Aston Group

Waltham Forest

47 Greenleaf Road Retrofit Home

Walthamstow

Welcome

Aston Group are keenly aware of the ongoing research into climate change. We understand that the world is heating up and steps must be taken now to slow – or even reverse – the process.

That is why we are delighted to have had the privilege to work with the London Borough of Waltham Forest on its flagship whole-house retrofit project at 47 Greenleaf Road. It's a fantastic opportunity to demonstrate what can be achieved by local authorities, landlords and property owners to make Britain's existing housing stock more energy efficient.

But more than that, it also demonstrates that these steps can be taken while keeping resident safety and wellbeing in mind. Every decision made during this project weighed the energy efficiency benefits against the possible effects on residents and the wider community. From the impact on fuel poverty, to fire safety and the aesthetics of the building itself, all aspects of the project were thoroughly researched by the design team before being implemented.

Over the course of the project, it was inspiring to see our teams and partners engage with the subject of achieving net-zero, sourcing innovative solutions to common problems. It also demonstrated how modern technological developments are making energy efficiency more accessible for all.

This white paper is designed to inspire individuals and organisations too, demonstrating the practical solutions we developed while highlighting some of the challenges we faced, so you can start making steps on your own net-zero journey.

If you would like to know more about any aspect of this project, please do not hesitate to get in touch via mail@astongroup.co.uk.

Best wishes,

Alan Thomas
Managing Director

"Over the course of the project, it was inspiring to see our teams and partners engage with the subject of achieving net-zero"

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Understanding the climate emergency

An understanding of the climate emergency and its impact around the world serves to highlight the importance of the whole-house retrofit project and its place in the wider landscape.

On 1 May 2019, UK Parliament declared a climate change emergency, following the lead of local authorities across the land – including the London Borough of Waltham Forest. However, by December 2020 the crisis seemed more pressing, prompting Prime Minister Boris Johnson's pledge to reduce the UK's greenhouse gas emissions by 68% by the end of 2030 – and achieving net-zero by 2050.

The rate of climate change – and its impact on both human and animal life – is growing too large to ignore. In fact, it is believed that achieving net-zero by 2050 may be too late to stop global temperatures increasing by 1.5°C.

What is climate change?

Climate change refers to the rising average temperature of the Earth. It is thought that an increase of 1.5°C above pre-industrial levels will pose a significant risk to human health – and some regions are already seeing the impact.

According to data shared by the United Nations Environment Programme (UNEP), the global average temperature in 2019 was 1.1°C above the pre-industrial period. At the close of 2019, sea levels had risen a record amount as greenhouse gases caused the planet to warm and polar ice to melt.

NASA images illustrate just how rapidly these changes are occurring and how quickly habitats are being destroyed.

As a result, both human and animal populations are starting to feel the effects of climate change, in the UK and abroad. Further UNEP data shows that 30% of the world's population is exposed to deadly heatwaves for more than 20 days a year, while average temperatures from 2010 to 2019 were the highest on record. And while it may seem, here in the UK, that an increase in temperatures is a good thing, in December 2020 the Local Government Association (LGA) reported that eight in 10 councils in the UK had been affected by a climate change incident in the past five years.

Much of this is down to the reduction in natural environments, such as rainforests, which are often referred to as the 'world's lungs'. Trees and plants harness carbon dioxide and other gases so they're not in the atmosphere creating a greenhouse effect. However, increasing industrialisation and habitat destruction mean that green spaces are being destroyed while greenhouse emissions increase.

> "Eight in 10 councils in the UK had been affected by a climate change incident in the past five years"
>
> **Local Government Association**

Understanding the climate emergency

What can the housing sector do?

While it may seem like an insurmountable task, there are steps we can all take to reduce our carbon emissions and the effects of climate change.

This is a challenging task. However, by making a concerted effort to reduce our carbon emissions, we can start to change the situation while also having a positive impact on our communities and the people within them.

According to the Carbon Saving Trust, the majority of residential carbon emissions are generated by heating systems. Their data estimates that the average UK home generated 2,745kg of CO_2 during 2017. This was followed closely by transportation, which generated 2,376kg of CO_2 per household.

To help reduce emissions, many organisations, including the Local Government Association, now offer grants and funding to help local authorities take action on climate change at a grassroots level. The aim is to tackle carbon emissions while improving the resident quality of life, optimising air quality and increasing the availability of affordable, clean energy. In doing so, they improve the wellbeing of their communities and reduce fuel poverty.

Aston Group fully support these initiatives. We're educating and training our teams so they're able to install and manage renewable energy systems, alongside other innovative new technologies, so we can support organisations like the London Borough of Waltham Forest in their efforts to reach net zero. This white paper sets out how we tackled one of their biggest projects, retrofitting a family home in East London.

What is 'net zero'?

According to the Carbon Saving Trust, the phrase 'net zero' means: "Achieving a balance between the carbon emitted into the atmosphere, and the carbon removed from it. This balance – or net-zero – will happen when the amount of carbon we add to the atmosphere is no more than the amount removed."

Sources

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Waltham Forest Council's response to the climate emergency

For more than a decade, the London Borough of Waltham Forest has made climate change a priority. Here we take a look at some of the steps it has already taken to reduce carbon emissions and improve community wellbeing.

Back in 2009, Waltham Forest Council published its first Climate Change Strategy, explaining its ambition to become the 'greenest borough in London'. However, by April 2019, as scientific research reinforced the rapid rate of climate change, the Council had declared a climate emergency and set out its intention to become a net-zero borough by 2030.

In response, it launched the Waltham Forest Climate Emergency Commission. Made up of sector specialists, the Commission has been tasked with finding and implementing innovative ways to achieve net-zero throughout the community.

But while achieving net-zero is essential, the Commission keeps resident comfort and wellbeing in its sights, ensuring efficiency doesn't come at the cost of resident wellbeing.

To ensure the Climate Change Strategy is reflected in the asset management planning a Climate Emergency Core Group was established in 2020.

We have detailed some ways in which Aston Group have worked with Waltham Forest to tackle the climate emergency in the housing sector so far.

Sources

https://www.walthamforest.gov.uk/node/6757

What is fuel poverty?

The UK government defines 'fuel poverty' as follows:

'A household is considered to be fuel poor if:

- they are living in a property with a fuel poverty energy efficiency rating of band D or below,

and

- when they spend the required amount to heat their home, they are left with a residual income below the official poverty line.'

The London Borough of Waltham Forest (LBWF) currently has the third-highest rate of fuel poverty in London. As fuel prices rise, this trend is set to continue, unless action is taken. LBWF are actively looking for ways to address this issue including whole-house retrofits. Retrofits can help to create warmer, more energy-efficient homes for all residents.

External Wall Insulation

Cost: £630,000
Funding: Green Homes Grant

Working with Aston Group, Waltham Forest Council installed external wall insulation at 50 residential properties during 2020/21, resulting in warmer, more fuel-efficient homes. The local authority investigated a wide range of options, ensuring they were both sustainable and fire safe, before settling on 90mm mineral fibre insulation boards, which reduce the amount of heat lost through the exterior envelope of residential properties.

Solar panel and battery storage installation

Cost: £355,000
Funding: Salix/Carbon Offset Fund

Waltham Forest has invested in the installation of more than 1,000 solar PV installations to street properties throughout the community. A recent project saw the local authority partner with Aston Group to install solar PV panels and battery storage at Longfield House, Clifton House and Plaxton Court, sheltered accommodation blocks for over-55s. Within the first 6 weeks, Longfield House had used 41% less power from the grid than usual in communal spaces.

Learn more

If you'd like to know more about the energy efficiency projects we've worked on, simply visit our website.

About 47 Greenleaf Road

In order to demonstrate the improvements that a whole-house retrofit can have upon the energy efficiency of existing housing stock, Waltham Forest Borough Council appointed long-standing partners Aston Group to manage the retrofit of 47 Greenleaf Road, its first-ever eco show home.

47 Greenleaf Road was selected as the ideal property for the project not only because it was unoccupied, but also because it is typical of houses of its age and energy performance.

A report published by Waltham Forest Council in 2019 highlighted that 51% of the borough's carbon emissions were generated by residential properties. Not only that, but the same report also revealed that 14.6% of homes in the area were fuel poor households.[1]

New-build properties with energy-efficient technology are part of the solution to this problem, but it's not feasible to replace Waltham Forest's – or the nation's – current housing stock with new builds.

With 70% of Waltham Forest's 107,216 homes pre-dating 1944[2], it's vital to find a way to reduce carbon emissions from existing homes. This is where whole-house retrofitting comes in.

It is anticipated that the changes set out in this white paper will reduce thermal heat loss from 370W/m^2.K to 150W/m^2.K.

The annual heat demand is also estimated to fall from 17,219kWh to 7,995kWh per year, while the EPC banding will rise to from E to A.

What is a whole-house retrofit?

A retrofit is the process of reducing older buildings' emissions by introducing new materials and modern, fuel-efficient technologies, which help manage energy usage.

47 Greenleaf Road in Waltham Forest was chosen as the ideal location for the borough's pilot project because it is representative of many of Waltham Forest's residential properties. It is a four-bedroom, end-of-terrace Victorian property and its energy inefficiency reflects its age. It was also vacant, making it the ideal choice, allowing Waltham Forest Borough Council to showcase the project to homeowners and landlords.

51% of the borough's carbon emissions were generated by residential properties

Vital statistics

Property: **47 Greenleaf Road, E17**

Age: **1902**

Energy efficiency rating: **E**

Annual heat demand: **17,219kWh**

Bedrooms: **4**

Position: **End of terrace**

Budget for retrofit: **£112,000**

Project start date: **11 January 2021**

Project end date: **23 July 2021**

Working with Aston Group the London Borough of Waltham Forest set the challenge of raising the property's EPC rating from band E to band A, while reducing its carbon usage by approximately 50 tonnes of CO_2 over 30 years, using a wide range of measures throughout the property, from improved thermal insulation, heating and ventilation, to the introduction of solar PV and battery storage.

Over the coming pages, we will explore some of the measures introduced, explaining how they were chosen and implemented, while highlighting some of our learnings along the way.

Sources

1 https://www.walthamforest.gov.uk/node/6757
2 https://www.walthamforest.gov.uk/node/6757

Pictures of the property before work began

Preventing heat loss

Addressing heat loss is a vital first step in any retrofit project. By minimising the amount of heat lost through the fabric of the building, homes become warmer and more efficient almost instantly.

According to Energy Saving Trust, a huge 25% of heat is lost through uninsulated roofs , while TheGreenAge estimates that 35% of heat is lost through uninsulated walls and a further 10% is lost through the floor.

Thankfully, sustainable fire-safe insulation materials can be employed throughout residential properties to reduce these figures and make homes more energy efficient. Not only does it reduce the amount of fossil fuels burned – and greenhouse gases emitted – it also means that fuel bills are reduced, helping to minimise fuel poverty.

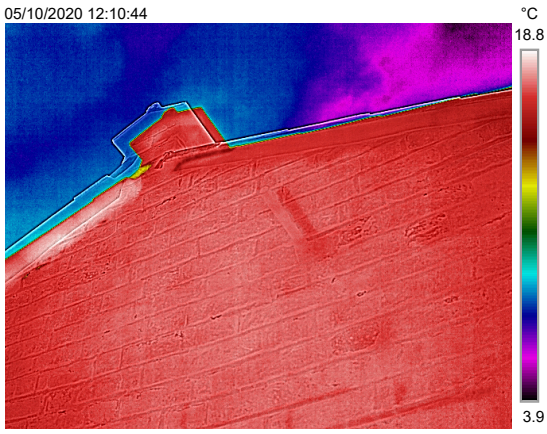
Given 47 Greenleaf Road's EPC rating of E, adding insulation throughout the property was a natural first step towards improving performance and demonstrating the benefits of a retrofit.

External wall insulation

While cavity wall insulation is common in homes built after 1920, older properties like 47 Greenleaf Road typically have a solid wall envelope. There is no cavity to fill with insulation materials, so it was vital to find an alternative.

Thanks to developments in building materials, there is now a wide range of external wall insulation (EWI) options available on the market. Typically, these are cut to shape and attached to the outside of a property before being rendered and painted. Most are designed to last for the life of the property, providing a long-lasting solution to heat loss in period properties.

Although the London Borough of Waltham Forest is focussed on achieving net zero, it has always maintained its commitment to resident safety, which must not be compromised by the retrofit process. As the result of a thorough due diligence process, 90mm Rockwool insulation slabs were chosen for the retrofit. Not only are they 97% recyclable and renewable but they are also non-combustible.



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Distance	3 m
Atmospheric temp.	10 °C
Ext. optics temp.	22 °C
Ext. optics trans.	1
Relative humidity	30 %

Geolocation

Location	N 51° 35' 16.35", W 0° 1' 25.16"

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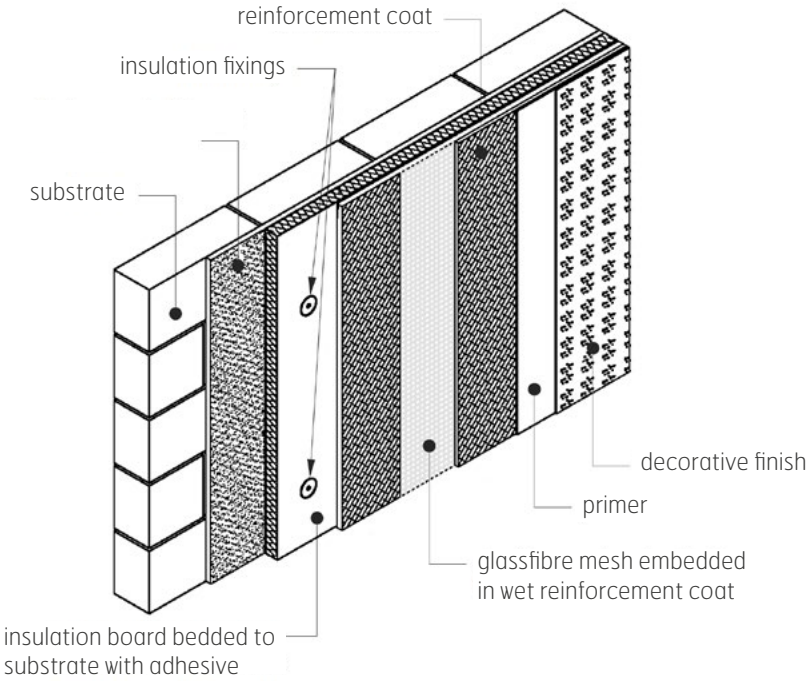
Thermal imaging of heat loss on the outside wall

90mm Rockwool insulation slabs



Once sourced, the Rockwool slabs were cut into shapes that matched the side and rear of the property, before being attached to a new base rail, which was installed at the same height as the internal ground floor.

A render was then applied to the boards, along with a mesh, in order to provide additional tensile strength and ensure the render was crack resistant. A decorative topcoat was then applied to complete the insulating process.

Key learnings

Before the installation of EWI began, the Aston Group team applied for planning permission because it would alter the appearance of the property. Although the installation process was simple, delays caused by Covid 19 meant that the planning application took longer than anticipated.

In addition, the installation team had to be mindful of weather conditions throughout. The Rockwool insulation material must not get damp before it's installed, so we often had to work around the temperamental British weather.

External wall insulation being installed

External wall installation against the existing house

Final render on the external wall insulation

Internal wall insulation

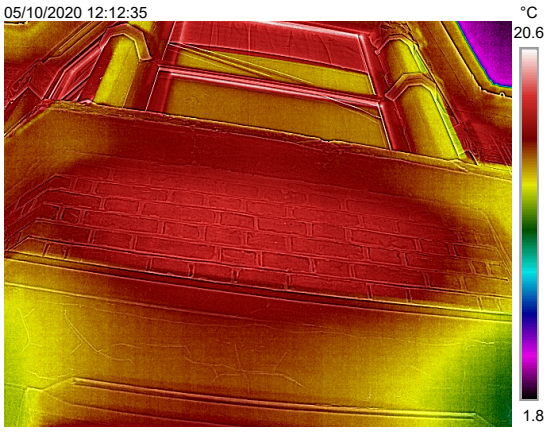
One of the main attractions of a period property like 47 Greenleaf Road is its striking red-brick Victorian facade. Unfortunately, adding EWI to the front of the property would mean hiding the appearance, making this an unattractive option for the Council.

The solution was internal wall insulation (IWI), which was installed at the front of the property. Working in conjunction with the council, we selected a 60mm insulated plasterboard, featuring a 12mm layer of Celotex on one side. Designed to have a low profile, this option was chosen because it does not encroach upon the rooms and is a low fire risk.

It was applied to the interior walls with a 'dot and dab' wet adhesive before it was levelled out and covered with plaster for a smooth finish, which could be decorated with paint or wallpaper.

Key learnings

Internal wall insulation is widely available and there are new products coming onto the market all the time. For instance, Matilda's Planet is a new product designed specifically for the retrofit process. It can be quickly and simply slotted together at the property with minimal impact on the resident, while energy bills may be reduced by as much as 30-50%.



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Ext. optics trans.	1
Relative humidity	30 %

Geolocation

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Thermal imaging of heat loss at the front of the building

Installation of the internal wall insulation

Loft insulation

Loft insulation is a simple but efficient means of reducing heat loss through the roof of a property.

Although the property did have some insulation in place, after measuring the thickness, we increased the amount to ensure the material reached 270mm, in line with current building regulations.

Key learnings

Victorian – and older – properties are renowned for being inefficient because they were built before modern building techniques and materials were available. Sealing the property envelope with insulation helps to stop draughts and heat loss, providing a solid foundation for other energy-saving measures. It is vital to address these issues before other action is taken.

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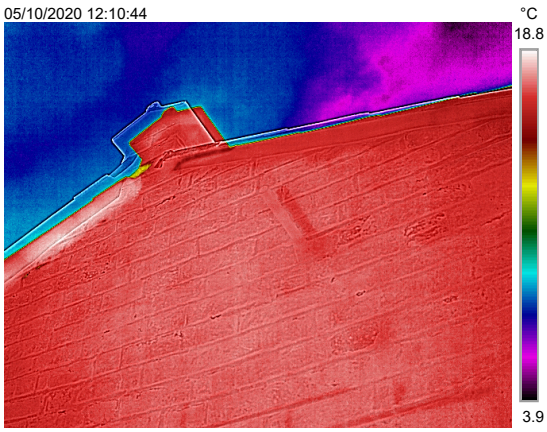

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Ext. optics trans.	1
Relative humidity	30 %

Geolocation

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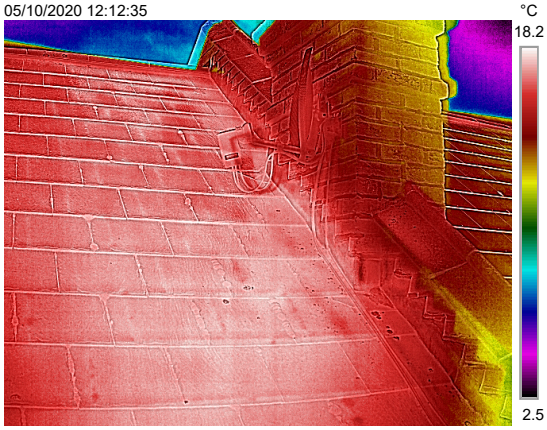

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Relative humidity	30 %

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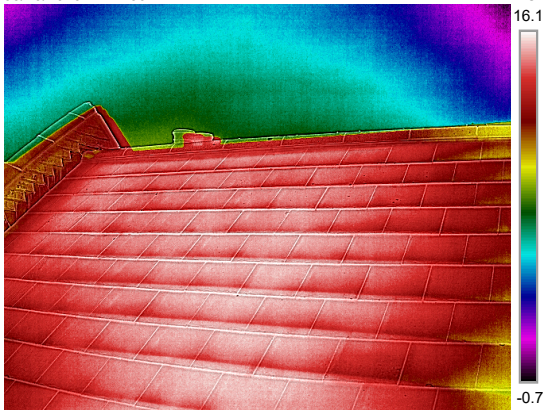

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Ext. optics trans.	1
Relative humidity	30 %

Geolocation

Location	N 51° 35' 16.33", W 0° 1' 24.94"

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Thermal imaging of heat loss through the roof

Underfloor insulation

While wall and loft insulation are commonplace insulation techniques, underfloor insulation is considered a difficult procedure and is often disregarded. Thanks to modern technology, however, it's easier than ever before.

Approximately 10% of heat is lost through suspended timber floors. While you could replace the floorboards with concrete, you'd lose the warm, welcoming aesthetic and potentially prevent the property from breathing. Underfloor insulation is therefore a preferable alternative and it no longer has to be a difficult process.

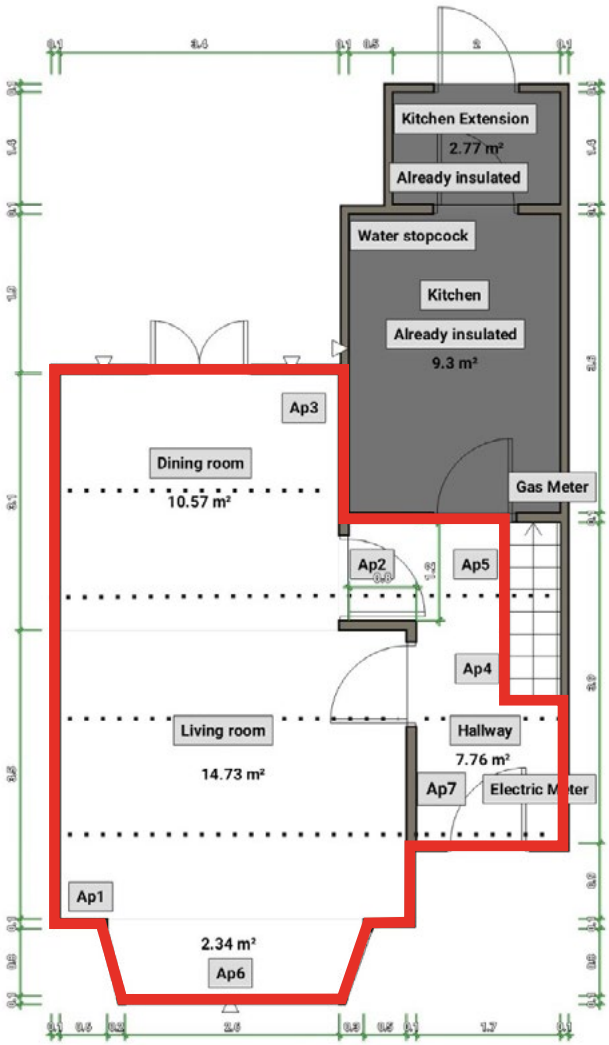
What is Q-Bot?

Q-Bot is an innovative robotic device designed to install underfloor insulation materials without disrupting the existing floor structure. It sprays expanding polyurethane foam on the underside of floorboards sealing any gaps and reducing draughts. In fact, Q-Bot can reduce the average homeowner's heating bills by 16%, or £150 a year. It's so effective that Q-Bot is the only insulation company verified by the Energy Savings Trust.

And while you may assume you'd have to take the whole floor up, only a small section of the flooring is affected. Most of the carpet and furniture can stay in place, which is ideal if a property is occupied.

It's important to note that, although the insulation is a form of plastic, it can last for between 30 and 80 years and any carbon emissions used in the manufacturing process are offset by resident energy savings. Plus, it has been shown to protect timbers by preventing water from destroying the joists' cell structure.

Area being insulated at 47 Greenleaf - 35.4m^2



Plan of ground floor area that will be insulated

Floor heat loss U-value 0.75W/m2K

How does it work?

Before the insulation was added, Q-Bot's specialist team surveyed 47 Greenleaf Road, sending its state-of-the-art MK7 robot beneath the floorboards to investigate whether there was space for the robot to move around without affecting pipework or cabling.

Once viability was confirmed, a small hatch was opened in the floor, so the robot could be lowered beneath the boards. Controlled at ground level by a member of the Q-Bot team with a console and monitor, the robot was used to create a 3D map of the space, identifying pipework, cables and ventilation points. Once mapped, the robot could spray on the foam.

A small air space was left between the foam and the floor to allow air circulation, in order to prevent mould and mildew, in line with building regulations.

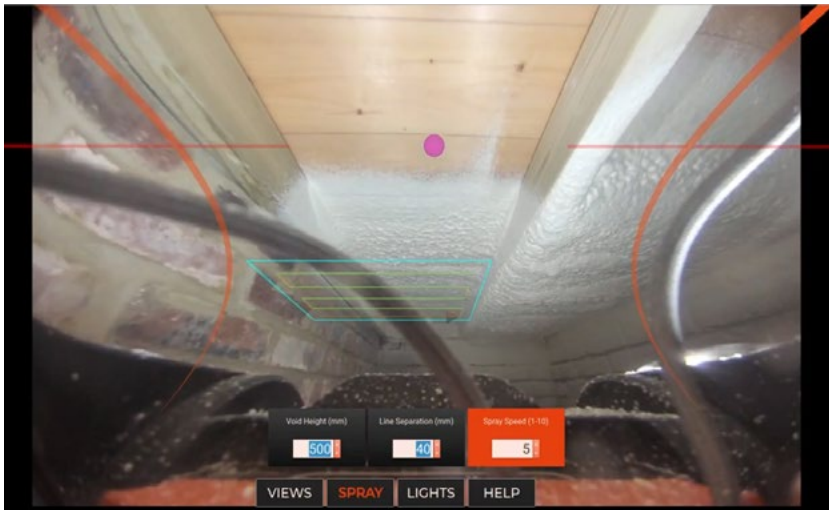
The whole process took a matter of days and was air-tested after completion to ensure the floorboards were properly sealed and insulated.

Sources

https://q-bot.co

https://q-bot.co/news/q-bot-only-insulation-company-be-verified-est-save-ps195-gas-heated-home

Robot being controlled to spray insulation foam under suspended floor



Smart air bricks

Air bricks are essential to ensuring a flow of fresh air beneath the floorboards, preventing the build-up of damp, which can be hazardous to resident health.

Modern technology has brought these devices into the 21st century, enabling them to open and close based on weather conditions. This can aid a property's energy efficiency, trapping warm air beneath the floor, providing additional insulation.

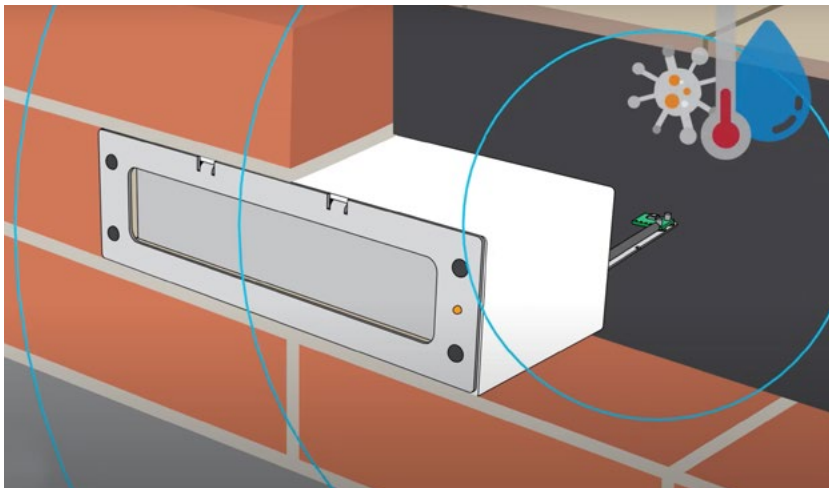
We installed AirEx smart air bricks as part of the whole-house retrofit. These internet-connected, battery-powered devices replace static air bricks, using sensors to measure temperature, humidity and air quality. Smart algorithms enable automatic airflow regulation while taking into account local weather and air quality data. They open to reduce underfloor humidity, and close to reduce heat loss and improve comfort, all without compromising on air quality in the home.

With low maintenance operation, they're ideal for rental properties. The batteries cleverly sit behind the air brick and can be replaced when they lose charge (typically after two years). The air vent just needs to be gently removed from its slot in the wall and the battery replaced.

Key learnings

The installation of underfloor insulation can be rapid and effective and works alongside other energy-efficient technologies, such as air bricks to keep homes warm, healthy and efficient.

Image credit: www.airex.tech



Smart air bricks located at the property

10% heat lost through windows and doors

Windows and doors

Adding new windows and doors can improve the performance of many properties, resulting in reduced energy consumption and fuel bills. Here we take a look at the modern solutions installed at 47 Greenleaf Road.

Having increased the insulation of the walls, under the floors and in the loft, the next consideration was the glazing. With approximately 10% of heat lost through windows and doors[1], the retrofit team carefully considered the options to reduce that figure and maximise the impact of insulation on energy efficiency.

Low-e glass

According to the Energy Saving Trust, installing A++ rated double-glazed windows can save the average semi-detached property £95 per year on heating bills and around 405kg of carbon dioxide[2].

Given those figures, Waltham Forest made the decision to update the low maintenance uPVC double-glazing at 47 Greenleaf Road, rather than adding secondary glazing. The existing frames were kept in place, but the glass was replaced to minimise waste and expense.

The new glass had an innovative low-e coating on the glass to increase its insulation qualities. This sits within the double-glazed unit, allows light and thermal radiation to enter the house, but doesn't allow it to leave, trapping heat within the property.

Sources

1 https://www.thegreenage.co.uk/where-am-i-losing-heat-home/

2 https://energysavingtrust.org.uk/advice/windows-and-doors/

Replacement glass units

- 4mm clear toughened glass externally
- Argon gas-filled sealed units with 16mm white warm edge spacer bars
- 4mm clear 1.0 toughened glass
- Centre pane U-value is 1.0W/m2K

New external doors

With an older a property, draughts around doors and windows are inevitable. As the property shifts and settles, frames move out of alignment. While it adds to the character, it unfortunately allows heat to escape.

As a Victorian property, 47 Greenleaf Road was no different. As a result, a new uPVC door was installed at the same time as the windows. The new door has better thermal properties than its wooden predecessor, allowing less heat to pass through. This new door also fits the frame better, reducing draughts and heat loss through gaps around the seal.

The replacement glazing took two days to install and makes the house much more efficient.

Other considerations

By insulating the property, there is an increased risk of condensation and damp because moisture cannot escape, which can pose a health risk to residents. As a result, a mechanical ventilation heat recovery system was installed as part of the retrofit to remove moisture and improve the circulation of fresh air. Turn to page 24 to find out more.

Switched on

While switching off our appliances is a quick fix when it comes to saving energy and money, there is now a vast array of rapidly developing technologies available on the market, which can be used to save – and create – electricity.

Photovoltaic solar panels

Having previously worked with the London Borough of Waltham Forest to install photovoltaic (PV) solar panels at three sheltered accommodation blocks, Aston Group also project managed the installation of a PV array at 47 Greenleaf Road, allowing the property to generate its own electricity from solar energy.

The south-facing system was made up of 12 monocrystalline panels, each with solar edge optimisers. The all-black panels are more aesthetically pleasing than other types, while also delivering greater efficiency than standard blue polycrystalline panels. Each one is capable of delivering 325 watts of power. Combined, the system has a total size of 3.9 kW, which is enough to fully charge a Nissan Leaf 100 times per year. It also reduces annual household carbon dioxide emissions by approximately 853kg.[1]

The solar edge optimisers were added to the system to ensure maximum panel efficiency. Without them, the system would cease to function if one of the panels was in shade. Although the optimisers are an added expense, it ensures property can continue to generate renewable energy if the panels are partially obscured.

The inclusion of a battery allows power to be stored for overnight use – any excess is then sold back to the grid. The size of the battery required careful consideration by the team. If it was either too large or too small, the battery lifecycle could be drastically reduced. As a result, an Alpha Smile-B3 AC coupled system was installed with 11.6kWh of battery storage (4 x 2.9kWh batteries) and housed within a specially built cupboard with a SolarEdge SE3680H inverter, fitted with optimisers behind each panel. The battery is located on the ground floor, it features ventilation and a smoke alarm, to ensure both accessibility and fire safety.

Installation of 12 photovoltaic solar panels

Array 1
10 x 325W JA Modules 3.25KW
Pitch 29 degrees
Orientation -45 degrees (West)

Array 2
2 x 325W JA Modules 0.65KW
Pitch 29 degrees
Orientation 45 degrees (East)

LED lighting

Energy Saving Trust estimates that the average home could save £40 per year by switching to energy-efficient LED lamps.[2] These lamps convert energy to light more efficiently than incandescent or halogen bulbs, with little lost as heat. Plus, they also last a lot longer so they need to be replaced less frequently.[3]

At 47 Greenleaf Road, the team opted to add a state-of-the-art Philips Hue smart lighting system as part of the retrofit project. Not only does it save energy, but lighting levels and colours can be adjusted from a smartphone or set to a schedule, so they can come on at specific times of day or night. It can even be set to turn on and off depending on whether the residents are home or not – and there's no waiting around for the filament to warm up.

The installation process was simple too. We replaced the existing light bulbs with Philips Hue lights throughout the property. Pendants were installed in the bedrooms, spotlights in the hallway and landing and modern strip lighting was added in the kitchen. We also added external lights at the front and rear of the property for security.

A Hue Bridge device, which attaches to the wifi router, was then plugged in so that residents can simply control the entire system through their smart devices.

Smart power sockets

Although smart sockets have been available for a number of years, uptake has been relatively slow. And while their primary function is to convert simple devices into smart devices, they can actually help to reduce energy usage almost immediately.

By simply installing these smart sockets occupants can turn devices on and off and monitor energy usage from anywhere in the world. It means they can turn off energy-hungry appliances even when they're out. Timers and automated sequences can also be created depending on resident needs and habits.

As a result, the London Borough of Waltham Forest made the decision to install Lightwave smart sockets as part of the retrofit project when rewiring the property. Designed specifically for existing systems, the brushed chrome flatplates are manufactured to sit neatly over the top of existing backboxes for easy installation.

Sources

1 Based on UK Government carbon factor of 0.23112kGs CO_2 e per kWh consumed - 2021

2 https://energysavingtrust.org.uk/getting-best-out-your-led-lighting/

3 https://www.lightsupplier.co.uk/how-often-led-replacement-bulbs/

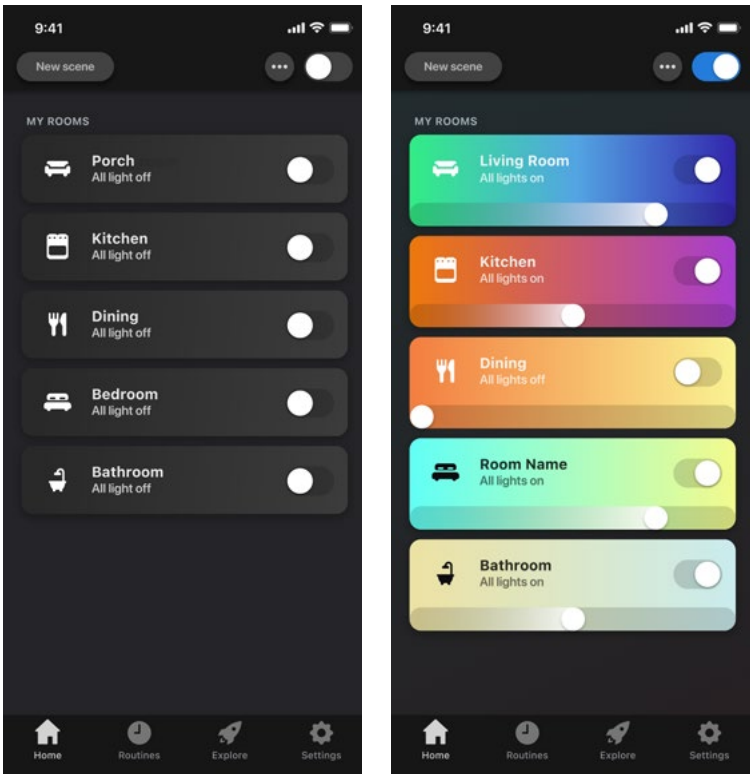
Smart Series products incorporate Apple HomeKit compatibility, 2-way communication, built-in energy monitoring (sockets) and more. The socket is quick and easy to DIY install and does not require extra cabling.

As with the Philips Hue, a central Smart Plus control hub was added to the system, which allows the sockets to be controlled via a smartphone app, or by voice, when paired with an Alexa, Google Home or Apple HomeKit device.

Of course, to ensure accessibility, the devices can be manually operated in the same way as a standard electrical socket.

Timescale

In total, it took 15 days to install the PV solar panels batteries, LED lighting and smart sockets at 47 Greenleaf Road. Working with a specialist partner for the solar panel installation ensured a smooth process and a professional finish.



Smart phone app that helps control the lighting in each room

Alpha battery storage in position

Sustainable heating

Keeping a house warm and cosy during the cold winter months is something many of us take for granted, but not only are most properties dependent on fossil fuels, many people also have concerns about affordability.

Keen to address both challenges, the retrofit project team sought to introduce innovative solutions that would reduce the property's reliance on high carbon gas central heating and reduce the cost of keeping inhabitants warm.

Air source heat pump

At the outset of the retrofit project, the London Borough of Waltham Forest emphasised its desire to install an air source heat pump at 47 Greenleaf Road. Although heat pump technology has existed since the nineteenth century, it hasn't been commercially viable until relatively recently, which means that public awareness remains low.

And while it is a complex system to explain, in simple terms, it's the opposite of a domestic freezer. The unit sits outside the property and harnesses heat from the outside air and pumps that into the central heating system to keep the property warm. It even works at temperatures as low as -15°.

The unit uses a small amount of electricity to power the system, which is typically sourced from the grid. However, at 47 Greenleaf Road, this is supplied by solar PV panels and battery storage (see page 18) so the system is entirely sustainable.

The system

Working alongside our project designer, we selected the Vaillant aroTHERM Plus air-to-water system. Not only is it designed to be highly efficient, but it is also versatile and can be used alongside radiators and underfloor heating systems.

Installing a Vaillant aroTherm heat pump

Powering both the heating and the hot water supply, the Vaillant system has an energy efficiency rating of A+++ and is filled with an environmentally friendly R290 refrigerant, which has a particularly low global warming potential. The gases are securely sealed away by the manufacturer, which meant that Aston Group gas engineers could safely install the system without additional training.

Although the initial cost of the system is large, compared to a traditional gas boiler/central heating installation, the energy savings will result in the costs being recovered over time. Plus there's very little maintenance involved and there are no annual gas safety inspections required. Not only that, but the system has an expected life span between 20-25 years, which makes it the ideal choice for private rentals and the social housing sector.

Key challenges

As with any project, there were some obstacles that needed to be addressed before the unit could be installed.

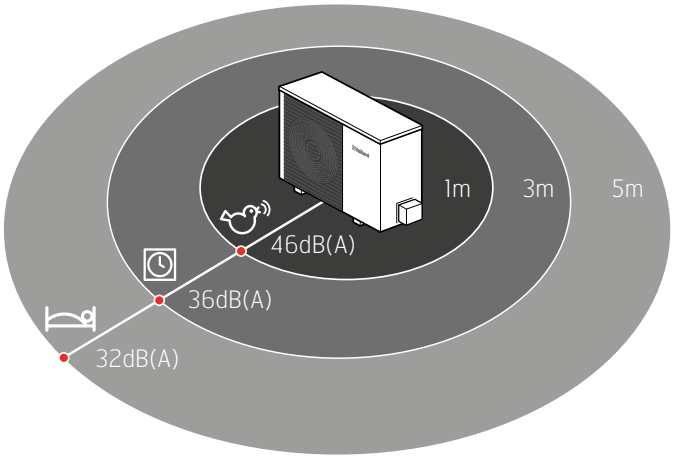
Location

In order to ensure smooth functioning and to comply with planning permission, the system had to be located 1m from the boundary, rainwater gulleys, window openings and electrical points. In addition, because the unit expels cold air, the unit had to be situated away from outdoor seating areas, so future residents wouldn't be subjected to icy blasts while enjoying their garden – although we hope the heating won't be used too often during the summer months.

Noise

In accordance with government guidance on liveable noise and disturbance, we installed one of the quietest air source heat pumps on the market. The Vaillant model has a Quiet Mark certification and operates at 54dB. However, the noise level reduces down to 32dB when 5m away from the unit, a figure that declines the further you are away. Careful positioning ensured that the impact on the neighbours was minimal, while the positioning of fences also helped to soften the noise impact.

Heat pump in position



Installation
Although air source heat pumps are installed in a similar fashion to a traditional gas central heating system, new radiators were required throughout the property in order to optimise the effect of the heating. The Vaillant system typically runs at 45°C, rather than 75°C, so larger radiators are required to heat the rooms because these have a greater surface area.

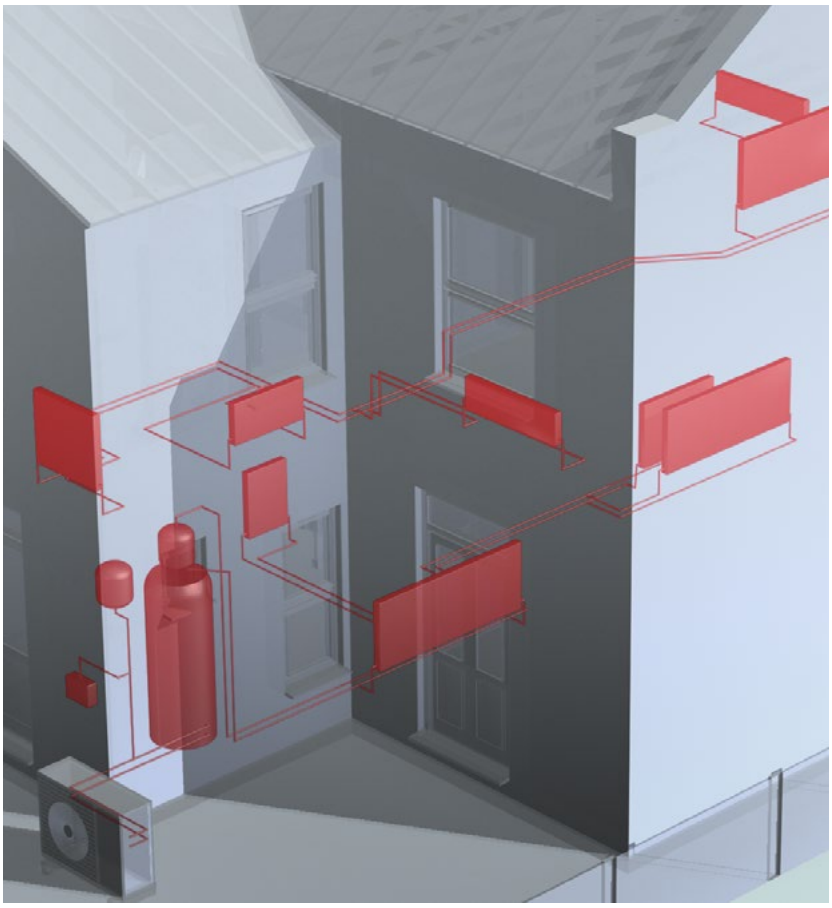
While it's an unlikely scenario, a glycol solution was also added to the system to reduce the risk of freezing during exceptionally cold weather.

Operation
To ensure maximum efficiency, air source heat pumps tend to run on a trickle system, which means they are always on.

Keen to keep the system as simple as possible for future tenants, however, we set the base temperature to a comfortable 21°C during the day and 18°C overnight. The Vaillant controls use sensors to monitor internal and external temperatures in order to maintain the levels set.

Occupants can increase the temperature if they need to, but it drops back down after three hours, ensuring that the temperature doesn't run high all the time.

It's important to note that, as with some central heating systems, the heating and hot water cannot run at the same time – hot water takes priority. The system installed has a 300l water tank to serve the four-bedroom property – rather than an average 120-150 litre tank – but it typically reheats in a short period of time so the heating is never off for very long.



Arrangement of ASHP, cylinder and radiators

Heat recovery

In order to maximise the benefits of the whole house retrofit project, two heat recovery systems were installed at 47 Greenleaf Road, allowing energy to be recycled and reused.

While sealing the property envelope and improving the heating system is ideal for energy efficiency, it's vital that moisture is able to escape from the house, so future occupants can enjoy living in a clean, dry atmosphere.

Thanks to modern technology, this is now a possibility. Two new heat recovery systems were added to make sure the house is both efficient and practical.

Mechanical Ventilation Heat Recovery system

Also known as an MVHR, this clever system single-handedly reduces energy bills while increasing the flow of fresh air through the house.

Installed in so-called 'wet areas', such as kitchens and bathrooms, an MVHR recovers heat from water vapour and uses it to keep the property warm. The heat from the extracted stale air is drawn through an air-to-air heat exchanger located within the heat recovery ventilation unit and is used to warm incoming fresh, filtered air for living rooms and bedrooms. In some cases around 96% of the heat generated can be retained.

The Titon continuous MVHR system does this by monitoring inside and outside temperatures and humidity levels before adjusting air circulation speed. It also offers a summer bypass facility, which allows heat to automatically exit the property during the summer without passing through the heat exchanger.

The whole system is fully automated, so residents don't have to do anything, which is ideal in a social housing or rental setting. In fact, it's so efficient that residents don't even need to open windows to access fresh air, while the landlord or homeowner only needs to change the filter once a year.

Installing a Titon 1.6 mechanical ventilation heat recovery unit

Key challenges

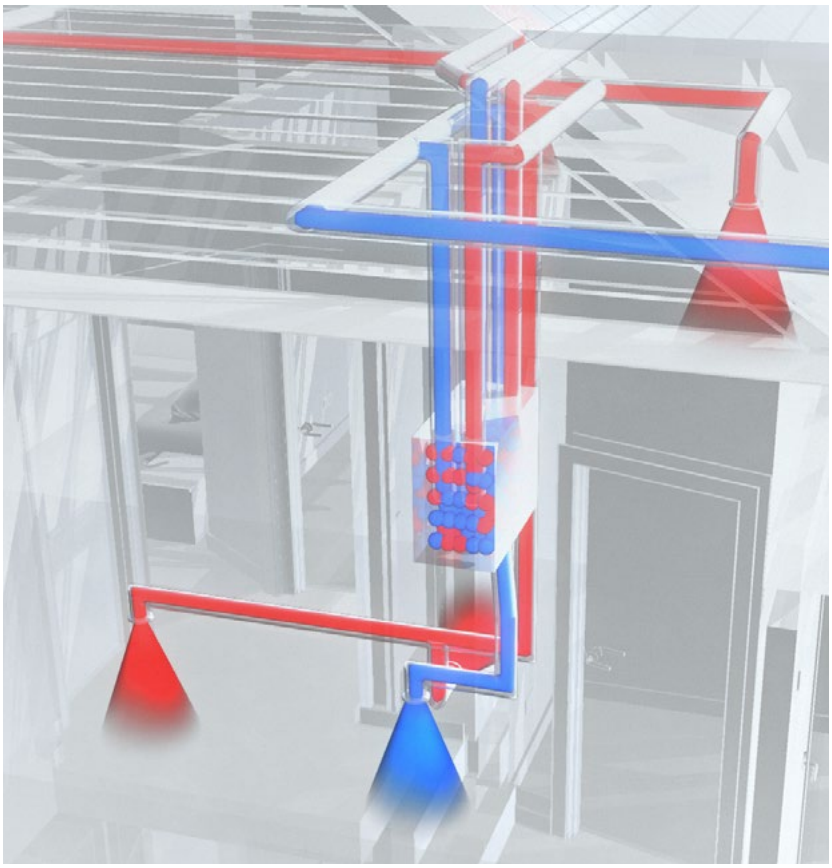
There were some initial challenges with the installation of the MVHR system, which were mainly related to the fitting of the duct system.

While the London Borough of Waltham Forest wanted to ensure that the property was energy efficient, it was important to demonstrate that this could be achieved without compromising on the aesthetics of the space.

As a result, the ducts were hidden wherever possible. They were either run between the ceiling and the first floor or in the loft, with discreet vents added to living spaces, allowing for the exchange of air.

The Titon MVHR system we selected uses a 125mm duct system, while the existing extractor fans used 100mm ducting pipes to channel air outside. Larger ducting was therefore added to reduce airflow restrictions.

Installation of ductwork



Layout of ductwork

Waste water heat recovery

According to ZYPHO, a four-person household using an electric shower system can easily spend £400 on showering per year, which is a considerable sum of money for most households. In order to minimise this bill, we installed a new wastewater heat recovery system.

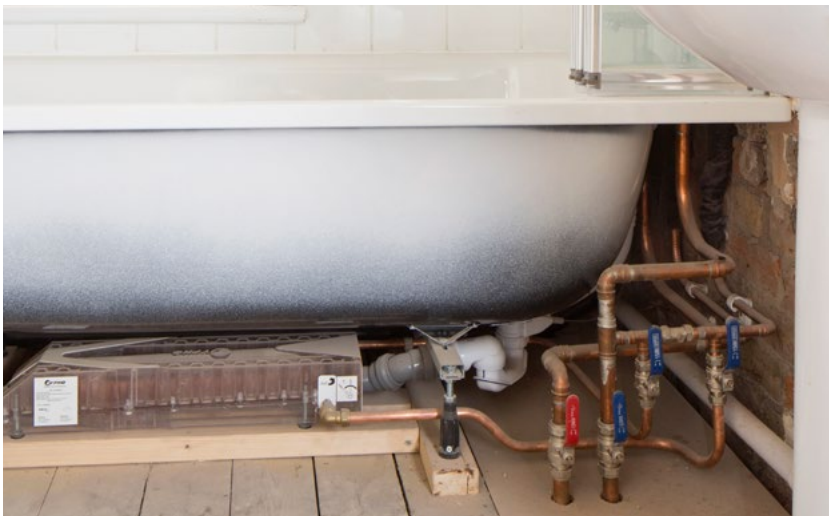
As with the air source heat pump, there are numerous options available, but many people are unaware of their existence – in spite of the impact they may have on fuel bills. They're usually easy to install, with a small system added to the waste pipe under the bath, which takes the warm water and uses it to heat incoming cold water.

There are both vertical and horizontal options available too, which means that they can be installed in a range of properties and are typically hidden, so the occupant never knows it's there.

ZYPHO explains that it can improve shower efficiency by 30 – 65% (dependent on the model)[1] and may even improve EPC bandings, so it was natural that we added one to 47 Greenleaf Road.

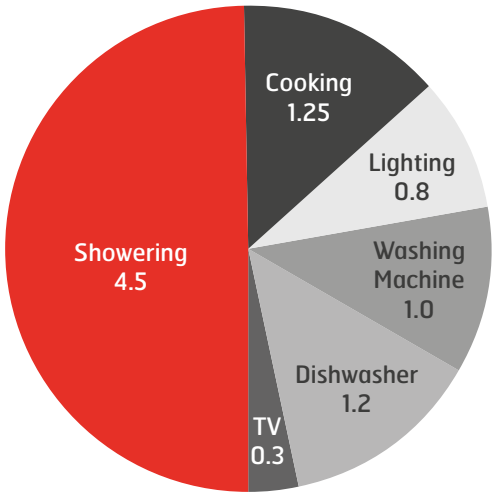
Sources

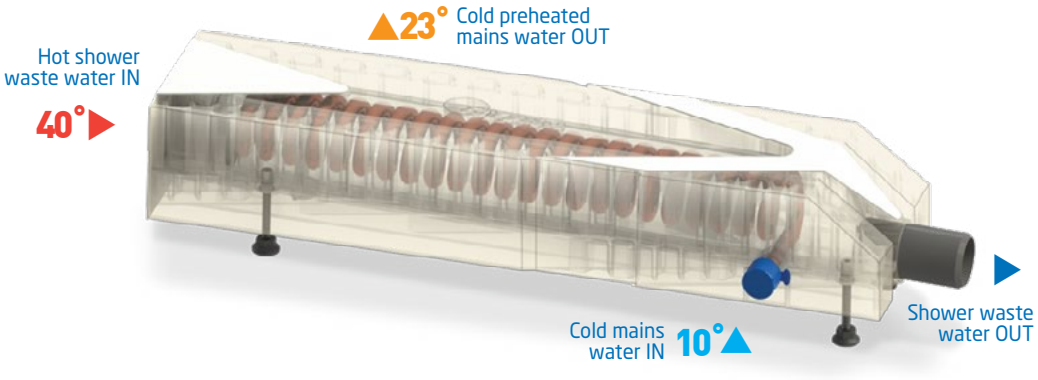
1 https://zypho.uk



Zypho bath tub system being installed

Typical use in UK household (kWh)





Sustainable planting

Although the primary priority for the whole-house retrofit project was the indoor space, we couldn't overlook the opportunity to create a sustainable, enjoyable outdoor area.

Although 47 Greenleaf Road is located in East London, it is blessed with both a front (5.5m x 2.8m) and rear garden (8.5m x 13.0m). In order to create an inviting family-friendly space, we worked to design a new garden that residents will enjoy for years to come.

The new plans focus on introducing new flowers and plants in order to create a healthy habitat for local wildlife. Broken down into several distinct spaces, the wildflower meadow and wildlife area at the bottom of the garden will attract pollinators and animals to the garden.

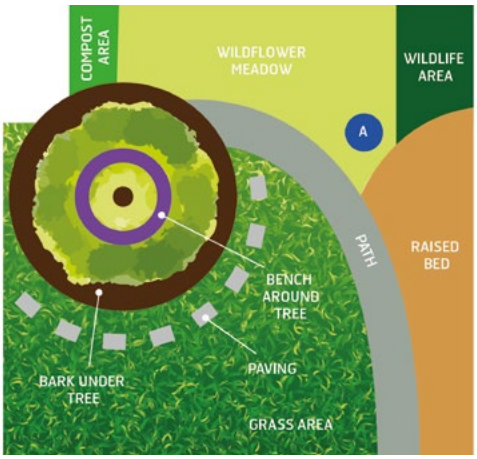
The addition of a small compost area also means that the garden waste can break down and be reused, rather than being bagged up and sent to landfill.

A new water butt has been installed on the patio too, so residents aren't dependent on tap water to water their plants.

We have introduced, buddleja, hebe, thyme, eucalyptus, and lavender and many more varieties of plants. Not only are they attractive, but they also act as pollution barriers in urban areas absorbing CO_2 while also encouraging biodiversity. We have also constructed a bug hotel from recycled materials.

Overall, the garden is low maintenance, so it's easy for future tenants to manage and enjoy and we look forward to seeing it flourish in future!

The back garden before landscaping and planting



Garden design

Garden being planted

Bug hotel

Energy efficiency results

Comparisons and analysis have been undertaken in order to compare the thermal performances between the original building and the design performance (calculated using the government approved SAP methodology). A regime of testing was also undertaken in order to validate the improvements.

Having set clear goals at the outset of the retrofit project, it was important to demonstrate the effectiveness of the measures implemented at 47 Greenleaf Road. Here are some of the top line results.

Thermal upgrades

Wall insulation

External wall insulation (EWI) was installed to the side and rear elevations of the property, using a 90mm EPS slab with a top-coat of render. EWI was not feasible on the street elevation in order to avoid loss of character to the property, therefore, Internal wall insulation (IWI) was installed to this façade using a 57.5mm insulated plasterboard.

Roof insulation

The roof was upgraded to 270mm of mineral wool insulation (between and above joists). This as expected to reduce heat loss through the roof by 50%.

Underfloor insulation

Floor insulation was installed to the main suspended floor via the Q-bot insulation system. Details can be found in the separate Q-bot impact report, however, was expected to reduce heat loss through the floor by up to 74%.

No insulation could be installed to the solid floor in the kitchen area.

Glazing

New high-performance double glazing was installed into the existing window frames.

Service upgrades

Mechanical ventilation

In order to further reduce heat loss and improve internal indoor air quality, a mechanical ventilation system with heat recovery was installed to provide fresh air throughout the dwelling.

Heating system replacement

The existing gas boiler has been replaced with an air-source heat pump, and associated hot water cylinder. This was predicted have a dramatic impact on the buildings carbon emissions, especially as the carbon intensity of the national grid is decreased with the uptake of renewable generation.

Photovoltaic array

A 3.9 kWp solar photovoltaic array has been installed, with associated battery storage. This should be capable of producing approximately 2,850 kWh of electricity per year, and the battery storage system shall maximise the amount of this energy that can be used by the occupant.

Waste water heat recovery system

A heat recovery system has been fitted beneath the bath, in order to recover a percentage of the heat lost down the drain, and recover this to the hot water system.

The original building reported an **EPC E**, after works, the building has achieved an **EPC A**

SAP performance comparison

The following figures include all energy required for heating, hot water, lighting, ventilation, pumps and fans, and are calculated using the SAP standardised assumptions for operation, heating set points and occupancy, based on the size and type of the dwelling. Whilst real-life operation of a dwelling is down to the resident and impossible to predict, the SAP methodology allows a consistent approach to be used in order to allow direct comparison of performance.

The original building reported an EPC rating of 'E'. Whereas, post refurbishment, an A rating has been achieved.

Costs have been calculated based on a fixed price of £0.05 per kWh for gas, and £0.19 per kWh for electricity (slightly higher than average to allow for inclusion of standing charges).

The impact of the photovoltaic array and battery storage system has been accounted for in the emissions and cost columns, by assuming that 80% of the generated energy shall be used by the occupant.

No additional allowance has been given for the remaining 20%. However, this could be sold back to the grid under the Smart Export Guarantee (SEG), lowering costs further.

Using the BEIS Fuel Carbon Factor predictions, projected carbon emission from the building have been calculated, at key points to 2035.

The table below detail the projected carbon emissions of the refurbished building, and the original building, had no upgrade been installed.

Carbon emissions and running costs

The UK electricity grid has been decarbonising at a rapid pace since 2005, and electrification is now seen as a greener alternative to gas fired systems for heating of buildings.

For reference, the carbon intensity figure used within the SAP calculation is 0.519 kg/kWh, where in reality, the current grid carbon intensity factor is closer to 0.2 kg/kWh.

The below chart details the projected carbon emissions for the design and tested performance, and also the design, tested, and pre-refurbishment performance. The energy use, cost and carbon figures were generated by feeding the tested performance back into the SAP software, and recalculating the energy figures.

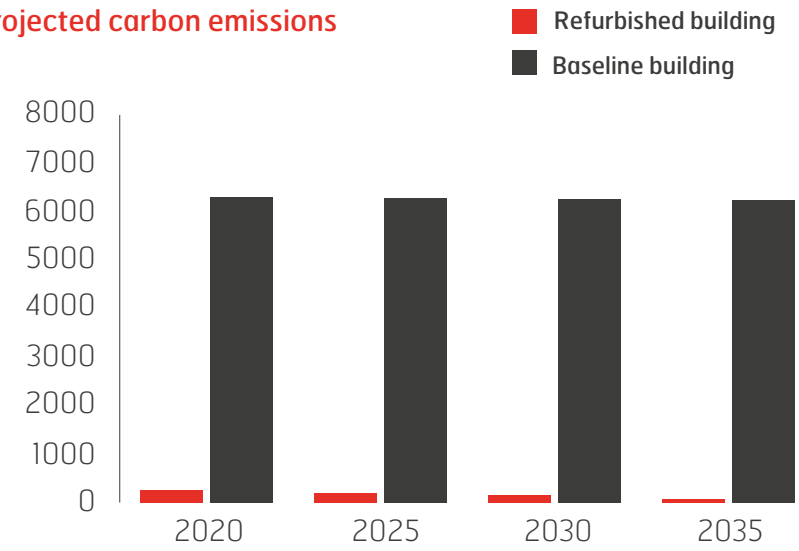
	Annual energy use (kWh/year)	Annual CO_2 emissions (kg/year)	Annual running costs (£/year)
Original building	29,471	6,596	£1,580
Refurbished building	4,654	945	£435
Improvement	**84%**	**86%**	**72%**
Tested performance	5,257	1,258	£568
Adjusted improvement	**82%**	**81%**	**64%**

As can be clearly seen from the chart and table, projected carbon emissions, when adjusted to BEIS predictions have been improved dramatically with the works undertaken.

The table below details the projected carbon emissions of the refurbished building, and the original building, had no upgrade been installed.

In addition, as fossil fuel has been removed from the property, it is also feasible to offset all remaining emissions through the adoption of a renewable electricity tariff.

Projected carbon emissions



Real CO_2 emissions by year (BEIS Predictions)	2020	2025	2030	2035
Refurbished building	262.39	196.79	154.88	74.71
Baseline building	6,310.84	6,283.39	6,265.84	6,232.29

82% improved energy use
81% reduction in CO_2 emissions
64% improved running costs

Funding

The total budget for the project was **£115,245.43**

This was made up of:
Carbon Offset Funding: £56,794.67
ECO3: £2,308.00
Housing Capital: £56,229.06
Landscaping: £10,000

Costs and savings

Although the London Borough of Waltham Forest is committed to achieving net-zero by 2030, funding and budgets play an important role in prioritising the opportunities available. Here, we explore the cost implications of the whole house retrofit at 47 Greenleaf Road

By providing a breakdown of the costs associated with the whole-house retrofit – and the estimated household savings – you should get a clear indication of the funding levels required, as well as the measures that delivered the greatest return on investment.

It's important to note that many of these options are long-term investments, although many may become mandatory for new dwellings when the Government's Future Home Standard comes into effect in 2025.

Air source heat pump (ASHP)

The Vaillant air source heat pump was added as part of the retrofit for several reasons, not least because it is more environmentally friendly than a gas boiler. It doesn't rely on carbon heavy fossil fuels and also saves the resident money.

In addition, the government is planning to ban the installation gas boilers from 2025. Hydrogen heating isn't a viable alternative yet, so an air source heat pump was the best option for this project.

Based on the SAP score, the resident would save around **£860 per year and a carbon emission reduction of about 4240kg per year**.

Underfloor insulation

The Q-Bot results shows a 74% reduction in heat loss through the floor. The U-value of the floor now complies with the Part L1B requirement for upgrading retained thermal elements in existing dwellings of <= 0.25 W/m2K. It is estimated that this equates to a **5% saving on household energy bills and a 5% (287kg) reduction in carbon emissions. This has also achieved a two point EPC improvement.**

Solid wall insulation

The resident should expect to see fuel bill savings of around **£341 per year and a carbon emission reduction of around 890kg per year**.

Loft insulation

The resident should expect to see fuel bill savings of around **£120 per year and a carbon emission reduction of around 580kg per year.**

Figures are based on Energy Saving Trust data and fuel prices as of June 2021.

Solar PV and battery

Assuming the resident uses all of the electricity generated, they could save around **£609 per year (based on a unit cost of £0.165 per kWh)**

Solar PV array capable of **generating approximately 3,692kWh per year**

The CO_2 saving amount to **853kgs per year** (this is based on the latest UK Government carbon factor of 0.23112kGs CO_2e per kWh consumed).

	Cost (£)	Cost savings (per year)	CO_2 savings (per year)
ASHP and radiator system	£10,200	£860	4240kg
Solar PV and battery storage	£14,015	£609	853kg
Underfloor insulation	£2,140	£67	287kg
Solid wall insulation	£13,987	£341	890kg
Loft insulation	£960	£120	580kg

Remember: If you or your organisation is considering investing in carbon-efficient technologies, there may be grants available from not-for-profit organisations or central government.

In conclusion

The retrofit project has been successful, with the property achieving an EPC band A as a result of the measures undertaken. The potential reduction in carbon emissions also demonstrate that it is possible for existing housing stock to be upgraded in line with the demands of modern living.

By reducing reliance on fossil fuels, the retrofit project means that future residents are less likely to experience fuel poverty, resulting in a better quality of life.

If you would like anymore information about the project – or to arrange a visit – please contact: **Aston Group on 0208 017 2234**.

Contact details

Aston Group

Building Services and Facilities Management

Head Office: Moss Lane, Romford, Essex, RM1 2PT

0208 017 2234

mail@astongroup.co.uk

astongroup.co.uk

The property completed and ready to rent

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