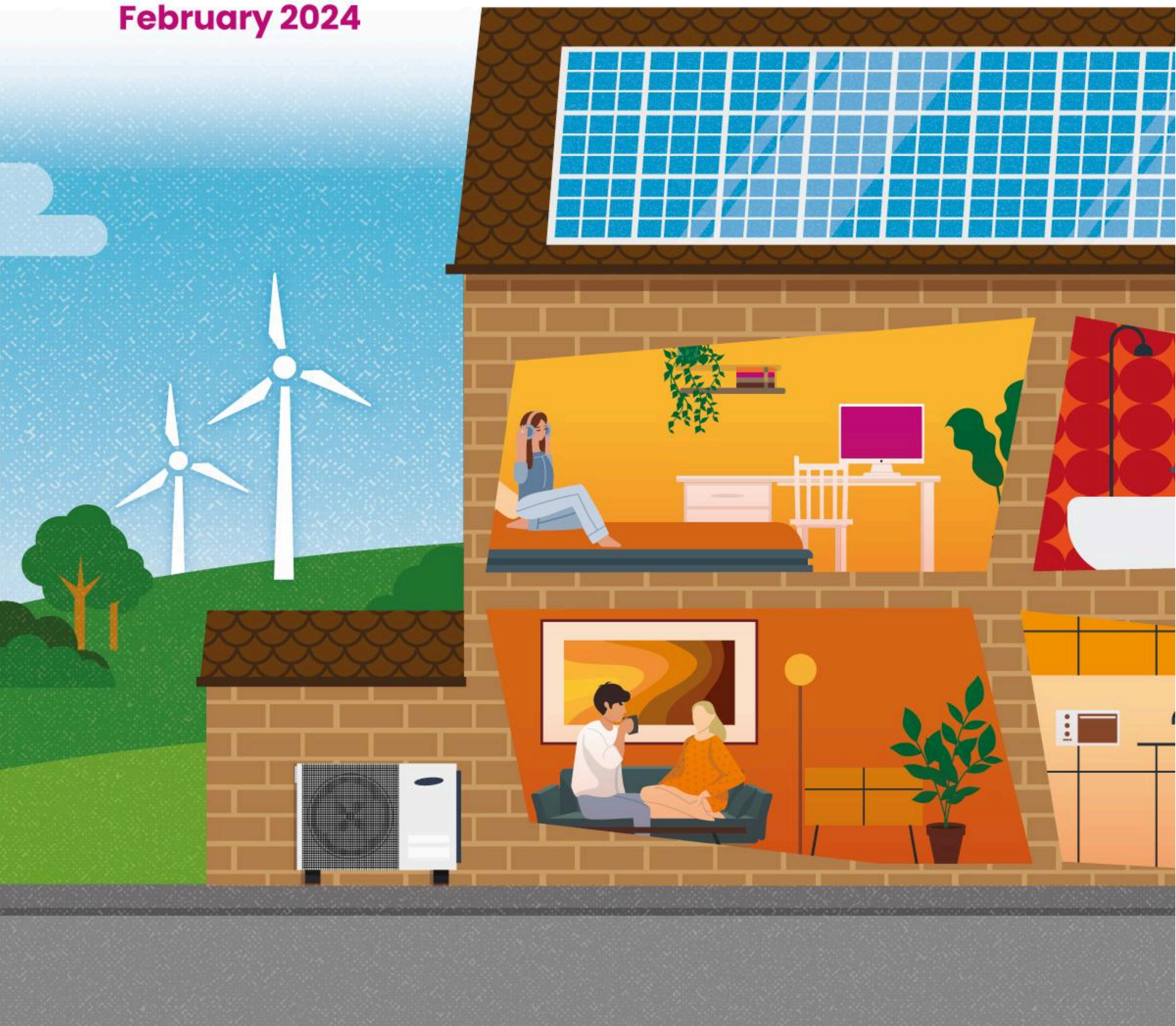
Possible.
Inspiring climate action

Wind-powered heat

Powering clean heat with clean energy to cut costs and emissions

February 2024



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Regen provides evidence-led insight and advice to transform the UK's energy system for a net zero future.

www.regen.co.uk
Twitter: @regeninsight

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Executive Summary

We urgently need much greater action to tackle both the climate crisis and the energy cost crisis. Domestic heat contributes around one seventh of the UK's carbon emissions[1] while soaring energy and gas bills have had hugely detrimental impacts on households' finances – and health – in recent years, with the NHS spending hundreds of millions of pounds each year to treat health conditions caused by cold homes.[2] Solutions to get households off gas power and on to clean electrified heating, such as heat pumps and heat networks, are being deployed far too slowly.

Shifting to heat powered by renewables will also make us less reliant on gas prices set in international markets and less vulnerable to the sort of price spikes we have seen in recent years. However, the cost of buying electricity from the grid to power heat pumps, particularly relative to the price of gas, is a key barrier to the much more rapid uptake of clean heat that is required. Electricity bills are also kept high by the decision to levy policy costs predominantly on electricity rather than on gas.

For clean, electrified heat to start being deployed in households at the much faster rate that is needed, these vital technologies will need to be accessible and understandable to consumers. And, crucially, low-carbon heat will need to be – at the very least – at price parity with running a gas boiler and, ideally, lower cost than remaining on gas heating. Without workable ways to make clean heat reliably cheaper than dirty heat, uptake is likely to remain far too slow. Hard-pressed households across the country simply cannot be expected to pay more for clean heating.

This report explores the potential for new community onshore wind projects to unlock part of the puzzle of making clean, local heat cheaper and therefore more attractive to roll out, ideally at scale. Deploying heat pumps or heat networks at community scale, rather than one household at a time, has multiple benefits. It offers the potential for faster deployment and swifter emissions reductions, while also offering consumers lower prices, a greater sense of confidence and

[1] Energy Systems Catapult, *A Guide to the Decarbonisation of Heat in the UK*
[2] BRE Group, *The cost of poor housing in England*. 2021.

more support, and affording local installers a more reliable supply of work.

Onshore wind is one of the cheapest energy sources available, and offers stable and predictable prices that protect consumers from the volatility and price spikes of gas. Our modelling of the match between wind power generation and heating demand found that wind is a good match for the electricity needed for clean heat – unsurprisingly, as winter is windier than summer. Our models compared the profiles of UK heat demand and onshore wind availability on an hourly basis using a 2 megawatt (MW) turbine supplying a community of 2,000 households, each with an air source heat pump, and estimated that wind would be able to fulfil 68% of heat demand. Adding 6 MW of solar across the households' rooftops (an average of 3 kW of solar panels to each home) could allow the generation to meet around 80% of demand, and adding in an additional 5.2 kW battery to each home took the matching up to 90%. The remaining energy would be obtained via the electricity grid.

Our modelling indicates that this could generate significant savings for consumers, making clean heat much more attractive. **The annualised costs of clean heat plus wind power could offer a potential saving of 26% compared to gas heating, while including domestic solar and batteries could bring the potential savings up to 31%. The carbon savings from this would also be sizeable, reducing emissions by up to 90% compared to gas heating, and by 64% compared to running heat pumps on grid electricity.** In addition, surplus electricity generated during some time periods that wasn't needed to power clean heat could provide cheaper electricity to homes or be exported, cutting energy bills and providing a revenue stream. **For the combination of wind, solar and batteries, the decrease in energy bills could be equivalent to a further 20% reduction in the annualised cost of heating.**

And of course, local energy projects also create a range of other local benefits including investment, skills and jobs. This type of project could also allow faster emissions cuts by allowing communities to get on with decarbonising heat without needing to wait for electricity network upgrades.

It's clear that combining clean heat with clean energy will be essential to maximise benefits to both the consumer and our climate, and that wind power is a very good match for heat demand. However, there are significant policy barriers standing in the way of the development of wind-powered heat projects. These include:

- The policy costs levied on electricity rather than gas make clean electricity artificially expensive compared to gas, creating perverse incentives for consumers to stay on gas.
- It is still virtually impossible to deliver new onshore wind projects in England, due to onerous and unclear planning regulations.
- The upfront costs above any subsidy require access to low-cost finance.
- The time, energy, resources and expertise required at community level to develop and deliver projects.

In order to address these barriers, the following policy changes are needed from government:

- Electricity market reform is required so that consumers can benefit from the lower costs of clean renewable energy, particularly rebalancing policy costs away from electricity bills.
- The remaining planning barriers for new onshore wind in England need to be removed, with particular support for community projects.
- Community energy and heat projects need access to grant funding and low-cost finance.
- Support is needed for innovation to develop replicable models of technology, governance, finance and engagement for locally led or owned clean energy and/or heat projects that prioritise community benefits and reduced costs and emissions.
- The Boiler Upgrade Scheme (BUS) should be expanded to provide support for community heat projects. For community shared ground loop systems, the 45 kWth (kilowatt thermal) limit should be removed. For community schemes looking to deploy a number of individual heat pumps, community energy groups should be enabled to facilitate collective administration and purchasing backed by BUS funding (with households' permission).

Contents

Introduction

We are facing both a climate crisis and an energy cost crisis, and there is an opportunity to tackle both through a novel approach to decarbonising heat.

The National Infrastructure Commission stated in 2023 that:

"Gas boilers, which currently heat around 88 per cent of English buildings, need to be phased out and replaced by heat pumps.

"Around eight million additional buildings will need to switch to low carbon heating by 2035, and all buildings by 2050. Heat pumps and heat networks are the solution.

"They are highly efficient, available now and being deployed rapidly in other countries." [3]

As the Climate Change Committee has highlighted, heat decarbonisation is not happening fast enough, despite good intentions and high targets.

"The Government proposes to scale-up the market for heat pump installations to 600,000 by 2028, but current rates are around one-ninth of this". [4]

To effectively address the climate crisis by swiftly boosting the adoption of essential low-carbon technologies for decarbonising heat, these solutions must be readily accessible and more cost-effective than operating a gas boiler.

There are various barriers preventing a more rapid take up of decarbonised home heating. These include a lack of information for people and communities on the options available, overly restrictive planning conditions, a lack of support to get community heat projects going, the frequently higher upfront costs of these systems, and difficulties in finding installers with the expertise to undertake the work. Higher running costs are linked to the higher market price per unit of electricity compared to gas, with the UK having one of the highest electricity-to-gas price ratios in Europe.[5] This ratio

[3] (Second National Infrastructure Assessment - NIC) October 2023, p.11
[4] 2023 Progress Report to Parliament - Climate Change Committee (theccc.org.uk) (p.20)
[5] Nesta, How the UK compares to the rest of Europe on heat pump uptake 08 August 2023

does not reflect the lower cost of renewable electricity generation, or the emissions reductions achieved by transitioning away from gas. The lack of clarity and consistency in the grid connection approvals process is also emerging as a barrier to accelerated heat pump rollout.[6]

This report attempts to address the cost barrier to community level decarbonised heat take up, by exploring a 'Wind+Heat' model that pairs community onshore wind generation with electrified heat. This model has the potential to allow communities to move en masse and at speed to heat pumps, and benefit from electrified heat powered by clean electricity which is generated locally and supplied at lower cost. This would maximise both emissions reductions and cost decreases from electrifying heat, while also removing the risk of further cost volatility and spikes linked to the cost of gas power.

Clean heat needs clean electricity

As we electrify and decarbonise our heating, annual electricity demand for heat is expected to at least triple by 2050, from 19 TWh today to 60-80 TWh in 2050.[7]

Clean heat needs to be powered by an expanded clean, renewable electricity supply. The additional power needed for electrified heating also needs to be affordable for households, in order to maintain public support for a rapid transition away from fossil fuels and towards clean alternatives.

So what's the solution?

This project explores how we can combine renewable generation technology with electrified heat technology – a wind power plus heat pumps model – to maximise both savings to households' energy bills and reductions in carbon emissions. We have explored whether local and community projects could support the decarbonisation of heat at least cost for households. Wind+Heat is a model that pairs locally-owned wind turbine generation with low carbon heating technology, such as heat pumps installed at scale in

[6] Heat Pump Association, Unlocking Widescale Heat Pump Deployment in the UK, Nov 2023
[7] FES in 5 (2023), p.12 download (nationalgrideso.com)

the community or a shared loop ground source heat pump network.

The key factors we have considered in this study that impact the viability and benefits of 'Wind+Heat' schemes are:

- Matching demand and generation: how well different forms of renewable energy generation match when power is needed. If they are mismatched, then there will be more reliance on more expensive sources of generation from the grid, with higher emissions due to the use of gas power, or an increased need for electricity storage, with associated costs.
- Cost to build, install and run: the cost of these technologies is a critical factor, including not only the cost of installing heat pumps, but also developing renewable generation. How much will it cost to get planning permission and develop, build and operate renewable energy per unit of electricity generated and unit of heat delivered?
- Wider benefits: community energy and heat schemes will have wider social and economic benefits to their communities, and have significant potential to tackle energy poverty in areas of deprivation. We mapped areas of highest deprivation against distance to a potential onshore wind project, and found that around a third of these areas are within 1km of a potential wind project.
- Impact on electricity system and network: how the schemes could benefit the electricity network and system by delaying or removing the need for upgrades. The UK's electricity networks are estimated to need between £100bn and £140bn investment[8] to achieve net zero by 2050 on the wires, pylons and substations that deliver electricity to our homes. In addition, typically around 9% of electricity is lost as it is transported.

[8] BEIS, 2022, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1096248/electricity-networks-strategic-framework-appendix-1-electricity-networks-modelling.pdf

Matching demand and generation

1. Onshore wind generation can meet 68% of heat demand

At a basic level, the UK experiences windier conditions in the cooler months of the year, which means that wind energy availability is well correlated with heat demand.

Onshore wind energy generation matches well with heat demand

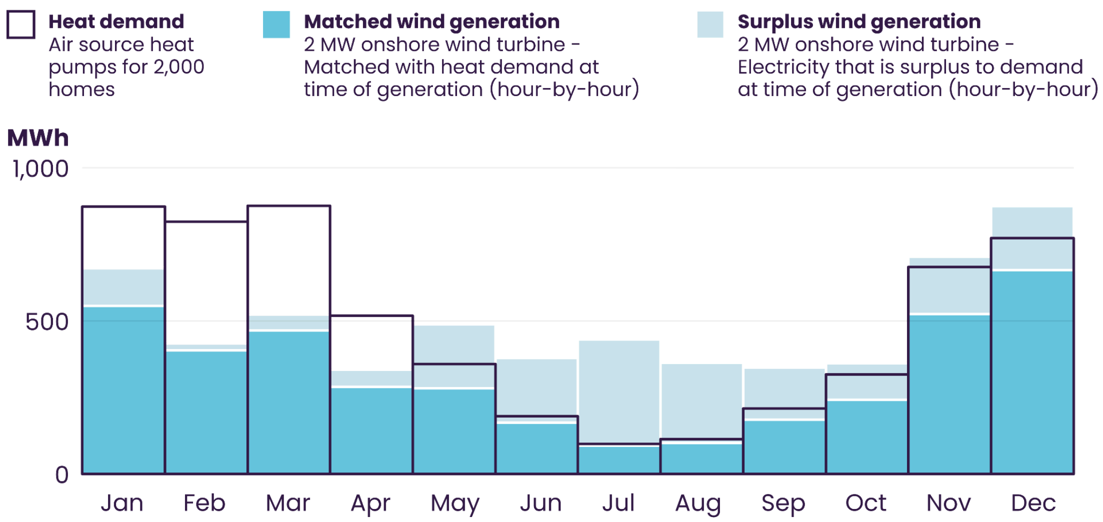


Fig. 1: Comparison of air source heat pump electricity demand to onshore wind electricity generation (based on 2019 data).

To illustrate this, we modelled a 2 MW onshore wind turbine[9] operating at a 34% capacity factor,[10] supplying a community of 2,000 households where individual air source heat pumps (ASHPs) have been deployed to each household.

[9] For this type of community project, it is possible that smaller turbines would be preferred from the perspective of community acceptance, but it would only be possible to create a supply chain for these if there was significant demand. From an economic standpoint, it is preferable to use as large a turbine as is acceptable in order to reduce the cost of energy as much as possible. Industry feedback suggests that 1 MW is the upper limit of lower-powered turbines available on the market. We modelled a 2 MW turbine, but in practice under the existing supply chain turbines are either smaller, i.e. 1 MW or below, or larger, i.e. 4 MW for commercial-scale projects.
[10] Taken from renewables.ninja modelled power output data.

We assumed that each home had a 10.8 MWh average annual heat demand and their installed heat pump had a 3.7 Seasonal Coefficient of Performance or 'SCoP'.[11]

The result of matching the profiles of heat demand and onshore wind on an hour-by-hour basis over the course of a typical year (based on 2019 data) is summarised in the diagram above. This estimates that using community wind generation to power local heat demand could synchronously (i.e. at the time of generation, rather than using battery storage) fulfil 68% of heat demand.

Although solar is an important part of the energy mix (particularly as we use a lot of electricity in the day), the graph below shows that solar alone is not well matched to meeting demand from domestic heat pumps.

We modelled each house having a 3 kW rooftop solar photovoltaic (PV) system installed, a typical size of installation. This total 6 MW of domestic solar synchronously met only 30% of heat demand from our households. There were big gaps in the winter months when heat demand is highest.

Solar PV generation can synchronously match around 30% of heat demand on an hourly basis

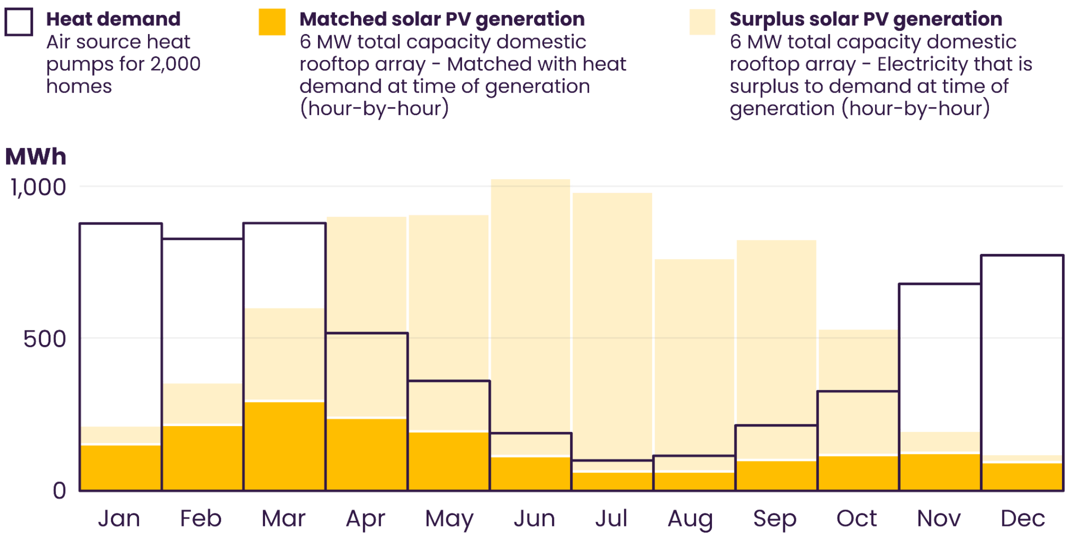


Fig. 2: Comparison of air source heat pump electricity demand to solar PV generation (based on 2019 data).

[11] SCoP is a measure of heat pump efficiency across the year, where a higher number is better. A SCoP of 3.7 means that the heat pump delivers an annual average of 3.7 units of heat energy for each unit of electrical energy consumed. This number is based on data from Heat Geek showing that highly-trained installers can consistently achieve SCOPs of 4 and above.

2. Adding domestic solar to a Wind+Heat project could meet around 80% of clean heat demand

To see the impact of additional technologies, we modelled adding rooftop solar alongside the wind turbine. If each home also had a 3 kW solar PV array, totalling 6 MW of solar and 2 MW of wind capacity across the community, the generation output would match the demand from the heat pumps around 80% of the time.

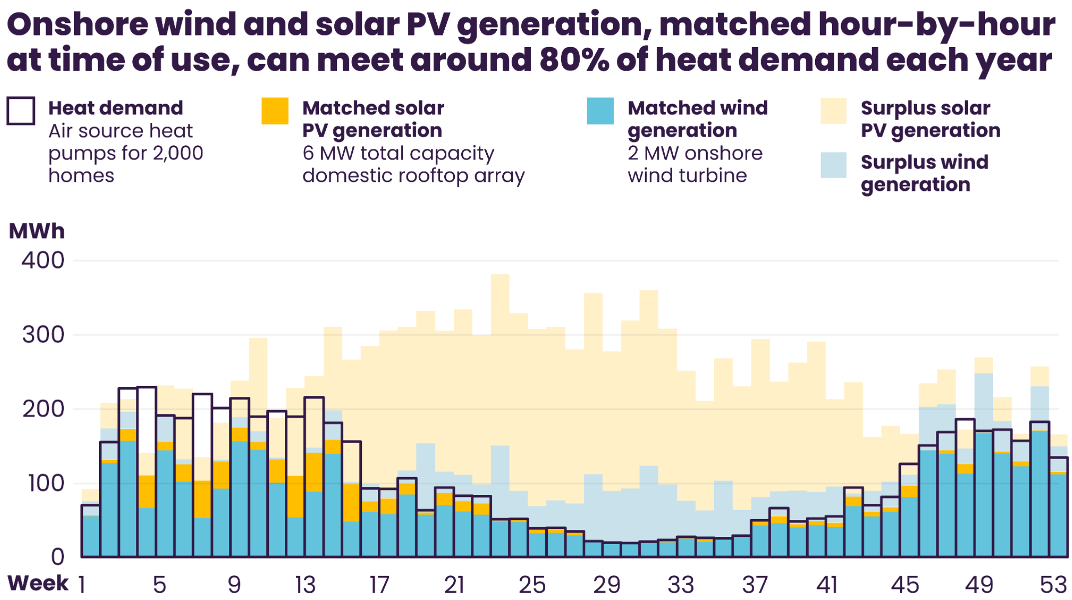


Fig. 3: Comparison of air source heat pump electricity demand to onshore wind and solar PV generation (based on 2019 data).

3. Adding batteries could bring matching up to over 90%

We modelled the impact if each of the 2,000 homes had a domestic battery (5.2 kW capacity, two hour duration) that was networked and programmed to work collectively as a community battery. Our modelling found that, in a typical year, this combination of onshore wind and solar generation, paired with domestic batteries for balancing, could match 90% of the additional power needed to electrify heat. Solar PV complemented wind generation, and the batteries stored excess energy to be used later.

For many time periods, the combination of wind, solar and battery also provided enough electricity to meet some of the pre-existing electricity demand of households, such as for appliances or, as will become more common, for charging electric vehicles. Above this level, surplus power generated could also be exported or the batteries used to arbitrage energy prices, to provide additional revenue. Meeting just 30% of typical domestic non-heat electricity usage with this surplus energy and exporting the remainder to the grid would reduce a household's total electricity bill. This reduction is equivalent to a further 20% reduction of the annualised cost of heating (based on an export price of 6.4p/kWh).

To minimise drawing electricity from the grid for electrified heat, the parameters of the scheme could be adjusted to either reduce the number of homes relative to the wind turbine, or increase the power rating of the wind turbine. For example, pairing a 2 MW wind turbine with 1,000 homes could increase matching to around 97%. Increasing the ratio between turbine power rating and number of homes would result in an increase in surplus energy but also a likely reduction in the levelised cost of electricity (LCOE) of onshore wind due to economies of scale (i.e. larger turbines produce cheaper electricity). The additional energy surplus would require an offtaker to pay for the additional energy, otherwise the cost of the energy generated would rise. The additional surplus energy generated that is not used by electrified heat demand could then either be used by the local community for non-heat electricity demand, sold to a local non-domestic 'anchor' consumer (such as a hospital) or exported to the grid.

Cost to build, install and run

4. Wind+Heat projects could be cheaper than gas

We estimated the cost of a Wind+Heat project to a 2,000 home community, and compared this with the existing cost of fossil fuel heating from gas, as well as air source heat pumps powered from the grid. This analysis showed that Wind+Heat projects were cheaper than gas.

A key issue is that the Wind+Heat projects are estimated to cost more upfront to install than traditional heating, although they could then be cheaper to run, provided that the heat pump system is installed to a high level of performance. Existing fossil technologies are often cheaper to install, but then could cost a lot to run, particularly when subject to price volatility from the heating fuel, as seen in 2022 and 2023 with the energy price crisis.

Once we compared equivalent annualised costs of the different approaches, we found that a Wind+Heat project could be the same cost or cheaper than continuing with gas boilers, whilst also offering significant environmental, economic and social benefits to homeowners and their communities.

Many consider gas heating to have cheaper running costs than heat pumps. However, this is not necessarily true for well installed, high performance heat pump systems. Our analysis of the Ofgem energy price cap shows that the unit price (per kWh) for electricity is up to four times higher than gas. Assuming a boiler efficiency of 85% and equal annual heat demand, a heat pump system operating at a SCoP of 3.5 or above will be cheaper to run than a gas boiler. Where electricity could be sourced more cheaply than market prices from local or community run renewables, heat pumps will be even more competitive with gas boilers. Consumers haven't directly experienced the full pain of gas price volatility since the Energy Price Guarantee insulated households from the full additional expense, with some of the higher energy prices ultimately paid for via taxation.

To compare the different technologies, we calculated the annualised cost of heating a typical medium energy use home.[12] For electrified heat technologies, this was based on the Department for Energy Security and Net Zero's (DESNZ) 'Electricity Generation Costs 2023', using the Department's cost estimates for electricity generation technologies, including onshore wind and domestic-scale solar. For heating technologies and batteries, we worked out an annualised cost that combined both the upfront cost (including the new £7,500 Boiler Upgrade Scheme grants) and running costs.

Wind+Heat is cost competitive, cuts emissions and protects consumers from fossil fuel price volatility

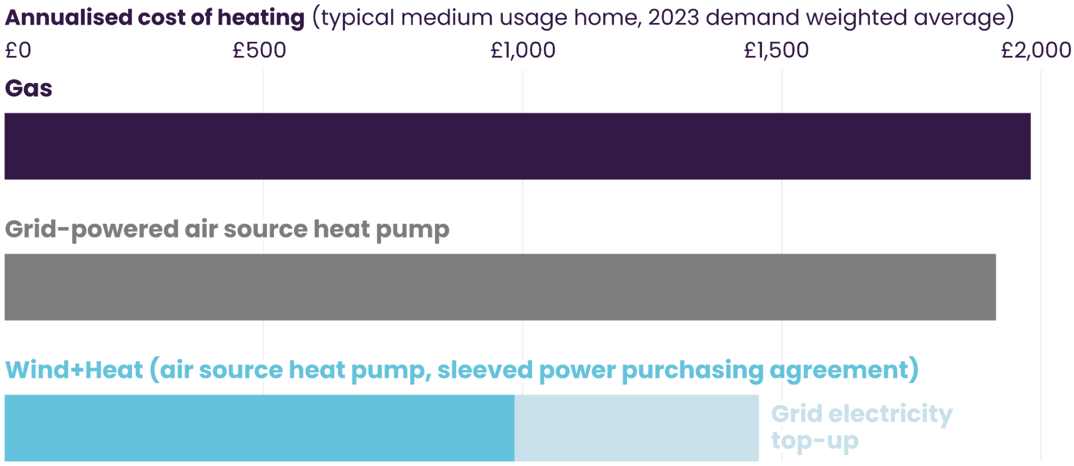


Fig. 4: Annualised cost comparison of domestic heating using gas and air source heat pump (2023 demand weighted average).

'Wind+Heat' represents an electrified heat scheme for 2,000 homes paired with a 2 MW community onshore wind turbine, with remaining electricity demand to power the heat pumps met by electricity from the grid. The 2023 weighted average is the average annualised cost of heating in 2023, weighted by

[12] Typical medium energy use taken from Ofgem data, available at: www.ofgem.gov.uk/average-gas-and-electricity-usage

the level of heat demand in each quarter, combined with the Ofgem energy price cap per quarter.

Assessing the annualised costs of installing, maintaining and powering the heating system, modelling shows that Wind+Heat technologies offer a potential 26% saving compared to typical gas-heated properties (based on demand-weighted 2023 data).[13] A Wind+Heat scheme, complemented by domestic rooftop solar and batteries (used to improve the matching of heat demand with renewable generation), would have an annualised cost of around £1,400 (based on demand-weighted 2023 data), a 31% saving compared to the modelled annualised cost of gas-powered heating.

Key inputs and uncertainties in this modelling included the gas and electricity prices, for which we used 2023 Ofgem energy price cap data, and the cost of borrowing/interest rates.

5. Wind+Heat could build local resilience with home grown energy, avoiding the pain of volatile energy prices

The equivalent annualised cost of Wind+Heat schemes are not only cost-competitive with the cost of gas heating via a supplier at current gas and electricity prices; importantly, they could also protect communities from the worst effects of energy market volatility. The chart below shows that Wind+Heat projects could have heated homes more cheaply than gas during 2023's price volatility.

We have all experienced the pain of high energy prices, following shocks that hit the international trade in fossil fuels. Wind+Heat projects can avoid the volatility and risk associated with global fossil energy prices by providing locally generated renewable electricity at stable prices. Had the Energy Price Guarantee not been in place in the last year to subsidise energy prices set by the Ofgem energy price cap, [14] households using fossil gas heating would have been

[13] Based on the Ofgem energy price cap for gas in 2023, customers on a standard variable tariff, based on the England, Scotland and Wales average for people who pay by Direct Debit. Includes VAT.

[14] *Gas price for this analysis was based on constant standing charge and varying unit price according to the Ofgem energy price cap (GB average, direct debit payment, includes VAT). The price cap excludes the effect of the Energy Price Guarantee..*

exposed to annualised system heating costs 50% higher than that of a Wind+Heat scheme.

This analysis shows that Wind+Heat schemes would have been cheaper than gas for all levels of the energy price cap set in 2023, where the gas price cap varied between 7p and 17p.

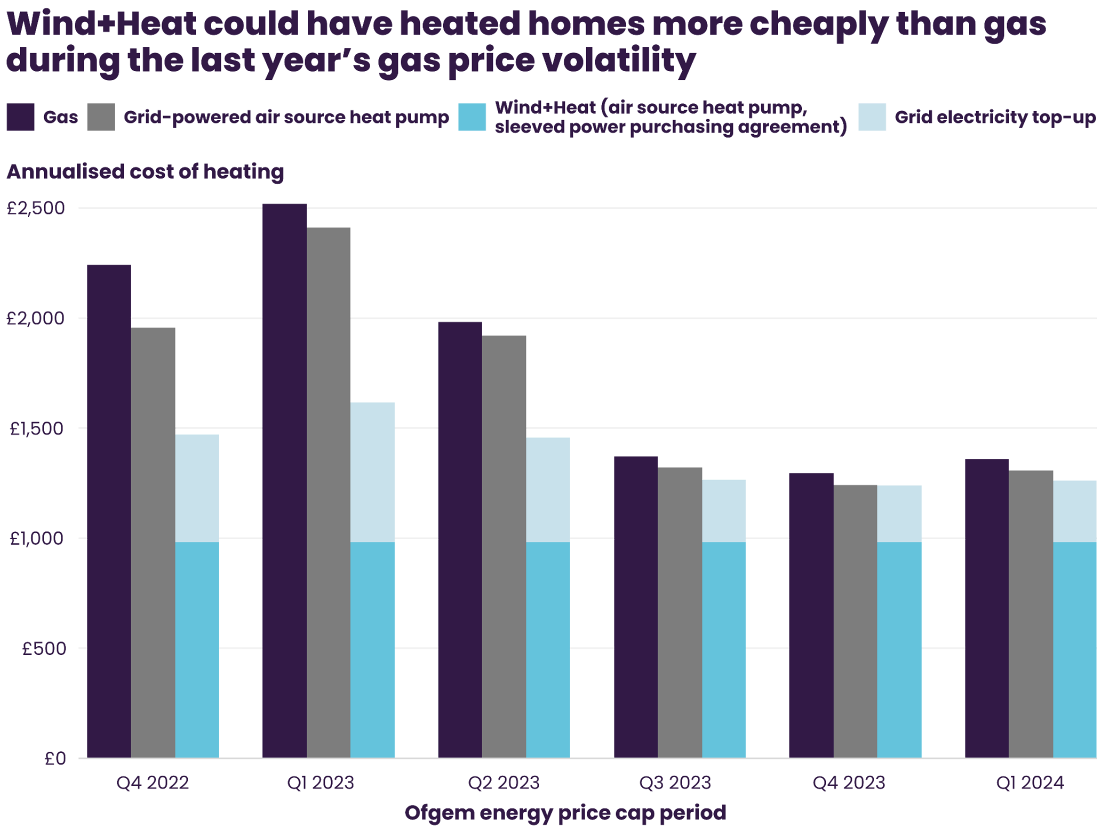


Fig. 5: Annualised cost comparison of domestic heating using gas and air source heat pump (per quarter).

6. This would also maximise emissions reductions from electrifying heating.

Wind+Heat could also reduce carbon emissions for household heating by up to 90% by relying more on clean wind-powered heat and less upon gas, or provide a 64% reduction in emissions against using a heat pump powered by grid electricity.

Wind + Heat schemes could reduce domestic heating emissions by up to 90%

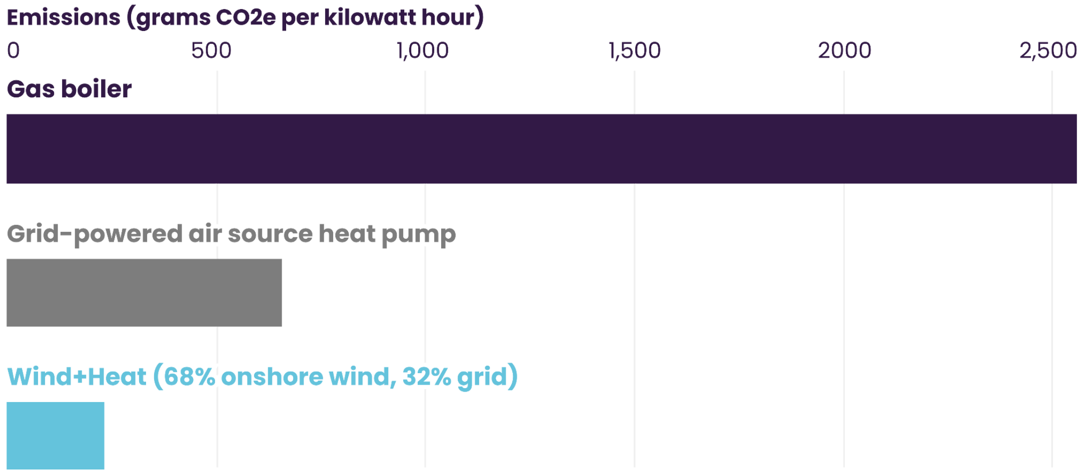


Fig. 6: Annual carbon emissions resulting from domestic heating using gas and air source heat pump.

Wider benefits

7. Community-owned wind projects could help to decarbonise heat in a fair, coordinated way, with profits and benefits from renewables being kept locally

As well as providing value to households, the Wind+Heat model could also generate significant revenue for local communities if wind farms providing the electricity are community-owned, ensuring that the revenues and benefits of projects support the local area and local economy.

Photo: Ambition Lawrence Weston turbine in operation[15]

A community-owned wind turbine provides both clean electricity for community use and income to the community. This wind turbine in Bristol is expected to generate millions of pounds for its community owners over its 20 year life.

If onshore wind projects are fully or partly owned by community organisations, there is an additional benefit from their being able to directly interact with a diverse range of local people, support higher quality public engagement and, optimally, increase support for these projects at the crucial

[15] www.ambitioncommunityenergy.org/gallery

planning stage through directly responding to local needs and concerns.

As of 2023, there are 17 community-owned onshore wind farms in England, providing significant benefits back to the local area (please see Appendix 2 for an overview of these benefits). As well as direct financial benefits for the local area, these can also often lead to wider benefits, such as increased skills and knowledge of local residents. A study of community wind projects in Scotland found that community owned wind farms provided an average of 34 times more benefit payments to local communities than privately owned projects.[16]

Case study: Gamlingay community-owned turbine

The Gamlingay community turbine is a 37m tall wind turbine located just outside of the village of Gamlingay in Cambridgeshire. The project started in 2010 and the turbine became operational in 2013.

The project was wholly funded by local residents and businesses. Priority was given to smaller investors to ensure that as many local people as wanted to invest could do so. This community ownership has enabled local people and businesses to directly benefit from the project, with 10% of the net income being used for a community fund. Community members can apply for this money to fund community projects. So far this has been used to fund a wide range of local projects including a community orchard, supporting solar panels on the roof of the church and improvements to a children's play area.

While the project was largely supported, there were some members of the community who were originally opposed. The community nature of the project helped to overcome initial opposition as community members could inform others about the value of the project and help to 'myth bust'. Community support has also

[16] Aquatera, *Community owned wind farms have paid their communities 34 times more than commercial counterparts*, 17 June 2021

increased over time as people recognised the value of the project.

Image: Gamlingay wind turbine.
Credit: Gamlingay community turbine (GCT)

8. Wind+Heat projects could also help to tackle fuel poverty and help level up the UK

Over 3,700 of the most deprived areas (Lower Layer Super Output Areas, or LSOAs)[17] in England are within 1km of an onshore wind resource area, which illustrates that there are significant opportunities for Wind+Heat to tackle multiple local issues, including energy poverty. Of the 30% of LSOAs which are most deprived, around a third are within 1km of a potential wind project.

The map illustrates that these opportunity areas are concentrated in the Midlands and North of England, which also have higher heat needs and lower average temperatures.

[17] LSOAs are geographical areas of approx. 1,500 residents. Deprivation is measured by seven indices, including income, education, employment, health and crime.

More than 3,700 deprived neighbourhoods in England are within one kilometre of a high-level wind resource area

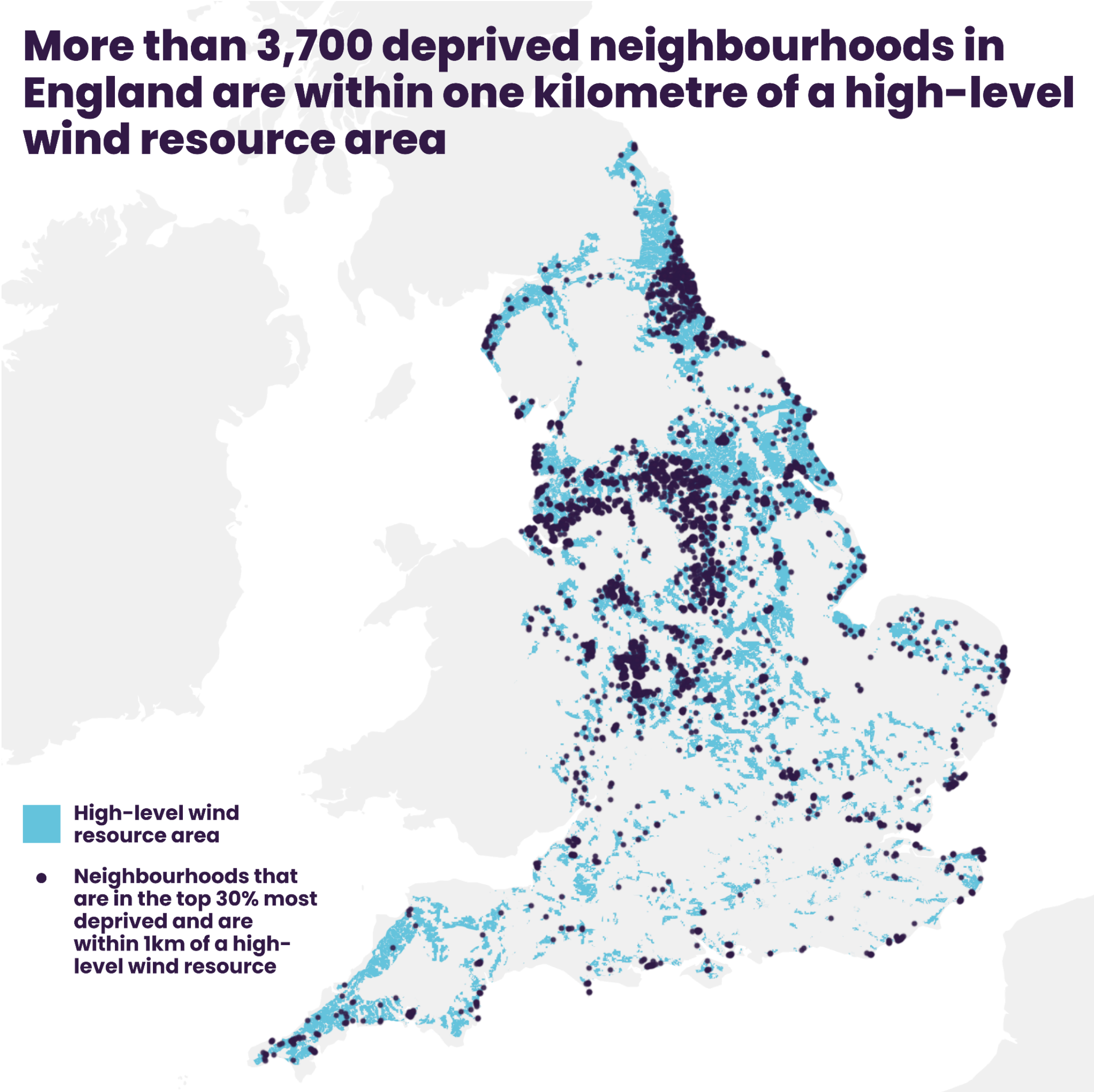


Fig. 7: Location of top 30% most deprived LSOAs relative to high-level wind resource in England.

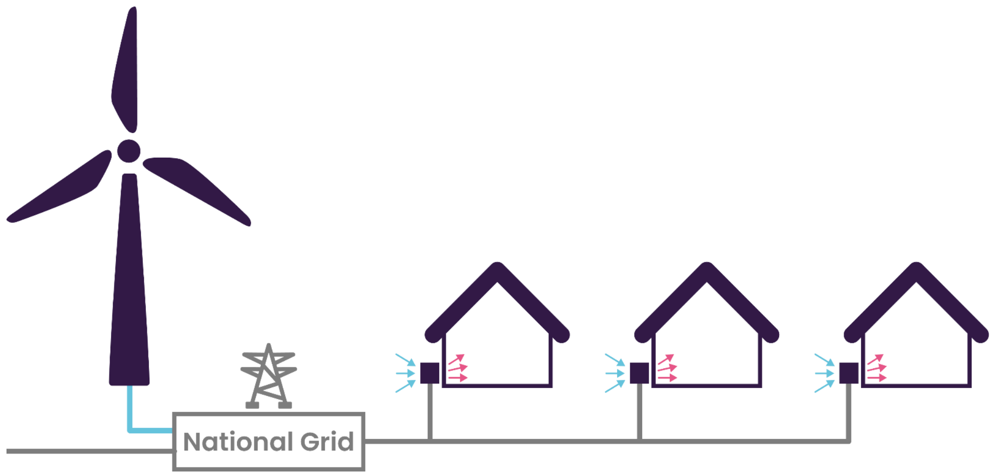
Impact on the electricity system

9. How Wind+Heat projects connect to the grid is a key cost variable

In a Wind+Heat project, how generation projects are physically or contractually connected to the communities they provide electricity to is a key issue and a current barrier, which will determine if projects will ultimately save consumers money.

To investigate this, we modelled two different ways to connect a Wind+Heat project to the homes it serves:

1. The project used the existing electricity network in the area to connect to homes, and they were connected together virtually using the existing network via a type of 'sleeving contract' which allowed them to to purchase electricity from the site.



2. The project connected the wind project to homes via its own private network cabling, called a private wire.

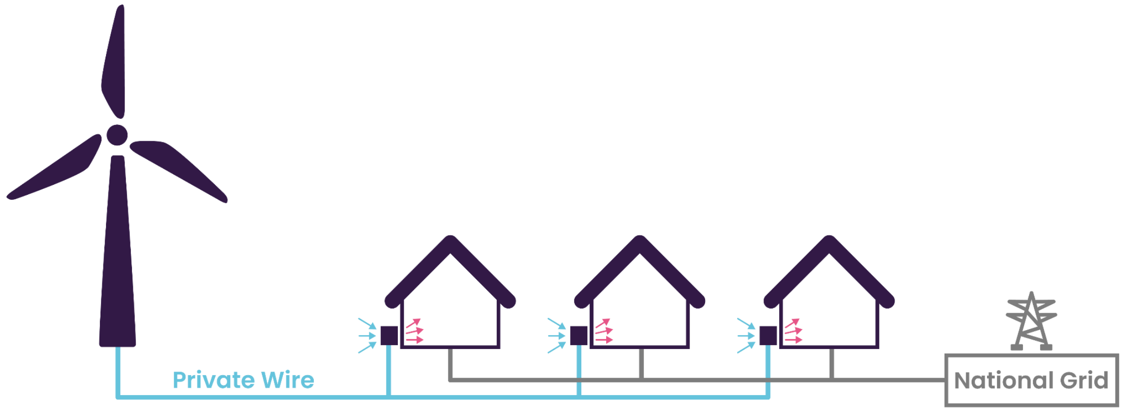


Fig. 8: Sleeved PPA and private wire connection arrangements between a wind turbine and domestic heat pumps.

Under the sleeved contract version, we assumed the electricity generated by the wind project was available to purchase by local residents at 15% below the market price, similar to the Octopus Energy Fan Club.

However, with a private wire, this saving is significantly higher as the electricity used by the project avoids paying the additional network and policy costs that are levied on electricity once it uses the existing electricity network. These costs, which a private wire arrangement avoids, currently make up approximately 60% of the cost of electricity purchased from a supplier. In our modelling, a payment equal to half of the financial benefit of this saving was paid to the onshore wind turbine developer. Therefore, the electricity used by the Wind+Heat project is 30% cheaper than grid electricity.

For both the sleeved PPA and private wire arrangements, we modelled that any surplus electricity generated (i.e. not used to meet domestic electrified heat demand) is sold at a price equivalent to the levelised cost of energy generation. The buyer of this surplus electricity is unspecified, so it could be any combination of local domestic and non-domestic customers, local battery storage, or exported via the grid. Therefore the requirement for the private wire to be connected to the network is dependent on the volume of export required, i.e. if it cannot be used entirely by the local private network.

10. Wind+Heat schemes on new build housing could save up to 38% on annualised heating costs

In our modelling, a private wire scheme connected to a 2,000 strong community using individual air source heat pumps (ASHPs) would offer a 38% reduction in equivalent annualised heating costs compared to fossil gas, based on 2023 prices (where the price for each quarter is weighted by demand).

This is because, in a private wire arrangement, there is a 60% reduction in the cost of electricity compared to the grid. We assumed a benefit split equally between the generator and the demand customers, providing power 30% more cheaply for the demand customer when using the onshore wind power directly.

Although private wire schemes could offer good value for money in operation, they require the construction of a private network to connect all the buildings together. This is a significant additional expense where electricity network infrastructure already exists. As a result, they are most likely to apply to new build developments, where a newly constructed electricity network for the development could be transferred to or owned by the community and used to connect the homes to the generation directly. Retrofitting private wire networks is unlikely to be viable for the majority of cases.

There are further regulatory barriers, such as the requirement to be a registered supplier if the scheme is above a certain size and the need for customers to be able to switch suppliers when they wish, which would need to be addressed for private wire sites.[18]

[18] For information on Licence Exempt Supply see: Selling Electricity to Consumers: What Are Your Options? (ofgem.gov.uk)

Equivalent annualised system cost comparison of different connection agreements vs gas heating

Wind+Heat: individual ASHPs 2023 average (demand weighted)		**Fossil gas**	**Heating oil**
		£1,970	£1,400
Private wire	£1,230	-38%	-12%
Sleeved PPA	£1,450	-26%	+4%

11. 'Local matching' of demand and generation in Wind+Heat could save network costs both now and in the future

Every year the UK loses around 9% of its electricity through network losses.[19] Losses are inevitable when transporting electricity around the country, and they are highest on the lower voltage distribution networks that transfer power to homes.

An additional benefit of the wind-powered heat model of powering clean heat with clean energy via the local matching of demand and generation is that it could reduce network losses; it could also reduce other costs on our electricity network. Lower volumes transported during periods where demand and generation is matched locally means network assets will be subject to less wear. Matching demand and generation locally could also reduce the cost of balancing services and use of the transmission network.

In theory, these schemes could also reduce future network investment costs. The more that electricity generation and demand is matched locally, the more it could reduce or delay the need for costly and time-consuming network reinforcement.[20] Wind+Heat schemes could mean, therefore, that some places can get moving more quickly on decarbonising heat without needing to wait for the network to catch up. Modelling the range of potential network cost savings as energy bill reductions was beyond the scope of this paper so they are not included in our headline figures for bill savings for households, meaning the ultimate benefits of

[19] Statista, Electricity lost in transmission in the United Kingdom (UK) in selected years from1970 to 2022
[20] Accessing the network benefits from local matching – a working model? - Regen

the Wind+Heat approach could be higher than estimated here. Ideally, there would be a mechanism for communities able to locally balance their generation and demand, such as those hosting Wind+Heat projects, to be able to share in the benefits of avoiding or minimising network reinforcement costs.

12. Shared or community heat schemes could save even more for networks by moderating peak heat demand

One of the issues for electricity networks is the potential for significant extra peak demand for electricity, caused by the increased power requirements of running heating on electricity rather than gas. Guaranteeing these demand peaks can be satisfied requires investment in surplus network capacity which will be unused most of the time. One of the measures to address this could be the use of heat networks, thermal storage or shared community ground source heat pumps (GSHPs) rather than individual air source heat pumps (ASHPs) - see the following case study on Heat the Streets.

For example, a shared community ground array could offer a lower peak demand[21] than ASHPs by its increased system efficiency, particularly in high humidity conditions around freezing point. The network can also be used for thermal storage during times of lower demand, consequently reducing the level of electricity required to meet heat demand during peak periods. Where ASHP efficiency falls at low temperatures, backup heat sources of lower efficiency (but unaffected by temperature) may also be used. In contrast, GSHPs are not directly impacted by air temperature or humidity. Where feasible, heat networks could also connect to local sources of waste heat or thermal stores to boost system performance all year round. These advantages could provide a significant benefit for electricity networks by mitigating the need for network reinforcement.

Ofgem should consider whether there is a route for potential savings on network reinforcement to be shared with community heat developers to incentivise the development of community level heat and renewable energy schemes.

[21] Rethinking heat: a utility based approach for ground source heat pumps - Regen

Case study: Heat the Streets

The Heat the Streets project was run by Kensa Utilities between June 2021 and June 2023. This innovative project was sponsored by the European Regional Development Fund (ERDF), and involved a street-by-street approach to ground source heat pump deployment in an off-gas network village (Stithians).

The project involved installing ground source heat pumps in new and existing homes and connecting the ground source heating systems to shared ground-loop arrays, a communal network of underground pipes that extract renewable heat via boreholes. 98 homes have been fitted with ground source heat pumps and 22 enabled for future connection. The ground source heat pumps provide 100% of the properties' heating and hot water. The project was five times over-subscribed.

Wind+Heat schemes could provide some big opportunities for communities. However, they are much harder to develop in practice than in theory

There are significant policy barriers to developing Wind+Heat projects, both from the perspective of onshore wind development and for homes looking to install electrified heating systems:

- Electricity bills are still subject to much higher policy costs than gas, making heat pumps less attractive and creating perverse incentives to remain on fossil heating systems.
- It is still virtually impossible to deliver new onshore wind projects in England, due to onerous and unclear planning regulations.
- The supply chain does not offer new onshore wind turbines around the 2 MW scale, since it has focused on larger sized turbines.
- Both onshore wind and heat pumps have significant upfront costs, making the cost and availability of finance a critical factor in their viability.
- The time and energy needed to bring communities together to take coordinated action on climate is crucial. Not all communities have these resources, or access to the technical expertise needed to develop community energy and heat projects.

Therefore, to realise the potential of Wind+Heat schemes, systemic changes are required, particularly around the calculation of electricity bills, onshore wind planning, and community support, financing and innovation.

Electricity bills are still subject to much higher policy costs than gas, making heat pumps less attractive.

13. We need… Electricity bills that reflect the lower costs and emissions of renewable energy - and reward local Wind+Heat projects for the benefits they provide.

As electricity bills are currently constructed, households are not sent sufficiently strong price signals to incentivise community clean energy and heat projects or recognise the benefits they provide. As well as the cost of generating electricity itself, electricity bills also include policy costs and network costs. Both of these additional elements need to change to support faster delivery of decarbonised heat. Critically, there are currently far greater policy costs levied on electricity, which makes the business case for electrified heat projects more difficult. With a more equitable spread of policy costs between gas and electricity, communities would be able to receive more of the financial benefits from these schemes.

In its Second National Infrastructure Assessment (October 2023), the National Infrastructure Commission recommended that government should incentivise building owners to switch to a heat pump or heat network by 2035 by 'taking policy costs off electricity bills and ensuring the cost of running a heat pump is lower than the cost of running a fossil fuel boiler'.[22] In March 2023, the government's new energy security strategy, 'Powering Up Britain', committed to "set out plans during 2023-2024 to rebalance gas and electricity costs in household bills with the aim of making electricity bills cheaper and speeding up electrification for households and businesses."[23] No further progress appears to have been made at the time of writing.

Secondly, the financial benefits could be shared with communities via lower network costs levied on bills. This work has also shown that there is potential for Wind+Heat projects that locally match electricity demand and generation to result in lower network losses now and in the future. To make projects more viable, communities and others need to be able to access those current and future savings and include it in their business models. However, there are currently few means by which to do this.

[22] National Infrastructure Commission, 'The Second National Infrastructure Assessment', October 2023
[23] DESNZ, 'Powering Up Britain: Energy Security Plan', March 2023

In the short-term, as per the Balancing and Settlement Code (BSC) modification proposal P441[24] proposed by Green Energy and represented by Energy Local,[25] communities whose demand and generation can be locally balanced and connected to the same primary substation, could, where appropriate, operate as a Complex Site.[26] These schemes could offer a lower cost of energy to households matching their demand with local generation, while also offering a higher price for generators than they would otherwise receive. In the medium or longer term, there will need to be further regulatory change to incentivise projects that can help networks avoid cost by reducing peak loads. This could be via incentives or revenue available through a distribution system operator and local flexibility markets.

Onshore wind is still nearly impossible in England due to restrictive planning policy (and 2 MW turbines aren't being manufactured!)

14. We need… Planning unlocked for onshore wind in England, and a supportive policy for community ownership.

In 2015, onshore wind in England was effectively banned following the introduction of severe restrictions to onshore wind planning policy. As a result, only a handful of projects have progressed since 2015, including only one community-owned turbine (please see Appendix 3 for details of these policy restrictions).

As well as harming the UK's decarbonisation targets, this restrictive policy has also been responsible for a huge associated loss of economic opportunity for communities across England. A significant amount of wind resource in the Midlands and the North remains untapped, as illustrated in our mapping.

Recent national policy updates in 2023 (please see Appendix 3), though much lauded by the government, have done very little to change this situation. As of December 2023, the

[24] https://www.elexon.co.uk/mod-proposal/p441/
[25] https://energylocal.org.uk/
[26] Complex Sites are a site classification for determining energy bills. They are typically used for areas such as university campuses or large businesses which have operations in different buildings over a geographic area and connected at different points to the electricity network. These can include both generation and demand sites.

change to planning rules had resulted in no new applications for onshore wind projects in England.[27]

A survey undertaken with community energy organisations in England has shown that communities are unlikely to bring forward new onshore wind farm projects under the newly updated policy. Of the 16 community energy groups which responded, when asked whether they thought these changes would be sufficient to allow new wind projects to come forwards, just one group answered “yes”, with nine groups responding “no” and six saying that they were unsure. When asked if, following these changes, they will consider trying to bring forward a new onshore wind project in England, just three out of the 16 groups answered “yes”, with seven responding “no” and the rest “maybe”.

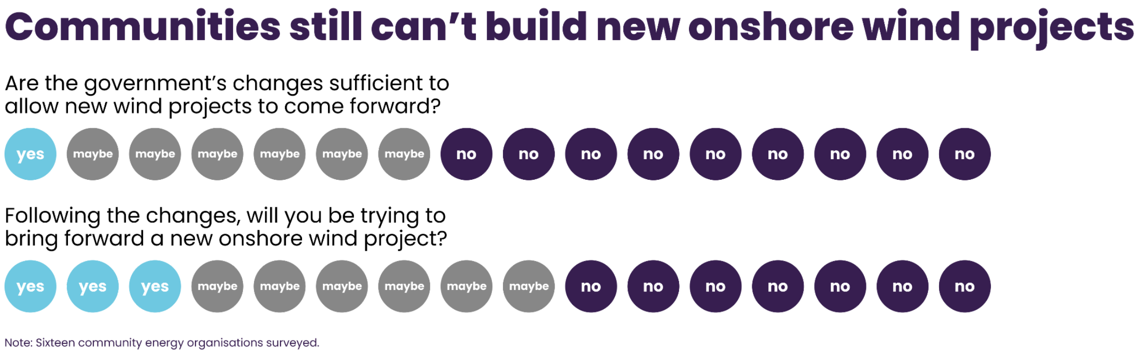


Fig. 9: Survey of community energy groups.

Instead, to encourage new wind farms to come forward in England a full removal of the current policy restrictions is needed (footnote 57 of the revised National Planning Policy Framework), so that onshore wind farms are treated in the same way as other infrastructure. The UK needs a rapid transition to clean energy, and it is clearly unhelpful for there to be a uniquely restrictive planning regime which applies only to onshore wind, and not to new dirty energy projects.

We also need proactive policy support for community-owned generation schemes. This could be achieved through additional policy wording such as 'proposals for community-owned or part community-owned wind turbines should be encouraged'. Alternatively, a stronger approach could be taken to make community ownership of a renewable energy scheme a material consideration in the planning system. This stronger approach has been

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27 https://www.theguardian.com/environment/2023/dec/27/zero-onshore-wind-plans-submitted-in-england-since-de-facto-ban-was-lifted

suggested for Wales by the National Infrastructure Commission for Wales.[28]

Case study: the challenges of developing a community-owned wind turbine: Humshaugh Net Zero

Since 2015, communities looking to develop onshore wind have faced challenges due to restrictive planning policy. These challenges have been particularly acute in locations where the local authority has not been supportive of developing onshore wind. In such cases, communities have either decided not to pursue onshore wind development or have had to find a way around the local policy, which is extremely difficult. The community in Humshaugh have tried to do this by using a neighbourhood plan.

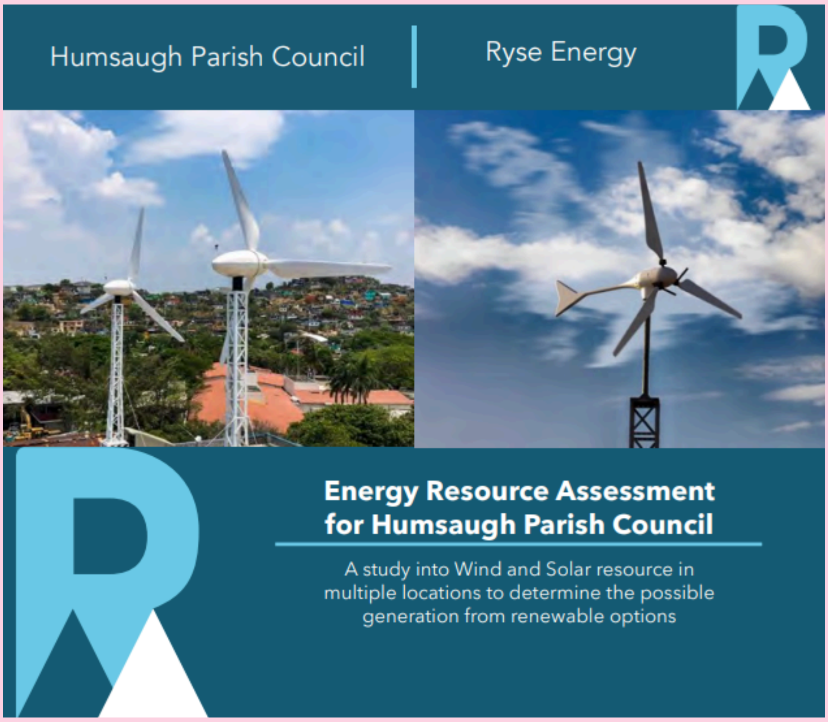
Humshaugh Net Zero's journey to try to develop community wind started in 2020 when they used Rural Community Energy Funding to commission a report to explore the potential for onshore wind and solar generation in Humshaugh, Northumberland. Regarding wind energy, the report identified the benefit of having one large turbine over a number of smaller turbines. Significantly, seventy-seven small turbines would be required to meet the Parish's current demand, whereas one large turbine could meet all the demand.

Existing local authority planning policy limits the size of wind turbines that could be installed in the parish. The policy only considers large turbines to be suitable near existing wind farms. In order to overcome this policy barrier, Humshaugh Net Zero are working to allocate an onshore wind turbine site within their neighbourhood plan.

The neighbourhood plan route is not a quick process. The plan is currently in draft form and the group is looking at a potential location for a community turbine on a former quarry site. The plan will then have to go

28 https://nationalinfrastructurecommission.wales/wp-content/uploads/2023/10/NICW-renewable-energy-report-English.pdf

through a review and approval process to become adopted policy.
Comparatively, an onshore solar farm identified through the same initial report has been granted planning permission this year. Due to the less restrictive policy for solar farms, the solar farm did not need to be allocated through the neighbourhood plan process.



Both onshore wind and heat pumps have costs loaded upfront, making the interest rate for borrowing a critical factor in whether the business case stacks up.

15. We need... Community projects to have access to grant funding and low-cost finance

The cost of finance is a critical factor in developing onshore wind generation to cut the energy costs for clean heat projects. The diagram below shows the impact that the interest rate has on the calculated Levelised Cost of Energy for an onshore wind turbine, rising from £78/MWh at 1% to £125/MWh with a 6% interest rate.

Impact of finance interest rate on Levelised Cost of Energy (LCoE) for onshore wind

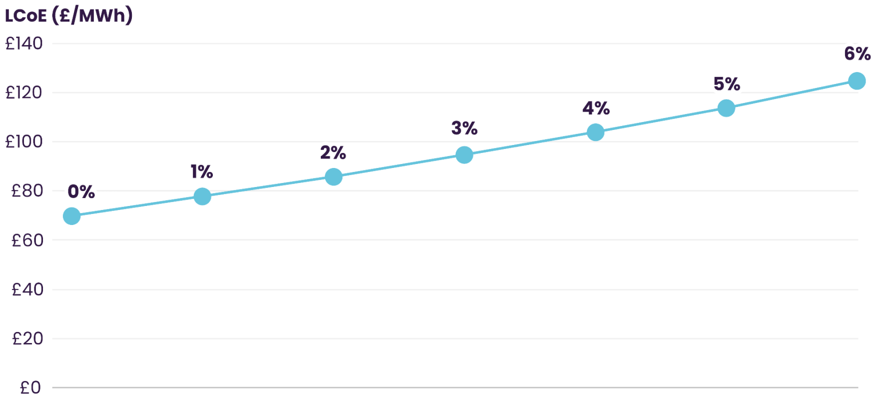


Fig. 9: Relationship between onshore wind Levelised Cost of Energy and finance interest rate.

Access to funding, including both grant funding and low-cost finance, will be critical to allow these complex community-led renewable energy developments to get going.

The cost of generation can be relatively easily estimated using the DESNZ 'Electricity Generation Costs 2023', renewables.ninja capacity factor data and assumed cost of finance/hurdle rate. However, developer feedback suggests that the resulting renewable generation cost estimates are too low.[29] Greater availability of community-scale generation cost data would give greater confidence in and accuracy of higher-level cost-benefit analyses, such as that discussed in this report.

However, the community engagement costs of these types of developments are often under-estimated and under-valued. There is a significant role that local stakeholders or community energy groups can play in terms of building support, coordination of businesses and other interests, and conducting consultations. This ongoing community engagement can be a huge and complex undertaking, with little funding available. The recently launched Community Energy Fund is a welcome step forward, and is expected to

[29] If the LCOE figures used in the analysis are indeed lower than what is presently being achieved, then they can be considered as target values for viability, because they result in a cost of Wind+Heat that is below the cost of gas heating. A lower onshore wind LCOE could be achieved by installing a wind turbine with a higher power rating or a larger rotor diameter (or both), for example. See Appendix 1 for more details.

help with some of these costs and get projects closer to the development stage.

There is also the recently increased Boiler Upgrade Scheme (BUS) funding. However, in order to develop a replicable model for Wind+Heat projects, there needs to be an ongoing (rather than time-limited) subsidy. The National Infrastructure Commission has recommended that the government provides "a subsidy of £7,000 per property owner for installing a heat pump or connecting to a heat network from 2024, with information published on how this subsidy will reduce over time as take up increases and installation costs fall".[30]

Funding should also be made available to community heat schemes whose scale falls between individual households (eligible for BUS funding) and the larger scale schemes eligible for funding from schemes like the Green Heat Networks Fund (minimum end customer demand of 2 GWh/year in urban areas, or minimum 100 dwellings connected for rural off gas grid networks). There is no policy support at all for shared loop systems between these two scales, which represents a huge missed opportunity because this is the 'Goldilocks zone' for community energy schemes. Whilst GSHPs as part of a shared ground loop are eligible for the BUS grant, regulations stipulate a 45 kWth total capacity limit, restricting the size of shared ground loops to around 5-10 properties - far smaller than a typical shared ground loop scheme. Lifting this cap would allow larger community schemes, including shared ground loop GSHP versions of the Wind+Heat schemes described in this report, to unlock greater efficiencies and a faster rate of deployment in transitioning larger community groups to clean renewables-powered heat.

Extending BUS eligibility to community heat schemes on a per household basis could ensure their viability in facilitating more rapid, efficient and widespread deployment of individual household ASHPs within large communities. This would incentivise transitioning to electrified heat en masse - not only accelerating the rate of transition but creating sufficient demand to balance local multi-MW wind turbine generation, whose economy of scale would deliver electricity at lower prices. Facilities must also be made available to communities to access infrastructure finance and low-cost

[30] Second National Infrastructure Assessment - NIC October 2023, p.11

finance, potentially in partnership with a local authority, with the National Infrastructure Commission recommending 'access to zero percent financing, backed by government'[31] for additional costs of installation above the upfront subsidy.

The effort needed to bring communities together in coordinated action on climate cannot be overestimated.

16. We need... more innovation to develop replicable models of technology, governance, finance and engagement.

There is a huge opportunity for Wind+Heat schemes to build more local renewable energy that benefits communities, decarbonising heat with home-grown energy and avoiding significant network infrastructure investment.

However, there are currently barriers to these schemes succeeding, in addition to those around networks, finance and planning.

In particular, the governance and ownership models for both community-owned renewables (partly or fully owned) as well as shared heat infrastructure need to be explored and developed. Sharenergy's Community Heat Development Unit is running an 18-month project with Community Energy England and the Marches Energy Agency to identify areas most viable for successful community heat networks and to develop a business model that can operate in these areas.

A critical area for innovation is also the process of effective community engagement in the energy transition. Community ownership for energy could be an important element of engagement, bringing people along on the journey to net zero and ensuring that the wider community is properly engaged and involved in the process - and can see real, tangible local benefits from this.

Getting people to take action in their homes is the subject of a number of existing schemes such as Net Zero Living, but more are needed, particularly at the smaller scale of community or street level.

[31] Second National Infrastructure Assessment - NIC October 2023, p.11

Case study:
Bishop's Castle Heat+ Wind project

Bishop's Castle in south Shropshire is off the gas grid, so most of the heating comes from oil and LPG boilers.

The Bishop's Castle heat and wind project aims to develop a community heat network to supply heat from an air source heat pump that would be powered by a community-owned 1MW wind turbine. A 500 kW solar farm may also be developed to help power the project. This ongoing project has been part-funded by a grant received from Power to Change obtained through Shropshire and Telford Community Energy (STCE).

The heat network is expected to supply at least 100 houses, as well as the community college, leisure centre and Enterprise House. The centralised heat pump would supply hot water through pipes into houses. Each house would have a heat exchanger, rather than an individual heat pump.

The project identified that the proposed heat network would not be viable without the wind turbine.

At the time of writing the onshore wind turbine has been allocated in a local authority Place Plan, with a future planning application to be submitted. Ecology and further feasibility studies will be starting soon.

Any surplus profit made by the wind turbine would be used to fund community projects.

https://lightfootenterprises.org/climate-action/

Appendix 1: Modelling and viable LCOE figures for generation

Levelised Cost of Energy (LCOE) data (i.e. the cost of energy over the lifetime of a power generation system, measured in £/MWh) for wind and solar generation was calculated using the following data:

- DESNZ 'Electricity Generation Costs 2023'
  - Onshore wind - 'High' cost scenario
  - Solar PV < 4 kW – 'Low' cost scenario[32]
- renewables.ninja wind and solar PV generation capacity factor data
- Modelled interest rates:
  - Domestic solar PV and battery storage projects – access to zero-cost government finance, and
  - Community onshore wind generation – access to low-cost government finance (3% modelled).

Using these data, our model output **LCOE figures of £94/MWh for onshore wind and £46/MWh for domestic rooftop solar PV**. These cost figures result in an equivalent annualised cost of heating that is consistently cheaper than gas and grid-powered ASHPs, based on energy prices in the last year.

For Wind+Heat projects to be consistently cheaper than gas, the development costs need to be the same as or lower than we have projected. Periods of high/volatile fossil fuel prices may mean that Wind+Heat LCOE figures higher than those above could still be cheaper than gas and oil heating.

Some evidence has suggested that currently development costs are higher than our cost data. The LCOE is impacted by key variables including capacity factor, the DESNZ 'Electricity Generation Costs 2023' data and the interest rate associated with the cost of finance.

[32] Because the DESNZ study did not include small scale wind - given lack of economies of scale - we assumed the highest figures for onshore wind. However the DESNZ study did have small scale PV - we assumed the low cost scenario for this as it was expected to be a 'bulk purchase'

Capacity factor

A lower capacity factor will push the cost higher as less electricity is generated for the fixed capital cost of the technology. The capacity factor is determined by technology, geographical location and available wind resource. Some areas of the UK are conducive to lower capacity factors and others higher - for example, solar capacity in Scotland is c. 9-10% versus the rest of the UK which is nearer 12%. Capacity factors are rising due to improving technology and locations. [33]

DESNZ Generation Costs

The key development cost components are construction and infrastructure costs, operations & maintenance and pre-development costs. These cost components need to be minimised to drive lower generation costs. For example, stimulating the supply chain for 2 MW turbines could realise economies of scale (as would deploying larger turbines) and reducing planning costs. Estimates were used in this methodology as there is very little evidence of the current costs of smaller onshore wind development in the UK due to the hiatus in onshore wind project development.

Cost of finance

The interest rate of project finance is a critical variable (see *'14. We need… Community projects to have access to grant funding and low-cost finance'*). In our modelling, a three percentage point increase in interest rate (from 3% to 6%) increased the onshore wind LCoE by more than 30% due to the increased cost of finance. Offering zero-cost government finance to householders or low-cost finance for community generation projects would have a significant impact in minimising the cost of electricity.

[33] Staffell, Iain and Pfenninger, Stefan (2016). Using Bias-Corrected Reanalysis to Simulate Current and Future Wind Power Output. Energy 114, pp. 1224-1239. doi: 10.1016/j.energy.2016.08.068

Appendix 2: community owned onshore wind farms in England and the benefits that they provide.

Site name and turbines	Community energy organisation	Summary of community benefits
Ambition Lawrence Weston Turbine 1x 4.2 MW turbine	Ambition Community Energy	The income will help fund a development plan for Lawrence Weston. It will contribute to a new £1.7 million community hub for the area, which will provide support, training and debt advice to local residents.
Gorran Highlanes wind farm 2x 80 kW turbines.	Community Power Cornwall	3% of the revenue generated is provided to Transition St. Goran for other low carbon activities in the local area. Activities to date include insulation for the village hall, LED lighting in the village church, conversion of old school rooms into affordable housing, support for the local public toilets and a community woodland scheme.
BF Adventure, Halvasso 1x Aircon 10kW wind turbine	Community Power Cornwall	BF Adventure receives a fixed electricity price at parity to the export value, saving approximately 70% on standard electricity retail prices. These benefits will be in place for the 20 year lifetime of the project. This has dramatically reduced the charity's current running costs and enabled them to invest in new site activities including additional bunk houses and a new adventure barn.

Site name and turbines	Community energy organisation	Summary of community benefits
Four Winds 2x 500kW turbines, one near Duckmanton near Chesterfield and one between Grimethorpe and Cudworth called Shafton Turbine.	Four Winds Energy Cooperative Limited	Intention, subject to all final capital and operating costs, to set aside 5% of turnover per year and will share equally any interest that annually exceeds 10% to support local community projects. Some examples of funded projects are provided on the project website e.g Duckmanton School Solar Panels, Oxcroft centre replacement of lights with LED and Rhubarb farm composting toilet.
Gamlingay Community Turbine 1x 330 kW capacity turbine	Gamlingay Community Turbine	Gamlingay Community Turbine Ltd pledged to give 10% of its net income to a community fund.
'Geoff Watson' Croft West Wind Turbine. 1x 60 kW turbine	Ecodynamic CBS	No information available online
50 kW wind turbine at Salway Ash	Energy Local: Bridport wind Dorset Community Energy	Wind, peer to peer trading modelling suggests that each household will match approximately 10% of their electricity consumption with the wind generation, with an anticipated saving of 10-15% on their electricity bills over a year.
Harlock Hill 2x 2.3 MW Enercon Wind Turbines	High Winds Community Energy Soc Ltd Harlock Hill wind farm	High Winds intends to donate a portion of its profits each year to the Baywind Community Energy Trust. The Trust will be responsible for spending the funds on local projects. Donations to date to the Trust: 2020 £30,000 plus £29,435 from the neighbouring Mean Moor wind farm site. 2019 £30,000 2018 £30,000 It also provided additional funds during Covid.

Site name and turbines	Community energy organisation	Summary of community benefits
Hockerton Housing Project HHP erected a 5 kW Proven wind turbine in early 2002 and in early 2005 complemented this with the installation of a 5 kW Iskra wind turbine. Both turbines are 26m Installation of a second-hand 225kW Vestas V29 wind turbine in 2010	Hockerton Housing Project / Sustainable Hockerton Hockerton Housing turbines	Since its inception, Sustainable Hockerton has aimed to invest in a wide range of activities that will make the parish economically, socially and environmentally sustainable. Funding comes from revenue generated by the wind turbine and solar PV systems since 2010. For example, by 31st March 2020 £38,399 had been spent in the village.
Hottwind 1x RRB Energy 225 kW turbine	Hottwind at Longley	Surplus funds from the Wind Turbine Project are gifted to a community fund, the Bright Green Community Trust (BGCT). This fund is used to support other local 'green' projects that reduce carbon emissions and contribute towards a more sustainable future for the Holme Valley community. This BGCT trust fund is independent from the HoTTWind@Longley Community Benefit Society and is managed separately.
Blackshaw Head community turbine 1x 10 kW turbine	Pennine Community Power	No information available online

Site name and turbines	Community energy organisation	Summary of community benefits
Community Wind Turbine at Alvington 1x 500 kW wind turbine	Resilient Energy Forest of Dean formerly Resilient Energy Alvington Court Renewables Ltd	Alvington Turbine Community Resilience Fund provides grants to help address current needs and future challenges in the host community of Alvington, Aylburton and environs. Information on how the funds have been spent are available on the website
St Briavels Turbine 1x 500 kW turbine	Resilient Energy Great Dunkilns	St Briavels Turbine Community Resilience Fund's purpose is to help to build community resilience in St Briavels and environs by addressing current needs and future challenges. The website provides a list of all of the grants provided in the first 4 years of operation (2013-2017) totalling over £55,000 and includes details of some of the grants provided in 2019.
Resilient Energy Mounteneys turbines Two 500 kW turbines	Resilient Energy Mounteneys Renewables Limited	REMR Community Resilience Fund helps to address the current needs and future challenges in the host communities of Kingswood, Wickwar, Hillesley and their immediate environs. Some of the projects that the fund has been spent on are listed on the website, including: play equipment, LED lighting in a school, partial cost of new heating system in hall, memorial garden, LED lighting at Youth Centre, improvements to community assets, defibrillator.
Hownsgill wind turbine, and High Knitsley turbine.	Small Wind Co-op	100% owned by the Small Wind Co-op's members

Site name and turbines	Community energy organisation	Summary of community benefits
South Brent Community Energy turbine One Vestas V27 wind turbine, rated at 225kW	South Brent Community Energy Society Ltd	Surplus from the operation of the wind turbine and solar panels at the Recreation Ground are directed to new energy saving and renewable energy generation projects for the benefit of the community of South Brent and surrounding area. To August 2023 grants totalling almost £96,000 have been awarded to energy saving projects in and near South Brent (summarised on the webpage).
South Wheatley wind turbine	South Wheatley Environmental Trust	Investing the surplus in local household energy efficiency projects (run as a grant scheme), renewable energy projects and energy conservation education at local schools. At the beginning they developed some basic guidelines for the grant application process: a) An application must be made before the energy conservation project commences; b) Grants are strictly for household projects; c) The Trust members review the application and vote whether it is granted, and d) The minimum grant is £50 and maximum £500. Between 2007-2012, the Trust had given away around £5000 worth of energy conservation grants. After the repair works in August 2011 they were able to expand their grant scheme to the areas of Maxworthy, Caudworthy, Trosell, Clubworthy, Copthorne, Brazacott, Billacott and South Wheatley. The South Wheatley Environmental Trust awarded one of the more unusual grants to the local St Paternus church in North Petherwin in 2008. The grant paid for a study to consider the feasibility of installing a 750w micro-wind turbine on the church's tower.

Site name and turbines	Community energy organisation	Summary of community benefits
Westmill Wind Farm 5x 1.3MW turbines	Westmill Wind Farm Co-operative Westmill Wind Farm	Profits from the five turbines are distributed to community funds, such as sustainable energy and educational activities along with share interest to the members.

Appendix 3: Background to onshore wind planning restrictions

In 2015, the UK Government introduced severe restrictions on onshore wind planning in England.[34] The planning policy specified that proposals for wind turbines would only be considered acceptable if they met two criteria:

1. Firstly, the turbine(s) had to be located in an area that had been identified as suitable for wind energy in the local authority's development plan (this could include adopted neighbourhood plans).

This proved challenging to achieve. By 2023 only 10% of Local Planning Authorities had updated their development plan to allocate areas for onshore wind.[35] Many local authorities either did not have the time or resources available to do so or assumed that wind farms would not be suitable in their local area.

2. The second criteria involved demonstrating that 'the planning impacts identified by the affected local community have been fully addressed and the proposal has their backing'.

This second requirement proved very difficult to assess as there is no clear definition or measurement of community backing. For example, there is an appeal decision of an onshore wind farm being refused due to just two local residents objecting.

Overall, this policy proved extremely difficult to meet, with only 12 planning applications for new onshore wind farms being approved in England between 2016-2022. Of these 12 applications only one was for a community project (Ambition Community Energy turbine in Bristol).

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[34] In June 2015 the UK Government issued a Written Ministerial Statement (WMS) for onshore wind farms in England that was subsequently incorporated into the National Planning Policy Framework (NPPF).
[35] See Windemer (2023) 'The impact of the 2015 onshore wind policy change for local planning authorities in England'
https://rebeccawindemer.files.wordpress.com/2023/03/the-impact-of-the-2015-onshore-wind-policy-change-for-local-authorities-in-england.pdf

The 2023 policy change for onshore wind: not going far enough.

In September 2023 the National Planning Policy Framework was updated to amend the policy on onshore wind. Rather than removing the additional planning requirements, as climate groups and community energy groups called for, the new policy changed only a few elements of the wording. The changes were:

- **Change in community backing requirement.** The wording on community backing was changed to state that the planning impacts identified by the affected local community should be adequately addressed (rather than fully addressed) and that the proposal has community support (rather than backing). While this change aims to prevent a small number of objectors from preventing a wind farm from getting planning permission, there is no clarity on how community support will be evidenced or measured.
- Onshore wind farms can now be allocated in **Supplementary Planning Documents** as well as development plan documents. The benefit of this change is that local authorities do not have to update their full local plan in order to allocate areas for onshore wind. The challenge is that local authorities will still need the time, skills and resources to be able to create a Supplementary Planning Document.

The government also introduced potential routes for onshore wind farms to be developed via rarely used planning 'Orders'.[36] Conversations with both local authorities and community energy organisations suggest that these are unlikely to be used.

[36] Local Development Orders (used by Local authorities to provide permitted development rights for specified types of development in defined locations), Neighbourhood Development Orders (that grant planning permission for specific types of development in a particular area) and Community Right to Build Orders (a form of Neighbourhood Development Order which can grant planning permission for small-scale community-led developments). All three measures have rarely been used in planning and have not been used for renewable development.

Appendix 4 : Modelling references

Data	Description	Source
Hour-by-hour heat demand and generation profile matching	Illustrative annual data. 10.8 MWh average annual heat demand per household, based on Ofgem's typical annual gas use figure for a 'medium' usage household of 12 MWh, with an assumed boiler efficiency of 90%.	Spatio-temporal heat demand for LSOAs in England and Wales Alexandre Canet, Cardiff University (2021) Generation profiles: renewables.ninja generation data
Levelised cost of energy of onshore wind and domestic rooftop solar PV.	Onshore wind: uses 'High' cost scenario from DESNZ 'Electricity Generation Costs 2023' reflecting the small scale deployment. Solar PV: uses 'Solar PV < 4 kW' cost assumptions, 'Low' scenario, reflecting the scale of deployment.	Costs: DESNZ 'Electricity Generation Costs 2023' Capacity factor from renewables.ninja generation data Assumed interest rates for project development and householder finance
CAPEX & OPEX costs of heat (electrified and fossil fuels), domestic solar PV and battery	Data from Kensa/Element study from building type '3-bed Victorian terrace representing an average UK home' Includes Boiler Upgrade Scheme subsidy of £7,500 for heat pump installation. Solar PV & battery: £2,000 domestic battery CAPEX and installation. 0% government loan finance for households GSHP: shared ground loop groundworks, subject to 3% interest rate for finance Oil: ONS average price of heating oil and delivery surcharge (based on current market data).	Delta-EE 'The Cost of Installing Heating Measures in Domestic Properties', Kensa/Element 'Low Carbon Heat Study – Phase 1', Carbon Trust 'Heat pump retrofit in London' Regen desk research ONS average heating oil price

Data	Description	Source
Grid electricity and gas unit and standing charges, proportion of consumer electricity bills allocated to 'non-commodity costs'	Ofgem energy price cap (standing charge and volumetric costs) set at Q4 2023 levels. These costs vary both regionally (the analysis uses the GB average), temporally (the energy price cap is adjusted each calendar quarter) and volumetrically (the extent to which standing charges are proportionally significant compared to volumetric charges).	Ofgem's default tariff cap level calculation data
Payments to the community energy project developer	Equal to half of the 'non-commodity costs' that would ordinarily be applicable to grid electricity (but can be avoided by the private wire scheme).	
Non-commodity costs	Not applicable to private wire schemes. Sleeved PPA scheme is subject to non-commodity costs on the volumetric energy cost with a proposed 15% discount, to reflect the redundancy of some charges due to local balancing, such as transmission, balancing and capacity market costs.	Ofgem energy price cap data for October-December 2023
Onshore wind modelling parameters	2 MW power rating, 25 year operating lifetime, 3% hurdle rate (access to cheap government finance), 95% availability.	

Data	Description	Source
Electrified heat technology modelling parameters	(ASHP) SCoP 3.7 (GSHP) SCoP 4.0 Kensa/Element 'Low Carbon Heat Study – Phase 1' assumes COP values of 4.0-5.5 (45°C flow temperature). Heat Geek's highly-trained installers achieve SCoPs of 4.0 and above. RHI data shows mean SCoPs of GSHP are 0.3 higher than ASHP (average ASHP SCoP 3.6, GSHP SCoP 3.9 for new installations)	Kensa/Element 'Low Carbon Heat Study – Phase 1' Heat Geek RHI monthly deployment data: March 2023 (Quarterly edition)
Domestic battery modelling parameters	5.2 kWh per household 2hr duration (2.6 kW power limit) Capacity modelled collectively rather than per household.	https://lr-renewables.co.uk/product/givenergy-5-2kwh-lifepo4-battery/ includes 20% discount for community scheme mass purchase
Solar PV modelling parameters	3kW per household	

Glossary

ASHP	Air Source Heat Pump
BUS	Boiler Upgrade Scheme
CAPEX	Initial Capital Expenditure
COP	Coefficient of Performance
DESNZ	Department for Energy Security and Net Zero
Equivalent annualised cost	The cost per year of owning and operating an asset over its entire lifespan.
GSHP	Ground Source Heat Pump
kW or MW	Kilowatt or megawatt – units of power, i.e. energy generated/consumed/transferred per second
kWh or MWh	Kilowatt-hour or megawatt-hour – units of energy
LCOE	Levelised Cost of Energy An estimation of the cost of energy over the lifetime of a power generation system
Non-commodity costs	Charges and fees beyond the actual cost of energy itself. These may include expenses related to distribution, transmission, taxes, policy, capacity market.
O&M	Operations and Maintenance
OPEX	Operational Expenditures over time
PPA	Power Purchase Agreement – a contract between an electricity generator and a customer where the power purchaser buys energy at a pre-negotiated price.

SCoP	Seasonal Coefficient of Performance – a measure of heat pump efficiency across a whole year. It reflects the number of heat energy produced per unit of electrical energy that is consumed.
Wind+Heat	A term used in this study to describe a model that pairs locally-owned wind turbine generation with low carbon heating technology, such as heat pumps installed at scale in the community or a shared loop ground source heat pump network