Property DecarbonisACTION plan

3 Great Close,
Great Shelford,
CB23 7BH

netzerocollective.co.uk

Contents

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After an in-depth survey and a period of energy use analysis, we recommend that this property is retrofitted with the following measures:

Loft insulation Relay

Air source heat pump

Upgraded radiators

Battery storage

Our modelling suggests that this property will need:

- Air source heat pump to reach a minimum SCOP of 3.87 at 45°C flow temperature, domestic hot water cylinder and oversized radiators
- 4kW smart battery storage
- Loft insulation relay to reach a maximum u-value of 0.18W/m2K

This will achieve:

- **125% reduction** against current building performance, saving 39 tons of CO_2 by 2050
- A saving for the tenant of an estimated £558 per annum (assuming use of agile tariffs)

Property analysis

Methodology

An in-depth property survey was conducted using current energy retrofit survey standards including PAS2035, SAP and MIS 3005. The property has been fitted with monitoring equipment capturing electricity usage, temperature, and humidity data alongside gas meter readings.

The outputs of the survey and monitoring have been passed to the University of Southampton (UoS) Department of Climate Change, Energy & Buildings to model retrofit options and the associated carbon savings. The UoS has established a bespoke model using TRNSYS software, specifically tailored to forecasting the impact of retrofit measures including, but not limited to: heat pumps, solar PV and energy efficiency improvements. The methodology analyses the impacts of each measure on carbon reduction and running cost against a 'business as usual' scenario where no upgrades to the property were made other than works that would be carried out as part of regular servicing and cyclical replacement programmes.

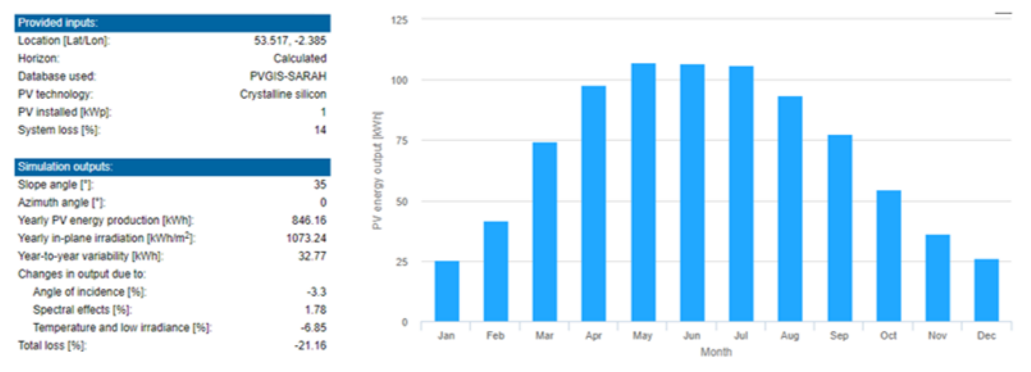
Current site data **(Table 1)**

Age	Type	Floor area m^2	EPC rating
1950-1966	2 bed Semi-detached bungalow	61	B
Space heating demand kWh pa	**Water heating demand kWh**	**Monitored electricity use kWh**	**Monitored gas use**
6466	1808	8,400	n/a
Space heating demand kWh m^2 pa	**Space and water heating system**	**Secondary heating**	**Flow temperature**
106	High heat retention storage heaters and hot water cylinder	none	n/a

Electrical generation capacity

The property has a south-east facing roof with limited shading. We estimate the roof area available is 35 m2, which if fully covered would be a 4.67 kWp PV system. A system of 4kWp already exists at 3 Great Close.

A 4 kWp PV system has been modelled on a 35 degree slope facing South-West (Irradiance 1,088 kWh/m2 annum, yield 928 kWh/kWp). The annual generation is predicted at 3,712kWh.



Provided inputs:	
Location [Lat/Lon]:	53.517, -2.385
Horizon:	Calculated
Database used:	PVGIS-SARAH
PV technology:	Crystalline silicon
PV installed [kWp]:	1
System loss [%]:	14

Simulation outputs:	
Slope angle [°]:	35
Azimuth angle [°]:	0
Yearly PV energy production [kWh]:	846.16
Yearly in-plane irradiation [kWh/m²]:	1073.24
Year-to-year variability [kWh]:	32.77
Changes in output due to:	
Angle of incidence [%]:	-3.3
Spectral effects [%]:	1.78
Temperature and low irradiance [%]:	-6.85
Total loss [%]:	-21.16

Figure 1 – Example PV energy output chart

It is anticipated that without storage options (due to mismatch between generation and electrical demand) 62% of this will be exported to the grid.

Energy Storage

With the installation of an energy storage solution the level of PV export falls to 44%. The most suitable energy storage system has been calculated to be a 4kw battery. The modelling accounts for battery cycling to avoid import from the grid and battery recharging from excess PV which would otherwise be exported for no payment.

Although space within the main property is limited there may be space within the external store for the installation of a battery storage system.

Heating and hot water demand load

Heat emitter upgrades

The property’s current heat emitters are made up of high heat retention storage heaters. These would require replacing with a low temperature wet system accommodate an air source heat pump.

Heat pump options

There are available locations at the side or rear of the property to site an air source heat pump. We believe the best option for location of a heat pump is at the side of the property. This is located far enough from adjacent properties and bedrooms to reduce any potential noise nuisance issues.

Although space is limited, there may be space within the cylinder cupboard or external store for a slimline thermal store.

Heating technology performance

Having developed the building profiles, we consulted extensively with heat pump manufacturers and installers to identify the optimum types of heat pump and heating systems. We have selected specific technologies that would be suitable for overcoming the unique challenges of each installation.

To understand the likely performance of the heat pump in-situ we used reported MCS seasonal co-efficient of performance (SCOP) data for the predicted flow temperatures required for the property.

The performance of all technologies will be remotely monitored during operation to confirm actual in-home performance. The NetZero Collective monitoring equipment already in the property will be re-commissioned alongside the new measures and remain in situ for a minimum of two years.

Based on this analysis we recommend a heat pump that achieves minimum SCOP of at 3.87 at 45°C flow temperature.

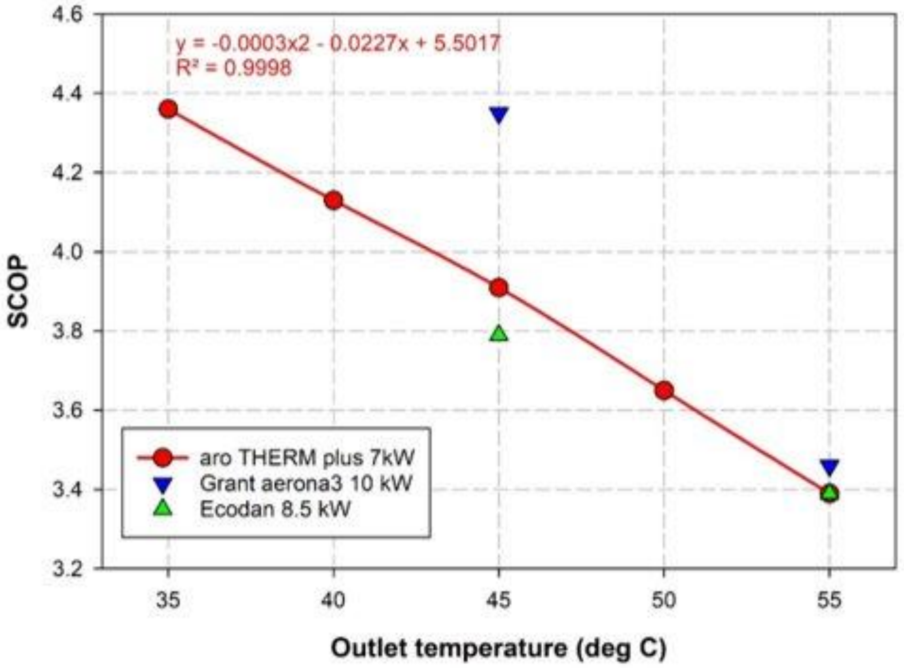
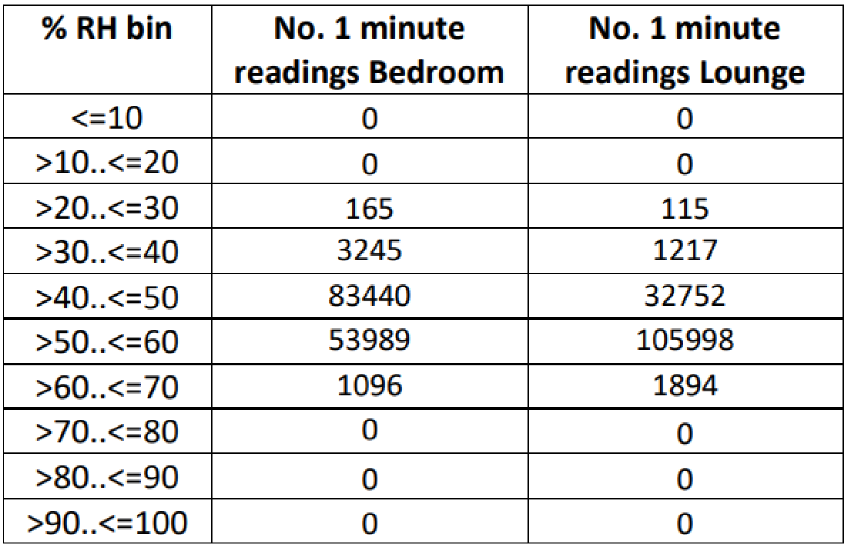


Figure 2 – Seasonal Co-efficient of Performance against outlet temperature for selected ASHP models

Damp and condensation

The relative humidity (RH) of the property has been monitored over the winter period and analysis has shown no recorded condensation risk events were recorded where RH was above 80% and therefore the property is not seen as high risk.



% RH bin	No. 1 minute readings Bedroom	No. 1 minute readings Lounge
<=10	0	0
>10..<=20	0	0
>20..<=30	165	115
>30..<=40	3245	1217
>40..<=50	83440	32752
>50..<=60	53989	105998
>60..<=70	1096	1894
>70..<=80	0	0
>80..<=90	0	0
>90..<=100	0	0

Table 3 – relative humidity monitoring data

Property fabric

The property is assumed to be of timber frame construction with partially insulated walls and has 250mm loft insulation. This indicates adequate thermal fabric efficiency and airtightness. However, there are many areas of uneven loft insulation that would benefit from a relay. It is recommended that loft insulation be relayed across the whole roof space to maximum u value of 0.18W/m^2. In addition the use of a boarded walkway and task lighting would allow access to PV inverter without disturbing the loft insulation in the future.

Figure 4 – Missing loft insulation under tank at 43 Macaulay

Resident behaviour and education

How people control and use energy in the home is a crucial factor in reducing energy consumption and cost. The Missing Quarter report (produced by AGMA) estimated this factor as contributing at least 25% towards any target.

Action to encourage households to change behaviour is an essential component of any plan to reduce carbon and address fuel poverty. Time should be taken to ensure residents using new technologies fully understand the most effective way to operate them. This includes offering easy user guides and assistance on finding the most appropriate tariffs.

The current tenant shows monitored electricity usage of 8,400 kWh. Note that this value includes heat supply as well as appliances and lighting, as 3 Great Close has electric heating, hot water supply and showers. Monitored temperature data shows the tenant living at 25.3°C in the living and room and 25.5°C in the bedroom these figures are significantly higher than would be modeled under sap conditions and therefore actual cost may be higher than modeled without additional behavior change.

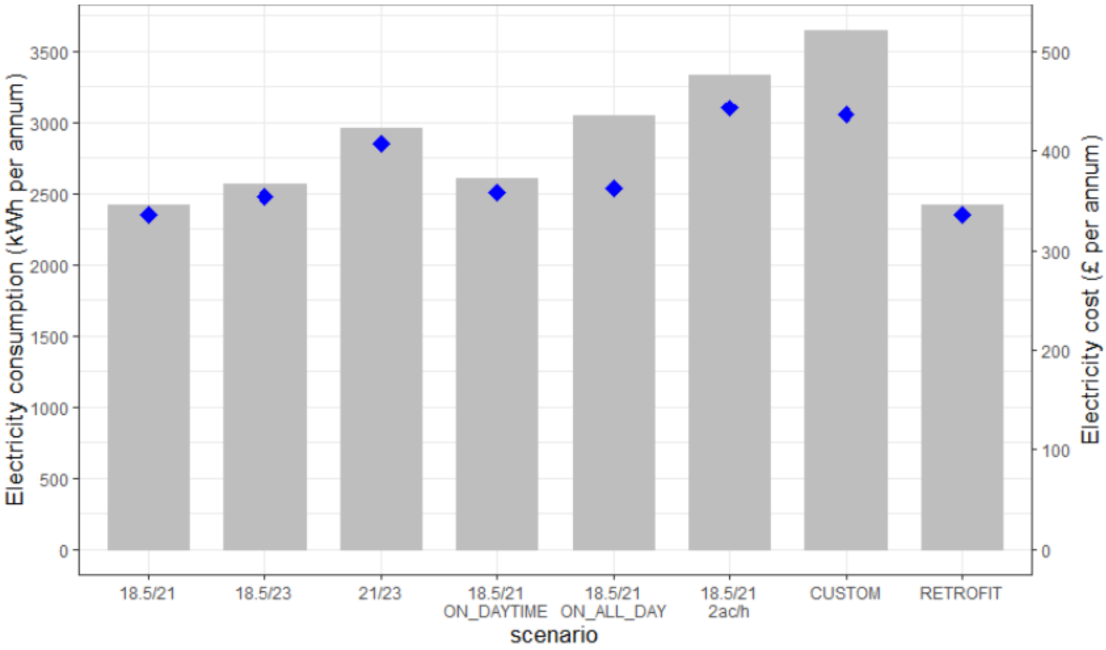


Figure 5 – modelled environmental scenarios for electricity consumption and cost, this excludes the benefit of PV in the kWh calculation (-3712 kWh per annum).

Risk and mitigation

The survey identified the building fabric in good state of repair with no known water penetration, damp or structural defects. There were no identified risks in regards to the proposed measures, however, the installation phase will conduct further measure-specific risk assessments.

The installation of the energy efficiency measures recommended in this report should be carried out in accordance with PAS 2030/35; where low carbon technologies within the scope of the MCS are specified (Solar PV & ASHP), the installation of those systems should be carried out in accordance with the applicable MCS standards.

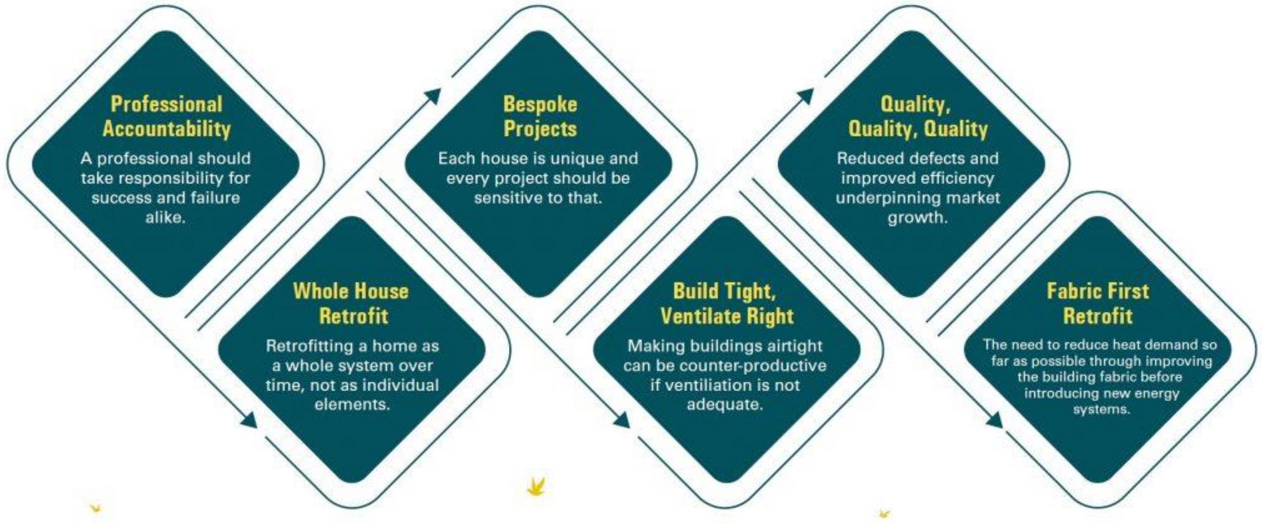


Figure 6 – PAS2035 Process

Design and costing

Initial CAPEX costs

We estimated the costs of measures by:

1. Developing costing models for each building in collaboration with our supply and install partners.
2. Using industry experience to estimate days required for design, installation and commissioning of systems.
3. Obtaining indicative costs from manufacturers and installers for relevant system configurations.

OPEX costs

Annual servicing: an essential aspect of maintaining good performance for both heat pumps and gas boilers. Therefore, our cost assumption is that all technologies are serviced annually. Our installers have provided reliable data on annual service costs.

Lifecycle: a key factor in the costs analysis is the rate at which capital equipment must be replaced within a 30-year time period. We use standard lifetimes for each technology based on industry experience and information provided in CIBSE guidance. The following lifecycle assumptions are used:

- Gas boiler: 12 years
- Air Source Heat Pump: 15 years
- Ground Source Heat Pump: 20 years
- Closed ground loops: 50 years

It was assumed that all or a proportion of capital equipment would require replacing at these intervals. Where capital equipment is to be replaced, installation costs are typically assumed to be lower initial installation. This is because the additional work of transforming the heating system would not be necessary the second time around e.g. installing new pipework and larger radiators.

To calculate fuel bills, we use standard rates for electricity and gas alongside agile tariff rates from Octopus energy, all reviewed by University of Southampton.

For buildings with low heat use, the standing charge can make a significant proportion of the overall fuel bills and the potential to remove the gas standing charge can be a significant benefit of installing a heat pump.

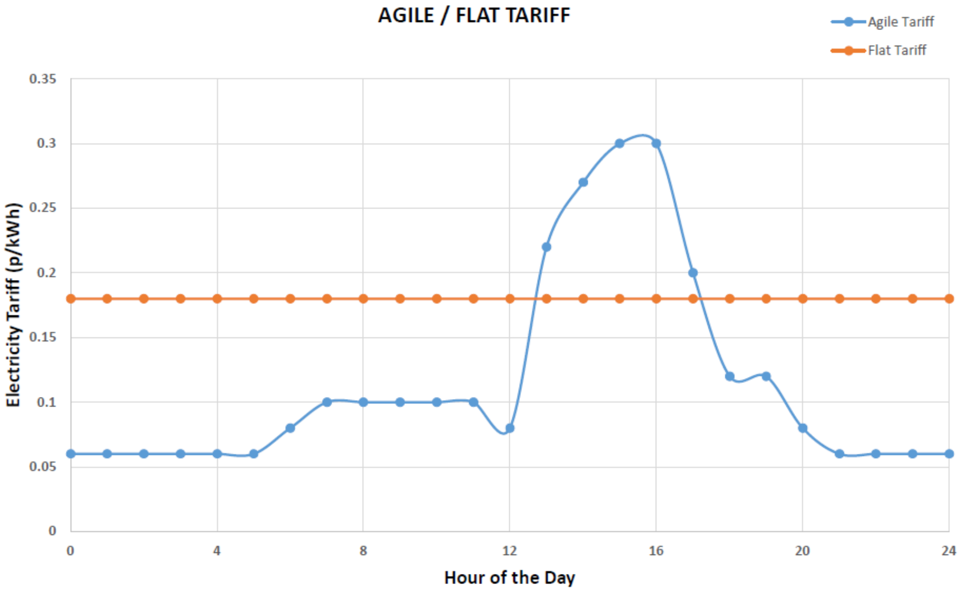


Figure 7 – Example hourly electricity tariffs

Funding opportunities

Renewable Heat Incentive (RHI)

Renewable Heat Incentive payments are based on the deemed proportion of renewable heat produced by a renewable heating technology. It is calculated using the property’s EPC rating and the efficiency of the technology installed. Payments have been based on current domestic RHI tariffs paid over 7 years as of the date of this report, currently available EPC from a neighbouring property and technology efficiencies stated in Table 2. (A new EPC will need to be lodged to be eligible for RHI funding)

Energy Company Obligation (ECO)

Due to the property being EPC rated D or higher there is no available ECO funding.

Social housing decarbonisation fund (SHDF)

Depending on the delivery timescales of the recommended measures, it may be possible to apply for SHDF funding towards the cost of some or all of the measures recommended. However, the next round of bidding has yet to be announced and therefore has not been included within the report.

Green Homes Grant: Local Authority Delivery (LAD)

Depending on the local authority area it may be possible to access LAD funding. However, as the local authority has not been approached this funding has not been included within the report.

Demand side response

Utilising smart battery storage technologies may allow asset owners to access income by providing demand side or firm frequency response services to the grid. However, the aggregated domestic market in this area is still very new and therefore has not been included within this report.

Summary

Under the retrofit scenario laid out total carbon emissions could be cut by over **125%** excluding appliance usage with no increase in lifetime costs from a business as usual scenario (when tenant bills are taken into account).

CO2 savings	Under a business as usual scenario, this property is predicted to emit 39t CO_2 cumulatively by 2050. By retrofitting the property with recommended measures could deliver significant CO_2 savings of 125**%**, excluding appliance electricity usage.
Fuel bills	Fuel bills are predicted to decrease by **61%** under the retrofit scenario. The saving is built on the efficient heat pump, solar PV generation, resident switch to agile tariff and removal of the gas standing charge from the property.
Operating costs	When annual services are factored in, overall operating costs are similar to gas systems due to the simpler checks required and engineer skills shortages. However, the service costs for heat pumps could be expected to fall over time as the market develops.
Lifetime costs	Under the retrofit scenario, lifetime costs are marginally better than the BAU lifetime costs when all grants and tenant savings are accounted for across a 15 year period.

Appendix 1: Costed retrofit proposal

Retrofit scenario (Table 2)				
		Existing system	**NetZero Collective recommendation**	**Cost* (£)**
packages of retrofit measures	heating technology installed	no upgrades	air source heat pump and thermal store	£7,500
	Solar	none	none	£0
	Fabric upgrades	none	loft insulation	£500
	Fabric upgrades	none	none	0
	Storage	none	battery storage	£4,500
energy performance	EPC	B	B	
system design	Flow temp (c)	75	45	
	Efficiency	0.89	3.87	
co2 emissions	cumulative T by 2030	9.63	-2.502	
	cumulative T by 2050	31.03	-8.062	
CAPEX		0	£12,500	
Funding	RHI	0	£4,675	7 Years
	ECO	0	N/A	
	other	0		
CAPEX Sub-Total			**£7,825**	
				Saving (£)
OPEX	Tenant fuel bill	902	£344	£558
	Service	110	£110	£0
lifetime costs including fuel bills	15 year	£17,180	£14,635	£2,545
	30 year	£34,360	£25,445	£8,915
lifetime costs excluding fuel bills	15 year	£3,650	£9,475	-£5,825
	30 year	£7,300	£14,125	-£6,825

*All costs based on estimates, actual cost may differ.

Appendix 2: Floor Plan

Appendix 3: Monitoring Data