APPENDICES

Retrofitting Heat Pumps In London's Community, Arts and Leisure Buildings

Appendix 1: Case Studies

Case study participants were asked to provide responses to a number of questions about their ASHP project, their responses are set out below.

Please note that some of these projects will have moved on significantly from the date at which responses were collected, which was **June 2022.**

Case Study 1: Caxton House Community Centre - Power Up North London

Project overview

The purpose of this project is to support the decarbonisation of Caxton House Community Centre based in Islington, North London ("CHCC"). CHCC is a charity that provides vital services to the local community and is situated in an area of high social deprivation and fuel poverty. This project will deliver reduced carbon emissions from the running of this building and will benefit the community through improved well-being in the building, making CHCC a more inviting space for vulnerable people, while offering a demonstration project to inspire heat pump take up from other community sites.

Power Up North London has a long-standing relationship with CHCC going back to 2018 when PUNL helped to raise funding for the installation of LED lighting and organised some energy advice workshops for local residents. With this decarbonisation project the focus is to install low carbon heating using the fabric first approach. PUNL has been leading and managing this project starting with the decarbonisation feasibility study that provided us with the heat loss calculations and recommendations for prioritising the staged decarbonisation of CHCC. It was CHCC who flagged the urgent need to replace their windows and this work was undertaken concurrently with the feasibility study which validated the carbon savings from the window replacement. At this point, in June 2022, all of CHCC's windows have been replaced, funding has been raised for new skylights and refurbishment of exit doors, as well as for the installation of a building management system that will enable room-level control of heating. The next steps are to raise funding for a mechanical ventilation and heat recovery system and for an air source heat pump system and to have these installed by December 2022.

Origins of the project

- Where did the idea of doing the project come from?
- Who led the project?
- What was the process of getting buy-in / support for the project from the Management Committee and Staff?
- What was the process of getting buy-in support from the community?

PUNL has been interested in delivering decarbonisation projects but until 2021 the organisation's sole focus had been the delivery of rooftop solar projects. The financial models and path to decarbonisation were therefore yet to be developed when the CHCC decarbonisation feasibility project started in March 2021. PUNL has an ongoing relationship with CHCC and approached them with the idea of installing a renewable heat system. CHCC were enthusiastic and at the same time keen to know the right sequence and conditions for installing a heat pump. PUNL explained the process would involve a feasibility study that would deliver recommendations for the decarbonisation and stressed the importance of taking a fabric first approach.

CHCC were clear that their Management Committee would be supportive of the project from an environmental benefits perspective, and while running cost savings would be an added advantage, this was not their primary focus. CHCC run a variety of weekly activities and collect feedback on a regular basis from local residents attending these. From this feedback they knew that this project would be attractive to existing users and could also potentially draw-in new ones once the project was fully delivered.

PUNL decided to team up with CREW Energy for the project management as they were more advanced in their understanding of heat pump projects and were in the process of delivering their first one for a local sports centre. PUNL applied to the London Community Energy Fund for feasibility funding and the funding bid was successful.

In April 2021 PUNL commissioned Energy Systems Catapult (ESC) to work with them to develop a financial model for funding the chosen renewable heat solution. A second quote was obtained for delivering the technical consultancy work on this project and in July 2021 PUNL appointed a mechanical, electrical and public health systems (MEPH) consultancy to undertake the decarbonisation feasibility study at CHCC. The primary purpose of this study was to examine the technical options for installing renewable heat solutions at this site to reduce carbon emissions and improve air quality.

The building

- Type of building
- Total indoor floor area
- Outside area
- Number of floors and rooms
- Any other notable features?

CHCC is a modern, detached brick and concrete building that was constructed in 1976. It has three floors, a total indoor floor area of 1500 m^2 and 19 rooms, some of which are used as offices by local charities and some as community spaces for running regular activities. There is a large sports hall with a high roof and rafters and this serves very well as a venue for indoor sports events. Amongst other users of the sports hall, a local aerial theatre charity called Scarabeus Aerial Theatre, uses this space to deliver choreographed aerial performances and runs regular workshops here.

The area at the front has a paved parking area and some plants in raised beds. The back has concrete paving and there are raised planters for growing vegetables that are used for community food growing programmes and to teach local people about nutrition and how to cook simple, nourishing meals. There is scope to site heat pumps at the back and front of the building as all of this land is part of CHCC's footprint.

Interventions

- What specific work was carried out in relation to heat decarbonisation?
- What previous fabric improvements were carried out to improve the thermal efficiency of the building?

Initially, Caxton House's energy efficiency was reviewed and the decision made to replace all their existing windows. PUNL raised the majority of the capital through an LCEF4 capital grant and this was supplemented by additional funding raised by Caxton House. Thermal performance has been improved by replacing all 43 windows with high performance triple glazed windows supplied by Green Building Store. The window replacement work has also precipitated other actions to improve energy efficiency in the building including draught-proofing and refurbishing fire exit doors and replacing existing skylights with double-glazed units.

At the time of this report funding for the building management system (BMS) has been raised through another LCEF grant and this system is in the process of being procured and installed. The next step will be installation of mechanical ventilation with heat recovery (MVHR) to provide the best energy and carbon efficiency. The decarbonisation recommendations also include servicing the roof and insulating the external walls to reduce heat losses. These actions will be undertaken over the next few years subject to funding.

The building is well maintained with regular investment in updating the internal décor and soft furnishings and recently a new community kitchen was installed. We are not aware of any fabric improvements to CHCC prior to this project

Permissions

- Were any planning permissions needed for the work?
- If so, how was the process of obtaining planning permission?
- Were any other permissions required (eg from building owner / freeholder / etc)?

All the work carried out at CHCC did not require planning permission. The installation of an Air Source Heat Pump will be covered under permitted development and so will not require any planning consent either. CHCC did require permission from the building owner and this was obtained at the start.

Timing

- How long did the project take from start to finish?
- Please list out the major milestones within the project and their rough timescales

The project was started in March 2021 when the LCEF4 grant applications for feasibility and capital funding were successful. Work is still underway to raise funding for the MVHR and ASHP systems. If PUNL is successful in obtaining funding and install these systems by the end of this calendar year then this project will have taken two years from initial conception through to feasibility and capital funding applications, appointing contractors and getting the work delivered.

Major milestones:

LCEF4 feasibility and capital grant applications and response: Jan – March 2021
Appointment of contractors:
    Financial modelling consultant: April 2021
    MEPH consultant: June 2021
Delivery of feasibility report: September 2021
Delivery of financial model: October 2021
LCEF5 capital grant application and response: Nov 2021 – Feb 2022
Delivery of ASHP tender specification document: April 2022

Benefits

- What carbon savings were achieved / can be expected from the project?
- What savings to energy bills were achieved / can be expected from the project?
- What other benefits have been observed as a result of the project?

The carbon savings from this retrofit project will be phased in as the different stages of decarbonisation are completed as shown in the table below. CHCC emitted 40 tonnes of carbon a year from its space and water heating needs. Based on the figures provided by the decarbonisation feasibility report the following savings have been achieved or will be delivered once the interventions are in place:

- The first two phases of window replacement and installation of BMS and MVHR systems are expected to deliver a carbon saving of 10 tonnes a year.

- The installation of an ASHP system will deliver further energy savings equivalent to carbon savings of 9 tonnes a year. The existing boiler will be left in place as a back-up until such time as all the final fabric improvements have been achieved.

- The full decarbonisation is expected to deliver energy savings of 26 tonnes per year.

Intervention	Carbon saving per year in tonnes
Window replacement	5
BMS & MVHR systems	5
ASHP system	9
Additional retrofit actions: Wall and roof insulation	7
Total	26

Using the financial model developed during this project CHCC is projected to achieve running cost savings of £7k every year. They are also attracting new hires for their community rooms due to the improved ventilation and aesthetics from the new windows. This is bringing in additional income that will be invested back into community activities including running energy efficiency workshops to help residents with ideas for lowering their energy bills.

This project is helping to demonstrate the types of decarbonisation solutions that are available for community buildings and how community energy groups like PUNL can help community sites to decarbonise and support the delivery of Islington Council's zero carbon 2030 targets. CHCC is part of the Octopus Community Network of 14 sites and PUNL is in discussions with a couple of centres about supporting them with their decarbonisation plans. They have been inspired by the work that has been undertaken by CHCC and the improvements that have been achieved.

Costs and funding

- What were the total costs of the project? Please provide a breakdown of the major components of the cost
- How was the project funded?
- What level of subsidy was required for the project to go ahead?

All of the retrofit feasibility work and interventions so far have been funded through grants either from the London Community Energy Fund or Islington Council's Section 106 funding. The total cost of this project will depend on the measures that CHCC implements. Quotes for wall and roof insulation are prohibitively high at this stage and will be challenging to fund through grants.

As the project is still underway the following figures show either actual costs or estimates for works to be undertaken:

- Decarbonisation feasibility study, financial model development, preparation of tender document for ASHP procurement and project management: £12k
- Triple glazed windows X 43 including installation & disposal of old windows: £ 71k
- Building management system installation: £35k (estimate)
- Heat recovery system installation: £20k (early estimate)

- Wall and roof insulation: £150k (estimate)
- Air Source Heat Pump procurement installation: £82k (estimate)
  Total = £370k

Unexpected / unplanned events

- Did everything go according to plan or were there any unexpected events / developments?
- Did the project reach completion on time? If not, what caused the delay?
- Did the project come in on budget? If not, what caused the extra spend?

PUNL has learnt a lot from this project about the types of skills and contractors required to deliver this work, the costs of delivering such projects and the timelines for delivery. It is clear that this type of project requires significant technical expertise in choosing the technologies to be implemented and in designing and implementing systems for heating, building management and ventilation. Some aspects of this project have taken longer to implement and others have gone to plan.

The window installation went to plan in terms of timing principally because CHCC took an active role in the measurements and detailing of the types of windows required and in the liaison with the supplier. The windows did cost a lot more than the original estimates provided for the LCEF grant once the supplier came on site to take the detailed measurements. Part of this was due to professional measurement of the windows and part of it due to higher installation costs. The supplier charged a premium price for installation but they also demonstrated good attention to detail and provided a positive customer experience.

The BMS system installation has taken longer, first due to the time taken to obtain the funding, and second due to delays experienced in getting quotes that are within the original budget. Two factors are driving this increase in cost, one is a significant rise in the cost of particular components and the other is a more detailed specification which requires rewiring that was not included in the budget quote.

Challenges

- What challenges did you come across in relation to delivering this project?
- Were there any specific challenges in relation to this being a community energy project?
- Were there any specific challenges in relation to the project being in a community building?
- Do you have any suggestions for overcoming the challenges you faced?

Scope challenge: The decarbonisation feasibility report took several iterations and a lot longer than planned. Part of this was due to data errors that had to

be corrected and part of it was due to differing expectations about the level of detail required. For instance, it was not clear at the outset how much information the MEPH consultant should be expected to provide on heat loss at this site. We now know that this is a matter for negotiation and that the level of granular detail, that is, heat loss per room or space versus heat loss overall from each fabric should be agreed at the start. In a lot of cases the granular detail of room-level heat loss can be provided by the appointed ASHP contractor once they are in place.

Technology and price: The choice of technology for our renewable heat system, ground source versus air source heat pump also took longer than planned. The challenge here was the strong recommendation from our MEPH consultant to install a GSHP system on the grounds of better performance versus an ASHP system. The cost of the GSHP system was 2.5 times that of the equivalent ASHP system and the difference in performance was not easily verifiable from available data. PUNL conducted its own research in this area and concluded that in London where winter temperatures do not go below 5-7°C the difference in ASHP versus GSHP performance is not very significant for a building that has the right fabric improvements in place. PUNL could justify the choice of an ASHP system both from the perspective of value-for-money and performance.

Financial payback: In the absence of the Renewable Heat Incentive or any other form of subsidy the financial model does not currently provide a payback for renewable heat systems as the capital costs significantly exceed the savings in running costs. Charities like CHCC do not qualify for the Public Sector Decarbonisation Scheme so that funding for such systems needs to be sourced from grants, donations or capital funding from the site itself.

Expertise: It is helpful to have somebody with an engineering background to review decarbonisation reports and a technical specialist to project manage the appointment of contractors and to supervise their delivery. This skillset may be provided by a volunteer or a paid technical consultant.

Contractors: Finding contractors to quote for doing these works and getting them to deliver within the timelines set by grant funders can be challenging. Our BMS quote for capital works was a budget estimate received over 18 months ago when funding was being applied for. Actual prices are coming in at significantly higher levels due to a more detailed specification and also price rises for some technical equipment.

Installation disruption: The impact on the community building from installation disruptions needs to be factored in. CHCC had the windows installed in late August when they knew that they could minimise impact on their occupants and user groups. For the BMS system once again this issue needs to be factored in.

Any other useful information

- Is there any other useful information / advice you can provide?

It has been challenging to source the capital funds for the CHCC ASHP system. A couple of climate-focused grants declined to fund the project as they said they were seeking projects that "directly supported vulnerable energy consumers". The Energy Redress Scheme also added the following considerations for suitability that they felt were not offered:

- Projects that support the development of innovative products/services or
- Projects that have a realistic prospect of delivering a replicable business model that does not rely on grant funding.

While both these criteria are possibilities from the CHCC ASHP project they are not immediately deliverable but will emerge in time. We believe that self-funding ASHP models can become the norm as electricity suppliers and ASHP manufacturers start partnering to make these units affordable... see link...Octopus energy invests in heat pumps

Case Study 2: Devas Youth Club - CREW Energy

Retrofitting Heat Pumps into Community Buildings: A CREW Case Study

Project Overview

CREW's first community building heat pump project was at Devas Club, a youth centre in Battersea. Devas runs homework clubs, has dance and recording studios and a gymnasium. The centre also offers office space to local social enterprises and holds inclusion lunches for the elderly.

In May 2021 CREW installed 4 16kW Nibe F2040 air source heat pumps (ASHPs) to work in concert with a gas boiler that was installed in 2017. Running two heat sources like this is known as bivalency. The system was designed to optimise between the two heat sources based on cost but in theory this could also be carbon.

This project was funded via a community share offer with a projected dividend of 4%. Income streams come from the now departed non-domestic RHI plus a heat charge to the Club on 1.5 pence per kWh consumed.

Origins of the Project

CREW started working with Devas Club in 2018 after an introduction from a local councillor. Devas already had Solar PV installed on the roof in 2011 and had a plan to reduce its carbon footprint by 5% p.a. and ultimately become zero carbon. The scoping for that plan was funded by a grant from LCEF. CREW and the Devas management teams identified several areas that needed to be addressed. Phase one saw CREW install LED lights funded by UKPN's Power Partners fund. Phase 2 was funded by the Wandsworth Local Fund and included a building management system for smart heating controls and the installation of secondary glazing. Buoyed by these two successes we moved to Phase 3 of the project in spring 2021 and the

installation of heat pumps on the roof of the building. The Devas management team were supportive from the very start and the fact that this project would cut their carbon footprint by 17 tonnes further smoothed the process. Funding for this project came through our first community share offer for which we achieved the Standard Mark.

The project was led by CREW Energy and our supporting installer was the now defunct Greensquare Renewables. We requested quotes from two other companies ISO Energy and Ground Sun. Only Greensquare provided a quote that allowed the economics to stack up. It was very valuable spending time with the design team and the chief engineer (someone who has supported us with subsequent design changes despite leaving the company). The sales person won't be there when the installation is happening, so its key you meet the design and install team and form an opinion of them.

The choice of installers in London was and remains very limited. Iso had an employee who volunteers for SELCE. The other two we found on the MCS register (https://mcscertified.com/find-an-installer/). Greensquare was the closest to us and we had seen their vans in SW London. Ground Sun was very helpful when we called to explain the project. As more people are installing heat pumps all the time, we would recommend talking to local residents about their experience with installers in your area. We have been put off considering two firms thanks to feedback from CREW members.

Our community engagement for this project solely focussed on fundraising. We were confident there would be no local resistance to the project as the heat pumps were to be placed on the roof and would not be visible to local residents. And as they were to be placed 20 m from the nearest property, sound was very unlikely to be an issue.

The Building

Devas Club was purpose built in 1970 as a space for young people to learn new skills, build resilience and be the best they can be. The building is set over four floors with a gym and recording studios in the basement. The ground floor has a games area, function rooms, kitchen and an IT suite. The first floor hosts the main hall and on the second floor are offices for social enterprises.

The building has a flat roof that houses a basketball court, a solar array and now 4 heat pumps. Each floor of the building is separated by 500mm of concrete slab flooring which provides excellent thermal mass to store and retain heat.

The total floor area of the building is 1800 sqm. While the building dates back to 1970 the rear of the ground floor was rebuilt in 2017 with greatly improved insulation and glazing. Secondary glazing was added to the offices on the 2nd floor and to the windows in the hall as preparation for this project. The latter was part of phase 2 of CREW's WLF project, which also included the installation of a destratifier in the main hall to bring heat back down from the two storey ceiling.

Table 1 shows the heat loss calculations for the ground floor rooms that were used for the design of the heat pump system. Note the power requirement rating of the rooms depending on if they were modernised or not, running from 62 W/m2 in the new build to 136 W/m2 in the old.

Table 1: Ground floor Heat loss calculation table

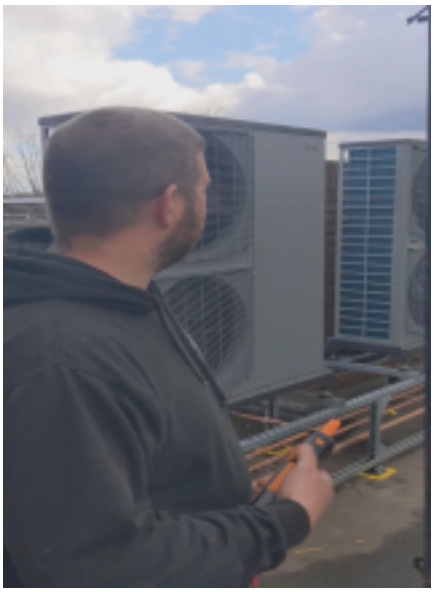
	Design Temp	Power (W/m2)	Area (m2)	Power (W)	Energy (kWh
Entrance Gallery	18	133	14.18	1886	5175
ICT Room	21	66	33.46	2194	2887
Reception/ Games Area Ground Floor	21	47	177.56	8374	15580
Kitchen	21	70	28.8	2025	4989
Sadie Hut Room	21	110	45.74	5019	11058
Devas Bar Room	21	63	46.97	2970	7622
Devas Bar Toilet	21	79	6.53	238	587
Devas Office	21	79	27.34	2172	4535
Classroom	21	67	59.62	3984	7932
Youth Workers Office	21	136	10.19	1401	3137

Devas Club had a relatively new boiler dating back to the refurb in 2017, so it was decided early on in the project to retain this system and develop a bivalent solution that would allow for back up heating. All of the hot water in the building was provided by direct electric systems and again it was decided to retain those systems to keep costs down. Table 2 shows the modelled heat supply between the heat pump and the gas boiler.

Table2: Annual Space heating demand and Supply

Space heating Annual Heat Demand		
Demand	kWh/yr	199311
Heat supplied by HP, excluding auxiliary heaters	kWh/yr	148896
Seasonal Coefficient of performance (SCOP)	SCOP	3.76
Electricity consumed by HP, excluding auxiliary heaters	kWh/yr	39600
Renewable heat supplied by HP	kWh/yr	109296

Interventions:



From the modelling above, the engineers decided that 4 16kW heat pumps would be able to provide heat down to 4 degrees and provide 75% of the space heating capacity. The calculations were based on the upgrading of the windows and the addition of the destratifier in the hall. No consideration was made to the upgrading of the fabric. Our reasonings for this were cost and the fact that the system was designed to be bivalent. When it gets cold the gas boiler can kick in and run at a cheaper rate than the heat pumps. The flow temperature of the heat pumps was designed to be 45º Celsius. And again as the system is being run in bivalency no upgrades were made to the heat emitters (radiators and coil fans) in the building

Above you can see an image of chief engineer Keith, with the heat pumps in the background. The four units run in cascade so as demand increases more units come online. This decision is determined currently by the Nibe control panel in the boiler house. We plan to change this so that the building's smart heating controls will ultimately take control of the decision

making process. The benefits of this decision are that the building management system is taking more measurements across the building as it measures heat on a granular level and it has the ability to analyse more data sets to make the correct decisions.

To make the most economic decisions, the system has to consider the following parameters:

- The relative price of gas and power
- The efficiency of the boiler
- The efficiency of the heat pump, which depends on both the flow temperature and the outdoor temperature. The higher the flow temperature the less efficient the heat pump. The cooler the outdoor temperature the less efficient the heat pump
- The comfort of the people working and playing in the building is of prime importance. As temperature drops the heat pump, as measured by the return temperature, will start to struggle. At this point the Gas boiler needs to kick in and provide heat at a higher flow temperature (75º).

Table 3 shows the efficiency of the Nibe 2040 heat pump at varying flow temperatures. This number is based on an average winter season temperature of 7º. London's average winter temperature is much warmer than this.

Table 3: SCOP of the Nibe 2040

NIBE F202-16kw Seasonal Coefficient Of Performance (SCOP)	
Flow Temperature (° C)	SCOP
35	4.29
40	4.02
45	3.76
50	3.53
55	3.29

Initially we had chosen the Vaillant Arotherm system due to its R32 refrigerant's low Global Warming Potential (GWP) of just 3. Unfortunately COVID had severely hampered supply and with the RHI March 2021 deadline looming we were forced to change to the Nibe F2040 system that uses an older R-410A refrigerant that has a GWP of 2088.

Another factor we built into our design of the system was the installation of two 1000 litre storage tanks. We calculated these units could provide 1 hour of space heating that would allow for heat shifting to reduce the peak demand burden. As you may recall, the building also has a lot of thermal mass with 500mm concrete floors between each level. This would

also allow us to store heat and allow coasting through peak periods. More work needs to be done within the BMS software before we can really work with this element of the technology. Interestingly these tanks only cost £2400 to install. To shift the equivalent heat using battery storage would cost around £11 000.

Permissions:

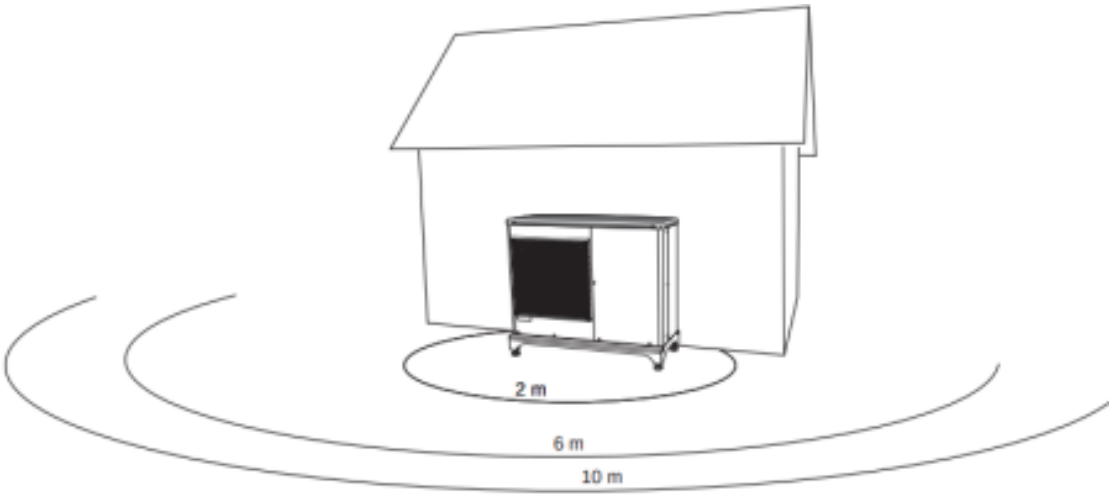
A single heat pump either, commercial or domestic, is considered permitted development. Once you go over one unit planning permission is required. As this was our first heat pump installation we paid £260 for pre-planning advice. I would suggest that was not value for money as the planner had little knowledge of the technology. Interestingly when it came to making our planning application and in the subsequent response the planners describe our system as an air conditioning unit. Planners, please move with the times!

It is fairly straightforward what you need to provide. It really is just four factors:

- Can the system be seen from the road as this could raise objections
- Can neighbouring housing hear the unit?
- Does the system block a fire exit?
- Have you provided to scale drawings of the set up

As our system was roof mounted it is not visible to the general public. And as it sits behind a locked fence it in no way inhibits a fire exit. Our biggest concern was noise and potential challenges from the local community. The Nibe units are 61 dB(A) nominally. The addition of 3 more units only increases that figure to 64 decibels. London background noise is 41 dB(A). Diagram 1 shows how noise falls with distance. The heat pumps are over 20m from local housing, so noise was not a consideration.

Diagram 1: Nibe Sound Pressure Levels



Air/water heat pump		*F2040-6*	*F2040-8*	*F2040-12*	*F2040-16*
Sound power level* According to EN12102 at 7/45 (nominal)	L_{WA}(A)	50	54	57	61
Sound pressure level at 2 m free standing.*	dB(A)	36	40	43	47
Sound pressure level at 6 m free standing.*	dB(A)	26.5	30.5	33.5	37.5
Sound pressure level at 10 m free standing.*	dB(A)	22	26	29	33

Timing:

This project was partly funded through the Next Generation Fund. Our project launched in the spring of 2020. A combination of COVID lockdown, finding our first community building and then mobilising teams during lockdown meant that progress was slow for the first 4 months of this project.
We had an agreement in principle with Devas by June 2020 but to and froing with the Trustees and lawyers took a further four months.

While those negotiations were proceeding, albeit slowly, CREW's comms team started work on planning the community share offer. Writing the share offer took a couple of months but achieving the Standard Mark extended this process greatly. We launched the share offer in December 2020 and raised just over £30k from the local community. Thanks to the Standard Mark we were able to apply for match funding from the Community Booster scheme. CREW closed our fundraise on Jan 31st 2021 and requested installation from our install partners, Green Square Renewables (GSR).

The next month was then spent chasing GSR for a start date with the end of the RHI (March 31st 2021) in mind. GSR finally came on site on March 15th with an ambition to complete the installation by the end of the Month. By this time, we had decided to request an RHI extension as a precaution as we were losing faith in GSR. We applied for the RHI extension on

March 31st and this was duly granted until September 2021 and subsequently extended until March 2022 and March 2023 by OFGEM.

The project hit delays due to the complexity of the installation. The system had to be designed to run in a bi-valence with the current gas boiler and the addition of the two 1000 litre storage tanks, which also added complexity. COVID and Brexit caused further delays in kit supply. The installation was eventually completed in June 2021. As the system does not provide hot water there was likely to be no demand over the summer.

We went back on site at the end of September to find that the heat meter had not been connected to the power supply. We chased GSR and finally they came back in late November to remedy the problem. We checked in on the site in the first week of December only to find the heat meter was still not connected. At this point we found out that GSR had gone bust. So we engaged with a third party heating company to help us resolve the outstanding issues. As the heat meter was not live we were unable to complete our RHI forms and missed valuable income from both the RHI and the heat charges to Devas Club. Thankfully we budgeted for issues such as these in our fundraise and have enough money to cover the first three years of debt repayment. The RHI application was made over the Christmas 2021 period. It seems pointless to spend too much time on the RHI application process as it now defunct but we will say that it was a difficult form to complete, the software was glitchy but the staff were helpful when issues arose. If you are going to tap into the RHI's replacement scheme, the Boiler Upgrade Scheme, budget plenty of time for the application.

Benefits:

The biggest driver for any heat pump project is carbon saving. It is hard to think of any other technology that gives as much bang for your buck. You are likely to save only half the amount of carbon, spending the same amount of money on solar PV. This is important when considering the great reduction of subsidies for commercial projects. Many community projects will be funded by grants in the coming years. Most of these grants will come from local authority CIL or S106 funding. As these councils start to panic about their lack of progress in hitting their zero carbon targets, their community investment will become more targeted on projects that cut carbon. Heat pump projects can offer large carbon savings and improve local air quality compared to other investments.

- Our project will save Devas 17 tonnes of carbon in year one.
- It was projected to save Devas £900 on its heating bills per year.
- It is projected to save 149 000 kWh of gas flue emissions including particulate matter, nitrous oxides and carbon monoxide.

- This was London's first community heat pump project and this has led to CREW supporting three other London groups as they start the journey into renewable heat. We are working with PUNL on a civic centre, Repowering on a school and a civic centre and One Stone Grove on their own building.

Cost and Funding:

The cost of the heat pump installation was £42 000 for 4 16 kW heat pumps. The storage tanks were a further £2400 but these were covered by the Next Generation budget as a piece of innovation work.

CREW raised £50 000 for this project via its community share offer, giving us a buffer for overruns and to cover the costs of interest payments for the first two years of the project.

For CREW to be able to afford the debt repayment and interest (which has been set at 3% in our share offer) we needed the RHI and a heat usage payment from Devas club. The heat payment is currently set at 1.5p per kWh and under the contract this price is index linked to CPI. You can see from the cash flow model below that despite these two payments the economics are still very marginal. Factors that improve this model are a period of higher inflation (as we are now experiencing) and if the centre starts to run its fan coils in cooling mode through the summer, so increasing demand.

With the RHI gone and the new BUS essentially a grant, the new project will need to be chiefly funded with further grants and perhaps some pay as you save investment from the building owners. The economics of running a heat pump compared to gas should improve over time.

Table 4: Cash flow model

	RHI Income	Client charge	Repayment	Debt	Interest	O&M	Cashflow	Acc Cashflow
		0					-£43,268.20	
1	£3,741.39	£2,235.00	£0.00	£50,000.00	£1,500.00	£100.00	£4,376.39	-38,892
2	£3,816.22	£2,279.70	£0.00	£50,000.00	£1,500.00	£102.00	£4,493.92	-34,398
3	£3,892.54	£2,325.29	£2,777.78	£47,222.22	£1,416.67	£104.04	£1,919.35	-32,479
4	£3,970.39	£2,371.80	£2,777.78	£44,444.44	£1,333.33	£106.12	£2,124.96	-30,354
5	£4,049.80	£2,419.24	£2,777.78	£41,666.67	£1,250.00	£108.24	£2,333.02	-28,021
6	£4,130.80	£2,467.62	£2,777.78	£38,888.89	£1,166.67	£110.41	£2,543.56	-25,477
7	£4,213.41	£2,516.97	£2,777.78	£36,111.11	£1,083.33	£112.62	£2,756.66	-22,720
8	£4,297.68	£2,567.31	£2,777.78	£33,333.33	£1,000.00	£114.87	£2,972.35	-19,748
9	£4,383.63	£2,618.66	£2,777.78	£30,555.56	£916.67	£117.17	£3,190.68	-16,557
10	£4,471.31	£2,671.03	£2,777.78	£27,777.78	£833.33	£119.51	£3,411.72	-13,146
11	£4,560.73	£2,724.45	£2,777.78	£25,000.00	£750.00	£121.90	£3,635.51	-9,510
12	£4,651.95	£2,778.94	£2,777.78	£22,222.22	£666.67	£124.34	£3,862.11	-5,648
13	£4,744.99	£2,834.52	£2,777.78	£19,444.44	£583.33	£126.82	£4,091.57	-1,556
14	£4,839.89	£2,891.21	£2,777.78	£16,666.67	£500.00	£129.36	£4,323.96	2,768
15	£4,936.68	£2,949.04	£2,777.78	£13,888.89	£416.67	£131.95	£4,559.33	7,327
16	£5,035.42	£3,008.02	£2,777.78	£11,111.11	£333.33	£134.59	£4,797.74	12,125
17	£5,136.13	£3,068.18	£2,777.78	£8,333.33	£250.00	£137.28	£5,039.25	17,164
18	£5,238.85	£3,129.54	£2,777.78	£5,555.56	£166.67	£140.02	£5,283.92	22,448
19	£5,343.63	£3,192.13	£2,777.78	£2,777.78	£83.33	£142.82	£5,531.82	27,980
20	£5,450.50	£3,255.97	£2,777.78	£0.00	£0.00	£145.68	£5,783.01	33,763

Factors that will start to make heat pumps cheaper than gas and that should be considered in an economic model:

- The ever improving efficiency of new heat pumps
- The decarbonisation of Asia from coal to gas will make gas prices increasingly volatile. The last price cap saw gas prices rise 66% compared to only 25% for electricity.
- Gas as we see currently has huge political risks attached.
- The current one way bet on carbon prices will also underpin the wholesale gas market.
- The Government's stated aim is to move legacy green levies from electricity to gas from 2023. This is 0.78p in total, so a 1.5p swing from electricity to gas
- The government has already moved the inflation factor on these levies from electricity to gas. That is currently 0.104p p.a.
- The public's dawning realisation that gas boilers are unreliable as they cost almost as much to maintain each year as they do to run. Which? suggests that the average household with boiler cover pays £278 p.a. Community buildings have to pay a few hundred pounds each year for gas safety check alone.
- By exiting gas a building is not only saving on maintenance and safety checks but also a second standing charge which can be several hundred pounds per year. As more households and businesses move away from gas the cost burden on maintaining the network will fall on fewer and fewer customers. This will be reflected in higher standing charges.

Unexpected / Unplanned Events

- COVID caused all kinds of issues from building access, to staff absence through to equipment delivery delays. These delays led to the need for an extension to the RHI and the subsequent headache that caused.
- GSR being poor communicators certainly made the project more challenging and did not allow us to plan everything in the way we would have liked.
- GSR going bust, while not entirely unexpected, certainly caused headaches with hand over, finalising the install and teething issues.

Challenges

- Dealing with GSR was our biggest challenge. They were non-responsive to emails and calls. The more we discussed projects with consumers and commercial businesses, non-responsiveness seems a theme across the industry. The install took months not weeks and communication was poor from their management team. We also did not get the handover that we expected (probably because they were in the process of going bust). Saying that, the engineers were very good and managed an extremely neat job. It was a shame the management team was so poor.
- The RHI extension was stressful as initially BEIS were inundated with requests and the budget was maxed out. On review many projects were unlikely to proceed and this budget was clawed back. Thankfully CREW was subsequently awarded an extension. Our advice in scenarios where a subsidy is ending is the following:
    - Never have a project that is six months from the end of a scheme.
    - If you do end up in such a crunch, request an extension at the earliest opportunity.
- Another issue we are still grappling with is how to integrate the heat pumps (4 x Nibe 16k 2040s) with the incumbent building management system. Currently, the heat pumps are deciding when to run and when to switch to the gas boiler. This has demoted the impact of the BMS to localised radiator controls only.
- Government vacillation over energy policy and extensions certainly caused and continues to cause issues for the renewable heat sector
- The OFGEM RHI application process was convoluted and the software incredibly bug ridden. It was not uncommon for the software to crash on a page over and over again, to the point where you would give up for a day or two and then try again, Only to crash two pages on. Our guess is the BUS system will be no more robust so be prepared.

Case Study 3: One Stonegrove - Stonegrove Community Trust

Project overview ● Brief description of the project	Moving our centre off of the District heat system that currently provides hot water and space heating for our whole estate. It is expensive, environmentally damaging, and fairly unreliable. We want to install an ASHP system for all of our heating needs.
Origins of the project ● Where did the idea of doing the project come from?	The intention to explore this came from our CEO Gus. Early conversations led us to believe that it would not work for us, but then we later realised we had dismissed it too quickly, with not enough research.
● Who led the project?	The overall project lead is our CEO Gus Alston. The technical lead is Toby Costin from CREW Energy.
● What was the process of getting buy-in / support for the project from the building managers etc?	As CEO leading, was not really required. However worth stating that this is something that is pretty much universally supported by our staff, volunteers and Trustees.
● What was the process of getting buy-in support from the community?	This has not really been shared with the wider community, except informally. The community engagement comes later, when we plan to use what we have learnt to help others to explore what environmental technologies and control systems might be appropriate in their settings.
● Who were your partners (eg. contractors, assessors) and how did you identify them?	CREW London are our main partner, introduced through the work that they did with Polka Theatre, Wimbledon. They chose Polar to work on the ASHP system design and to quote.
● Did you use a qualified retrofit assessor and coordinator?	Polar are leading on all of this. CREW recommended them as being suitable and up to the task.

The building ● Type of building	Modern (2016), steel and concrete with fiberglass type cladding.
● Total indoor floor area	c.20,000 ft2
● Outside area	Not large – only doing ASHP so less relevant?
● Number of floors and rooms	Nursery with assorted spaces. Two large halls. Two meeting rooms. Two offices. Reception. Café with seating area. Kitchenette. 5 toilets.
● Existing heating and hot water system	All through District heating system, which also provides to c.1,000 homes.
● Existing insulation (eg. roof, wall, double-glazing)	Exact type currently unknown, but modern building. Some paperwork issues.
● Any other notable features?	No.
Interventions ● What specific work was carried out in relation to heat decarbonisation?	Currently waiting on a quote for a quote for 3 X 16KWh ASHP system, and linking to our Heating Save BMS system.
● What previous fabric improvements were carried out to improve the thermal efficiency of the building?	None – building is modern and pretty efficient.
● Did you consider the materials being used for interventions in terms of their own carbon content (ie embodied carbon)?	Not relevant.
Permissions ● Were any planning permissions needed for the work?	Not yet, as the system design has not been signed off. We have had Planning

● If so, how was the process of obtaining planning permission?	granted for our solar panel array, for which we are still fundraising.
● Were any other permissions required (eg from building owner / freeholder / etc)?	They will be, from: 1) Barnet Council. 2) LDF (Church of England). We got these both in place for the solar panels.
Timing ● How long did the project take from start to finish?	This has been going for around 4 months so far. It has been challenging getting the time that we need from Polar, as they have been very in demand. Also it's gone over the Summer holidays time, which always slows things down. Additionally we're in no real hurry, as currently focusing on fundraising for the solar panel array.
● Please list out the major milestones within the project and their rough timescales	Currently aiming for: 1) Full feasibility completed by November 2022. 2) GLA funding for 1/3rd secured by March 2023. 3) Fundraising for the rest (c.£40,000) completed by end September 2023. 4) System installed by end 2023.
● How important was the sequencing of the work?	We are only in feasibility, which obviously has to come before the other parts.
Benefits ● What carbon savings were achieved / can be expected from the project?	14.2 tonnes CO2 annually.
● What savings to energy bills were achieved / can be expected from the project?	£5,000pa savings based on current energy prices. Expect that figure to approximate double when new rates announced in April 2023.

● What other benefits have been observed as a result of the project?	Because District heating systems are not subject to the price cap, the price can go higher, and is only changed annually. The other benefit of this project would be a more reliable system, and a centre that remains warm if there is an estate wide issue with the District heating system. This then means we can be a warm refuge for vulnerable people at that time.
● Which interventions provided the most carbon savings per £ of investment?	This is focusing on only one intervention.
Costs and funding ● What were the total costs of the project? Please provide a breakdown of the major components of the cost	The Feasibility project is £5,772. This includes funds for the fundraiser to begin raising the capital.
● How was the project funded?	100% funded so far from GLA LCEF.
● Does the project have any debt or obligation to pay back returns to investors?	No.
● What level of subsidy was required for the project to go ahead?	None
● What factors were considered when evaluating the feasibility of the project?	The feasibility is exploring the costs, and whether therefore the project can be financially viable. We are already pretty certain that the ASHP technology can be used to efficiently heat the building, but the feasibility study will confirm this.
Unexpected / unplanned events ● Did everything go according to plan or were there any unexpected events / developments?	Has been tricky to get people's time to help on the project, as those working around these technologies are very much in demand, from organisations with funds ready to commit.

● Did the project reach completion on time? If not, what caused the delay? ● Did the project come in on budget? If not, what caused the extra spend and where did the extra budget come from?	Currently running a little late, but not by much. The fundraising part will be challenging though. The feasibility part will definitely come in on budget.
<u>Challenges</u> ● What challenges did you come across in relation to delivering this project? ● Were there any specific challenges in relation to this being a community energy project? ● Were there any specific challenges in relation to the project being in a community building? ● Do you have any suggestions for overcoming the challenges you faced?	All referenced already in this form. Nothing to state yet. Permissions for this building are relatively complicated, as there is the building/ land owner, and the head leasee.
<u>Any other useful information</u> ● Is there any other useful information / advice you can provide?	Nothing springs to mind currently, but happy to keep speaking.

Appendix 2: Types of Air Source Heat Pump

Monoblock
In a monobloc arrangement, all of the core heat pump components are contained in the external unit. Hot water pipes for radiators and the hot water cylinder pass directly from the unit into the building. For medium and large applications, multiple units can be banked together to form systems over 1MW in size with the only real constraint being the amount of available space. Units are often located on the roofs of non-domestic buildings, or on dedicated ground adjacent to the building. Monobloc heat pumps can be quicker and easier to install than other arrangements as only standard electricity and water connections are required (i.e. there is no need for F-Gas qualifications on installation, as there may be for split systems).

Split air to water
Split systems consist of two separate units: an indoor unit and outdoor unit. The outdoor unit contains the evaporator; the indoor unit contains the compressor and condenser with refrigerant passing between the two. This configuration typically requires a smaller outdoor unit than a monobloc arrangement which may enable a greater choice of locations in retrofits where outdoor space is limited. For non-domestic installations, this may require internal space in a plant room. The amount of space will vary but is likely to be larger than existing gas boiler plant. At this scale, additional plant such as buffer tanks and thermal stores are also likely to need accommodating.

Split air to air
Split air to air heat pumps consist of an exterior condenser unit which is connected via refrigerant pipes to interior fan coil units that provide heating or cooling directly through blown air. Air to air split units are a common form of air conditioning in buildings. They do not provide hot water.

Internal air to water
In a fully internal heat pump, the evaporator is installed inside the building. The exterior air is brought into the unit via air ducts through the external wall. This technology can be combined with heat recovery from air-handling units or other waste sources by ducting exhaust air from the waste heat source in to the unit. These units are commonly provided as an integrated package with a hot water cylinder. This technology is typically found at smaller scales of 1-5kW.

Variable Refrigerant Flow (VRF) heat pump
VRF heat pump systems are a type of inverter driven split air to air heat pump, where the flow of refrigerant can be modulated to supply varying demand to different indoor units. Heating and cooling can often be provided simultaneously depending on the requirements of different zones within the buildings. In the case of blocks of flats, the indoor units could be small individual internal heat pumps units; in the case of commercial buildings, the indoor units are more likely to be fan coil units (FCUs) providing warm air to zones within the building.

Appendix 3: Data Sets

London non-domestic buildings (UKPN Heat Street Dataset)

Sector	Stock (# of buildings)	Total floor area (m2)	Initial Heating demand (GWhth)
Community, Arts & Leisure (CAL)	14,667	11,249,017	1,146
Other Non-Domestic Buildings (Including: Education, Emergency Services, Health, Hospitality, Industrial, Offices, Retail, Storage)	334,964	136,806,106	13,733
All non-Domestic	349,631	148,055,123	14,879

London Community, Arts & Leisure buildings (UKPN Heat Street Dataset)- Building Size

Community, Arts & Leisure	Stock (# of buildings)	Total floor area (m2)	Initial Heating demand (kWhth)
Large	1,624	5,668,694	590,605,020
Medium	11,051	5,277,643	525,952,281
Small	1,992	302,680	29,660,409
All	14,667	11,249,017	1,146,217,710

London Community, Arts & Leisure buildings (UKPN Heat Street Dataset)- Gas System

Community, Arts & Leisure/**with Gas System**	Stock (# of buildings)	Total floor area (m2)	Initial Heating demand (kWhth)
Small	1,355	198,320	20,831,164
Medium	7,424	3,703,685	389,028,256
Large	1,240	3,741,105	392,958,706

Community, Arts & Leisure building in London Boroughs- GLA dataset vs UKPN dataset

No	Boroughs	GLA			UKPN		
		Building number	Total floor area (m2)	Initial Heating demand (kWhth)	Building number	Total floor area (m2)	Initial Heating demand (kWhth)
1	BARKING AND	307			325		

	DAGENHAM		301,552	24,831,301		350,035	36,219,260
2	BARNET	532	445,958	41,221,601	626	452,808	46,490,881
3	BEXLEY	370	281,250	34,933,510	254	204,371	20,677,084
4	BRENT	485	547,207	63,706,600	398	311,575	32,048,101
5	BROMLEY	530	653,876	50,927,425	552	371,954	38,390,622
6	CAMDEN	754	1,609,864	140,877,546	897	567,668	57,023,300
7	CITY OF LONDON	198	1,703,025	94,170,893	227	80,131	7,218,969
9	CROYDON	431	2,063,063	175,180,258	431	237,326	23,818,179
10	EALING	511	473,702	47,188,238	13	10,466	1,063,341
11	ENFIELD	470	437,012	50,683,124	349	352,902	35,640,621
12	GREENWICH	510	479,484	57,937,054	496	495,865	49,983,409
13	HACKNEY	530	1,565,119	164,491,581	548	380,539	39,117,614
14	HAMMERSMITH AND FULHAM	623	746,283	54,242,133	399	473,850	49,004,906
15	HARINGEY	332	898,439	69,817,727	498	351,216	35,617,641
16	HARROW	386	456,856	61,200,583	265	295,014	30,101,925
17	HAVERING	266	303,566	27,315,482	271	171,964	17,531,670
18	HILLINGDON	257	135,229	33,471,772	152	81,717	7,879,690
19	HOUNSLOW	501	1,203,448	28,599,514	17	17,214	1,801,555
20	ISLINGTON	325	312,200	42,673,995	547	243,762	24,484,615
21	KENSINGTON AND	315			1,150		

	CHELSEA		834,281	79,182,204		749,606	77,337,444
22	KINGSTON UPON THAMES	270	976,223	202,456,558	136	148,649	15,293,963
23	LAMBETH	299	296,400	39,425,520	613	307,949	31,502,472
24	LEWISHAM	350	607,110	61,738,069	394	240,449	24,506,647
25	MERTON	345	564,262	44,742,872	235	202,869	21,103,002
26	NEWHAM	517	318,255	27,471,987	439	1,127,668	116,225,786
27	REDBRIDGE	478	2,394,823	230,162,629	253	231,915	23,551,094
28	RICHMOND UPON THAMES	457	504,826	40,699,131	249	139,792	14,402,517
29	SOUTHWARK	399	491,903	38,843,556	571	592,586	61,276,211
30	SUTTON	486	1,821,678	120,749,155	242	154,484	15,965,796
31	TOWER HAMLETS	284	242,818	35,771,841	594	401,908	40,076,867
32	WALTHAM FOREST	698	1,973,929	163,919,133	256	117,513	11,432,995
8	CITY OF WESTMINSTER	307	183,188	25,283,668	626	499,505	51,353,424
33	WANDSWORTH	455	615,674	55,391,549	1,644	883,748	88,076,109
	Grand Total	**13,978**	**26,442,505**	**2,429,308,212**	**14,667**	**11,249,017**	**1,146,217,710**

Appendix 4: PSDS supported ASHP projects in London

List of heat pump projects in London funded through the Public Sector Decarbonisation Scheme (PSDS)

The Public Sector Decarbonisation Scheme (PSDS) supports the aim of reducing emissions from public sector buildings by 75% by 2037, compared to a 2017 baseline, as set out in the 2021 Net Zero and Heat and Buildings strategies.

- Phase 1 of the PSDS provided £1 billion in grants over the financial years 2020-2021 and 2021-2022.
- Phase 2 of the PSDS provided £75 million of grant funding for the financial year 2021-2022.
- Phase 3 of the PSDS will in total provide £1.425 billion of grant funding over the financial years 2022-2023 to 2024-2025, through multiple application windows. The first Phase 3 application window, Phase 3a, closed to new applications in November 2021. The second Phase 3 application window, Phase 3b, will provide up to £635 million of funding over the financial years 2023-2024 to 2024-2025. The application window for Phase 3b closed on 31 October 2022.

This table below:

- Includes only sites in London funded through the Government's PSDS ***that include*** the installation of heat pumps (ie additional projects in London were funded through the PSDS that did not include heat pumps)
- This list is taken from the BEIS/DESNZ project summaries webpages

PSDS Phase	Projects Awarded in London WITH heat pumps
PSDS 1	Harris Federation, Croydon Harris Federation in Croydon has been awarded £3,491,503 to install heat decarbonisation and energy efficiency measures at 12 school buildings. Ageing gas boilers will be replaced with **air source heat pumps**, solar panels will be installed to provide renewable energy, and existing lighting will be replaced with LED lighting. The building management system will also be improved and an energy storage system will be installed.
PSDS1	Imperial College Healthcare NHS Trust Imperial College Healthcare NHS Trust has been awarded £26,901,902 to deliver various energy efficiency and heat decarbonisation measures at Charing Cross Hospital and Hammersmith Hospital. **Heat pumps** and solar panels will be installed, alongside more energy efficient LED lighting, improvements to building insulation, and optimisation of the energy

	management system. The funding aims to achieve a 20% reduction in energy consumption at each site, which will contribute to the Trust's ambition of achieving net zero carbon by 2040.
PSDS1	London Borough of Barnet London Borough of Barnet has been awarded £1,381,317 to upgrade a range of Council owned buildings. **Air source heat pumps** will be installed to reduce reliance on gas boilers, solar panels will be installed to provide a source of renewable energy, and LED lighting will be installed to improve the energy efficiency of the buildings.
PSDS1	London Borough of Brent The London Borough of Brent has been awarded £3,234,890 to deliver energy efficiency and heat decarbonisation measures to the 17 Council buildings with the highest energy consumption. The Borough will install **heat pumps**, wall, floor and roof insulation, improved energy metering and new building energy controls. This project forms part of the Council's strategy to reach net zero emissions before 2030.
PSDS1	London Borough of Camden The London Borough of Camden has been awarded £770,683 to upgrade Swiss Cottage Library. **Air source heat pumps** will be installed to replace fossil fuel heating systems, in addition to the installation of secondary glazing to the windows. This will contribute to the Council's target to become net zero by 2030.
PSDS1	London Borough of Ealing The London Borough of Ealing has been awarded £2,831,622 for 3 projects to deliver heat decarbonisation and energy efficiency measures across 45 sites, including schools, that are owned and operated by the Council. The sites will receive **heat pumps** with backup electrical heating to replace gas fired generation of hot water, as well as insulation, solar panels and smart metering.
PSDS1	London Borough of Enfield The London Borough of Enfield has been awarded £3,819,097 to upgrade a range of buildings, including the Civic Centre, the Council's biggest and busiest building. Measures to be installed include **heat pumps**, solar panels, double glazing, controls for lighting and heating, and insulation. This will help the Council achieve its target to be a carbon neutral organisation by 2030.
PSDS1	London Borough of Hackney The London Borough of Hackney has been awarded £263,501 to install **ground source heat pumps** at the West Reservoir Centre. This will decarbonise the heating and production of hot water and will be powered

	by the existing solar panels on the site. This will help contribute to the Council's plans to reach net zero by 2040.
PSDS1	London Borough of Harrow The London Borough of Harrow has been awarded £2,483,197 for 3 projects to upgrade a range of Council owned sites. **Air source heat pumps and** solar panels will be installed at the Harrow Arts Centre complex, which includes Grade II listed Elliott Hall auditorium. Eight schools and a day care centre for elderly residents will also be upgraded with various decarbonisation and energy efficiency measures, including air source heat pumps, LED lighting and insulation. This will support the Borough in their aim to become carbon neutral by 2030
PSDS1	London Borough of Hounslow The London Borough of Hounslow has been awarded £18,895,354 for 2 projects to fund multiple energy efficiency measures in 33 schools and 31 public buildings in Hounslow. Measures include installation **of heat pumps**, solar panels and energy efficient LED lighting. This funding will assist the Borough in becoming carbon zero by 2030, in line with their climate emergency action plan.
PSDS1	London Borough of Lambeth London Borough of Lambeth has been awarded £8,141,872 for 3 projects to install energy efficiency and heat decarbonisation measures in multiple buildings managed by the Council, including 23 schools, Brockwell Hall, 5 libraries, 2 community buildings and offices. Measures to be installed include **air source heat pumps**, solar panels, LED lighting upgrades, double glazing and loft insulation. This will contribute to the Council's commitment to reach net zero emissions on its own estate by 2030.
PSDS1	London Borough of Merton The London Borough of Merton has been awarded £497,231 to replace old gas boilers with **new air source heat pumps** at several of their buildings, including children's centres and libraries. Gas fired hot water systems will be removed from the buildings, and energy efficiency will be improved through installing insulation. This will contribute towards the Council's aim to make their operations zero carbon by 2030.
PSDS1	London Borough of Newham London Borough of Newham has been awarded £2,679,754 to decarbonise their corporate headquarters at Newham Dockside. The Borough will install energy efficient LED lighting, a **heat pump** and solar panels to generate renewable energy. This will contribute to their commitment to become net zero by 2030.
PSDS1	London Borough of Southwark

	The London Borough of Southwark has been awarded £1,304,315 to install **air source heat pumps,** solar panels and improved insulation at a range of Council-owned buildings. This will help to contribute to the Council's aim to achieve net zero carbon by 2030.
PSDS1	London Borough of Tower Hamlets The London Borough of Tower Hamlets has been awarded £721,163 to replace ageing gas boilers with **air source heat pumps in 4 Council buildings**, including 2 children's centres, Toby Lane depot and Jack Dash House. Jack Dash House will also have its lighting replaced with energy efficient LED lighting. This will contribute to the Council's target to be net zero by 2025
PSDS1	London Borough of Waltham Forest London Borough of Waltham Forest has been awarded £2,278,380 for 3 projects to decarbonise 12 sites across the Borough. The sites will receive wall and loft insulation, double glazing and LED lighting upgrades. Solar panels and **air source heat pumps** will also be installed. This will reduce the Council's fossil fuel consumption, contributing to a reduction of carbon emissions.
PSDS1	London North West University Healthcare NHS Trust London North West University Healthcare NHS Trust has been awarded £9,929,776 to deliver heat decarbonisation and energy efficiency measures at Northwick Park Hospital and St Mark's Hospital. This will include **installing a heat pump**, upgrading the lighting system to energy efficient LED lighting, and installing insulation, solar panels and battery storage. The Trust will also optimise the building energy monitoring and controls and install a site-wide metering system.
PSDS1	Royal Borough of Greenwich Royal Borough of Greenwich has been awarded £3,912,227 for 2 projects to deliver energy efficiency measures and reduce carbon emissions in 9 buildings within the corporate property estate. This includes the replacement of gas boilers with air source heat pumps, the installation of solar panels to generate renewable energy, roof insulation, the installation of heat recovery ventilation systems, and the installation of LED lighting. The funding will also deliver improvements across 10 schools, **installing air source heat pumps**, energy efficient LED lighting and solar panels to provide renewable energy and increase the energy efficiency of the schools. These improvements form part of the Council's drive to net zero carbon by 2030 in line with its published draft carbon neutral plan.
PSDS1	Royal Borough of Kensington And Chelsea

	The Royal Borough of Kensington And Chelsea has been awarded £209,000 to install **air source heat pumps**, roof insulation, double glazing, and energy efficient LED lighting in 3 community buildings on the Lancaster West estate. This will support the goal of making the Lancaster West estate net zero by 2030.
PSDS1	St Ursula's Convent School, Greenwich St Ursula's Convent School in Greenwich has been awarded £222,709 to replace an ageing gas boiler with a ground source heat pump, and also to install LED lighting in the school. This will reduce carbon emissions and improve the energy efficiency of the school.
PSDS1	University of West London The University of West London has been awarded £5,015,751 to retrofit 4 of its buildings at the University's Ealing and Brentford campus locations. **Air and ground source heat pumps** will be installed, alongside additional solar panels, LED lighting, and improved insulation and glazing. This will significantly reduce the University's carbon emissions and support its plan to become a zero net carbon institution by 2030.
PSDS1	Westminster City Council Westminster City Council has been awarded £12,999,218 to upgrade more than 40 of their sites, including libraries, leisure centres and offices. The Council will **install heat pumps,** LED lighting, solar panels, insulation and upgrades to ventilation systems. This will support the Council's drive towards net zero emissions from all Council operations by 2030
PSDS1	Southwark Diocesan Board of Education The Southwark Diocesan Board of Education has been awarded £13,047,094 to install heat decarbonisation and energy efficiency measures in 68 Church of England schools across south London and Surrey. This will include installing air source heat pumps, solar panels, battery storage and energy efficient lighting, and improving the insulation of the schools. This will significantly reduce the carbon emissions produced by the schools.
PSDS2	Croydon Health Services NHS Trust Croydon Health Services NHS Trust has been awarded £570,081 to decarbonise their estates buildings The end-of-life gas boiler will be replaced with an **air source heat pump,** thereby enabling the gas connection to be removed. Energy efficiency will also be improved through installing double glazed window replacements, LED lighting, roof insulation, building management system upgrades and an air handling unit to improve ventilation.
PSDS2	Goldsmiths, University of London

	Goldsmiths, University of London has been awarded £5,000,000 to install an **air source heat pump** and new heat distribution pipework across the entire campus. This will contribute to the university's commitment to be a zero emissions campus by 2030.
PSDS2	London Borough of Hammersmith and Fulham London Borough of Hammersmith and Fulham has been awarded £465,330 for two projects to decarbonise Broadway Children's Centre and the Macbeth Centre Annex building, which serves as an adult learning centre. **Air source heat pumps** will be installed in both buildings. Window glazing will also be installed at the Broadway Children's Centre and loft installation will be installed in the Macbeth Centre Annex.
PSDS2	Metropolitan Police Service The Metropolitan Police Service has been awarded £881,774 for 3 projects to decarbonise Gipsy Hill Police Station, Walworth Police Station, and the dog training facilities at Keston Police Station. Existing gas and oil boilers in all 3 police stations will be replaced **with air source heat pumps**. Infrared heating will also be installed in the kennel block at Keston Police Station, and LED lighting will be installed at Walworth Police Station.
PSDS3a	**Christ's College, Finchley** Christ's College Finchley, a secondary school in East Finchley, has been awarded £1,942,000 to replace their existing heating system with **air source heat pumps.** The energy efficiency of the school will also be improved through the installation of insulation, draught proofing, heating pipework insulation, and improvements to the hot water distribution systems.
PSDS3a	**Croydon Health Services NHS Trust** Croydon Health Services NHS Trust has been awarded £2,498,202 to decarbonise Croydon Hospital, including the Postgraduate Medical Centre, the Genitourinary Medicine building, and the Birth Centre. **An air source heat pump** will be installed, alongside a variety of energy efficiency measures, including roof insulation, double glazing, a building energy management system, and improvements to the heating distribution pipework improvement.
PSDS3a	**Harris Federation, Croydon** Harris Federation has been awarded £1,297,680 to decarbonise 4 primary academies: Harris Primary Academy Coleraine Park, Harris Primary Academy Crystal Palace, Harris Primary Academy Kenley, and Harris Primary Academy Orpington. **Air source heat pumps** will be installed in all 4 schools, and roof mounted solar panels will be installed at the academies in Crystal Palace, Kenley and Orpington to provide a source of

	renewable energy. In addition, LED lighting and building energy management systems will be installed to improve the energy efficiency of the schools.
PSDS3a	**Hive Education Trust, Islington** Hive Education Trust has been awarded £664,436 to replace the end-of-life fossil fuel heating system at St Mary Magdalene Academy in Islington with an **air source heat pump**, and to install LED lighting to improve the energy efficiency.
PSDS3a	**Homerton University Hospital NHS Foundation Trust** Homerton University Hospital NHS Foundation Trust has been awarded £4,096,635 to install **air source heat pumps** at Homerton University Hospital's Mental Health Unit. Solar panels will also be installed to provide a source of renewable energy, and a building energy management system will be installed to improve energy efficiency.
PSDS3a	**Imperial College Healthcare NHS Trust** Imperial College Healthcare NHS Trust has been awarded £22,990,057 for 2 projects to **install an air source heat pump at Hammersmith Hospital** and an air source heat pump and two water source heat pumps at Charing Cross Hospital. A range of energy efficiency measures will also be installed at both hospitals, including LED lighting, cavity wall insulation, pipework insulation, and improvements to the heating distribution pipework.
PSDS3a	**Jewish Community Academy Trust, London** Jewish Community Academy Trust in London has been awarded £674,831 to replace end-of-life fuel heating systems with **air source heat pumps in** Hertsmere, Sacks Morasha and Wolfson Hillel Jewish Primary Schools. Solar thermal, draught proofing and heating pipework insulation will also be installed in all 3 schools, and solar panels will be installed in Hertsmere Jewish Primary School.
PSDS3a	**London Borough of Barnet** London Borough of Barnet has been awarded £5,956,396 for 2 projects to decarbonise 20 primary schools and 2 secondary schools, Moss Hall Nursery, Parkfield Children's Centre, New Park House Children's Home, and a nursing residential home. The existing fossil fuel heating systems in all the sites will be replaced **with air source heat pumps**, and solar panels will be installed at 15 sites to provide renewable energy. A variety of energy efficiency measures will also be installed across the sites, including heating pipework insulation, draught proofing and double glazing.
PSDS3a	**London Borough of Bromley**

	London Borough of Bromley has been awarded £465,916 to install air source heat pumps and electric heating at Southborough Primary School, which will reduce the school's carbon emissions from heat generation by 60%. Heating pipework insulation will also be installed to improve the energy efficiency of the school.
PSDS3a	**London Borough of Camden** London Borough of Camden has been awarded £2,071,329 for 5 projects to install heat decarbonisation and energy efficiency measures at Swiss Cottage Library, Talacre Community Sports Centre, and 3 schools: Eleanor Palmer Primary School, Primrose Hill Primary School, and Acland Burghley School. **Air source heat pumps will be installed on all sites;** electric heating will be installed at the three schools, and solar panels will be installed at Talacre Community Sports Centre. A variety of energy efficiency measures will also be installed across the sites, including roof and loft insulation, LED lighting, building energy management systems, and improvements to the heating distribution pipework.
PSDS3a	**London Borough of Ealing** London Borough of Ealing has been awarded £7,222,411 for 2 projects to install heat decarbonisation and energy efficiency measures across 6 primary schools, 2 secondary schools and 6 nursing residential homes**. Air source heat pumps**, solar panels, solar thermal, heating pipework insulation, and draught proofing will be installed in all 8 schools, and ground source heat pumps will be installed in the nursing residential homes.
PSDS3a	**London Borough of Hounslow** London Borough of Hounslow has been awarded £2,397,945 to install **air source heat pumps** and solar thermal in 6 primary schools and 4 secondary schools. A range of energy efficiency measures will also be installed across the schools, including LED lighting, draught proofing and pipework insulation.
PSDS3a	**London Borough of Islington** London Borough of Islington has been awarded £1,276,683 for 3 projects to install **air source heat pumps** and solar panels at Islington's Waste and Recycling Centre office and New Park Day Centre for the elderly, and to install **a ground source heat pump** at New River College, a referral unit that provides support for pupils who are not able to attend mainstream school. A range of other energy efficiency measures will be installed at the sites, including double glazed windows, LED lighting and heating controls.
PSDS3a	**London Borough of Lambeth**

	London Borough of Lambeth has been awarded £1,431,250 for 2 projects to install heat decarbonisation and energy efficiency measures at the Brixton Recreation Centre swimming pool, Upper Norwood Library and the Waterloo Action community centre. **Air source heat pumps will be installed at all sites,** alongside LED lighting, double glazing, insulation and building energy management systems. Solar panels will also be installed at Brixton Recreation Centre and Upper Norwood Library to provide a source of renewable energy.
PSDS3a	**London Borough of Richmond Upon Thames** London Borough of Richmond Upon Thames has been awarded £3,344,949 to install a range of heat decarbonisation and energy efficiency measures in 5 schools, Whitton Community Centre, the Civic Centre, a hostel providing temporary accommodation, and the Disability Action and Advice Centre. **Air source heat pumps will be installed in each of the buildings** and a range of measures will be installed to provide renewable energy and improve the energy efficiency, including solar panels, LED lighting, insulation and building energy management systems.
PSDS3a	**Metropolitan Police Service** The Metropolitan Police Service has been awarded £1,816,087 for 2 projects to replace oil and gas boilers with **heat pumps** at Brixton Police Station and Gilmour Section House service residence. The heating distribution pipework will also be improved at Brixton Police Station, and LED lighting and roof insulation will be installed at Gilmour Section House.
PSDS3a	**Royal Borough of Greenwich** The Royal Borough of Greenwich has been awarded £1,917,826 to upgrade 11 primary schools. The existing boilers in all schools will be replaced with **air source heat pumps,** and solar panels will be installed to provide a source of renewable energy. The energy efficiency of the buildings will also be improved through installing heating pipework insulation and draught proofing.
PSDS3a	**Royal Botanic Gardens, Kew** The Royal Botanic Gardens in Kew have been awarded £4,484,128 for 2 projects to decarbonise Nash Conservatory, a Grade II listed building, and Jodrell Laboratory. In both buildings, existing gas and oil boilers will be replaced with **air source heat pumps** and all lighting will be upgraded to new LED lighting. Draught proofing will also be installed at the Nash Conservatory, and solar panels and ventilation will be installed at the Jodrell Laboratory.

PSDS3a	**Royal Central School of Speech and Drama, London** The Royal Central School of Speech and Drama in London has been awarded £260,050 to decarbonise East Block, a mixed-use building containing a library, a computer suite, offices, meeting rooms, a student common room and a bar. The existing gas-fired boilers will be replaced **with air source heat pumps,** and the air handling unit will be upgraded to improve the energy efficiency of the building.
PSDS3a	**Royal Free London NHS Foundation Trust** Royal Free London NHS Foundation Trust has been awarded £511,704 to install **air source heat pumps** and LED lighting at several sites, including their main hospital building, a staff education centre, a recreation centre, a GP surgery, and Anne Bryans House, which provides residential accommodation for the Trust's employees.
PSDS3a	**South London and Maudsley NHS Foundation Trust** South London and Maudsley NHS Foundation Trust has been awarded £889,054 to decarbonise 3 buildings at Bethlem Royal Hospital: Monks Orchard, Chelsham House and River House. The existing gas boilers at Monks Orchard and Chelsham House will be replaced with **air source heat pumps**, supported by the installation of solar panels on the roofs of the 3 buildings to provide renewable energy. This will support the Trust in achieving its net zero target by 2040.
PSDS3a	**Southwark Diocesan Board of Education, London** Southwark Diocesan Board of Education has been awarded £2,801,773 to decarbonise 10 primary schools and a secondary school, St Martin-in-the-Fields High School for Girls. **Air source heat pumps** and solar thermal will be installed in all the schools, alongside a range of other measures including solar panels, heating pipework insulation and draught proofing.
PSDS3a	**St Matthias Church of England Primary School, London** St Matthias Church of England Primary School in London has been awarded £1,284,782 to replace their fossil fuel heating system with **air source heat pumps,** as well as to install solar panels to generate renewable energy. In addition, dry wall lining and roof insulation will be installed to reduce heat loss from the school.
PSDS3a	**United Colleges Group, London** United Colleges Group has been awarded £814,938 to decarbonise City of Westminster College in London. An **air source heat pump and water source heat pump** will be installed, alongside solar panels to provide renewable energy. Heating pipework insulation will also be installed to improve the energy efficiency of the college.

PSDS3a	**University of Greenwich** The University of Greenwich has been awarded £1,101,576 to install an **air source heat pump** to heat 5 buildings at Avery Hill Campus, including a student halls of residence building, conference facilities, and teaching buildings.
PSDS3a	**University of West London** The University of West London has been awarded £285,086 to replace the existing gas-fired boilers with an **air source heat pump i**n Villiers House building. Villiers House is a 9-storey multi-purpose building which provides a range of university facilities, including classrooms, meeting rooms, offices, dance studios, music rooms and an IT room.
PSDS3a	**Wandsworth Borough Council** Wandsworth Borough Council has been awarded £3,154,523 to decarbonise 2 leisure centres, 6 primary schools, and Ernest Bevin College secondary school and sixth form. **Air source heat pumps will be installed in all the buildings;** solar panels will be installed to provide renewable energy; and LED lighting and insulation will be installed to improve the energy efficiency of the buildings.
PSDS3b	**Home Office** The Home Office has been awarded £540,000 to decarbonise its immigration reporting centre at Eaton House in Hounslow. The current gas fired boilers will be replaced with an **air source heat pump**. Loft and draught insulation will also be installed, and the building energy management system will be upgraded.
PSDS3b	**London Borough of Camden** London Borough of Camden has been awarded £3,237,036 for 3 projects to upgrade Kingsgate Primary School, Hampstead Secondary School, the Grade II listed Highgate Library, West Hampstead library, Netherwood Day Centre, York Way vehicle depot and Waterlow Park visitor centre. **Air source heat pumps** will be installed in all buildings except for Waterlow Park visitor centre, where a **ground source heat pump** will be installed. Other improvements to be installed across the sites will include LED lighting, double glazing, dry wall lining, draught proofing, loft insulation and solar panels.
PSDS3b	**London Borough of Hillingdon** London Borough of Hillingdon has been awarded £13,751,385 to install **air source heat pumps** at the Council's 4 largest sources of carbon emissions: the Civic Centre, Winston Churchill Hall and Theatre, Highgrove Leisure Centre, and Hillingdon Leisure Centre. A variety of energy

	efficiency measures will also be installed across the buildings, including double glazing, secondary glazing, and loft and cavity wall insulation.
PSDS3b	**London Borough of Islington** London Borough of Islington has been awarded £225,946 to decarbonise King Henrys Walk, a nursing home which provides support services for people with learning disabilities. Gas boilers will be replaced with **air source heat pumps** and solar panels will be installed on the roof. Improvements to the building energy management system and heating pipework will also be made to increase the overall energy efficiency of the nursing home.
PSDS3b	**London Borough of Lambeth** London Borough of Lambeth has been awarded £2,295,170 to decarbonise 6 schools: Henry Fawcett Primary School, Kings Avenue Primary School, St Saviours Church of England Primary School, Telferscot Primary School, Walnut Tree Walk Primary School, and London Nautical School. The existing gas heating systems will be replaced with **air source heat pumps** in all the schools, and solar panels will be installed at three of the schools. A variety of energy efficiency measures will also be installed, including loft insulation, double glazing, hot water flow restrictors, heat storage, heating pipework improvements, speed drives, LED lighting, wall insulation and building energy management systems.
PSDS3b	**London Borough of Lewisham** London Borough of Lewisham has been awarded £872,604 to decarbonise 4 community centres and Downderry Primary School. An **air source heat pump** will be installed in each of the buildings, and solar panels will also be installed in all but one of the community centres. Additionally, LED lighting and cavity wall insulation will be installed at some of these buildings to improve their energy efficiency.
PSDS3b	**London Borough of Merton** London Borough of Merton has been awarded £3,136,593 to decarbonise the Borough's largest building, the 15 storey Civic Centre in Morden town centre. The existing end-of-life gas boilers will be replaced with **air source heat pumps** and the energy efficiency of the building will be improved by upgrading the hot water supply to point-of-use heaters.
PSDS3b	**London Borough of Sutton** London Borough of Sutton has been awarded £137,852 to install an **air source heat pump**, cavity wall insulation, double glazing, solar panels and LED lighting at Sutton Youth Centre.
PSDS3b	**London Diocesan Board for Schools: Stepney All Saints School**

	London Diocesan Board for Schools has been awarded £1,046,713 to decarbonise the design and technology building at Stepney All Saints School, a secondary school in London. The existing end-of-life gas heating system will be replaced with an **air source heat pump** and the energy efficiency of the building will be improved through the installation of double glazing, roof and cavity wall insulation, and ventilation improvements.
PSDS3b	**London Fire Brigade** The London Fire Brigade has been awarded £1,426,877 to decarbonise 5 fire stations: Bethnal Green Fire Station, Chelsea Fire Station, Edmonton Fire Station, Hainault Fire Station and Islington Fire Station. The existing gas boilers at all sites will be replaced with **air source heat pumps**, and solar panels will be installed at Bethnal Green and Chelsea Fire Stations. A range of energy efficiency measures will also be installed across the sites, including cavity wall insulation, draught proofing, roof insulation, double glazing, LED lighting, energy efficient ovens, and building energy management systems.
PSDS3b	**Metropolitan Police Service** The Metropolitan Police Service has been awarded £9,483,959 to upgrade 14 police stations across London. **Air source heat pumps** will be installed in each of the police stations, with additional electric heating to be installed in one of the stations. Energy efficiency improvements will also be installed across multiple sites, including double glazing and cavity wall insulation.
PSDS3b	**Newham College of Further Education** Newham College of Further Education has been awarded £833,807 to install an **air source heat pump** and an electric boiler at their Stratford Campus in East London.
PSDS3b	**Transport for London** Transport for London has been awarded £592,380 to support the decarbonisation of Therapia Lane Tramlink depot, a tram depot in Croydon. Old gas boilers will be replaced with **air source heat pumps,** infrared panel heaters, and point-of-use electric water heaters. Solar panels will also be installed, and the energy efficiency of the depot will be improved through the installation of a new ventilation system, roof insulation and LED lighting.
PSDS3b	**University of Greenwich** University of Greenwich has been awarded £370,926 to decarbonise the university's gym building. The gas fired heating system will be replaced with a **ground source heat pump**, and the energy efficiency of the

	building will be improved through the installation of roof and floor insulation, dry wall lining, double glazing and new LED lighting.
PSDS3b	**Westminster City Council** Westminster City Council has been awarded £3,829,522 to decarbonise 8 council buildings, including 2 primary schools, 3 community centres, 2 libraries, and Seymour Leisure Centre. **Air source heat pumps** will be installed at all sites, with solar panels also to be installed at the leisure centre, a school and a community centre. A range of energy efficiency measures will also be installed at five of the buildings, including heating pipework insulation, double glazing, roof and loft insulation, and LED lighting.
PSDS3b	**Whittington Health NHS Trust, North London** Whittington Health NHS Trust in North London has been awarded £2,499,367 to upgrade Hornsey Rise Health Centre, Northern Health Centre, River Place Health Centre and a building at Whittington Hospital which provides physiotherapy, social work services and residential accommodation. The installation of **air source heat pumps** and work to upgrade building energy management systems will take place in all four buildings, and solar panels will also be installed in the three health centres.