Piloting the Future Homes Standard

Peasecroft, Cottered, Hertfordshire

April 2024

LATIMER
by Clarion Housing Group

PILOTING FUTURE HOMES STANDARD

PROJECT OVERVIEW

Located in Cottered near Buntingford in East Herts, Peasecroft saw the demolition of four bungalows which had reached the end of their component life requiring significant re-investment, were no longer fit for purpose and not compliant with nationally described space standards. In its place we have developed seven new homes.

Following the release of the **Future Homes Standard** consultation in 2020, the Peasecroft development site provided Clarion with an opportunity to pilot the standard. Capital and operational expenditure data will be collected and analysed, along with post occupancy evaluation over a 12 month period, to inform the standard and construction of our future development programme.

The development sees the construction of five 3-bedroom terraced houses and two 2-bedroom semi-detached bungalows.

The houses have been designed with a fabric first approach with direct electric solutions (electric heaters and infrared panels) and the bungalows have adopted a technology led approach with air source heat pumps.

The Future Homes Standard will require new homes to reduce carbon emissions by at least 75% through low-carbon heating systems and fabric standards.

Richard Cook, group development director at Clarion, said:

" This landmark affordable housing project demonstrates our commitment to innovating and working ahead of the curve. Not only will the seven new homes at Cottered provide warmer and cheaper affordable homes to residents, they will provide valuable learning for our sector as we work towards meeting new legislation and future-proofing our homes for residents."

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PROJECT VISION & GOALS

This project was created with the aim to investigate the implications of building to the predicted future homes standard (notionally a 75% reduction in Part L 2013). The project was set up to review the buildability, costs and impacts to residents through structured monitoring during construction and handover, followed by post occupancy evaluation (POE) for a year after the residents move in.

A decision was made to review two approaches to reach the FHS to understand what is best in terms of ease of resident use, resident comfort, buildability and costs.

The bungalows would be a technology led approach with air source heat pumps (ASHP), with mechanical extract ventilation (MEV), and published notional fabric thermal performance.

The houses would be a fabric led approach with improved thermal performance, mechanical ventilation with heat recovery (MVHR) combined with simpler direct electric heating.

A further decision was made to test infrared electric heating panels on two of the houses, which promise reduction in energy bills and comfort.

Throughout the build the team from the Design, Technical and Innovation department in Latimer have monitored construction and installation of equipment, noting where the contractor and sub-contractors have found problems or not with the approaches and technologies.

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DESIGN AND DELIVERY TEAM

POLLARD THOMAS EDWARDS

Pollard Thomas Edwards (PTE) is a London-based architecture practice specialising in the design of homes, neighbourhoods, public and mixed-use buildings.

Since its beginnings in the 1970s, PTE has developed a strong track-record working with communities, local authorities and commercial clients to create buildings and places with a distinct people-centric focus.

At Peasecroft PTE acted as lead designer, architect and sustainability consultants through planning and delivery stages, and are leading the post occupancy evaluation of the completed homes.

We took our starting point to be a highly sustainable update of the traditional rural farm buildings and cottages of Hertfordshire. A pair of bungalows and five two storey houses are grouped into two short ranges arranged around a small, shared surface courtyard. We chose a monochrome colour palette that we combined with a traditional lapped cladding, gable roofs, and crisp contemporary detailing.

The courtyard layout allowed us to utilise the depth of the site, whilst reusing the existing access and retaining trees. By grouping like buildings together we have avoided the risks of complex shapes or junctions within the external walls, helping to simplify the delivery of improved thermal performance.

www.pollardthomasedwards.co.uk

LIFE BUILD

LIFE Build Solutions Limited is a building contractor delivering New Build, Refurbishment and Fit Out projects that exceed the client's expectations by focusing on the client's needs and priorities. Undertaking contracts from £1M to £30M either by negotiation, partnering, two stage or traditional procurement routes, our mission is to build relationships with clients for life by creating a culture of service excellence, using local resources and our proven supply chain, ensuring we deliver a quality product to budget and to the complete satisfaction of the client.

Utilising a traditional method of construction, the project includes the design and construction of five, three bedroom houses and two, two bedroom bungalows. In order to meet the clients requirement for a more sustainable method of construction all of the properties are designed & built to the 'Future Homes Standard'.

The key objectives of this standard being, reducing carbon emissions, transitioning to low-carbon heating, improving fabric efficiency and increasing energy performance requirements. In order to achieve this, the Scheme incorporates modern technologies including; Photovoltaic Panels (PV), Air Source Heat Pumps (ASHP), Mechanical Ventilation Heat Recovery (MVHR), Infra-Red Heating Panels and a liquid applied air tightness membrane in order to achieve a maximum designed air tightness of 1.0m3/hr/m².

Each of the properties have private gardens, landscaping and car parking provision with crossovers onto Peasecroft for forecourt parking. This includes all services, external works and all other associated works.

www.lifebuild.co.uk

WALLACE WHITTLE

Wallace Whittle is an independent Environmental Building Services Consultancy, providing sustainable Mechanical, Electrical & Public Health Services throughout the UK and Ireland.

At Peasecroft we researched and evaluated the proposed MEP systems and technologies, to determine sizes, specifications and performance requirements of heating and hot water generating plant, working in tandem with the high efficiency building fabric construction methods. Consideration of optimum ambient equipment locations to achieve maximum performance efficiencies, including Air Source Heat Pumps and Photovoltaic Arrays were implemented and spatial allowances were carried out for internal and external plant.

www.wallacewhittle.com

MIMRAM

Established in 1985, we are a full service, specialist design and build M&E contractor, providing an effective and efficient service in everything we do. We are committed to innovation and take pride in our delivery of a full range of M&E services that are on time, in spec and within budget.

What sets us apart from others is our people. Our belief in our trust based culture and core values allow our team to not only manage projects but also manage relationships with our clients that are long term and ones that are built on trust and reliability.

www.mimramservices.com

POTTER RAPER

Potter Raper is a Construction Consultancy offering Project Management, Quantity Surveying, Employer's Agent, Building Surveying, Joint Venture Management, Health, Safety & Environmental (including the Principal Designer role), Fund/Bank Monitoring services, Clerk of Works, Laser Scanning and CAD services, Sustainability Services, CIF Service and Decarbonisation and Retrofit Service.

We've been around since 1970 and over the years we have built a reputation of integrity, reliability, and excellence for all of our services Our business, which operates out of five offices in Beckenham, London, Colchester, Brighton and Cambridge, is continuously growing, with new expertise joining the company every month.

www.potterraper.co.uk

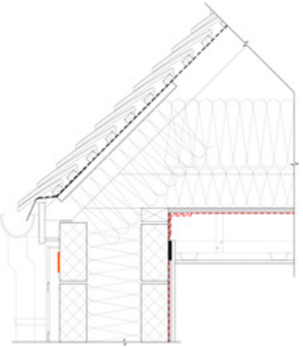
HYPEROPTIC

Founded in 2011 to shake up the broadband market, Hyperoptic provides hyperfast full fibre to homes and businesses across the UK. We're in our customer's corner with a hyper reliable connection, hyper fair pricing, and hyper service with more 5-star Trustpilot reviews than other providers.

Hyperoptic is proud to deliver our gigabit capable broadband at Peasecroft, enabling truly hyper-connected homes. And our equipment is already installed – meaning you can get up and running within minutes from the day you move in, without an engineer visit. For this development to assist Latimer with the POE, the first Clarion customers are receiving 12 months free service on our fastest 1GB plan.

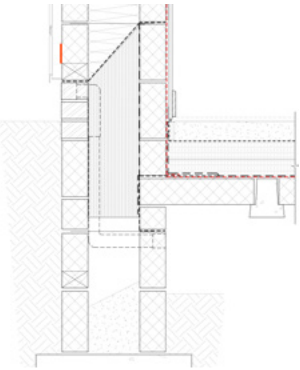
www.hyperoptic.com

CONSTRUCTION METHODOLOGY



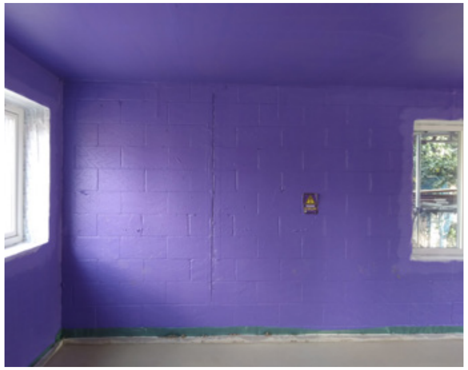
The construction method is traditional masonry with 200mm full filled cavity, using medium density concrete block in external leaf and aircrete block in inner leaf to mitigate thermal bridging at ground floor and roof junctions. They are externally finished with cement board cladding on timber battens fixed to the blockwork.

All junctions have been designed to be thermal bridge free, with independent lintels per masonry leaf in each wall opening.



The buildings have been constructed using beam and block ground floor, posi-joists in upper floors on the houses and timber truss roofs.

Windows and patio doors are triple glazed. In the bungalows they have trickle vents and in the houses they are fully airtight. They were installed in line with the cavity insulation layer and on the ground floor, a 100mm thick insulated door threshold was used to provide thermal continuity between doors and ground floor insulation.



A liquid airtight membrane applied to the internal face of the blockwork, combined with airtight tapes in junctions and quality control inspections helped deliver high levels of airtightness. Dot and dab plasterboard was applied on top of the airtightness membrane.

In the houses with MVHR, semi-rigid ventilation ductwork was installed within the thermal and airtightness layers to avoid heat losses.

PILOTING FUTURE HOMES STANDARD

INITIAL FINDINGS

New construction details had to be developed to suit the 200mm full fill cavity, to be thermal bridge free and airtight.

It was assumed that getting doors with a U-value of 0.85 W/m²K and airtightness Class 4 would be easy. It turned out that suppliers either did not want to supply small quantities or the doors were very expensive. In the end, the specification was relaxed to 1 W/m²K and airtightness Class 2.

MVHR and duct work location in standard houses is challenging and requires more detailed reviews with service zones and storage area.

The use of passive purple air tightness paint together with quality control measured produced better air tightness levels than expected across all homes.

Airtight construction trapped moisture during the construction phase introduced by the wet trades that went on internally and skimmed plasterboards took a long time to dry.

Approved Document Part O (Overheating) was challenging to meet on the bungalow ground floor windows, as these needed to be securely opened. Additional mechanical ventilation was required to prevent overheating on ground floor bedrooms.

Good practice to include Data Sheets for the materials used within Employers Requirements.

COSTS & PROGRAMME

Breakdown of elements within the build marginally increased the cost as set out on the right and although fabric first is historically more expensive in terms of capital cost compared to an M&E approach, a further study is required to see if the M&E is actually costing more in the long term in relation to the whole life costings (i.e. maintenance and replacement) particularly affecting service charges.

Due to the size and mix of the development, with the added complexity of the trialling different heating and hot water methods the percentage uplifts are to be reflected.

PROGRAMME

Start on site	March 2023
Completion	April 2024
POE	2024-2025

PILOTING FUTURE HOMES STANDARD

BUILD COST PLAN:

Building regs 2021	£3,200/m²
Future Homes Standard	£3,600/m²

8.5% total cost uplift

SUBSTRUCTURE — 18% uplift

- The main difference with future homes is that the size of foundations increased due to thicker walls.

SERVICES — 15% uplift

Cost increases due to the following mechanical installations:

- MVHR
- PVs
- Energy monitoring and controls

PROJECT/DESIGN TEAM FEES — 1.5% uplift

- Additional design works required, utilising specialists such as PTE architects for their future homes knowledge.
- No additional time taken on the construction programme to deliver these homes to the future homes standard.

SUPERSTRUCTURE — 7% uplift

- The walls are thicker due to increased insulation thickness.
- The windows and doors have better thermal performance which incurs additional costs.
- The roof build up is thicker due to the increased insulation thickness and the ceiling void for ductwork to run within the thermal envelope, resulting in additional costs.

INTERNAL FINISHES — 1.5% uplift

- The original tender allowed for wet plaster applied to the walls as the airtightness layer and finish.

  It was later changed to dot and dab plasterboard, with prior application of an airtight paint layer to the blockwork.

TECHNOLOGY FEATURES

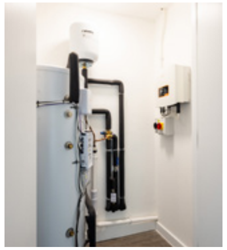
Plots 1-5 - Terraced houses

Plots 1-5 are two storey terraced houses which benefit from a low carbon energy solution primarily made up from Solar powered Hot Water reducing grid connected energy by 35% and effectively providing zero energy bills for hot water for 9 months of the year. Heating is all electric provided directly via Radiant Heat Panels on the ceiling or Panel Radiators on the walls which are optimised in output to meet reduced heat losses. To maintain temperatures and air quality a whole house ventilation system provides fresh air throughout the house.

1. Electric heaters

2. Infrared panels

3. Smart Cylinder



4. MVHR

5. PVs

6. EV charger

1. Electric heaters

The electric heaters in plots 3, 4 and 5 are wall mounted and provide heat through convection, heating the air. The Dimplex heaters have built in temperature control and timers, making each room a heat zone.

2. Infrared panels

The slimline far infrared heating panels are ceiling mounted in plots 1 and 2. The heat is produced from a carbon crystal element that emits far infrared waves, heating objects and people directly just like the sun. This means they operate a lower air temperatures and have a lower power output than traditional electric convection heaters. Heat is each room is controlled by a touch screen wireless controller from ATC.

3. Mixergy Smart Cylinder

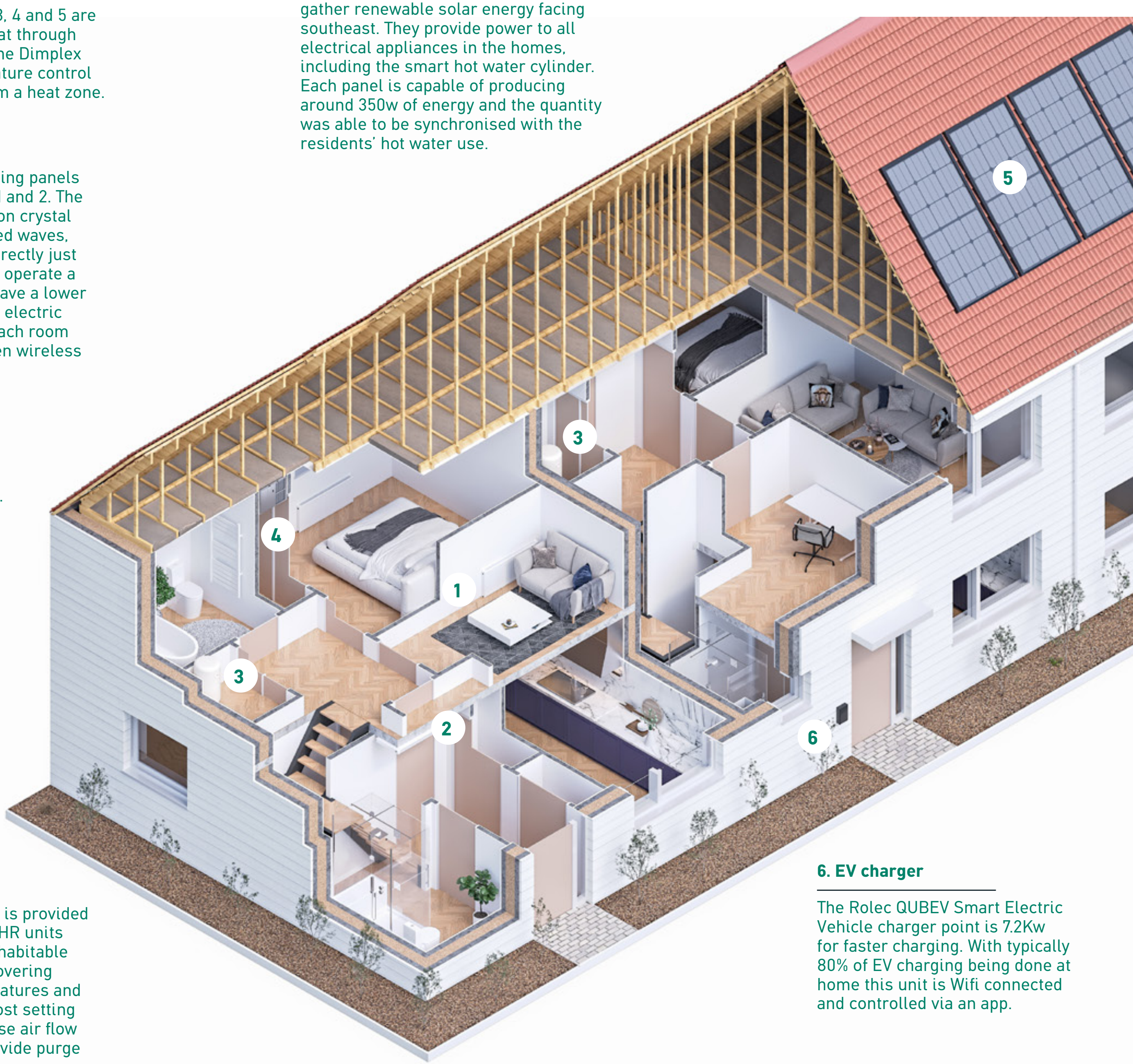
Hot water is produced using direct electric smart hot water cylinders from Mixergy. These learn the usage patterns of the occupants to ensure hot water is always available in the most cost effective way. The Mixergy tank stores only the hot water needed, as opposed to a traditional hot water cylinder that has to heat up the entire volume to meet smaller demands. A PV diverter is also included to maximise the use of the free energy generated by the PV array, providing up to 9 months of free hot water.

4. MVHR

The ventilation to the houses is provided by Zehnder Comfoair 200 MVHR units which deliver fresh air to all habitable areas of the house while recovering heat to help maintain temperatures and air quality. The MVHR has boost setting for warmer months to increase air flow through the house and to provide purge ventilation when required.

5. PVs

Viridian solar clearline fusion roof-integrated PV array is optimised to gather renewable solar energy facing southeast. They provide power to all electrical appliances in the homes, including the smart hot water cylinder. Each panel is capable of producing around 350w of energy and the quantity was able to be synchronised with the residents' hot water use.



6. EV charger

The Rolec QUBEV Smart Electric Vehicle charger point is 7.2Kw for faster charging. With typically 80% of EV charging being done at home this unit is Wifi connected and controlled via an app.

TECHNOLOGY FEATURES

Plots 6-7 - Bungalows

Plots 6-7 are single storey bungalows which benefit from a low carbon energy solution primarily provided via Air Source Heat Pumps located in the gardens. Solar Panels mounted on the roof provide renewable energy. Heating is a LTHW system via wall mounted radiators which are optimised in output to meet reduced heat losses. To maintain temperatures and air quality and a multi room MEV draws fresh air throughout the house.

1. Radiators

2. ASHP

3. ASHP / Cylinder

4. MEV

5. PVs

6. EV charger

1. Radiators

The LTHW radiators are wall mounted and provide direct heat output and were able to be sized to meet the very low space heating requirements of the homes. The heaters are controlled by Honeywell in room controllers and central heating controller.

2. ASHP

The Air Source Heat Pump is from Mitsubishi domestic Ecodan range. It uses R32 refrigerant generating heat at efficiencies in the range of 300-400%. This is providing heat for the home via the radiators and the domestic hot water is stored within the cylinder.

3. ASHP / Cylinder

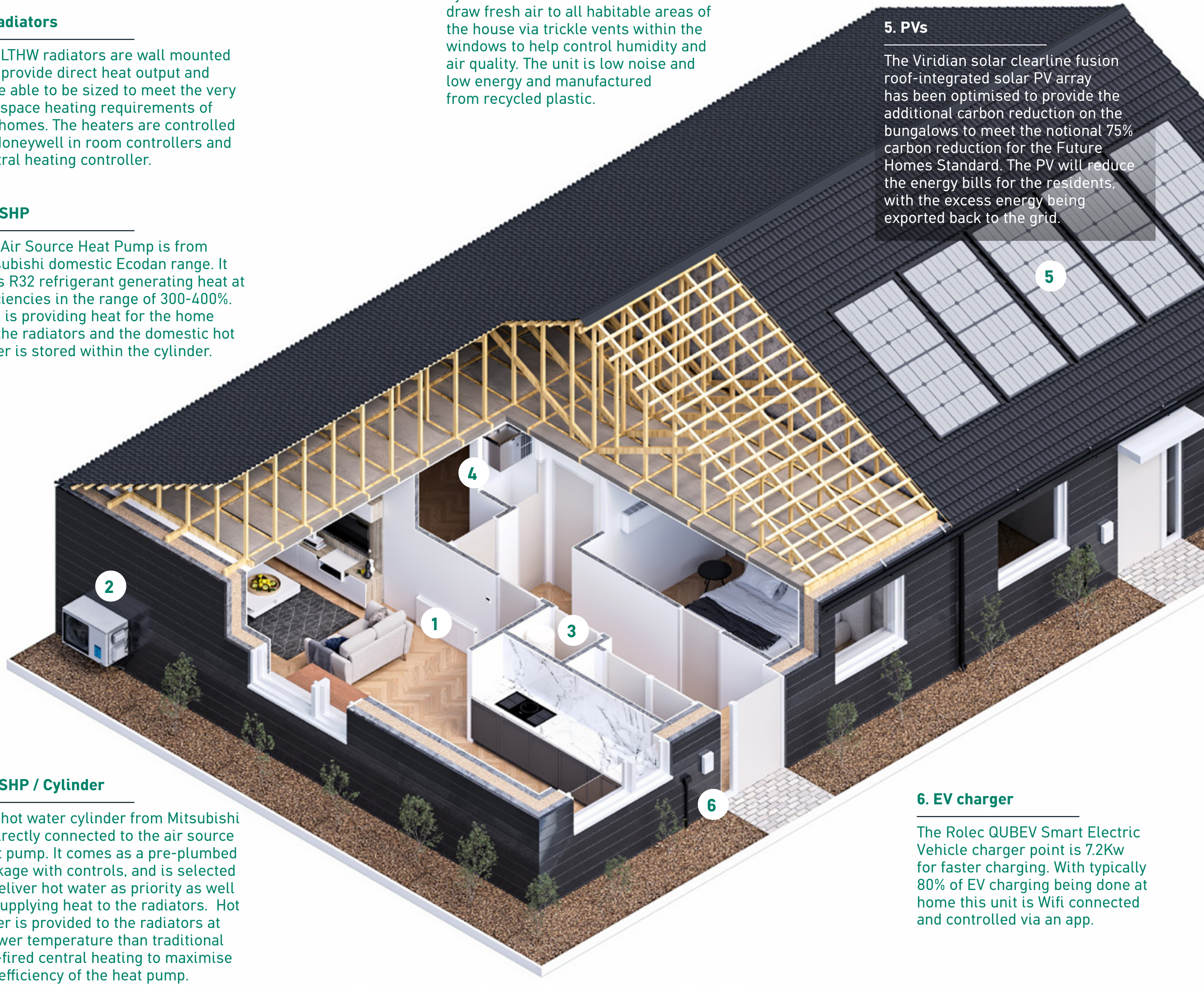
The hot water cylinder from Mitsubishi is directly connected to the air source heat pump. It comes as a pre-plumbed package with controls, and is selected to deliver hot water as priority as well as supplying heat to the radiators. Hot water is provided to the radiators at a lower temperature than traditional gas-fired central heating to maximise the efficiency of the heat pump.

4. MEV

The ventilation to the houses is provided by VentAxia Multihome MEV units which draw fresh air to all habitable areas of the house via trickle vents within the windows to help control humidity and air quality. The unit is low noise and low energy and manufactured from recycled plastic.

5. PVs

The Viridian solar clearline fusion roof-integrated solar PV array has been optimised to provide the additional carbon reduction on the bungalows to meet the notional 75% carbon reduction for the Future Homes Standard. The PV will reduce the energy bills for the residents, with the excess energy being exported back to the grid.



6. EV charger

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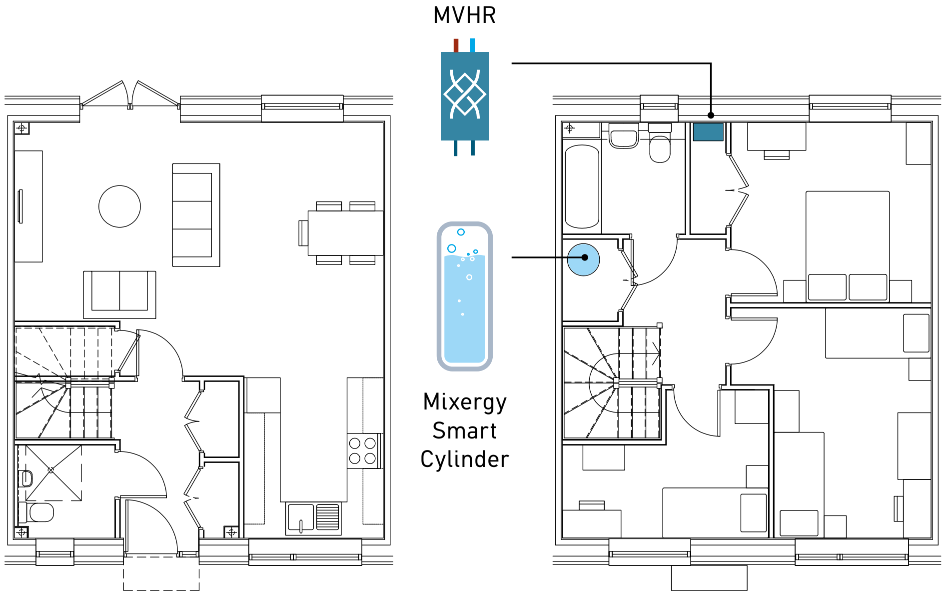
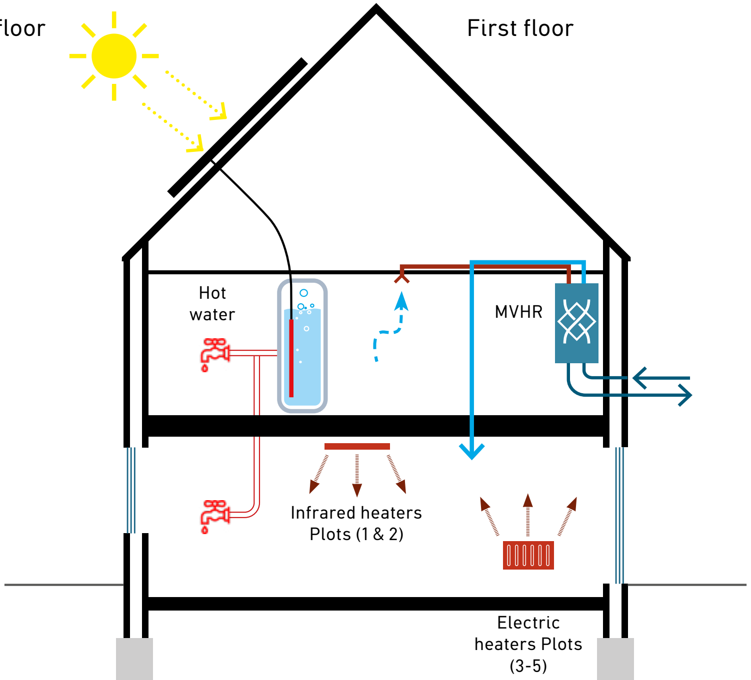
PLANS AND SECTIONS

Plots 1-5 Terraced houses

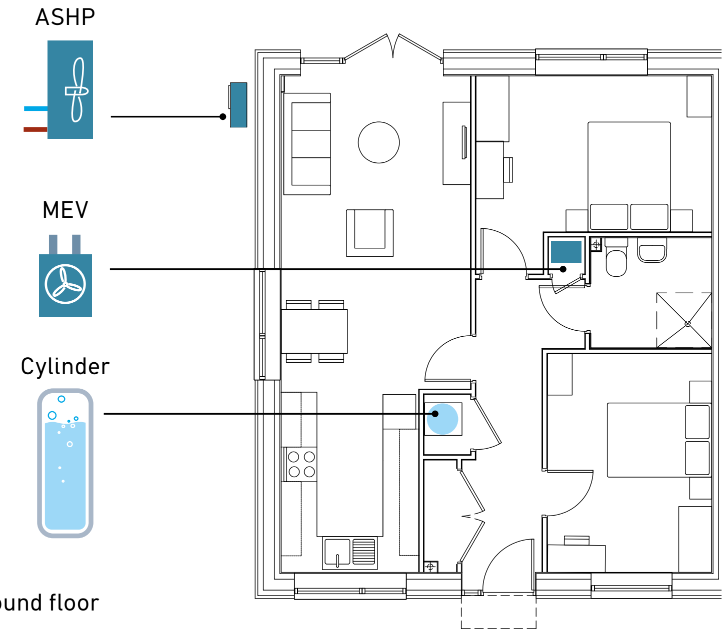


Ground floor

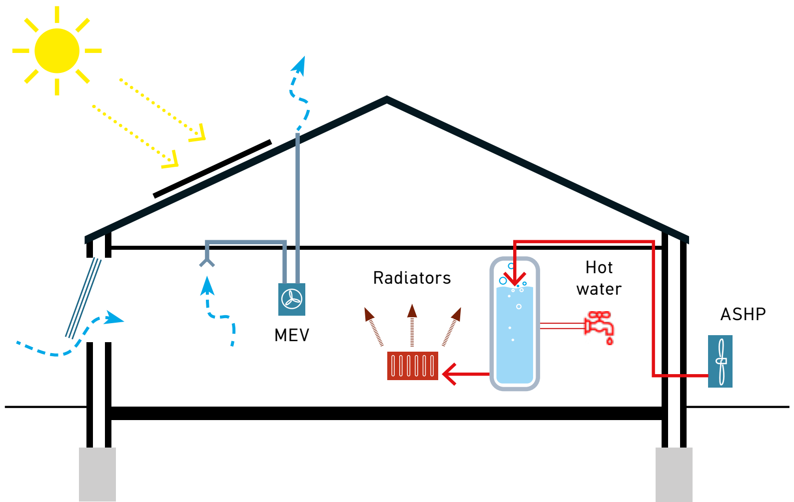
First floor



Plots 6-7 - Bungalows



Ground floor



THE FUTURE HOMES STANDARD

When the project was being designed the future homes standard has been described using indicative notional specifications in a 2020 consultation linked with the Part L 2021 update. These were indicated to be a 75% reduction in carbon emissions over Part L 2013 performance levels. These specifications were used as a guide to develop the Peasecroft design, with the 75% carbon reduction over Part L being the defining overall measurement.

The future homes standard is now undergoing a final pre-implementation consultation with the overall carbon reduction target remaining the same. However, the fabric thermal performance is reduced from the 2020 consultation. There are two options being considered, one with solar PV and one without. Another major change coming with the new future homes standard is a move away from SAP as the standard energy calculation tool to a new Home Energy Model. This is a much more detailed calculation tool.

PILOTING FUTURE HOMES STANDARD

Comparing our Future Homes at Peasecroft to the current standard under consultation our fabric specifications are much better, especially for air permeability which is 85% better than the notional building value. The ventilation systems used are also more efficient than the FHS notional specification, with the MVHR in the houses providing significant benefits in retaining heat.

The main differences are with the technology. The houses in the study are heated with direct electric heating and infrared panels, which are a less efficient form of heating in the home energy model compared to air source heat pumps.

ASHPs are in the FHS notional specification and are the heat source on our bungalows. In comparison to the PV option in the new FHS, our homes have less PV than that in the notional building specification with PVs.

However, the homes on Peasecroft are almost zero carbon when modelled in the new Home Energy Model. The bungalows have an emissions rate of -0.7 $kgCO_2/m^2$ and the houses 0.19 $kgCO_2/m^2$ using the demo HEM tool.

Parameter	**Peasecroft Specs**	**FHS Old (2020) notional dwelling**	**FHS new Option 1 notional dwelling**	**FHS new Option 2 notional dwelling**	**Part L 2021 notional dwelling**
Roof U-Value (W/m^2K)	0.11	0.11	0.11	0.11	0.11
External wall U-Value (W/m^2K)	0.14	0.15	0.18	0.18	0.18
Ground Floor U-Value (W/m^2K)	0.11	0.11	0.13	0.13	0.13
Window U-Value (W/m^2K)	0.82	0.8	1.2	1.2	1.2
Door U-Value (W/m^2K)	1	1	1	1	1
Thermal bridging Y-Value (W/m^2K)	0.06	0.05	n/a	n/a	0.2
Air tightness (m3/m2.h @50Pa)	0.3–0.6	5	4	5	5
Ventilation	MVHR/cMEV	natural vent	dMEV	natural vent	natural vent
Heat Source	ASHP/direct electric	ASHP	ASHP	ASHP	gas boiler
Waste water heat recovery	no	no	yes	no	yes
PV	3.35 kWp	no	40% of ground floor area equivalent (high-efficient panels facing south)	none	40% of ground floor area equivalent / 6.5 (facing south-east)

SUSTAINABILITY DATA

Full specification per plot

Dwelling identifier	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7
Dwelling type	Terrace house					Bungalow	
Construction method	Masonry - full fill cavity						
Energy compliance method	SAP 10.2						
Overheating method	Simplified					Dynamic thermal modelling	
Wall U-value (W/m^{2}K)	0.14						
Roof U-value (W/m^{2}K)	0.11						
Floor U-value (W/m^{2}K)	0.11						
Party wall U-value (W/m^{2}K)	0						
Window U-value (W/m^{2}K)	0.83						
Doors U-value (W/m^{2}K)	1						
Thermal bridging (Y-value)	0.06	0.08			0.06		
Space heating method	Infrared heaters		Electric heaters			ASHP wet radiators	
Domestic hot water heating method	Mixergy Smart Hot water cylinder					ASHP	
Cylinder size (L)	210					200	
Smart cylinder	Yes					No	
Waste water heat recovery	No						
Shower flow rate (LPM)	8						
PV (kWp)	3.35					3.015	
Battery	No						
Ventilation type	MVHR					MEV	
Airtightness (as-design) (m^3/hm^2@50Pa)	1					3	
Airtightness (as-built) (m^3/hm^2@50Pa)	0.61	0.58	0.83	0.56	0.67	0.41	0.42
Post occupancy evaluation	Yes						

As design sustainability data from SAP/EPC calculations

Dwelling identifier	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7
Area (m^2)	101					71	
Energy Efficiency Rating	90 B	92 A			90 B	87 B	
Carbon reduction % DER < TER ($kgCO_2/m^2$)	2.67<11.13 76%	2.06<10.14 80%	2.14<10.14 78.9%	2.05<10.14 79.8%	2.81<11.52 75.6%	2.06<11.39 81.9%	2.0<11.12 82%
Fabric Energy Efficiency % DFEE < TFEE (kWhPE/m^2)	34.0<40.5 16%	29.8<35.5 16.1%	29.9<35.5 15.8%	29.8<35.5 16.1%	35.1<42.2 16.8%	41.1<48.4 15.1%	40.3<47.2 14.7%
Primary energy % DPER < TPER (kWh/m^2)	27.42<58.07 52.8%	21.38<52.81 59.5%	22.2<52.81 58%	21.32<52.81 59.6%	28.83<60.2 52.1%	36.76<60.95 39.7%	36.18<59.53 39.2%

Part G calculations

Dwelling identifier	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7
Litres per person per day	101.93					97.84	

Construction Waste - Actual waste sent offsite

	Total (t)	t/100m^2	Diverted from landfill (t)	Diverted from landfill (%)
Construction	90.4	14	82.6	91.38
Demolition	0	0	0	0
Excavation	684.8	106.2	679.8	99.27
Total (offsite):	775.1	120.2	762.3	98.35
Total (offsite & onsite):	802.1	124.4	789.3	98.41

MONITORING & POST OCCUPANCY EVALUATION

A major part of this pilot programme is post occupancy evaluation of all seven homes. This is being carried out by PTE using BS 40101 to fully understand how these homes are performing and set out the benefits and drawbacks of living in homes built to the Future Homes Standard.

The monitoring started in the construction stage and comprised attendance on site by the architect to observe installation works and to document details to help evaluate performance and construction quality. The documentation of design and construction quality has been an important step to help explain the stage 6 monitoring results, setting out the significance and reasoning behind the results.

The evaluation has continued on completion with a smart Heat Transfer Coefficient (HTC) test from Build Test Solutions. This provides an as-built whole house measurement of heat loss; together with in-situ measurement of the u-values of the main building elements (walls, roofs, floors) to compare as designed and as-built.

The environmental monitoring period is for 12 months following occupation in May 2024, and will include a winter and summer season to test the performance of the homes in different conditions. We will be installing monitoring equipment from Purrmetrix to record the temperature, humidity and CO_2 levels in the homes over this first year of occupation.

This monitoring will measure indoor air quality to evaluate the airtightness and ventilation strategy is in use. Total energy and water usage will also be monitored using smart metering that will evaluate how the homes perform compared against predicted design levels.

As well as this technical monitoring of environmental and energy performance, PTE will also carry out interviews with all of the residents to understand:

- How do the residents find living in the homes?
- How comfortable are the homes?
- What are the key lessons learned on design, construction and product selection including the different heating solutions?
- How the homes perform in use? Including in use energy bills compared against the brief and predicted design.
- The pros and cons of building to the Future Homes Standard.

The monitoring period will conclude with a RIBA stage 7 report, including findings from resident surveys, a 360 review with key stakeholders, Smart HTC, and monitored environmental data for 12 month period. This final report will be completed in 2025, to include analysis of performance in use and how this was achieved, setting out lessons learnt for Latimer and the wider industry.

Opposite: Local labourer, James has been working on site for the past year and Mark, site manager said: "Housebuilding has moved on a lot in the past 5 years - The air tightness of these buildings has been way, way below anything I've experienced."

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by Clarion Housing Group

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