Project Documentation
Gebäude-Dokumentation

Abstract / Zusammenfassung

38 Unit apartment building at Agar Grove, Camden, London
MEP focussed report

This report describes the main features of Agar Grove Block A, which is a new build 38 unit multifamily apartment building in the Borough of Camden in London. This report focuses on the technical services (MEP).

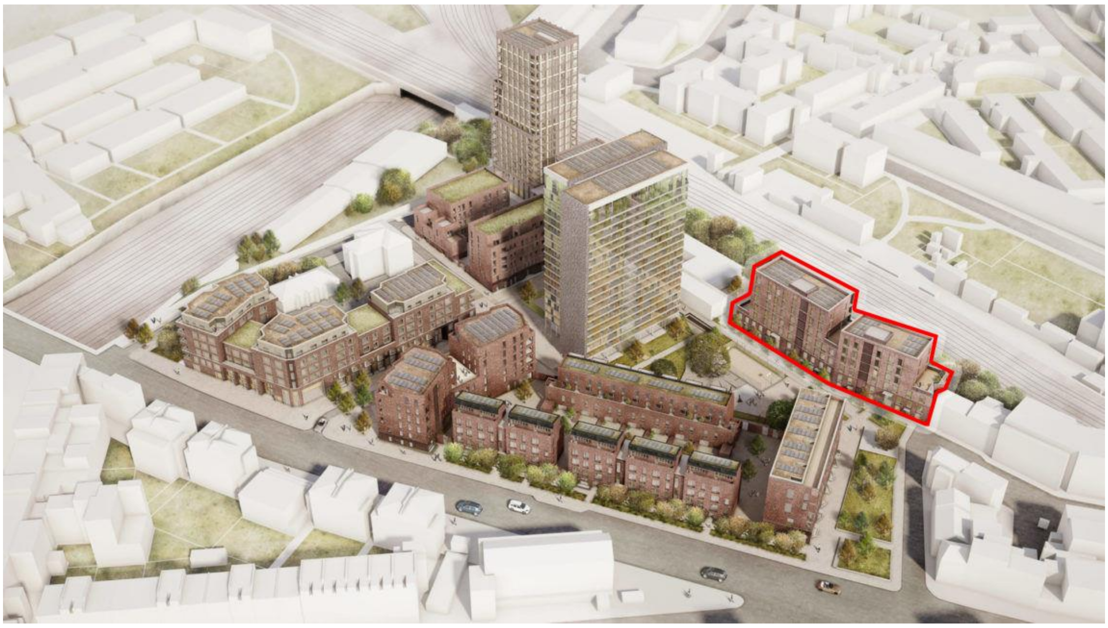
1.1 Data of building / Gebäudedaten

Year of construction/ Baujahr	2017	**Space heating / Heizwärmebedarf**	**13 kWh/(m²a)**
U-value external wall/ U-Wert Außenwand	0.165 W/(m^{2}K)		
U-value binstore soffit/ U-Wert Kellerdecke	0.187 W/(m^{2}K)	**Primary Energy Renewable (PER) / Erneuerbare Primärenergie (PER)**	-- kWh/(m²a)
U-value roof/ U-Wert Dach	0.085 W(m^{2}K)	**Generation of renewable energy / Erzeugung erneuerb. Energie**	-- kWh/(m²a)
U-value window/ U-Wert Fenster	Uf-Fixed 1.020 W(m^{2}K) Uf-Opn 1.240 W(m^{2}K)	**Non-renewable Primary Energy (PE) / Nicht erneuerbare Primärenergie (PE)**	118 kWh/(m²a)
Heat recovery/ Wärmerückgewinnung	82 % (overall avg.)	Pressure test n_{50} / Drucktest n_{50}	0.59 h-1

Special features/ Besonderheiten	Thermally broken steel walkway incorporating brick outer skin to South façade, thermally broken window cill detail & support for wide cavities, various thermally broken details, airtightness strategy, basalt wall ties resin anchored.

Brief Description

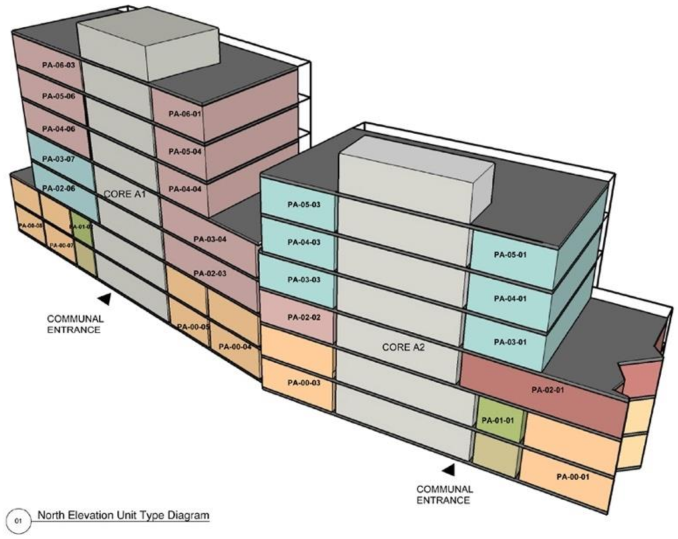
Agar Grove Block A (outlined in red) is a new build 38 unit multifamily apartment building in the Borough of Camden in London. It is the first phase of around 500 units masterplan for regeneration of a 1960s housing estate. It is one of the largest Passivhaus schemes in the UK currently. The council is the lead developer.

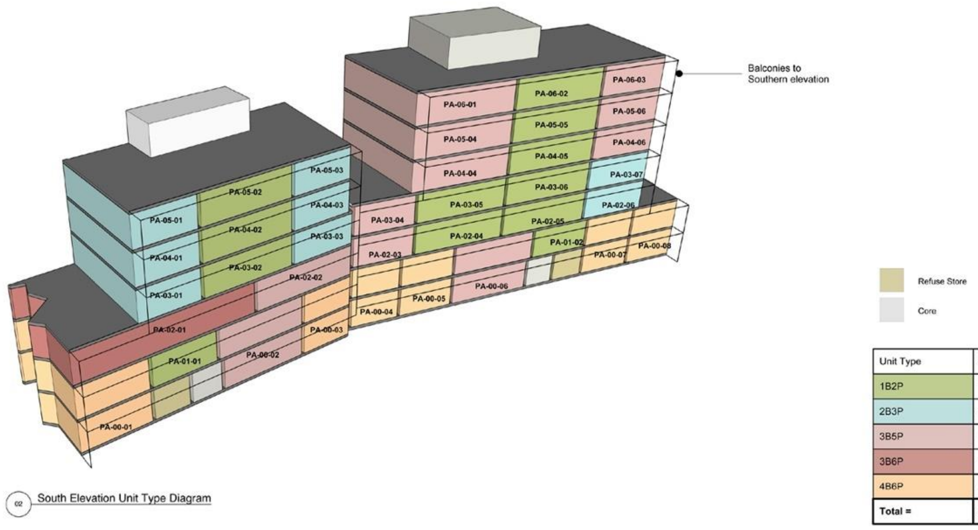


Overview of proposed Agar Grove Estate regeneration. ©Hawkins/Brown

The materials and building form of the masterplan were carefully developed by the architects to coordinate with and enhance the local neighbourhood, whilst also doubling the density of population. Approximately half of the masterplan is subsidised housing. The development is carefully phased over many years so that the residents can remain on site, moving only once; from their current into their new homes.

Block A, outlined in red above, faces North to the new estate and South to a busy railway line. The ground & first floor units are two level maisonettes, with 3-4 stories of apartments above. Most units are dual aspect.





Unit Type	Number
1B2P	12
2B3P	8
3B5P	11
3B6P	1
4B6P	6
Total =	**38**

Overview of Accommodation Schedule- Unit type breakdown in 3D

The budget was limited, the costs are comparable to a non-Passivhaus scheme.

The local vernacular informed the brick façade. This introduced design challenges to achieve low thermal bridging and costs.

Local regulations stipulated a district heating solution with a single large energy centre for the whole 500 unit masterplan. This was negotiated back to block-by-block communal heating which was designed, built and commissioned to demonstrate best-in-class efficiencies.

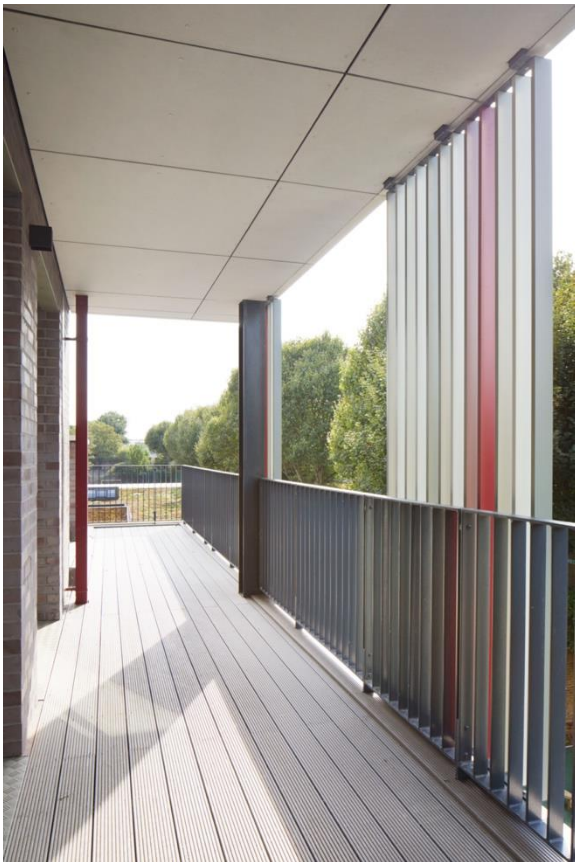
2 Responsible project participants

	Early stage	Post contract
Client	London Borough of Camden	London Borough of Camden
Architects	Hawkins\Brown	Architype
Main Contractor	-	Hill
Structural Engineer	Stantec	Stantec
Services Engineer & Building physics	Max Fordham	Robinson Associates
Passivhaus Planner	Max Fordham	Architype/Elemental Solutions
Landscape Architect	Grant Associates	Jo Wild
Project Manager & QS	Arcadis	
Certifying body	WARM	
Certification ID	17962-17999_WARM_PH_20180502_PW	
Author of project documentation	Bertie Dixon & Robert White	
Date, Signature	20/06/2022	

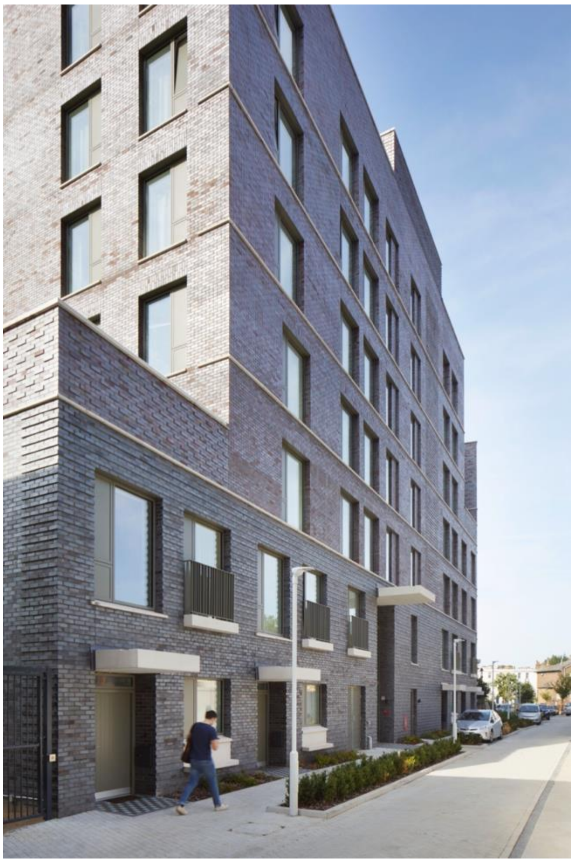
3 Views of Agar Grove Block A

South Elevation ©Architype

North Elevation (North West) ©Architype



South Elevation – Typical Balcony View ©Hawkins/Brown



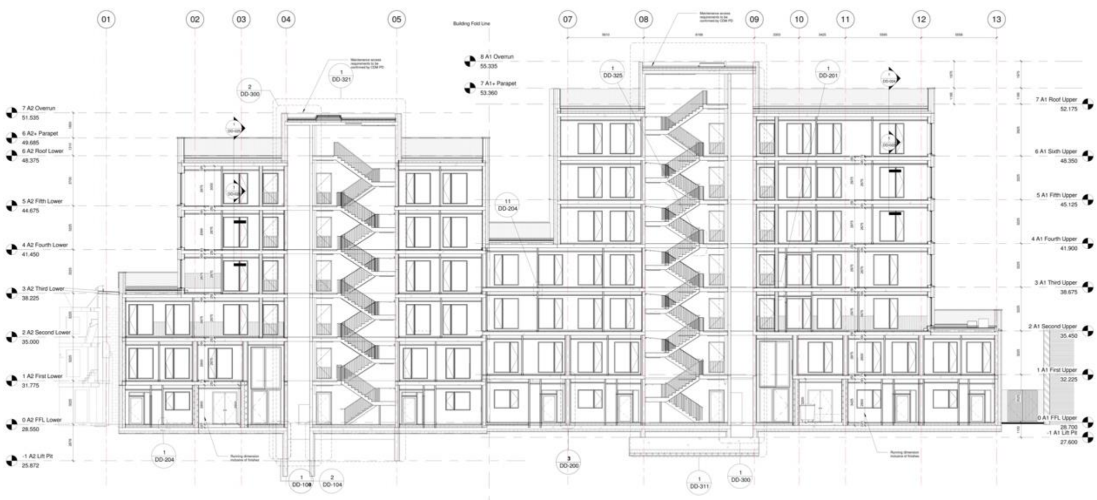
North Elevation (North East) ©Hawkins/Brown

4 Floor plans

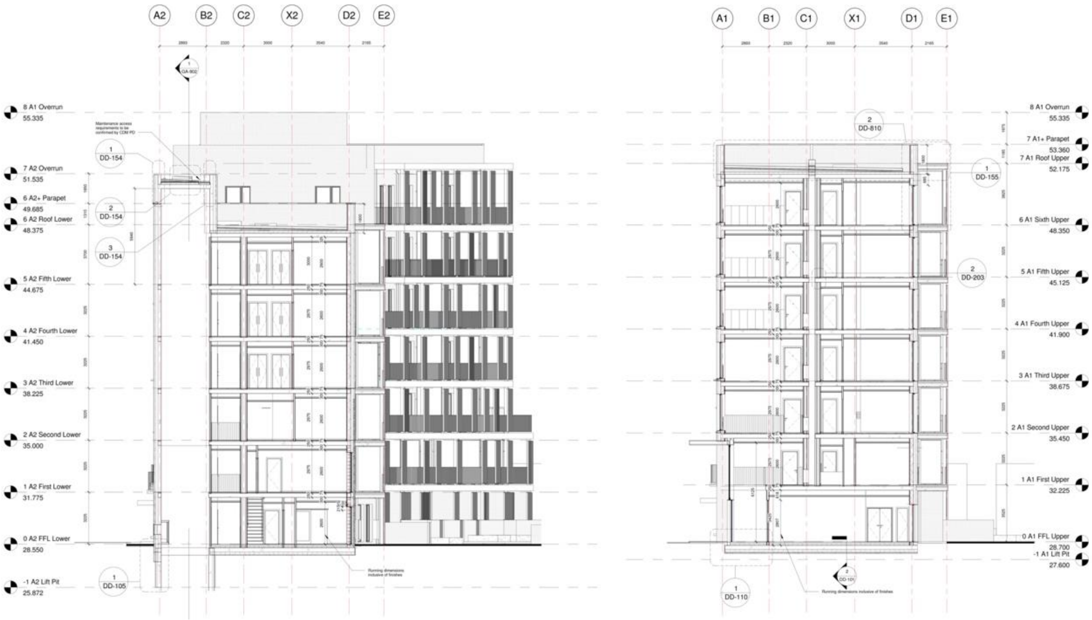
Overview of Floor Plans

5 Sectional drawings

North East Cut Section from North to South via. BIM Model ©Architype



Longitudinal Cross Section from East - West



Cross Section from North - South

6 Elevation drawings

North Elevation

East Elevation

South Elevation

West Elevation

7 Construction details of the envelope and Passivhaus technology

7.1 Ground Floor

Ground Floor	Slab on grade; insulation below slab	U-value 0.252 W/(m²K)

7.2 Construction including insulation of exterior walls Exterior wall assembly (s).

Exterio r wall	Brickwork outer leaf, 150mm blown-in mineral wool full fill cavity, Blockwork with thin joint mortar, insulated service void, 15mm Plasterboard.	U-value 0.165 W/(m²K)

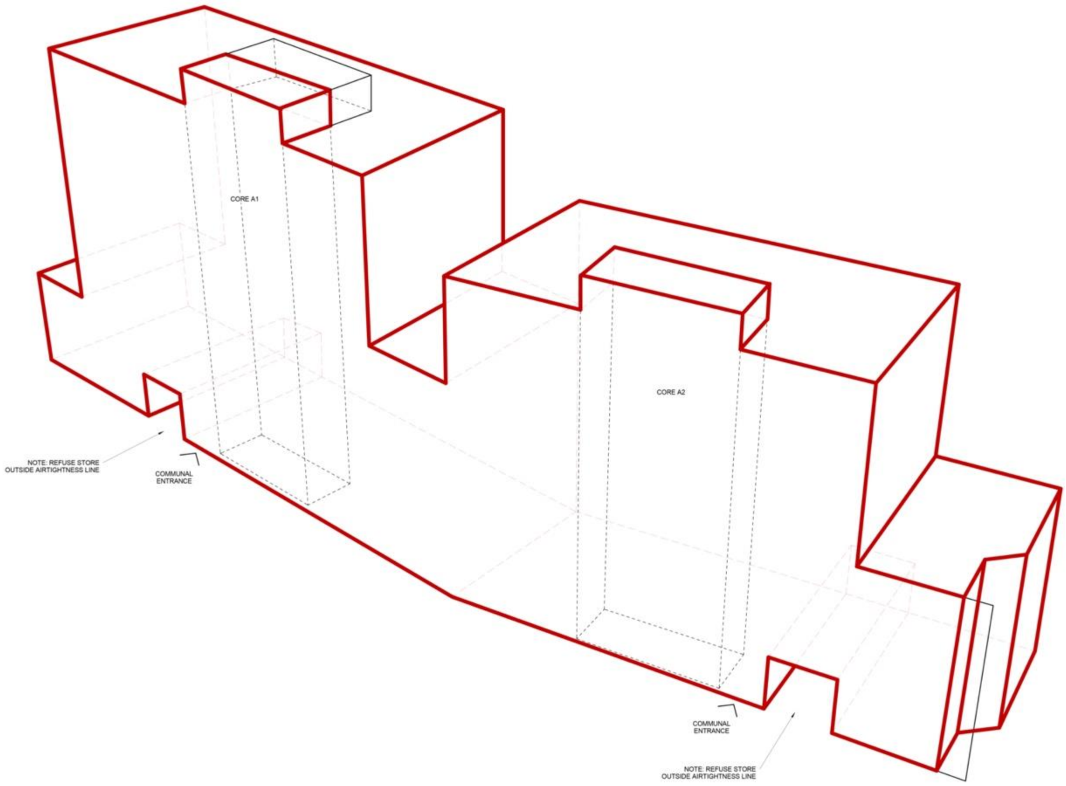
7.3 Construction including insulation of the roof Roof build-up (s).

Main Roof	Green roof; Underlay; PIR insulation, Concrete roof deck, metal framed support system gypsum plasterboard.	0.085 W/(m²K)

7.4 Window data

Window	Triple low-e glazing filled with inert gas. Wooden window frames with insulated frame with Aluminium face	0.7 W/(m²K)

8 Description of the envelope



Overview of Airtightness boundary – View from North

The building is concrete framed with block infil. The cavity to the Outer brick skin is full-filled with blown inert insulation. For more detail on the thermal envelope refer to the accompanying report by Architype

8.1 Windows & Rooflights/AOV

The windows for the project Windows are taken from Ideal Combi's Futura+ & Futura+ I range. The U value of the frames range between 1.02 W/(m²K) & 1.24 W/(m²K). The g-value ranges from 0.32 – 0.52 across orientations.

Layout of tapered roof insulation system

The window units are fixed into a plywood frame fixed within the window structural opening. This allowed the windows to be suspended into the cavity zone ensuring the maximum thermal performance is achieved. This allowed for the airtight taping to be applied to be windows and AAC blockwork prior to application of the sand/cement parge coat.

8.2 Roof Construction

The flat roof consists of a tapered insulation ontop of in an situ concrete slab.

The parapets are thermally separated using a propriety Halfen thermal break system.

8.3 Special features

Many of the expressed architectural features required innovative use of specialist thermal breaks. Some examples have been provided below.

9 Planning of ventilation ductwork

9.1 Maisonettes

- Each Maisonette is vented by a single ComfoAir Q350 MVHR unit, located in the hall cupboard adjacent to the external wall. Air is drawn directly from outside.
- No pre or post heater was fitted to the ventilation.
- Ducting is spiral wound galvanised circular ducts above a false ceiling.
- Effective heat recovery 81%
- Specific input power 0.42 Wh/m^3
- Typical external pressure to atmosphere 10 Pa
- Typical external pressure to building 15 Pa

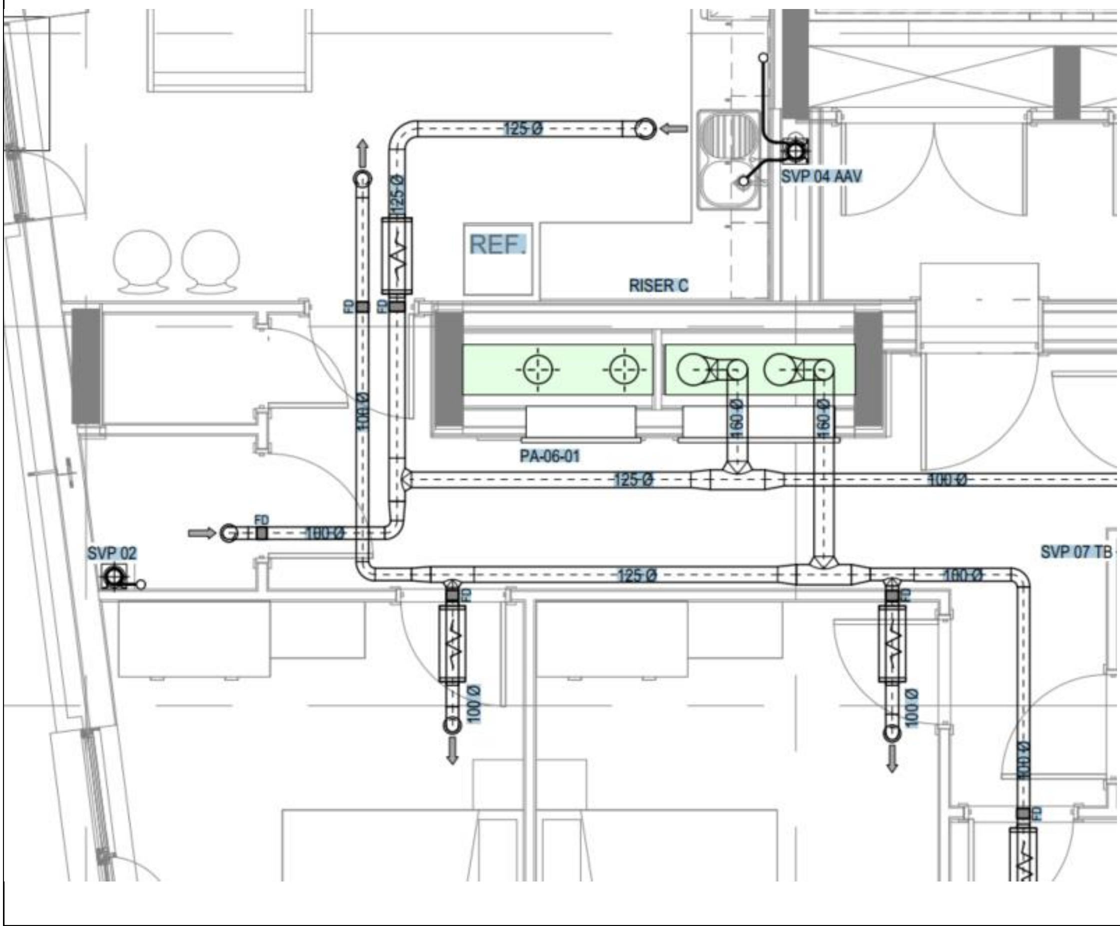
Ground floor; First floor. The ventilation ductwork is routed in the ceiling void of each maisonette.

PA-00-03		BASIC 100 (m³/h)
EXTRACT	**STANDARD (m³/h)**	**MAXIMUM (m³/h)**
KITCHEN / DINING	68	115
BATHROOM	35	59
UTILITY STORE	15	25
WC	24	41
TOTAL	142	240
SUPPLY		
LIVING ROOM	44	74
BEDROOM 00-03-09	32	54
BEDROOM 00-03-10	32	54
BEDROOM 00-03-12	17	29
BEDROOM 00-03-13	17	29
TOTAL	142	240

Typical Maisonette ventilation rates.

9.2 Apartments

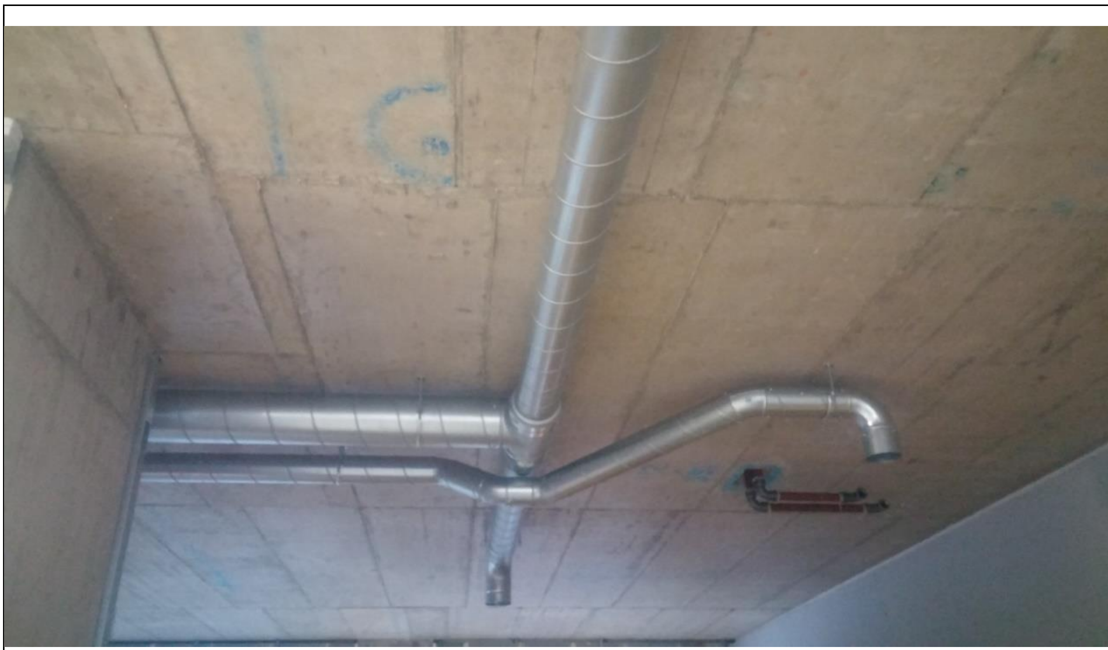
- The apartments are vented by two roof-mounted Swegon Gold RX AHUs, one AHU per riser. These include a rotary heat exchanger, and no pre- or post-heating.
- The supply & extract ducts are routed via vertical risers; one riser stack of apartments, there are 14no risers in total. Branches to each apartment have flow rate modulation & control by Swegon Adapt motorised dampers with Swegon Wise control. In this way the resident can control the ventilation rate of their apartment. Acoustic and fire separation required for each branch.
- Effective heat recovery 82%
- Specific input power 0.45 Wh/m^3
- Typical external pressure to atmosphere 0 Pa
- Typical external pressure to building in design 101Pa; measured at commissioning 115Pa (favourably compares to typical VAV system pressures of 400Pa)



Internal risers contain vertical duct runs and Swegon Adapt motorised dampers on each apartment branch. The ductwork is routed in the ceiling void of each apartment to each room

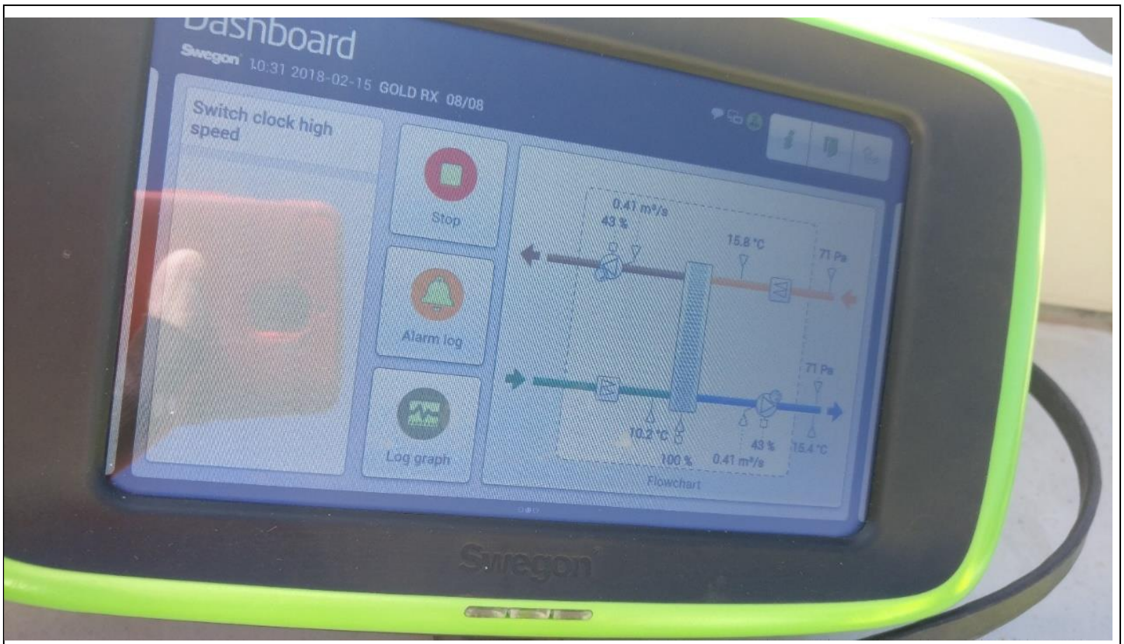
PA-03-03		BASIC 65 (m^3/h)
EXTRACT	**STANDARD (m^3/h)**	**MAXIMUM (m^3/h)**
KITCHEN	46	60
BATHROOM	31	40
UTILITY STORE	15	20
TOTAL	92	120
SUPPLY		
LIVING / DINING ROOM	37	48
BEDROOM 03-03-04	35	46
BEDROOM 03-03-05	20	26
TOTAL	92	120

Typical apartment ventilation rates

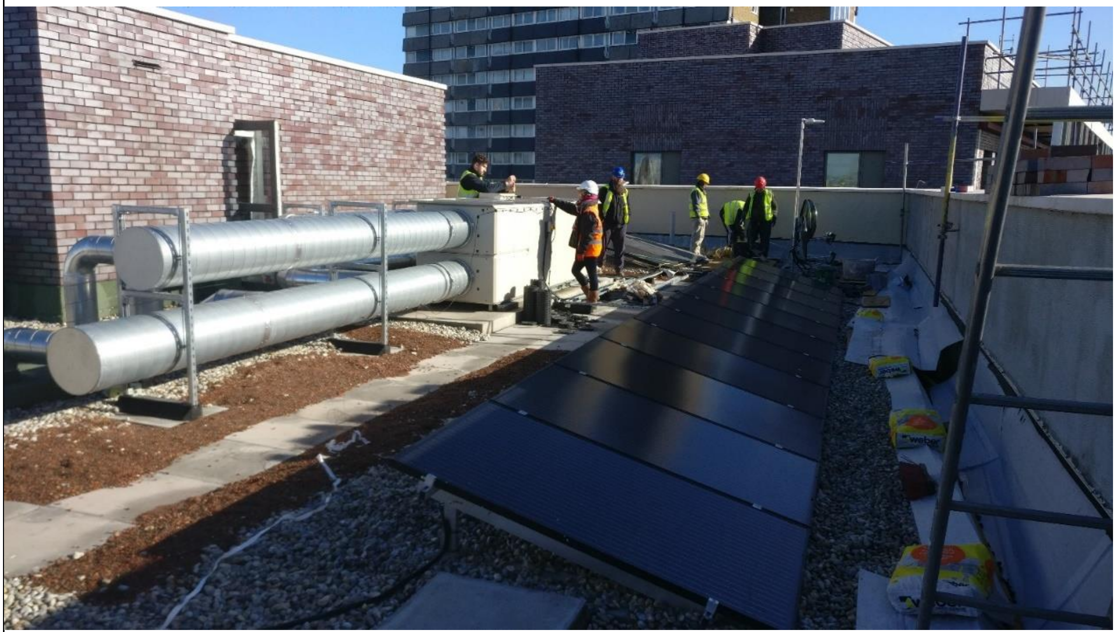


Ducting during installation

Ventilation riser, branch to apartment and damper arrangement.



Screen shot of Swegon AHU controller



Communal AHU on roof.

10 Heat supply

10.1 Communal heating design & commissioning approach

The planning department stipulated a district heating system, with a single large energy centre for the whole 500 unit masterplan. The designers presented to the department the technical and financial issues with this policy. These include:

- Inefficiencies due to sizing & modulation of systems during 10+ years of masterplan phasing,
- Required higher temperatures and pressures,
- High capital and running costs
- Risk of summer overheating

The negotiated compromise was a block-by-block communal heating system, with a plant room for each building containing gas boilers. Primary low temperature hot water (LTHW) is circulated to a heat interface, metering and control unit (HIU) in each apartment.

The efficiency of these systems is limited by their extremely extended geometry; heat is circulated 24/7 all year through kilometres of pipework. The heat losses from such systems can be reduced through good design, but a certain amount is unavoidable. This presented the designers with a challenge to achieve PER rates and avoid summer overheating. These issues are often not considered fully in communally heated non-Passivhaus developments, as described elsewhere[1]

The design approach was:

- To limit heat loss by minimising pipe length, diameter, and flow temperatures. The insulation is high quality of specification and installation. The HIUs are very well insulated SAV units.
- The return temperature must be as low as possible to reduce heat losses & improve boiler condensation & thus efficiency. Avoiding hot water storage in the flats in favour of large capacity heat exchangers provides low return temperatures.
- The space heating is fed directly (as opposed to indirectly via a heat exchanger). The circulating flow rate is variable according to demand, controlled by a differential pressure sensor.

A good design is only half of the solution; the installation was very carefully completed by the skilled team, and the commissioning process was a significant enhancement on normal procedures. Once the system was fully commissioned and set to work, the system was ‘road tested’ over 48 hours. Typical demands for heating and hot water were simulated on site by running heating and opening water outlets. The heat metering system was fully operational and recording data during this test.

The heat losses and return temperatures were logged and compared to benchmarks. The benchmarks build upon the excellent work of Fairheat[2] in this area. This measurement highlighted numerous issues with the boiler set up and various valve settings around the building. Only once the benchmarks were achieved was the system

[1] New Metrics for Communal Heating Design - Max Fordham
[2] https://fairheat.com/

accepted as completed. This level of commissioning is very unusual. It gave the contractor and client teams reassurance that the system was fully compliant, before it was handed over.

The metrics against which the performance was measured.

- <90W per customer continuous distribution loss between plant room and HIU; (<50W is often achieved nowadays). *Measured value in commissioning for Block A; 94W*[3]
- <30m total distribution pipe length, per customer;
- <38kW HIU rating for a 1 bathroom property; demand calculated on the Danish, or preferably, the Swedish Curve (e.g. total heat load >3kW per apartment for schemes >60 units);
- VWART<40C; i.e. the Volume Weighted Average Return-water Temperature, which can be calculated with relative ease from metering data over a period, say 24 hours; *Measured value in monitoring for Block A; 35-40C.*
- Bypass flow < 5% i.e. flow that is unaccounted for by the HIUs.

These values can be compared to any communal heated project at any stage: during feasibility, design, commissioning and ongoing performance monitoring.

The design features and commission process are described in detail in the article 'New metrics for communal heating'[4]. Many of the approaches have since been included in national best practice technical guidance[5]

At Agar Grove the communal heating was tested during commissioning using these metrics; in order to demonstrate actual in-use performance prior to handover. This is an example of an as-built yet pre-handover quality assurance check. Although this is rarely implemented, the author feels strongly that this type of testing is of critical importance to delivering quality for large bespoke systems such as communal or district heating.

10.2 Communal system arrangement

A plant room on the roof level contains 4no boilers. By selecting multiple small boilers, this allows modulation down to meet the very small heat demand (pipe heat loss only- this load is experienced around 70% of the year). The pumps are variable speed with a remote pressure sensor; to ensure minimum pumping power and lowest return water temperatures.
Each pair of apartments is served by one riser: there are 6no heating risers. When compared to a more-typical single riser with long horizontal branches, very little horizontal pipework is required. This reduces the total length of pipework substantially. Separately located are two risers for mains water, which can thus remain cool. Pipe work is sized at higher pressure loss to reduce bore & so heat loss. High quality insulation including thermally broken supports is applied to the full length of circulating pipework, including all fittings and components, and throughout all wall/floor penetrations.

10.3 Apartment & maisonette heating

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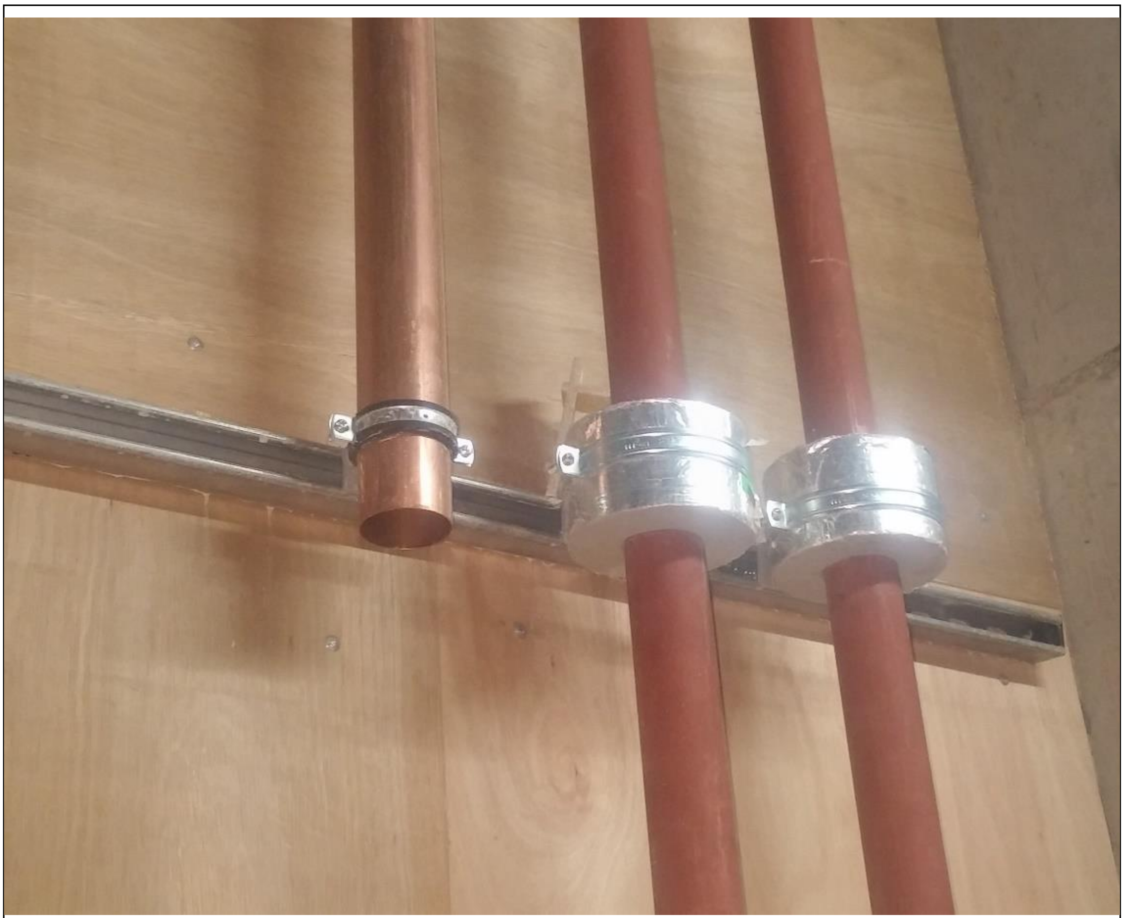
3 https://www.cibsejournal.com/case-studies/agar-grove-performance-assured/
4 New Metrics for Communal Heating Design - Max Fordham
5 https://www.cibse.org/knowledge/knowledge-items/detail?id=a0q3Y00000IMrmGQAT

Low temperature hot water (LTHW) at 55-65C is circulated to a heat interface, metering and control unit (HIU) in each apartment. Fully insulated SAV 5 HIUs were selected for their minimum heat loss and reliable controls. Hot water is generated instantaneously & hygienically on demand by a heat exchanger. Hot water distribution is in a radial arrangement with 10mm small bore pipework to reduce dead leg volumes.

The apartment space heating is connected directly to the communal LTHW system (as opposed to indirectly via a second heat exchanger). Radiators are generously sized. They are thermostatically controlled with flow limiting valves. All of these features ensure low return temperatures, even at part loads. Only two radiators were required per apartment to provide the necessary heat. In the bathrooms 'wet' towel rails connected to the heating circuits are provided. These also have an electric element for summer use. If residents require a very warm interior, portable electric radiators are available for their use.



Thermally isolated pipe supports, during installation.

4no boilers allow fine modulation for low heat loads. Circulator pumps were also selected and arranged to modulate to <5% of peak

Remote differential pressure sensor for close control of variable speed LTHW pumping.

11 PHPP calculations

Passive House Verification

		Building:	Flats 1 - 38
		Street:	14 - 16 Wrotham Road
		Postcode/City:	NW1 0RE / London
		Province/Country:	GB-United Kingdom/ Britain
		Building type:	Domestic
		Climate data set:	GB0001a-London (Central)
		Climate zone:	4: Warm-temperate; Altitude of location: 33 m
		Home owner / Client:	London Borough of Camden
		Street:	33-35 Jamestown Road
		Postcode/City:	NW1 7DB / London
		Province/Country:	GB-United Kingdom/ Britain
Architecture:	Hawkins Brown / Architype	**Mechanical system:**	Max Fordham / Mark Robinson
Street:	159 Saint John Street / Upper Twyford	Street:	42-43 Gloucester Crescent / Unit 1, 6 Enterprise Way
Postcode/City:	EC1V 4QJ / HR London / Hereford	Postcode/City:	NW1 7PE / SV London
Province/Country:	London / Herefordshire; GB-United Kingdom/ Britain	Province/Country:	GB-United Kingdom/ Britain
Energy consultancy:	Max Fordham / Architype	**Certification:**	WARM: Low Energy Building Practice
Street:	42-43 Gloucester Crescent / Upper Twyford	Street:	3 Admirals Hard
Postcode/City:	NW1 7PE / HR2 London / Hereford	Postcode/City:	PL1 3RJ / Plymouth
Province/Country:	London / Herefordshire; GB-United Kingdom/ Britain	Province/Country:	Devon; GB-United Kingdom/ Britain

Year of construction:	2018	Interior temperature winter [°C]:	20.0	Interior temp. summer [°C]:	25.0
No. of dwelling units:	38	Internal heat gains (IHG) heating case [W/m²]:	2.7	IHG cooling case [W/m²]:	3.6
No. of occupants:	81.3	Specific capacity [Wh/K per m² TFA]:	84	Mechanical cooling:	

Specific building characteristics with reference to the treated floor area

				Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area m²	3265.0				
Space heating	Heating demand kWh/(m²a)	13	≤	15	-	yes
	Heating load W/m²	9	≤	-	10	
	Frequency of overheating (> 25 °C) %	6	≤	10		yes
	Frequency excessively high humidity (> 12 g/kg) %	0	≤	20		yes
Airtightness	Pressurization test result n_{50} 1/h	0.6	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	118	≤	120		yes

[2] Empty field: Data missing; '-': No requirement

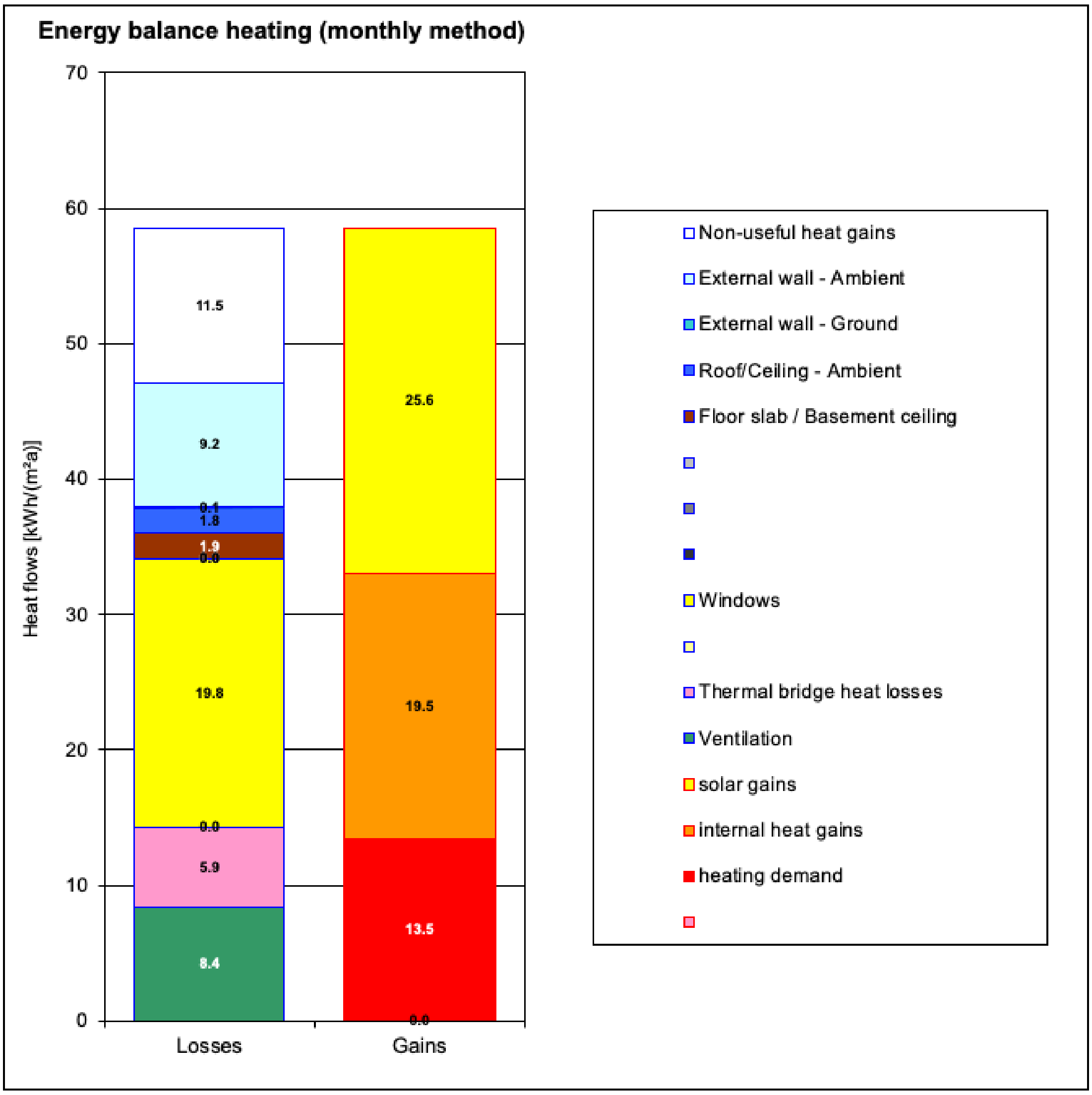
I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

Passive House Classic? yes

Snapshot of Verification Overview

The building achieved a final Heating Demand of 13.48 kWh/(m^{2}a) which is less than the Passivhaus criteria of 15 kWh/(m^{2}a). Although the building was certified under the Heating Demand criteria, the building also achieved a favourable Heating Load value of 9.36 W/m^2 which is less that the alternative certification criterial of 10 W/m^2.

Frequency of overheating (>25°C) calculates at 6% which passes based on the Passivhaus maximum criteria of 10%. Individual units have been assessed using dynamic thermal simulation methodology and each unit passes based on the individual unit cooling/ventilation strategy agreed for the design.



Heating Energy Balance (Monthly)

The transparent (windows & doors) elements account for just over a third, 33.8% of the total losses, the external walls account for almost a fifth, 15.7%.

The transparent elements account for 43.7% of total heat gains Internal heat sources contribute around a third, 33.3%. Resulting in the heating demand that remains at 13.48 kWh/(m^{2}a).

12 Construction costs

- The Project was delivered by Camden Council's Community Investment Programme (CIP) which invests in the long term future of the borough.
- The clients quantity surveyors describe the build costs were £2,713 /m^2 as per the build contract, which was comparable to a Non-Passivhaus scheme on this site.

13 Measured results in use

13.1 Measurement data acquisition

Max Fordham and LB Camden performed post occupancy evaluation. This involved:

- Monitoring of internal conditions
- Monitoring of building services set points and efficiencies
- Interviews with occupants to gauge their comfort & satisfaction, as part of regular Building User Surveys.

13.2 Measured energy consumption values; communal heating

As described above, the communal heating system was thoroughly tested against robust metrics post-completion yet pre-handover. This included 24 hours of running in ‘idle’ then 24 hours of mimicked actual demand.

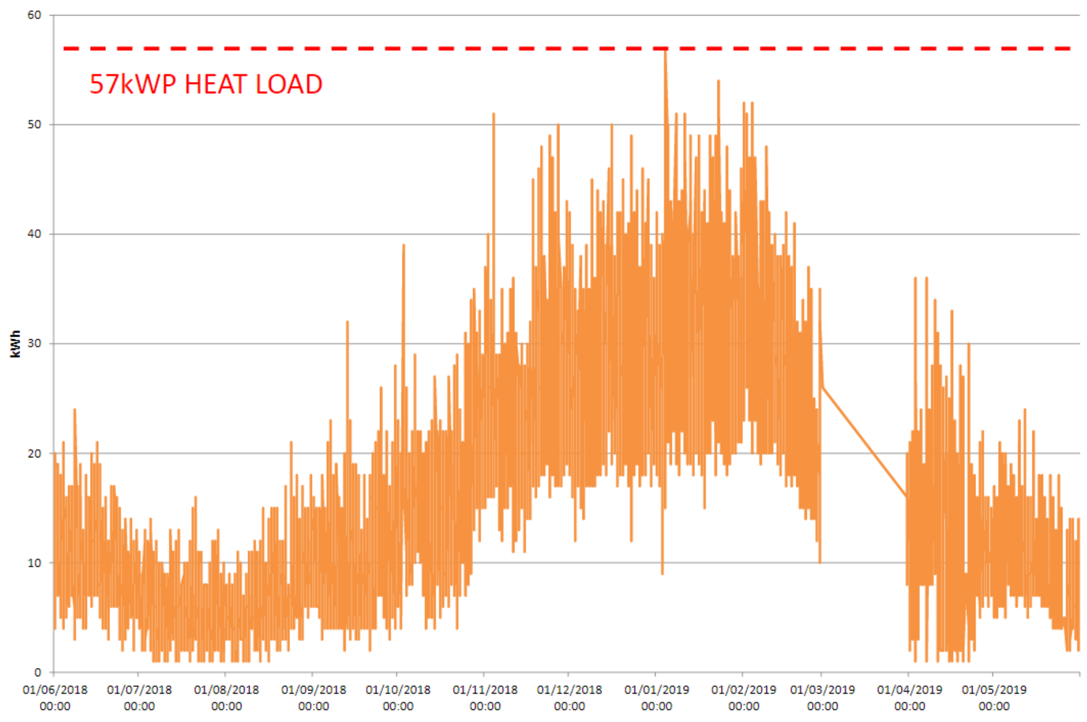
Basic quality control checks such as this are unfortunately a rarity, even in high profile buildings such as this. The PHI do not explicitly require validation of communal system distribution efficiency prior to certification. This is a weakness in the process, as highlighted in a paper presented to the PH Conference in Munich, 2018[6].

The results of the as built testing of the communal heating systems at Agar Grove are presented below. These metrics can be set at the briefing stage, checked at each design stage, measured pre-handover and in occupation.

6 https://www.maxfordham.com/assets/media/downloads/20180310%20Efficient%20heat%20system%20design%20in%20large%20PassivHaus%20multifamily%20buildings;%20A%20UK%20experience.pdf

KPI		Target Value	London scheme measured
Total distribution pipe length per customer	m/ customer	30	25
VWART Volume Weighted Average Return-water Temperature	°C	<40	40
Bypass flow	% of peak	<5	0
Continuous distribution loss between plant room and HIU	W/ customer	50	90

Communal heating scheme; measured performance at commissioning vs. best-case target metrics7



Building heat load as measured in January 2018_Max Fordham

Instantaneous peak heating load was measured as 57kW in 2018. This is approximately 17W/m^2. This is heat load as measured at the boiler, so will include losses from distribution, which may partially explain the increase from PHPP heat load

[7] https://www.maxfordham.com/research-innovation/new-metrics-for-communal-heating-design/

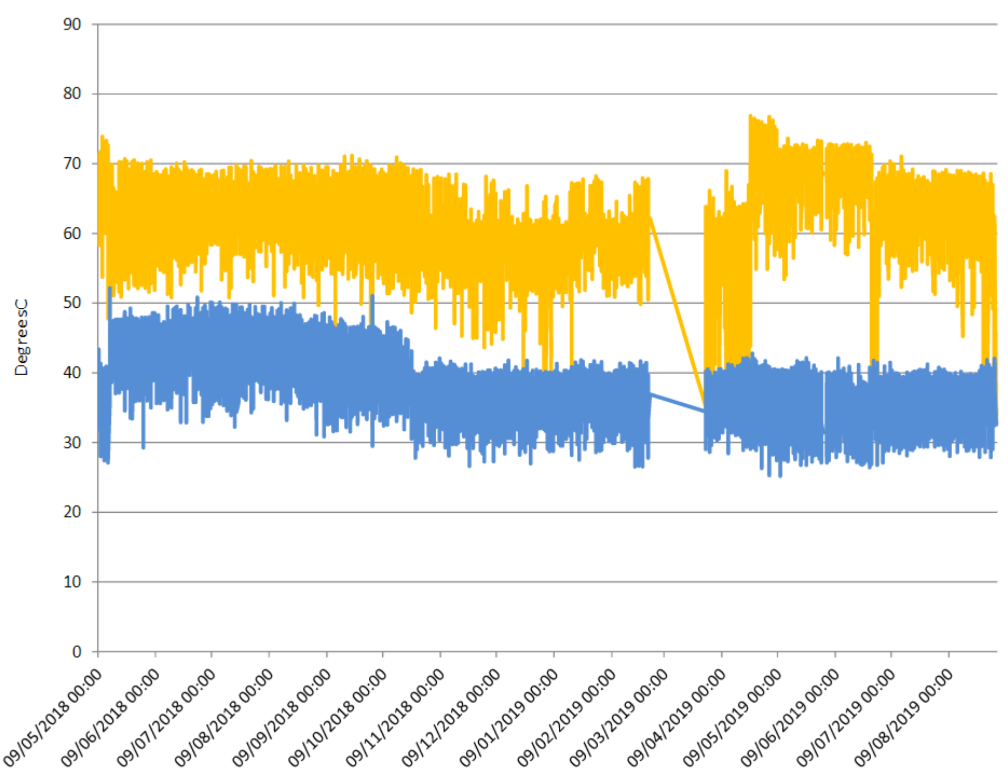
(measured in occupied zone) or 9W/m^2. External & internal conditions, hot water load and controls may also contribute to the differential between prediction and measurement.

At design stage Agar Grove communal system was designed at 55C flow and 35C return. The low flow temperature was set to minimise distribution losses. The flow temperature has been increased in occupation by facilities management to 65C flow 35C return. This was a response to improve stability of the heat supply.

Distribution losses in use have been reported as 162W/customer. If this figure is too high it can lead to summer overheating amongst other issues. This sensitivity is relevant to any modern efficient multifamily building.

Although this is an increase on the target, it still compares very favourably to other measured schemes. Typical modern systems are at 400W, and national averages are above 700 W/customer[8].

A good measurement of the health of a communal heating system is the delta or difference between flow and return temperatures. Communal systems may typically be designed at 80C flow, 60C return (20K delta). However, in reality, due to poor design or commissioning they will operate at less than 5K delta. This leads to high heat losses and pumping power.



Communal heating flow and return temperatures measured during July 2018_Max Fordham

[8] https://www.gov.uk/government/publications/energy-trends-march-2018-special-feature-article-experimental-statistics-on-heat-networks

The graph above, of May to August 2019, shows a stable differential of around 30K. This demonstrates a well-designed, installed, commissioned, and maintained system.

13.3 Ventilation monitoring

The communal ventilation systems are equipped with onboard monitoring systems. At the time of writing results from this are not available for review.

13.4 The user experience; in-use surveys

The redevelopment of the wider Agar Grove Estate is deliberately phased over 10+ years; in order to minimise the disruption to the social fabric of the existing community. The phasing includes a single decant for all but one. The decant strategy has been carefully planned to allow for the single decant and redeveloping in stages across six phases. This fundamental principle was set by LB Camden to minimise disruption to residents.

Building User Surveys were undertaken in the first year by LB Camden. Most homes responded; the results were broadly positive. Some quotes and results presented below.

- "Light, airy and comfortable."
- "Never feel the cold in this flat"
- "Quietness, light, space"
- Air quality is good or very good (86% agree)

The survey identified a need to remind users to operate internal curtains to control solar gain.

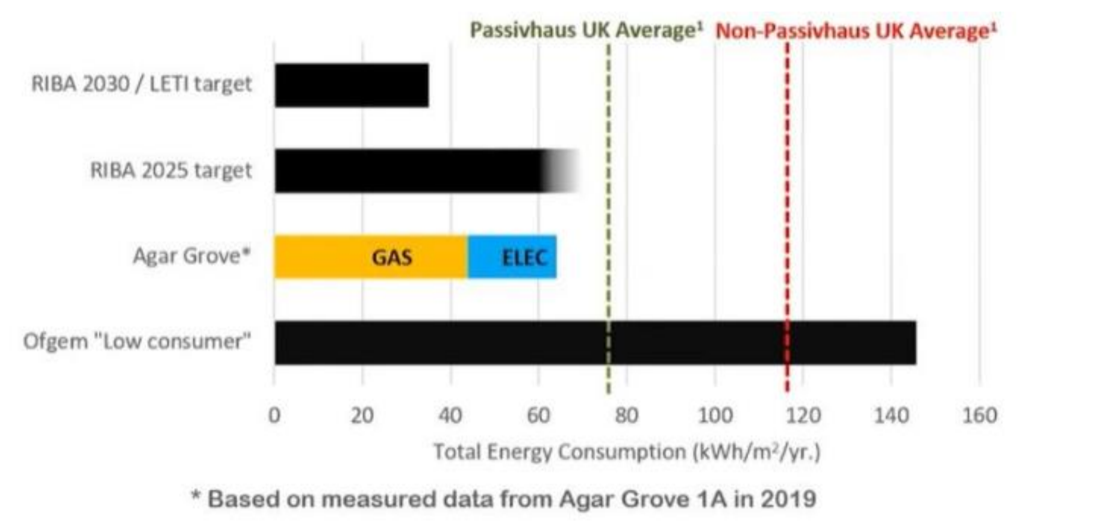
Condition monitoring of a few example apartments was carried out for one calendar year. CO_2, relative humidity and internal temperature were logged at half hour intervals.

- The CO_2 levels were found to be rarely above 600ppm with occasional maximums of 1000ppm.
- Relative humidty was found to be between 60%- 30% with occasional lows of 25%
- Winter internal temperature did not drop beneath 20C
- Summer internal temperature was above 26C in June & July. Fewer than 10 days in the year were greater than 30C. The summer in question was declared by the Met Office declared to be the joint hottest on record[9].

[9] https://en.wikipedia.org/wiki/2018_British_Isles_heat_wave

13.5 Measured energy demand in Agar Grove

The results of metered energy demand are presented below.



The graph above shows measured data from 2019 for energy consumption; comparing favourably to Passivhaus limits and to comparable targets. _Max Fordham

Specific energy value (final energy)	**Energy source**	**Measured data 2018/19**
All heat[10]	Gas via communal system	44 kWh/m^2.a
All electricity[11]	Grid	20 kWh/m^2.a

Measured total energy consumption from 2018/19 shows the building total energy consumption is within Passivhaus metrics.

[10] Including distribution losses, excluding boiler efficiency
[11] Total metered electrical use within flats (excluding communal systems) .

Winter sun penetrating through the balconies deep into the South facing living rooms

14 References

See footnotes in body text.

15 News Articles

Awards:

- Passivhaus Trust Award 2021; Large Building Category winner
- CIBSE Building Performance Awards 2020; Residential project of the year
- New London Architecture 2019 Overall winner
- New London Architecture 2019 Sustainability prize
- CIBSE Awards 2020 - Project of the Year - Residential - Winner
- Housing Design Awards 2019 - Completed - Shortlisted
- RTPI Awards 2019 - Excellence in Planning for Homes (small) - Shortlisted
- London Planning Awards 2019 - The Mayor's Award for Sustainable and Environmental Planning, and Good Growth - Winner
- The Sunday Times British Homes Awards 2018 - Development of the year (more than 100 homes) - Shortlisted
- The Sunday Times British Homes Awards 2015 - Housing Project - Commendation
- Housing Design Awards 2015 - Project Schemes - Winner
- BD Architect of the Year Awards 2014 - Masterplanning & Public Realm - Shortlisted
- BD Architect of the Year Awards 2013 - Masterplanning and Public Realm - Shortlisted

Articles:

- https://www.cibsejournal.com/case-studies/agar-grove-performance-assured/
- https://www.cibsejournal.com/case-studies/london-calling-passivhaus-goes-mainstream-in-camden/
- https://www.maxfordham.com/research-innovation/new-metrics-for-communal-heating-design/
- https://passivehouseplus.ie/magazine/new-build/big-time-uk-s-largest-passive-scheme-comes-to-camden
- https://www.cibse.org/Building-Performance-Awards/2020-Winners/Project-of-the-Year-%E2%80%93-Residential
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