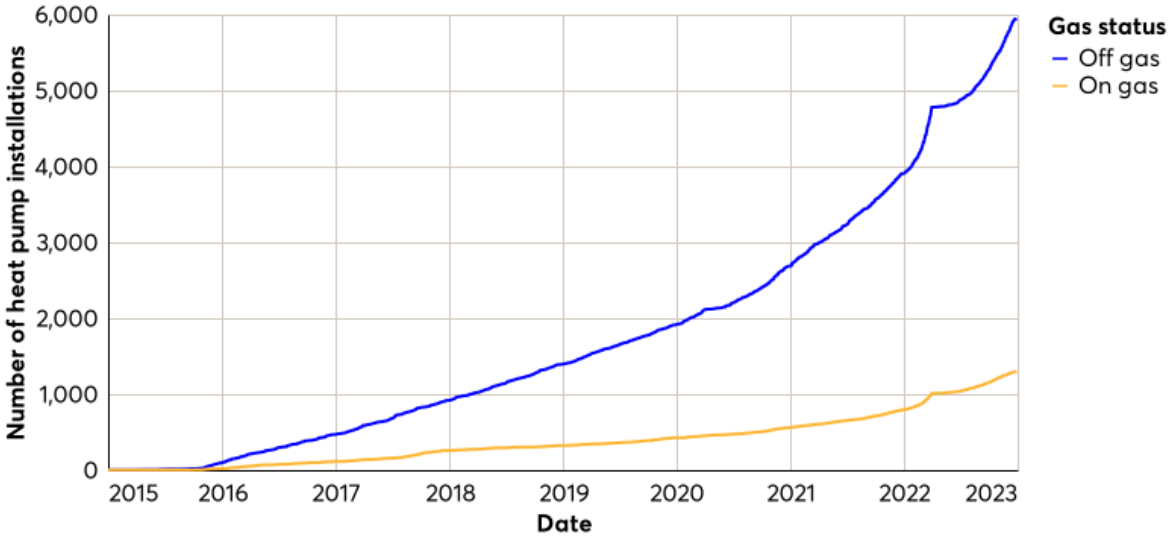
Nesta's previous analysis[23] suggests a higher concentration of heat pumps in more rural parts of Wales, and lower concentrations in cities and urban areas. We have not undertaken detailed research on this for Wales specifically, but factors we could reasonably assume are influencing this would be:

- **Planning restrictions** - which restrict the installation of heat pumps within a certain distance of neighbouring properties, or within a certain line of sight

[23] Nesta response to Senedd inquiry on decarbonising private homes in Wales https://www.nesta.org.uk/project/nesta-responds-to-senedd-inquiry-on-decarbonising-private-homes-in-wales/

- **Replacement of off-gas heating systems** - Off-gas grid homes don't have the option of installing combi-boilers and heat pumps may compare more favourably on both installation and running costs with oil or LPG based heating systems. In Wales, we note that there is a significant difference in the pace of adoption between on and off gas properties (see Fig 4).
- Evidence from Nesta in Scotland[24] examining a similar pattern concluded that many heat pumps were being installed to replace LPG or oil boilers.

**Fig. 4: Cumulative number of MCS certified heat pump installations in Welsh homes located in off- and on-gas postcodes**




**How do heat pump installations correlate with energy efficiency of buildings?**

[24] Modelling Heat Pump Growth in Scotland Nesta (2022) https://www.nesta.org.uk/feature/modelling-heat-pump-growth-in-scotland/

**Fig. 5: EPC ratings of all Welsh properties (N = 923,568)**

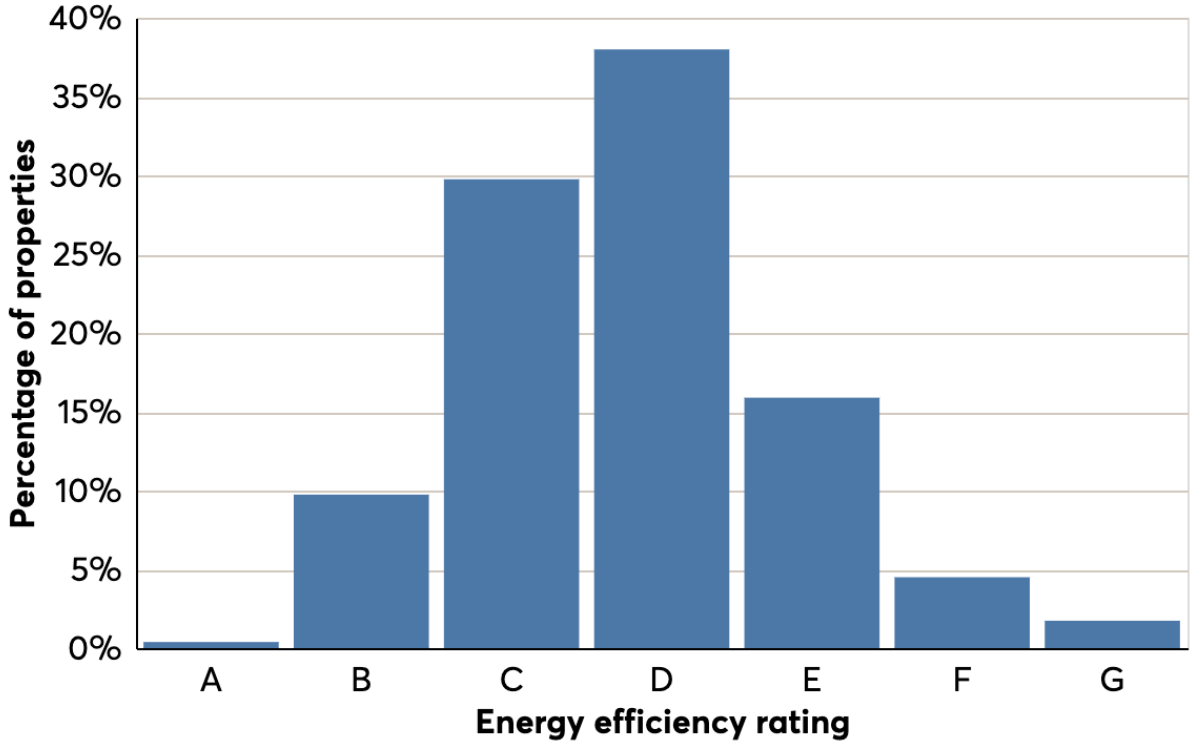



Fig. 5 shows EPC ratings of all Welsh homes in the EPC database.

**Fig. 6: EPC ratings of owner-occupied and privately rented Welsh properties with heat pumps (N = 5005)**

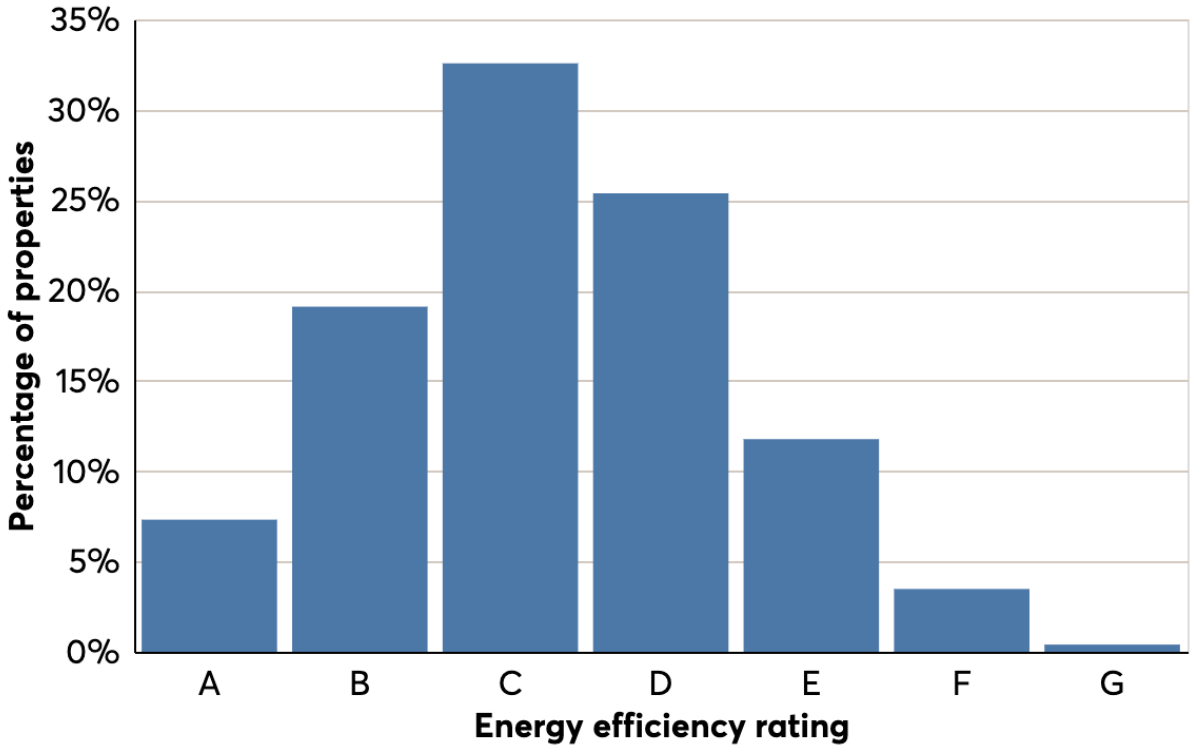


Fig. 6 shows owner-occupied and privately rented Welsh homes with heat pumps installed. This shows that heat pumps tend to be installed in more efficient homes than the average distribution, but a reasonable proportion are nevertheless in low EPC homes.

Nesta understands that in some cases the installation of a heat pump has caused the EPC rating of a property to decrease. The thermal efficiency of some of these homes may in fact be better than implied by the EPC rating.

**Older homes with heat pumps**

**Fig. 7: EPC ratings of owner-occupied and privately rented Welsh properties with heat pumps, built pre-2007 (N = 3338)**

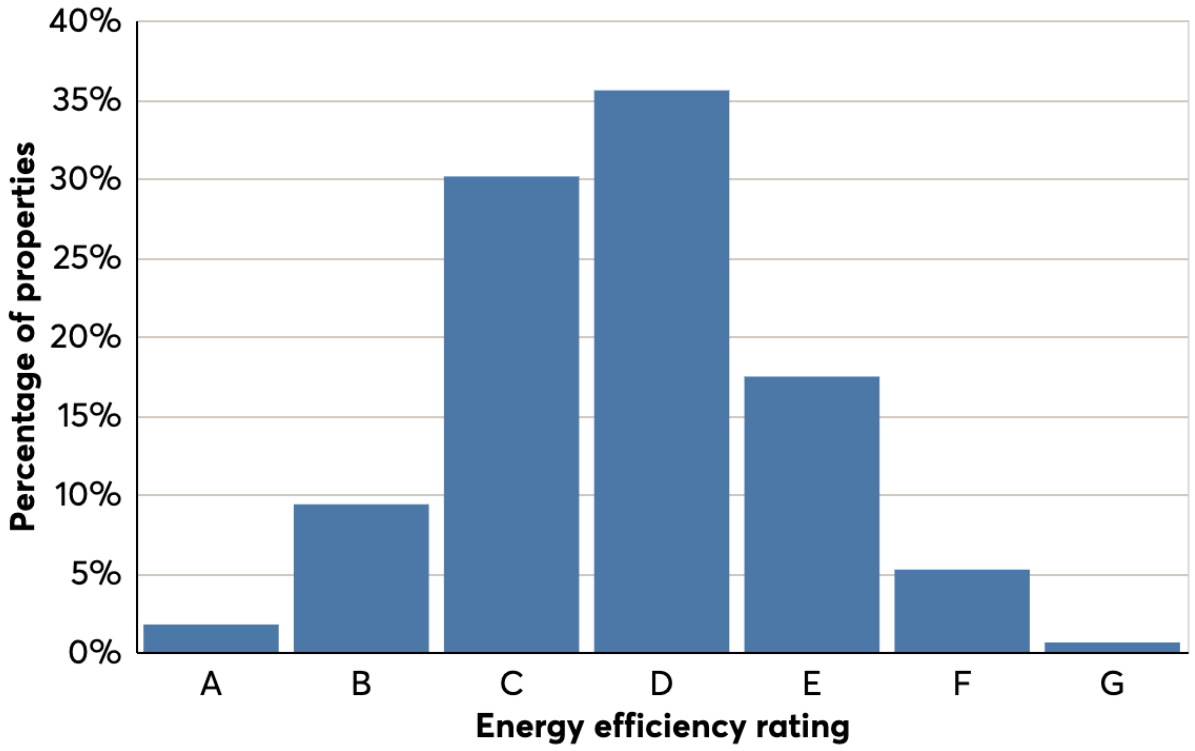



Fig. 7 shows all homes in Wales built before 2007 with heat pumps. These records cover all properties built before 1900 until 2007 - when EPC records began. We have assumed, because of their age, that the majority of these are homes where the heat pump was installed as a retrofit - rather than in a new build property.

Comparing Fig. 6 and 6 we can conclude that heat pumps installed as retrofits appear in private housing in similar proportions to the general distribution of EPCs across the whole housing stock (Fig. 5). The experience of home owners across these housing types would be a valuable area for further investigation.