Energy Statement

PHASE 2 AGAR GROVE

October 2018

Report Ref: ES/AGP2/201810 - BC

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Disclaimer

The performances of renewable systems, especially wind and solar, are difficult to predict with any certainty. This is due to the variability of environmental conditions from location to location and from year to year. As such all budget/cost/sizings, which are based upon the best available information, are to be taken as estimation only and should not be considered as a guarantee. NRG Consulting disclaims any responsibility to the Client and others in respect of any matters outside the scope of this report. This report is confidential to the Client and NRG Consulting accepts no responsibility of whatsoever nature to third parties to whom this report or any part thereof is made known. Any such party relies upon the report at their own risk.

1. EXECUTIVE SUMMARY

1.1 NRG Consulting have been appointed by London Borough of Camden to undertake an Energy Statement for the proposed redevelopment of Agar Grove Estate in Camden, NW1.

1.2 The proposal is for the demolition of all existing buildings and structures except Lulworth House and Agar Children's Centre (249 existing Class C3 residential units and 2 retail units), and erection of new buildings ranging between 4 and 18 storeys in heights along with the refurbishment and extension of Lulworth House (extending from 18 to 20 storeys in total) to provide a total of 493 Class C3 residential units, comprising 240 market, 37 intermediate and 216 social rent units; a community facility (Class D1); 2 flexible retail shop (Class A1) or restaurant and café (Class A3) units; business space (Class B1(a)); 2 flexible retail shops (Class A1), business (Class B1), or non-residential institution (Class D1) units; refuse and recycling facilities; car and cycle parking facilities; landscaping/amenity space; and associated works.

This report has been prepared specifically for Phase 2 of the development, comprising 57 residential units distributed between Blocks F, G and H as follows:

- Block F – 4-storey mansion block containing 14 stacked Duplexes;
- Block G – 5-storey mansion block containing 17 Triplexes and 5 Maisonettes;
- Block H – a pair of 4-storey high separated mansion blocks containing a total of 20 Duplex and Triplex units.

1.3 This document has been produced to address the energy requirements of Planning Condition 43 of the associated Application Ref: 2013/8088/P, which states:

Planning Condition 43 – Energy Efficiency

"The development shall be carried out in complete accordance with the submitted Planning Energy & Sustainability Report by Max Fordham, dated 11/12/2013 to achieve a minimum of 32% reduction in carbon emissions from the development, and evidence of passivhaus certification shall be submitted to and approved in writing by the local planning authority prior to the first occupation of any residential unit within the relevant phase of the development (a) phase 1; b) phase 2; c) phase 3; d) phase 4; e) phase 5; f) phase 6), unless an alternative strategy is submitted to and approved in writing by the local planning authority. The Plan shall contain mechanisms for monitoring, review and further approval by the local planning authority. The development shall at all times proceed in accordance with such Plan as will have been approved."

The Planning Condition requires a CO_2 emissions reduction of 32%. Due to the Planning Energy and Sustainability Report by Max Fordham referenced above being based on Part L 2010 and the guidance at that time, the original 32% target is being updated to 27% over Part L 2013, following the adoption of the 2013 Building Regulations Approved Document L1A.

1.4 The proposed energy strategy details how the development's CO2 emissions are reduced by 27% over Part L 2013 through measures prioritised in accordance with the Energy Hierarchy:

- *Be Lean (21.88% CO_2 reduction over Part L)*
    - Low U-values
    - Low Air Permeability
    - Mechanical Ventilation with Heat Recovery
    - Triple Glazed Windows

- High Efficiency Communal Gas Boiler with Low Temperature Distribution System and Modern Controls
- Heat Interface Units for Hot Water
- 100% Low Energy Lighting

- *Be Green (27.00% CO_2 reduction over Part L)*
  - 11.2 kWp of Photovoltaic Panels comprising 35no. modules

Calculations of the CO_2 emissions at each stage of the Energy Hierarchy are detailed in a table in Appendix 1.

1.5 All units of Phase 2 of the development will have Passivhaus Certification and Code for Sustainable Homes Level 4. The completed buildings will be verified by the Passivhaus Institute in Damstratt Germany. The 'fabric first approach' adopted to achieve these standards is detailed in Section 4.

1.6 This report responds to the energy requirements of the following:

- The National Planning Policy Framework (2012);
- Chapter 5 of the London Plan (March 2016):
  - Policy 5.1: Climate Change Mitigation
  - Policy 5.2: Minimising Carbon Dioxide Emissions
  - Policy 5.3: Sustainable Design and Construction
  - Policy 5.6: Decentralised Energy in Development Proposals
  - Policy 5.7: Renewable Energy
  - Policy 5.9: Overheating and Cooling
- The Mayor's Sustainable Design and Construction SPG (2014);
- The GLA Guidance on preparing energy assessment (2016);
- The Local Development Scheme of London Borough of Camden.

2. BASELINE CO_2 EMISSIONS

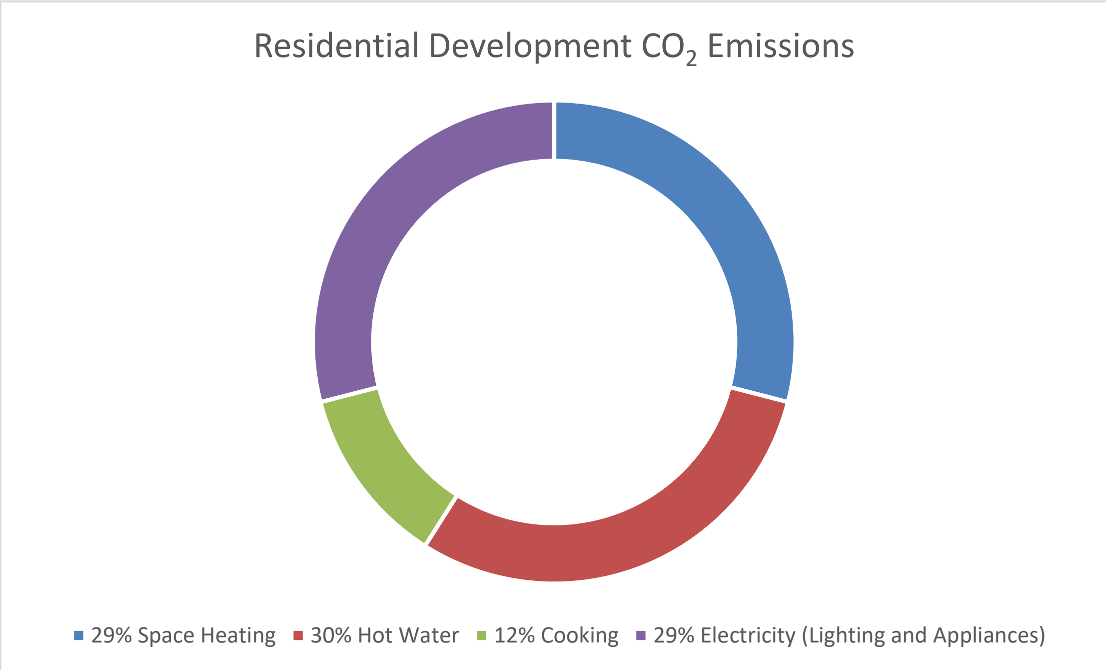
2.1 In order to estimate the predicted energy demand and regulated CO_2 emissions for the site, SAP Calculations have been carried out on all plots by a licensed and OCDEA accredited SAP Assessors using the NHER Plan Assessors Version 6.3.4.

2.2 The baseline CO_2 emissions covered by Part L 2013 of the Building Regulations will be expressed as the Target Emissions Rate (TER), obtained from the SAP calculations.

2.3 Regulated CO_2 emissions result from the energy use for:

- Space heating
- Hot Water
- Lighting
- Pumps and Fans

2.4 Typical CO_2 emissions for residential development are broken down as follows:



2.5 Unregulated energy use is not counted within SAP or for the purpose of Part L. For residential development, it typically includes energy uses in areas not directly covered by Building Regulations, infrastructure and external areas such as:

- Small power (appliances)
- Cooking
- Lighting to the communal corridors and stairwells
- External Lighting (roads, courtyard, bin and cycle store)

2.6 Unregulated CO_2 emissions have been calculated using the BREDEM-12 methodology via a spreadsheet issued by NHER which is based on the occupancy rate of the dwellings. Due to the nature of these emissions, it is impossible to predict by how much they can be reduced as this relies outside the control of the authors and developers. Therefore, these emissions as noted will remain the same throughout the energy hierarchy.

2.7 According to the SAP calculations, the baseline CO_2 emissions of the development are as follows:

	CO_2 Emissions (Tonnes per Annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development (TER)	**93.3**	**93.9**

3. BE LEAN

3.1 Passive Design – Building Fabric

The design of the development prioritises passive measures in order minimise heat loss cost effectively and achieve Passivhaus standards. The external envelope of the buildings will be highly insulated, airtight and free of thermal bridging conditions, with parameters selected to exceed the minimum requirements of the Building Regulations, as follows:

Element	Part L1A Limiting Fabric Parameters	Proposed Parameters
Ground Floors U-value	0.25 W/m^2K	0.09 - 0.11 W/m^2K
Exposed Upper Floors U-value	0.25 W/m^2K	0.2 W/m^2K
Main External Walls U-value	0.3 W/m^2K	0.15 W/m^2K
Dormers/Mansard Walls U-value	0.3 W/m^2K	0.11 W/m^2K
Sheltered Walls U-value	0.3 W/m^2K	0.13 W/m^2K
Party Walls U-value	0.2 W/m^2K	0.0 W/m^2K
Main Roofs U-value	0.2 W/m^2K	0.13 W/m^2K
Terraced Roofs U-value	0.2 W/m^2K	0.2 W/m^2K
Windows U-value	2 W/m^2K	0.93 W/m^2K Triple Glazing with Metal Frame and Low g-value
Doors U-value	2 W/m^2K	0.93 W/m^2K
Air Permeability	10 $m^3/(hm^2)$ @50Pa	3 $m^3/(hm^2)$ @50Pa
Thermal Bridging	Manual y-value calculation A mixture of SAP Default and bespoke calculations used for applicable thermal junctions. (Link to ACD details)	

3.2 Active Design – Building Services

The development will incorporate efficient building services to limit carbon emissions, including low-NOx heating system with energy efficient equipment, MVHR and low energy lighting. Real time smart energy monitors will be provided to all dwellings to enable occupiers to understand and adapt their energy use. The proposed building services are in compliance with the Domestic Building Services Compliance Guide (2013) and are detailed in the table below:

Building Services	Specifications
Ventilation	System 4 – MVHR Zehnder ComfoAir
Space Heating	Mains Gas Community Boilers Seasonal Efficiency of 97.1%
Emitters	Radiators
Heating Controls	Charging system linked to use, Programmer and at least 2 Room Thermostats
Hot Water	Heat Interface Units
Cooling	No Cooling
Lighting	100% Low Energy Bulbs Minimum luminous efficacy of 45 lm/c/W

3.3 A SAP Input Data Sheet for a representative plot can be found in the appendices to verify the above inputs.

3.4 By adopting enhanced building fabric and energy efficient services, the CO_2 emissions of the development are reduced by 21.88% over Part L 2013 as follows:

	CO_2 Emissions (Tonnes per Annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development (TER)	**93.3**	**93.9**
Be Lean: Energy Demand Reduction	**72.9**	
Regulated CO_2 Savings at *'Be Lean'* over Part L 2013	**21.88%**	

4. PASSIVHAUS STANDARDS

4.1 All units will be Passivhaus certified and the completed buildings will be verified by the Passivhaus Institute in Damstratt Germany to ensure they meet the strict energy performance requirements. The standard will be achieved by implementing 'passive' energy efficiency measures to deliver high energy performance and low consumption. The Passivhaus minimum criteria for the building fabric and services are:

- The external envelope will be highly insulated, airtight and free of thermal bridging conditions to reduce heat loss. This is being achieved via the following:
    - Low U-values achieved via high levels of insulation to the floors, walls and roofs;
    - Triple Glazed Windows with Metal Frame which will act as acoustic barriers when closed. The location and height of the windows will maximise access to daylight, sunlight and passive solar gains.
    - Air Permeability rates of maximum 3 m^3/hm^2 at 50 Pascals of pressure will help avoid cold draughts and improve comfort, while also reducing heat loss.
    - Heat loss through the building envelope will be minimised by targeting low U-values for doors as well.
    - Manual y-value calculations have been undertaken to minimise cold bridging and prevent the dwellings of cold spots which can lead to mould.

- The building services will supply energy efficiently and will have low energy equipment. The proposed specifications are:
    - Mechanical Ventilation with Heat Recovery units will be installed to each dwelling to continually supply fresh air and re-use up to 95% of the heat the would otherwise be lost.
    - Mains Gas Communal Boilers will supply energy with a seasonal efficiency of 97.1% and deliver substantial CO_2 savings.
    - Heat will be delivered via low temperature distribution system from the plantrooms to radiators in each dwelling. The pipes will be pre-insulated to minimise heat loss and prevent the risk of overheating. The heat distribution infrastructure will be designed to minimise pipe length to limit internal heat generation. In line with the CIBSE Heat Networks: Code of Practice, the maximum network flor and return temperatures will be of 70 C° and 40 C° respectively.
    - Energy saving heating controls will be installed, consisting of charging system linked to use, programmer and minimum 2 room thermostats per dwelling.
    - Hot Water will be supplied via individual Heat Interface Units to each dwelling.
    - Low energy lighting system with a minimum luminous efficacy of 45 lm/W will be installed throughout the buildings to minimise internal heat gains and energy use. There will be dedicated light controls and low energy fittings in the communal areas.
    - A or A+ rated electrical equipment.

4.2 Following this 'fabric first' model, the development achieves a reduction in regulated carbon emissions of **21.88**% over the Part L 2013 baseline. Further CO_2 savings are achieved at the 'Be Green' stage via a PV array of 11.2 kWp, comprising 35no. modules, as detailed in the following section.

4.3 The development will be Passivhaus certified by WARM via a compliant PHPP Model being undertaken by the Passivhaus Assessors (Architype). These details have been included in our calculations.

5. BE GREEN

5.1 The feasibility of all applicable renewable energy technologies is investigated below, taking into consideration the following factors:

- CO_2 savings achieved;
- Site constraints and opportunities;
- Potential conflicts with alternative solutions;
- Level of maintenance;
- Cost.

Solar Photovoltaic	
Advantages	**Disadvantages**
• It can provide significant CO_2 savings by producing electricity which is carbon intensive; • It is relatively easy to install and manage compared to other renewable technologies; • It requires no fuel; • It has a zero-carbon footprint, with no GHG emitted from its operation; • Feed-in Tariffs are available for excess energy produced, which can be sent to the grid;	• Its efficiency depends on the roof location and orientation and therefore these parameters will be carefully considered; • It has low efficiencies at nights and under clouds; • It requires un-obstructed and un-shaded space of the roof;
Feasibility Solar PV would successfully contribute to achieving the CO_2 reduction target of 27%, while also meeting the on-site electrical demand. The buildings provide sufficient, un-obstructed roof spaces for the installation of PV panels. Therefore, this technology is deemed feasible for the development.	

Solar Thermal Collectors	
Advantages	**Disadvantages**
• It is relatively easy to install and manage; • It has low capital cost and near-zero maintenance costs; • No fuel is required; • There are no associated noise issues or GHG emissions;	• additional plumbing and space for hot water storage is required, which may reduce the liveable space of the dwellings; • there are no direct CO_2 savings if there is no significant hot water demand; the system can be designed to meet up to 60% of the hot water demand and therefore CO_2 savings are limited; • long piperun from the collectors to the cylinders is required, resulting in distribution losses;
Feasibility This technology is considered less advantageous than PV due to:	

- the additional space required for Hot Water Cylinder which may reduce the area of the dwellings, especially with the Heat Interface Units proposed;
- the additional requirement for plumbing;
- the potential risk of overheating due to distribution losses from the collectors to the cylinders;
- lower CO2 savings.

As solar thermal collectors compete with PV for suitable roof space, they are being discounted in favour of PV, which is more cost-effective per tonne of CO2 saved and more convenient for the above reasons.

Biomass

Advantages	Disadvantages
• It has no requirement for additional gas or electrical supplies; • It has the potential to reduce a substantial amount of CO_2. • It would replace a conventional gas heating system, meaning the cost may be offset through money saved on a traditional boiler;	• The burning of wood pellets releases substantially more NOx emissions than a gas boiler, which could reduce the air quality of the site. • Regular fuel transportation and waste disposal required would add to air quality and traffic issues; • There is low availability of fuel supply contractors; • A plant room, fuel and ash storage is required, which may take additional land from the development; • Requires taller flues than gas boilers;

Feasibility

Biomass is not a preferred system due to potentially high NOx and particulate emissions which may have negative impacts upon the local air quality. Furthermore, fuel storage and delivery and waste disposal would be difficult due to space constraints on-site and lack of local biomass suppliers.

Air Source Heat Pumps (ASHP)

Advantages	Disadvantages
• The system has high performance coefficients (COP), producing 2-3 units of heat energy for every unit of input energy; • As ASHPs would replace a standard heating system, part of the cost would be offset through money saved on a traditional boiler; • It reaches optimum efficiencies with low temperature systems, such as underfloor heating; • It is easier and cheaper to install than a GSHP due to no requirement for buried pipes;	• Heat pumps have higher associated CO_2 emissions than a gas boiler, primarily due to the electric immersion top-up for hot water and the electricity required to run the pump; • Compared to a GSHP, it has lower COP due to varying levels of air temperatures compared to a more stable ground temperature; • The outdoor condensing unit can have negative visual and noise impacts, with noise levels of 50-60dB; • It is most effective for sites not connected to gas networks;

Feasibility

As this is a residential development, issues of noise may be of concern especially at night. The units would require providing heat in the winter when the difference between the internal and external air temperatures would be large, making the system less efficient. With gas available on site, there are no benefits of implementing electric heat pumps as the associated carbon emissions would be higher when compared to a gas heating system. Therefore, ASHP is discounted in favour of gas boilers and PV, which offer simpler installation and greater CO_2 savings.

Ground Source Heat Pumps (GSHP)	
Advantages	**Disadvantages**
• It has higher performance coefficients than ASHPs; • It has low maintenance and it is easy to manage; • As GSHPs would replace a standard heating system, part of the cost would be offset through money saved on a traditional boiler;	• A geological study would be required to see if the soil can provide adequate thermal transfer; • It is best suited for developments that have both a heating and cooling demand; • It has higher running costs than a conventional gas system; • The installation of ground loops would significantly increase the construction time and complexity; • The cost of installing boreholes is very high; • Boreholes require a significant amount of space on site;

Feasibility

A GSHP system would not deliver substantial carbon savings given the installation complexity and high capital cost which would outweigh the benefits, in comparison to other renewable technologies such as PV. The large infrastructure required would reduce the amenity space and the energy output would not be maximised with the lack of underfloor heating. Therefore, this technology is being discounted in favour of gas boilers and PV.

5.2 Following the above feasibility, PV panels are considered the most suitable renewable energy technology to maximise CO_2 savings on-site. The proposed system details are:

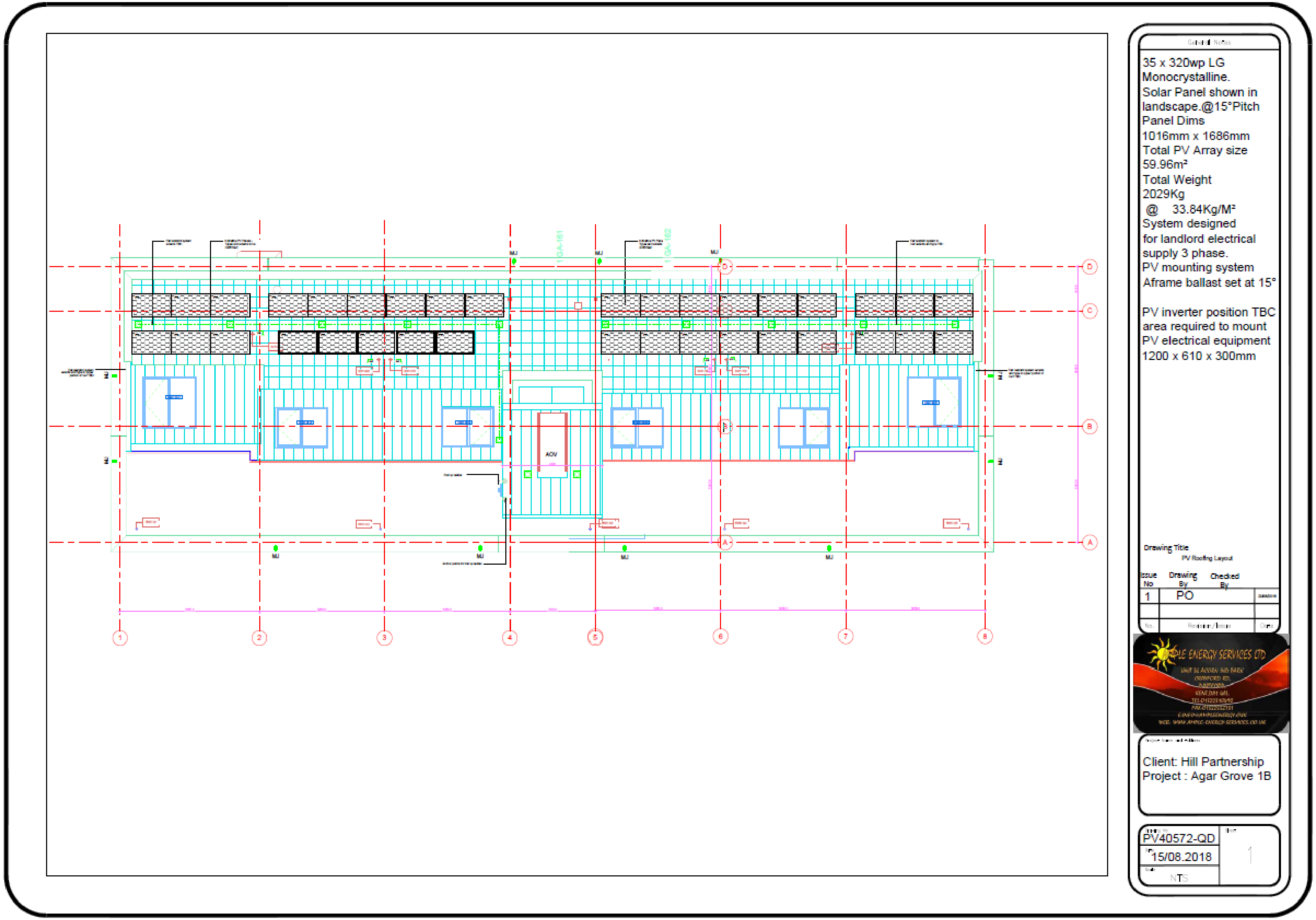
PV System Details	
CO_2 Reduction required for 27% Target	**4.78 tonnes CO_2/year**
CO_2 Offset via 1kWp	**0.427 tonnes CO_2/year**
PV Proposed for 27% Target	**11.2 kWp**
Module Output	**320 Watts**
Location	**Roof of Block G**

Tilt of Collectors	**15 to 37.5 degrees**
Orientation	**South-West**
Over-shading Factor	**<20%**
Number of Modules	**35no.**

5.3 The CO_2 savings achieved through the PV system amounts to an additional 6.56% reduction in regulated emissions over the 'Be Lean' stage. Overall, the proposed scheme achieved a regulated CO_2 emissions reduction of 27.00% over the Part L 2013 baseline, which meets the requirement of Planning Condition 43, as shown below:

	CO_2 Emissions (Tonnes per Annum)	
	Regulated	**Unregulated**
Baseline: Part L 2013 of the Building Regulations Compliant Development (TER)	**93.3**	**93.9**
Be Lean: Energy Demand Reduction	**72.9**	
Be Green: Renewable Energy	**68.1**	
Regulated CO_2 Savings at *'Be Green'* over Part L 2013	**27.00%**	

5.4 The PV Array will be installed on the roof of Block G only and will be facing SW for optimised output. An indicative layout of the system, taking into consideration there is no significant over-shading and sufficient access for installation and maintenance is provided, is illustrated on the following page:


35 x 320wp LG Monocrystalline.
Solar Panel shown in landscape.@15°Pitch
Panel Dims
1016mm x 1686mm
Total PV Array size
59.96m²
Total Weight
2029Kg
@ 33.84Kg/M²
System designed for landlord electrical supply 3 phase.
PV mounting system Aframe ballast set at 15°
PV inverter position TBC area required to mount PV electrical equipment 1200 x 610 x 300mm
Drawing Title
PV Roofing Layout
Issue No
Drawing By
Checked By
1
PO
Client: Hill Partnership
Project : Agar Grove 1B
PV40572-QD
15/08.2018
NTS
AOV

6. COOLING AND OVERHEATING

6.1 Adequate measures shall be proposed in the areas where overheating is likely to be an issue. In line with London Plan Policy 5.9, the overheating prevention and cooling strategy shall be development in accordance with the following hierarchy:

Cooling Hierarchy	Measures Undertaken
Minimising internal heat generation through energy efficient design	• The development is designed to good practice insulation levels; • Energy efficient lighting which lowers the internal gains from lighting; • Heat distribution infrastructure within buildings should be designed to minimise pipe lengths, particularly lateral pipework in corridors; • Adopting pipe configurations which minimise heat loss e.g. twin pipes
Reducing the amount of heat entering the building in summer	• Carefully designed shading measures have been considered, including: i. Specification of Internal blinds ii. Trees and vegetation iii. Orientation iv. Balconies
Use of thermal mass and high ceilings to manage the heat within the building	• Level of exposed thermal mass has been maximised to help to absorb excess heat within the building.
Passive Ventilation	• Openable windows will allow natural ventilation; • Some units will be dual aspect where cross-ventilation will be possible; • Heating in communal areas is not generally required;
Mechanical ventilation	• MVHR will be installed. Mechanical Ventilation will make use of 'free cooling' (when the outside air temperature is below that in the building during summer months). This will be achieved via a by-pass mode on the heat recovery system for summer mode operation.
Active Cooling	• No Active Cooling will be required.

6.2 All dwelling assessed under Plan Assessor pass criterion 3 of the Building Regulations, set out in Appendix P of SAP 2012, which relates to limiting the effects of heat gains in summer.

6.3 CIBSE Guide A – Environmental Design (2015) is the reference standard for overheating in the GLA SPG on Sustainability and the current industry standard amongst other CIBSE guides such as CIBSE TM52 "The Limits of Thermal Comfort: Avoiding Overheating in European Buildings" (2013). These set out guidelines on the number of hours a dwelling should not exceed a certain temperature.

6.4 In conclusion, the risk of overheating can be largely mitigated through the following:

- enhanced fabric performance through high levels of insulation;
- provision of MVHR;
- insulated, low temperature heat distribution infrastructure.

7. CONCLUSION

7.1 This document has been written to satisfy the energy requirements of the following:

- The GLA Guide to Energy Statements (2016)
- The Mayor's Sustainable Design and Construction SPG (2014)
- Chapter Five of The London Plan (2016)
- The Local Plan of the London Borough of Camden.

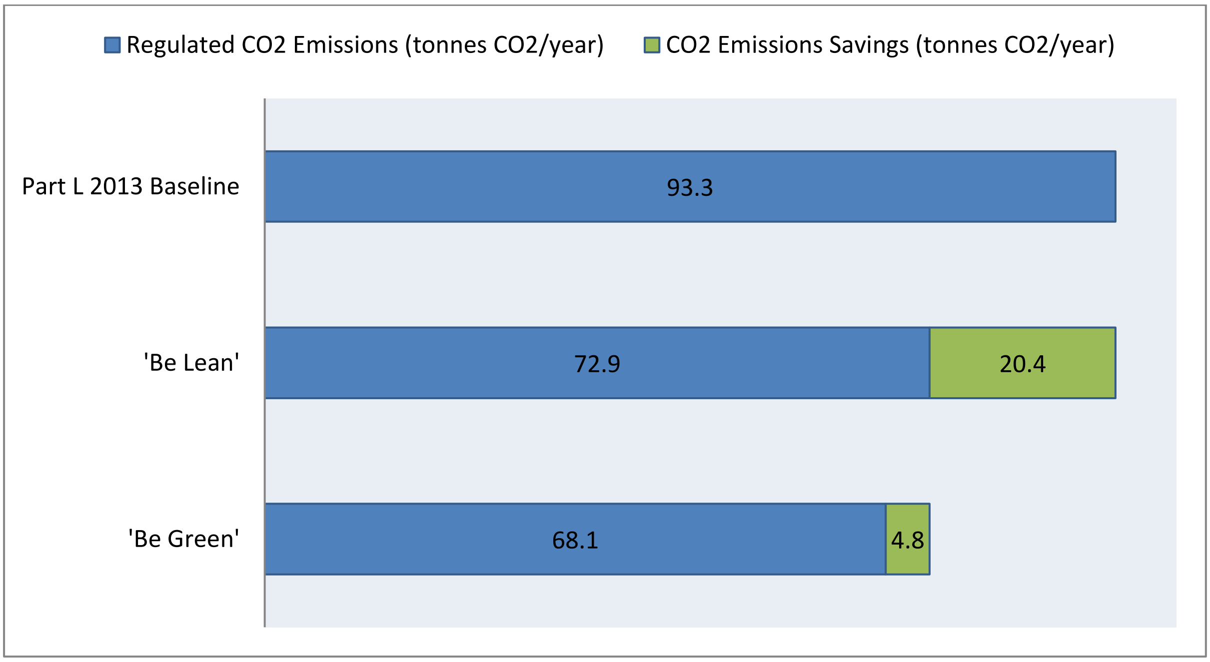
7.2 The development has CO_2 baseline emissions that are Part L compliant via passive Energy Efficiency Measures alone as highlighted in Section 4.

7.3 The baseline CO_2 emissions drop from 93.3 tonnes CO_2/year to 72.9 tonnes CO_2/year, that equates to a 21.88% decrease at the *'Be Lean'* stage, when taking into account the following:

- High levels of insulation to achieve low U-Values;
- Triple Glazed Windows;
- High efficiency Communal Gas Boilers with low temperature distribution infrastructure and modern controls;
- Heat Interface Units to each dwelling;
- Low Air Tightness requirements;
- Mechanical Ventilation with Heat Recovery;
- 100% low energy lighting with a minimum luminous efficacy of 45lm/W.

7.4 11.2 kWp of PV comprising 35no. panels are being proposed to maximise the CO_2 savings on-site and achieve the 27% CO2 reduction target of Planning Condition 43.

7.5 For clarity, the CO_2 emissions associated with each stage of the energy hierarchy are broken down below:



Appendix 1

Agar Grove
REDUCTION OF CARBON EMISSIONS BY 27%

PLOT	AREA	TER *Baseline Emissions*	Total TER	DER *'Be Lean'*	Total DER *'Be Lean'*	Unregulated Emissions	Total Unregulated
	m^2	kg $CO_2/m^2/yr$	kg CO_2/yr	kg $CO_2/m^2/yr$	kg CO_2/yr	kg $CO_2/m^2/yr$	kg CO_2/yr
F01	131.88	15.07	1,987	11.13	1,468	15.01	1,980
F02	131.88	13.86	1,828	11.72	1,546	15.01	1,980
F03	131.88	13.86	1,828	10.11	1,333	15.01	1,980
F04	131.88	13.86	1,828	10.11	1,333	15.01	1,980
F05	131.88	13.86	1,828	10.11	1,333	15.01	1,980
F06	131.88	13.86	1,828	10.11	1,333	15.01	1,980
F07	131.88	15.05	1,985	11.09	1,463	15.01	1,980
F08	97	17.11	1,660	13.11	1,272	17.39	1,687
F09	97	16.24	1,575	12.79	1,241	17.39	1,687
F10	97	16.24	1,575	12.39	1,202	17.39	1,687
F11	97	16.24	1,575	12.34	1,197	17.39	1,687
F12	97	16.24	1,575	12.74	1,236	17.39	1,687
F13	97	16.24	1,575	12.39	1,202	17.39	1,687
F14	97	17.11	1,660	13.34	1,294	17.39	1,687
H01	117.02	16.18	1,893	11.56	1,353	15.95	1,866
H02	108.62	17.38	1,888	14.17	1,539	16.54	1,797
H03	117.02	16.07	1,881	12.02	1,407	15.95	1,866
H04	117.02	16.07	1,881	12.02	1,407	15.95	1,866
H05	117.02	16.07	1,881	12.02	1,407	15.95	1,866
H06	117.02	16.18	1,893	11.56	1,353	15.95	1,866
H07	117.02	16.18	1,893	11.56	1,353	15.95	1,866
H08	108.62	17.38	1,888	14.17	1,539	16.54	1,797
H09	117.02	16.07	1,881	12.02	1,407	15.95	1,866
H10	117.02	16.27	1,904	11.63	1,361	15.95	1,866
H11	124.7	16.45	2,051	12.8	1,596	15.45	1,927
H12	120.29	16.95	2,039	14.32	1,723	15.74	1,893
H13	124.7	16.43	2,049	13.51	1,685	15.45	1,927
H14	124.7	16.48	2,055	13.48	1,681	15.45	1,927
H15	124.7	16.43	2,049	13.55	1,690	15.45	1,927
H16	124.7	16.31	2,034	12.71	1,585	15.45	1,927
H17	124.7	16.45	2,051	12.8	1,596	15.45	1,927
H18	120.29	16.95	2,039	14.32	1,723	15.74	1,893
H19	124.7	16.43	2,049	13.51	1,685	15.45	1,927
H20	124.7	16.31	2,034	12.71	1,585	15.45	1,927
G01	59.3	22.71	1,347	17.88	1,060	20.13	1,194
G02	59.3	24.37	1,445	20.53	1,217	20.13	1,194
G03	59.3	24.03	1,425	20.22	1,199	20.13	1,194
G04	59.3	22.36	1,326	17.55	1,041	20.13	1,194
G05	66.25	22.89	1,516	17.75	1,176	19.62	1,300
G06	84.09	16.44	1,382	12.7	1,068	18.34	1,542
G07	63.76	16.63	1,060	12.47	795	19.8	1,262
G08	63.76	19.28	1,229	16	1,020	19.8	1,262
G09	63.76	18.71	1,193	16.26	1,037	19.8	1,262
G10	63.76	17.2	1,097	12.91	823	19.8	1,262
G11	84.09	16.07	1,351	12.29	1,033	18.34	1,542
G12	84.93	17.45	1,482	13.3	1,130	18.28	1,553
G13	66.04	16.84	1,112	12.83	847	19.64	1,297
G14	66.04	19.1	1,261	16.15	1,067	19.64	1,297
G15	66.04	18.55	1,225	16.11	1,064	19.64	1,297
G16	66.04	17.37	1,147	13.22	873	19.64	1,297
G17	84.93	16.24	1,379	12.09	1,027	18.28	1,553
G18	84.93	18.37	1,560	14.71	1,249	18.28	1,553
G19	61.57	17.75	1,093	14.07	866	19.95	1,228
G20	61.57	19.89	1,225	17.33	1,067	19.95	1,228
G21	61.57	19.47	1,199	16.79	1,034	19.95	1,228
G22	61.57	18.18	1,119	14.54	895	19.95	1,228
G23	84.93	17.84	1,515	14.12	1,199	18.28	1,553
Total Area	**5,571**	**Total TER**	**93,329**	**Total DER *'Be Lean'***	**72,911**	**Total Unregulated**	**93,909**

CO2 Savings at 'Be Lean' (%)	21.88%
CO2 Offset Required for 27% Reduction (kg CO_2/yr)	4,781
CO_2 Offset per 1kWP PV (kg CO_2/yr)	427.00
PV Required for 27% Target (kWp)	11.20
PV Proposed (kWp)	11.20
CO_2 Reduction via PV (kg CO_2/yr)	4,782
CO_2 Emissions at 'Be Green' (kg CO_2/yr)	68,129
CO_2 Reduction over Part L 2013 at 'Be Green' (%)	27.00%

Appendix 2

Data Input Report
As Built - Draft

This as built submission has been carried out using Approved SAP software. The assessor has confirmed any changes from the design submission with the builder.

Assessor name	Mr Neil Rothon	Assessor number	4282
Client		Last modified	25/06/2018
Address	G01 Agar Grove, London, NW1		

Dwelling

Development:	N/A	House type:	
Property type:	Flat		
Flat type:	Ground floor	Year built:	2016
Tariff:	Standard	Assess summer overheating:	Yes
Thermal mass:	Medium	Thermal mass parameter:	250.00
Separated heated conservatory:	No	Degree day region:	Thames
Sheltered sides:	2	Terrain:	Dense Urban

Storeys:

Name	**Area (m²)**	**Height (m)**
Lowest occupied	59.30	4.08

Floors

Ref - Name	Type	Construction	Storey Location	Living Area (m²)	Area (m²)	U-value (W/m²K)
Floor 1 - Floor 1	Ground	Solid	Lowest occupied	36.38	59.30	0.09

Living area that has no heat loss: 0.00

Walls

Ref - Name	Type	Construction	Gross Area (m²)	U-value (W/m²K)
Wall 1 - ext MAIN	External	Cavity	40.56	0.15
Wall 2 - party	Party	Solid	42.30	0.00
Wall 3 - party to retail	Party	Solid	42.30	0.00

Roofs

Ref - Name	Construction	Gross Area (m²)	U-value (W/m²K)
Roof 1 - LOWER	Flat	6.24	0.20

Openings

Opening Ref: 1 Window, Triple glazed (low-E), ' N/A', master: Yes, linked to: 0

Location:	Wall 1	Source:	From Manufacturer	Orientation:	West
Overshading:	Average / Unknown	Width (m):	1.00	Height (m):	3.15
Frame:	Metal	Transmittance factor:	0.52	U-value (W/m²K):	0.93

Opening Ref: 2 Window, Triple glazed (low-E), ' N/A', master: No, linked to: 1

Location:	Wall 1	Source:	From Manufacturer	Orientation:	North West
Overshading:	Average / Unknown	Width (m):	0.85	Height (m):	2.70
Frame:	Metal	Transmittance factor:	0.52	U-value (W/m²K):	0.93

Opening Ref: 3 Window, Triple glazed (low-E), ' N/A', master: No, linked to: 1

Location:	Wall 1	Source:	From Manufacturer	Orientation:	West
Overshading:	Average / Unknown	Width (m):	1.02	Height (m):	2.70
Frame:	Metal	Transmittance factor:	0.52	U-value (W/m²K):	0.93

Opening Ref: 4 Window, Triple glazed (low-E), ' N/A', master: No, linked to: 1

Location:	Wall 1	Source:	From Manufacturer	Orientation:	East
Overshading:	Average / Unknown	Width (m):	1.58	Height (m):	2.78
Frame:	Metal	Transmittance factor:	0.52	U-value (W/m²K):	0.93

Opening Ref: 6 Half glazed door, Triple glazed (low-E), ' N/A', master: No, linked to: 0

Location:	Wall 1	Source:	From Manufacturer	Orientation:	N/A
Overshading:	N/A	Width (m):	1.13	Height (m):	3.00
Frame:	Metal	Transmittance factor:	0.57	U-value (W/m²K):	0.93

Thermal Bridging

Ref	Description	Length (m)	Source	ψ (W/m·K)	Result
E1	Steel lintel with perforated steel	0	Default Value	N/A	0
E2	Other lintels (including other stee	5.58	User Defined	0.113	0.6305
E3	Sill	4.45	User Defined	0.113	0.5029
E4	Jamb	28.66	User Defined	0.018	0.5159
E5	Ground floor (normal)	10.4	User Defined	0.117	1.2168
E19	Ground floor (inverted)	N/A	Default Value	N/A	0
E20	Exposed floor (normal)	N/A	Default Value	N/A	0
E21	Exposed floor (inverted)	2	Default Value	0.32	0.64
E22	Basement floor	N/A	Default Value	N/A	0
E6	Intermediate floor within a dwellin	N/A	Default Value	N/A	0
E6	Intermediate floor within a dwellin	N/A	Default Value	N/A	0
E6	Intermediate floor within a dwellin	N/A	Default Value	N/A	0
E7	Party floor between dwellings (in b	3.1	User Defined	0.049	0.1519
E7	Party floor between dwellings (in b	N/A	Default Value	N/A	0
E7	Party floor between dwellings (in b	N/A	Default Value	N/A	0
E8	Balcony within a dwelling, wall ins	N/A	Default Value	N/A	0
E9	Balcony between dwellings, wall ins	N/A	Default Value	N/A	0
E23	Balcony within or between dwellings	N/A	Default Value	N/A	0
E10	Eaves (insulation at ceiling level)	N/A	Default Value	N/A	0
E24	Eaves (insulation at ceiling level	N/A	User Defined	N/A	0
E24	Eaves (insulation at ceiling level	N/A	Default Value	N/A	0
E11	Eaves (insulation at rafter level)	N/A	Default Value	N/A	0
E12	Gable (insulation at ceiling level)	N/A	Default Value	N/A	0
E13	Gable (insulation at rafter level)	N/A	Default Value	N/A	0
E14	Flat roof	N/A	Default Value	N/A	0
E14	Flat roof	5.2	User Defined	0.127	0.6604
E15	Flat roof with parapet	N/A	Default Value	N/A	0
E16	Corner (normal)	4.8	User Defined	0.105	0.504
E16	Corner (normal)	N/A	Default Value	N/A	0
E16	Corner (normal)	N/A	Default Value	N/A	0
E17	Corner (inverted - internal area gr	N/A	Default Value	N/A	0
E18	Party wall between dwellings	10.8	User Defined	0.059	0.6372
E25	Staggered party wall between dwelli	4.8	Default Value	0.12	0.576
P1	Ground floor	22	Default Value	0.16	3.52
P6	Ground floor (inverted)	N/A	Default Value	N/A	0
P2	Intermediate floor within a dwellin	N/A	Default Value	N/A	0
P3	Intermediate floor between dwelling	19.6	Default Value	0	0
P7	Exposed floor (normal)	N/A	Default Value	N/A	0
P8	Exposed floor (inverted)	N/A	Default Value	N/A	0

P4	Roof (insulation at ceiling level)	N/A	Default Value	N/A	0
P5	Roof (insulation at rafter level)	N/A	Default Value	N/A	0
R1	Head	0	Default Value	N/A	0
R2	Sill	0	Default Value	N/A	0
R3	Jamb	0	Default Value	N/A	0
R4	Ridge (vaulted ceiling)	N/A	Default Value	N/A	0
R5	Ridge (inverted)	N/A	Default Value	N/A	0
R6	Flat ceiling	N/A	Default Value	N/A	0
R7	Flat ceiling (inverted)	N/A	Default Value	N/A	0
R8	Roof wall (rafter)	N/A	Default Value	N/A	0
R9	Roof wall (flat ceiling)	N/A	Default Value	N/A	0

Equivalent y value: 0.090

Ventilation

Air permeability entered: Yes
Seek exemption (<3 dwellings): No
Design air permeability rate: 3.00
Measured air permeability rate: 3.00
Measured in this dwelling: Yes
As-built air permeability rate: 3.00
As-built air permeability reference:

Number of...	Open fireplaces	Open flues	Flueless gas fires	Extract fans	Passive vents
	0	0	0	0	0

System Information:

Mechanical ventilation: Balanced (with heat recovery)
Values from: Product database
Product name: Zehnder ComfoAir 200
Approved installer: Yes
Number of wet rooms: Kitchen + 1 additional wet room
SFP: 0.91
Heat exchange efficiency: 93.00

Duct information:

Duct type: Rigid ductwork
Values from: Default
Product name: N/A
Duct insulation: Insulated ductwork

Space heating

Main heating category: Community scheme
Secondary heating: No
Open flue or chimney: N/A
Unconnected gas point: N/A
Smoke control area: N/A

Heat source: Mains gas - Boilers

Fraction of heat: 1.00
Efficiency (%): 97.10

Community system:

User entered distribution loss factor: No
Heat distribution system: Pre-insulated low temp variable flow (1991 or later)
Controls: Charging system linked to use, programmer and TRVs
Emitter: Radiators

Water heating

Type: From main
Cylinder in dwelling: No

Renewables

No renewables present

Other

Internal lighting

Standard fittings: 0
Low energy fittings: 1
Total fittings: 1

Summer overheating

Thermal mass parameter (TMP): 250.00

User defined air change rate:	No	Air change rate (ach):	N/A
Cross ventilation on most floors:	Yes	Window ventilation:	Fully open half the time
Source of user defined values:	N/A		
Curtains closed in daylight hours:	No	Fraction curtains closed:	N/A
Blind/curtain type:	N/A		

Special features (Appendix Q)

No Appendix Q special features present

Cooling details

No space cooling present

TER Worksheet
As Built - Draft

This as built submission has been carried out using Approved SAP software. The assessor has confirmed any changes from the design submission with the builder.

Assessor name	Mr Neil Rothon	Assessor number	4282
Client		Last modified	25/06/2018
Address	G01 Agar Grove, London, NW1		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		59.30	(1a)	x	4.08	(2a)	=	241.94	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	59.30	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			241.94	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	20	÷ (5) =	0.08	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.33	(18)
Number of sides on which the dwelling is sheltered		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.28	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.36	0.35	0.35	0.31	0.30	0.27	0.27	0.26	0.28	0.30	0.32	0.33	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
d) natural ventilation or whole house positive input ventilation from loft	0.56	0.56	0.56	0.55	0.55	0.54	0.54	0.53	0.54	0.55	0.55	0.56	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.56	0.56	0.56	0.55	0.55	0.54	0.54	0.53	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			11.43	x	1.33	=	15.15			(27)
Door			3.39	x	1.20	=	4.07			(26)
Ground floor			59.30	x	0.13	=	7.71			(28a)
External wall			25.73	x	0.18	=	4.63			(29a)
Party wall			84.60	x	0.00	=	0.00			(32)
Roof			6.24	x	0.13	=	0.81			(30)
Total area of external elements ∑A, m²			106.09							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	32.37	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		8.00	(36)
Total fabric heat loss	(33) + (36) =	40.37	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	45.11	44.91	44.71	43.78	43.61	42.80	42.80	42.65	43.11	43.61	43.96	44.33	(38)
Heat transfer coefficient, W/K (37)m + (38)m	85.48	85.28	85.08	84.16	83.98	83.17	83.17	83.02	83.49	83.98	84.33	84.70	
Average = ∑(39)1...12/12 =												84.15	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.44	1.44	1.43	1.42	1.42	1.40	1.40	1.40	1.41	1.42	1.42	1.43	
Average = ∑(40)1...12/12 =												1.42	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.96	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	80.79	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	88.87	85.64	82.41	79.18	75.94	72.71	72.71	75.94	79.18	82.41	85.64	88.87	
∑(44)1...12 =												969.51	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	131.79	115.27	118.95	103.70	99.50	85.86	79.56	91.30	92.39	107.67	117.53	127.64	
∑(45)1...12 =												1271.18	(45)
Distribution loss 0.15 x (45)m	19.77	17.29	17.84	15.55	14.93	12.88	11.93	13.70	13.86	16.15	17.63	19.15	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	1.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	0.21	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)	0.12	(50)
Enter (50) or (54) in (55)	0.12	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	3.57	3.23	3.57	3.46	3.57	3.46	3.57	3.57	3.46	3.57	3.46	3.57	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

3.57	3.23	3.57	3.46	3.57	3.46	3.57	3.57	3.46	3.57	3.46	3.57	(57)

Primary circuit loss for each month from Table 3

23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

Combi loss for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

158.63	139.50	145.78	129.67	126.34	111.83	106.40	118.14	118.36	134.51	143.50	154.47	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

158.63	139.50	145.78	129.67	126.34	111.83	106.40	118.14	118.36	134.51	143.50	154.47

∑(64)1...12 = 1587.12 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

65.29	57.72	61.02	55.25	54.55	49.32	47.92	51.82	51.50	57.27	59.85	63.91	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	15.43	13.71	11.15	8.44	6.31	5.33	5.76	7.48	10.04	12.75	14.88	15.86	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	171.18	172.95	168.48	158.95	146.92	135.61	128.06	126.29	130.76	140.29	152.32	163.63	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	(71)
Water heating gains (Table 5)	87.75	85.89	82.01	76.74	73.32	68.51	64.41	69.66	71.52	76.97	83.13	85.89	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	329.79	327.98	317.06	299.56	281.98	264.87	253.66	258.85	267.75	285.44	305.76	320.81	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
West	0.77	x	5.36	x	19.64	x 0.9 x	0.63	x	0.70	=	32.17	(80)
NorthWest	0.77	x	2.08	x	11.28	x 0.9 x	0.63	x	0.70	=	7.17	(81)
East	0.77	x	3.99	x	19.64	x 0.9 x	0.63	x	0.70	=	23.95	(76)

Solar gains in watts ∑(74)m...(82)m

63.29	124.39	207.11	306.89	381.23	392.72	372.86	316.70	242.33	148.11	79.00	52.01	(83)

Total gains - internal and solar (73)m + (83)m

393.09	452.36	524.17	606.44	663.20	657.59	626.51	575.55	510.08	433.55	384.76	372.82	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Utilisation factor for gains for living area n1,m (see Table 9a)

1.00	0.99	0.98	0.95	0.87	0.72	0.56	0.62	0.86	0.97	0.99	1.00	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.44	19.61	19.92	20.33	20.69	20.91	20.98	20.96	20.79	20.32	19.81	19.42	(87)

Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C)

19.73	19.73	19.74	19.75	19.75	19.76	19.76	19.76	19.76	19.75	19.75	19.74	(88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.98	0.93	0.82	0.61	0.41	0.47	0.78	0.96	0.99	1.00	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

17.69	17.93	18.38	18.98	19.46	19.70	19.75	19.75	19.59	18.97	18.23	17.66	(90)

Living area fraction — Living area ÷ (4) = 0.61 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

18.76	18.96	19.33	19.81	20.21	20.44	20.50	20.49	20.33	19.80	19.20	18.74	(92)

Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.76	18.96	19.33	19.81	20.21	20.44	20.50	20.49	20.33	19.80	19.20	18.74	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.99	0.98	0.93	0.84	0.67	0.50	0.56	0.82	0.96	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	390.93	447.73	511.62	566.85	556.68	442.69	315.10	324.52	417.49	416.58	380.96	371.18	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	1236.44	1199.28	1091.28	918.29	715.01	485.91	324.65	339.85	519.80	772.47	1020.37	1231.15	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	629.06	505.04	431.27	253.04	117.80	0.00	0.00	0.00	0.00	264.78	460.37	639.82	

∑(98)1...5, 10...12 = 3301.18 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 55.67 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00	(202)
Fraction of space heat from main system 2		0.00	(202)
Fraction of total space heat from main system 1	(202) x [1- (203)] =	1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) =	0.00	(205)
Efficiency of main system 1 (%)		93.50	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	672.79	540.15	461.25	270.63	125.99	0.00	0.00	0.00	0.00	283.18	492.38	684.30

∑(211)1...5, 10...12 = 3530.67 (211)

Water heating

Efficiency of water heater

88.12	87.95	87.53	86.57	84.63	79.80	79.80	79.80	79.80	86.59	87.71	88.20	(217)

Water heating fuel, kWh/month

180.01	158.62	166.54	149.79	149.28	140.14	133.33	148.04	148.32	155.34	163.62	175.13

∑(219a)1...12 =	1868.17	(219)

Annual totals

Space heating fuel - main system 1			3530.67	
Water heating fuel			1868.17	
Electricity for pumps, fans and electric keep-hot (Table 4f)				
central heating pump or water pump within warm air heating unit	30.00			(230c)
boiler flue fan	45.00			(230e)
Total electricity for the above, kWh/year			75.00	(231)
Electricity for lighting (Appendix L)			272.57	(232)
Total delivered energy for all uses		(211)...(221) + (231) + (232)...(237b) =	5746.41	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	3530.67	x	3.48	x 0.01 =	122.87	(240)
Water heating	1868.17	x	3.48	x 0.01 =	65.01	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	272.57	x	13.19	x 0.01 =	35.95	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	353.72	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.42	(257)
SAP value	80.13	
SAP rating (section 13)	80	(258)
SAP band	C	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	3530.67	x	0.216	=	762.62	(261)
Water heating	1868.17	x	0.216	=	403.53	(264)
Space and water heating				(261) + (262) + (263) + (264) =	1166.15	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	272.57	x	0.519	=	141.46	(268)
Total CO_2, kg/year				(265)...(271) =	1346.54	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	22.71	(273)
EI value					82.70	
EI rating (section 14)					83	(274)
EI band					B	

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	3530.67	x	1.22	=	4307.42	(261)
Water heating	1868.17	x	1.22	=	2279.17	(264)
Space and water heating				(261) + (262) + (263) + (264) =	6586.59	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	272.57	x	3.07	=	836.78	(268)

Primary energy kWh/year	7653.62	(272)
Dwelling primary energy rate kWh/m2/year	129.07	(273)

This as built submission has been carried out using Approved SAP software. The assessor has confirmed any changes from the design submission with the builder.

Assessor name	Mr Neil Rothon	Assessor number	4282
Client		Last modified	25/06/2018
Address	G01 Agar Grove, London, NW1		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		59.30	(1a)	x	4.08	(2a)	=	241.94	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	59.30	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			241.94	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(18)
Number of sides on which the dwelling is sheltered		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.13	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	79.05	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	0.27	0.26	0.26	0.25	0.24	0.23	0.23	0.22	0.23	0.24	0.25	0.25	(24a)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.27	0.26	0.26	0.25	0.24	0.23	0.23	0.22	0.23	0.24	0.25	0.25	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			12.59	x	0.90	=	11.29			(27)
Door			3.39	x	0.93	=	3.15			(26)
Ground floor			59.30	x	0.09	=	5.34			(28a)
External wall			24.58	x	0.15	=	3.69			(29a)
Party wall			84.60	x	0.00	=	0.00			(32)
Roof			6.24	x	0.20	=	1.25			(30)
Total area of external elements ∑A, m²			106.10							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	24.71	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		9.56	(36)
Total fabric heat loss	(33) + (36) =	34.27	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	21.34	21.09	20.83	19.56	19.31	18.03	18.03	17.78	18.54	19.31	19.82	20.32	(38)
Heat transfer coefficient, W/K (37)m + (38)m	55.61	55.36	55.10	53.83	53.58	52.30	52.30	52.05	52.81	53.58	54.08	54.59	

Average = ∑(39)1...12/12 = 53.77 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.94	0.93	0.93	0.91	0.90	0.88	0.88	0.88	0.89	0.90	0.91	0.92	

Average = ∑(40)1...12/12 = 0.91 (40)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.96	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	80.79	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	88.87	85.64	82.41	79.18	75.94	72.71	72.71	75.94	79.18	82.41	85.64	88.87	

∑(44)1...12 = 969.51 (44)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	131.79	115.27	118.95	103.70	99.50	85.86	79.56	91.30	92.39	107.67	117.53	127.64	

∑(45)1...12 = 1271.18 (45)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Distribution loss 0.15 x (45)m	19.77	17.29	17.84	15.55	14.93	12.88	11.93	13.70	13.86	16.15	17.63	19.15	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	1.00	(47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
Volume factor from Table 2a	4.93	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	0.12	(54)
Enter (50) or (54) in (55)	0.12	(55)

Water storage loss calculated for each month (55) x (41)m

3.66	3.31	3.66	3.55	3.66	3.55	3.66	3.66	3.55	3.66	3.55	3.66	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

3.66	3.31	3.66	3.55	3.66	3.55	3.66	3.66	3.55	3.66	3.55	3.66	(57)

Primary circuit loss for each month from Table 3

23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

Combi loss for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

158.72	139.59	145.87	129.76	126.43	111.92	106.49	118.23	118.45	134.60	143.59	154.56	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

158.72	139.59	145.87	129.76	126.43	111.92	106.49	118.23	118.45	134.60	143.59	154.56	

∑(64)1...12 = 1588.22 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

65.36	57.78	61.09	55.33	54.63	49.40	48.00	51.90	51.57	57.34	59.93	63.98	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	15.29	13.58	11.05	8.36	6.25	5.28	5.70	7.41	9.95	12.63	14.74	15.72	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	171.18	172.95	168.48	158.95	146.92	135.61	128.06	126.29	130.76	140.29	152.32	163.63	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	(71)
Water heating gains (Table 5)	87.85	85.99	82.11	76.84	73.42	68.61	64.51	69.76	71.62	77.07	83.23	85.99	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	326.75	324.95	314.06	296.58	279.02	261.92	250.70	255.88	264.76	282.42	302.72	317.76	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
West	0.77	x	5.90	x	19.64	x 0.9 x	0.52	x	0.80	=	33.41	(80)
NorthWest	0.77	x	2.30	x	11.28	x 0.9 x	0.52	x	0.80	=	7.48	(81)
East	0.77	x	4.39	x	19.64	x 0.9 x	0.52	x	0.80	=	24.86	(76)

Solar gains in watts ∑(74)m...(82)m

65.74	129.20	215.14	318.81	396.06	408.00	387.37	329.01	251.73	153.85	82.06	54.02	(83)

Total gains - internal and solar (73)m + (83)m

392.49	454.15	529.20	615.39	675.08	669.93	638.07	584.89	516.49	436.27	384.78	371.79	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	1.00	0.99	0.97	0.88	0.70	0.50	0.36	0.41	0.68	0.94	0.99	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	20.11	20.27	20.53	20.82	20.96	21.00	21.00	21.00	20.98	20.76	20.39	20.10	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C)	20.14	20.14	20.14	20.16	20.16	20.18	20.18	20.19	20.18	20.16	20.16	20.15	(88)
Utilisation factor for gains for rest of dwelling n2,m	1.00	0.99	0.96	0.85	0.65	0.43	0.29	0.34	0.61	0.92	0.99	1.00	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	18.95	19.19	19.55	19.96	20.13	20.18	20.18	20.19	20.16	19.89	19.37	18.94	(90)

Living area fraction Living area ÷ (4) = 0.61 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	19.67	19.85	20.15	20.49	20.64	20.68	20.68	20.68	20.66	20.42	19.99	19.65	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate	19.67	19.85	20.15	20.49	20.64	20.68	20.68	20.68	20.66	20.42	19.99	19.65	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.99	0.96	0.86	0.68	0.47	0.33	0.38	0.65	0.93	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	390.39	448.33	508.26	532.28	460.38	316.46	213.45	222.70	336.34	404.18	380.06	370.29	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	854.51	827.73	752.25	623.84	479.01	318.06	213.60	223.02	346.52	526.28	697.31	843.44	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	345.30	254.96	181.53	65.93	13.86	0.00	0.00	0.00	0.00	90.84	228.42	352.02	

∑(98)1...5, 10...12 = 1532.86 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 25.85 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)	'0' if none	0.00	(301)
Fraction of space heat from community system	1 - (301) =	1.00	(302)
Fraction of community heat from boilers		1.00	(303a)
Fraction of total space heat from community boilers	(302) x (303a) =	1.00	(304a)
Factor for control and charging method (Table 4c(3)) for community space heating		1.00	(305)
Factor for charging method (Table 4c(3)) for community water heating		1.00	(305a)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)

Space heating

Annual space heating requirement 1532.86 (98)

Space heat from boilers (98) x (304a) x (305) x (306) = 1609.50 (307a)

Water heating

Annual water heating requirement 1588.22 (64)

Water heat from boilers				(64) x (303a) x (305a) x (306) =	1667.63	(310a)
Electricity used for heat distribution				0.01 × [(307a)...(307e) + (310a)...(310e)] =	32.77	(313)

Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	335.76		(330a)
Total electricity for the above, kWh/year		335.76	(331)
Electricity for lighting (Appendix L)		270.05	(332)
Total delivered energy for all uses	(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	3882.94	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from boilers	1609.50	x	4.24	x 0.01 =	68.24	(340a)
Water heating from boilers	1667.63	x	4.24	x 0.01 =	70.71	(342a)
Pumps and fans	335.76	x	13.19	x 0.01 =	44.29	(349)
Electricity for lighting	270.05	x	13.19	x 0.01 =	35.62	(350)
Additional standing charges					120.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354) =		338.86	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.36	(357)
SAP value	80.96	
SAP rating (section 13)	81	(358)
SAP band	B	

12b. CO_2 emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of boilers	97.10					(367a)
CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) =	3375.01	x	0.216	=	729.00	(367)
Electrical energy for community heat distribution	32.77	x	0.519	=	17.01	(372)
Total CO2 associated with community systems					746.01	(373)
Total CO2 associated with space and water heating					746.01	(376)
Pumps and fans	335.76	x	0.519	=	174.26	(378)
Electricity for lighting	270.05	x	0.519	=	140.16	(379)
Total CO_2, kg/year				(376)..(382) =	1060.43	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	17.88	(384)
EI value					86.38	
EI rating (section 14)					86	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary energy from other sources (space heating)						
Efficiency of boilers	97.10					(367a)
Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) =	3375.01	x	1.22	=	4117.51	(367)
Electrical energy for community heat distribution	32.77	x	3.07	=	100.61	(372)

Total primary energy associated with community systems					4218.12	(373)
Total primary energy associated with space and water heating					4218.12	(376)
Pumps and fans	335.76	x	3.07	=	1030.78	(378)
Electricity for lighting	270.05	x	3.07	=	829.06	(379)
Primary energy kWh/year					6077.95	(383)
Dwelling primary energy rate kWh/m2/year					102.50	(384)

Appendix 3

Data Input Report
As Built - Draft

This as built submission has been carried out using Approved SAP software. The assessor has confirmed any changes from the design submission with the builder.

Assessor name	Mr Neil Rothon	Assessor number	4282
Client		Last modified	28/08/2018
Address	G01 Agar Grove, London, NW1		

Dwelling

Development:	N/A	House type:	
Property type:	Flat		
Flat type:	Ground floor	Year built:	2016
Tariff:	Standard	Assess summer overheating:	Yes
Thermal mass:	Medium	Thermal mass parameter:	250.00
Separated heated conservatory:	No	Degree day region:	Thames
Sheltered sides:	2	Terrain:	Dense Urban

Storeys:

Name	**Area (m²)**	**Height (m)**
Lowest occupied	59.30	4.08

Floors

Ref - Name	Type	Construction	Storey Location	Living Area (m²)	Area (m²)	U-value (W/m²K)
Floor 1 - Floor 1	Ground	Solid	Lowest occupied	36.38	59.30	0.09

Living area that has no heat loss: 0.00

Walls

Ref - Name	Type	Construction	Gross Area (m²)	U-value (W/m²K)
Wall 1 - ext MAIN	External	Cavity	40.56	0.15
Wall 2 - party	Party	Solid	42.30	0.00
Wall 3 - party to retail	Party	Solid	42.30	0.00

Roofs

Ref - Name	Construction	Gross Area (m²)	U-value (W/m²K)
Roof 1 - LOWER	Flat	6.24	0.20

Openings

Opening Ref: 1 Window, Triple glazed (low-E), ' N/A', master: Yes, linked to: 0

Location:	Wall 1	Source:	From Manufacturer	Orientation:	West
Overshading:	Average / Unknown	Width (m):	1.00	Height (m):	3.15
Frame:	Metal	Transmittance factor:	0.52	U-value (W/m²K):	0.93

Opening Ref: 2 Window, Triple glazed (low-E), ' N/A', master: No, linked to: 1

Location:	Wall 1	Source:	From Manufacturer	Orientation:	North West
Overshading:	Average / Unknown	Width (m):	0.85	Height (m):	2.70
Frame:	Metal	Transmittance factor:	0.52	U-value (W/m²K):	0.93

Opening Ref: 3 Window, Triple glazed (low-E), ' N/A', master: No, linked to: 1

Location:	Wall 1	Source:	From Manufacturer	Orientation:	West
Overshading:	Average / Unknown	Width (m):	1.02	Height (m):	2.70
Frame:	Metal	Transmittance factor:	0.52	U-value (W/m²K):	0.93

Opening Ref: 4 Window, Triple glazed (low-E), ' N/A', master: No, linked to: 1

Location:	Wall 1	Source:	From Manufacturer	Orientation:	East
Overshading:	Average / Unknown	Width (m):	1.58	Height (m):	2.78
Frame:	Metal	Transmittance factor:	0.52	U-value (W/m²K):	0.93

Opening Ref: 6 Half glazed door, Triple glazed (low-E), ' N/A', master: No, linked to: 0

Location:	Wall 1	Source:	From Manufacturer	Orientation:	N/A
Overshading:	N/A	Width (m):	1.13	Height (m):	3.00
Frame:	Metal	Transmittance factor:	0.57	U-value (W/m²K):	0.93

Thermal Bridging

Ref	Description	Length (m)	Source	ψ (W/m·K)	Result
E1	Steel lintel with perforated steel	0	Default Value	N/A	0
E2	Other lintels (including other stee	5.58	User Defined	0.113	0.6305
E3	Sill	4.45	User Defined	0.113	0.5029
E4	Jamb	28.66	User Defined	0.018	0.5159
E5	Ground floor (normal)	10.4	User Defined	0.117	1.2168
E19	Ground floor (inverted)	N/A	Default Value	N/A	0
E20	Exposed floor (normal)	N/A	Default Value	N/A	0
E21	Exposed floor (inverted)	2	Default Value	0.32	0.64
E22	Basement floor	N/A	Default Value	N/A	0
E6	Intermediate floor within a dwellin	N/A	Default Value	N/A	0
E6	Intermediate floor within a dwellin	N/A	Default Value	N/A	0
E6	Intermediate floor within a dwellin	N/A	Default Value	N/A	0
E7	Party floor between dwellings (in b	3.1	User Defined	0.049	0.1519
E7	Party floor between dwellings (in b	N/A	Default Value	N/A	0
E7	Party floor between dwellings (in b	N/A	Default Value	N/A	0
E8	Balcony within a dwelling, wall ins	N/A	Default Value	N/A	0
E9	Balcony between dwellings, wall ins	N/A	Default Value	N/A	0
E23	Balcony within or between dwellings	N/A	Default Value	N/A	0
E10	Eaves (insulation at ceiling level)	N/A	Default Value	N/A	0
E24	Eaves (insulation at ceiling level	N/A	User Defined	N/A	0
E24	Eaves (insulation at ceiling level	N/A	Default Value	N/A	0
E11	Eaves (insulation at rafter level)	N/A	Default Value	N/A	0
E12	Gable (insulation at ceiling level)	N/A	Default Value	N/A	0
E13	Gable (insulation at rafter level)	N/A	Default Value	N/A	0
E14	Flat roof	N/A	Default Value	N/A	0
E14	Flat roof	5.2	User Defined	0.127	0.6604
E15	Flat roof with parapet	N/A	Default Value	N/A	0
E16	Corner (normal)	4.8	User Defined	0.105	0.504
E16	Corner (normal)	N/A	Default Value	N/A	0
E16	Corner (normal)	N/A	Default Value	N/A	0
E17	Corner (inverted - internal area gr	N/A	Default Value	N/A	0
E18	Party wall between dwellings	10.8	User Defined	0.059	0.6372
E25	Staggered party wall between dwelli	4.8	Default Value	0.12	0.576
P1	Ground floor	22	Default Value	0.16	3.52
P6	Ground floor (inverted)	N/A	Default Value	N/A	0
P2	Intermediate floor within a dwellin	N/A	Default Value	N/A	0
P3	Intermediate floor between dwelling	19.6	Default Value	0	0
P7	Exposed floor (normal)	N/A	Default Value	N/A	0
P8	Exposed floor (inverted)	N/A	Default Value	N/A	0

P4	Roof (insulation at ceiling level)	N/A	Default Value	N/A	0
P5	Roof (insulation at rafter level)	N/A	Default Value	N/A	0
R1	Head	0	Default Value	N/A	0
R2	Sill	0	Default Value	N/A	0
R3	Jamb	0	Default Value	N/A	0
R4	Ridge (vaulted ceiling)	N/A	Default Value	N/A	0
R5	Ridge (inverted)	N/A	Default Value	N/A	0
R6	Flat ceiling	N/A	Default Value	N/A	0
R7	Flat ceiling (inverted)	N/A	Default Value	N/A	0
R8	Roof wall (rafter)	N/A	Default Value	N/A	0
R9	Roof wall (flat ceiling)	N/A	Default Value	N/A	0

Equivalent y value: 0.090

Ventilation

Air permeability entered:	Yes	Seek exemption (<3 dwellings):	No
Design air permeability rate:	3.00		
Measured air permeability rate:	3.00	Measured in this dwelling:	Yes
As-built air permeability rate:	3.00	As-built air permeability reference:	

Number of...	Open fireplaces	Open flues	Flueless gas fires	Extract fans	Passive vents
	0	0	0	0	0

System Information:

Mechanical ventilation:	Balanced (with heat recovery)	Values from:	Product database
Product name:	Zehnder ComfoAir 200	Approved installer:	Yes
Number of wet rooms:	Kitchen + 1 additional wet room	SFP:	0.91
Heat exchange efficiency:	93.00		

Duct information:

Duct type:	Rigid ductwork	Values from:	Default
Product name:	N/A	Duct insulation	Insulated ductwork

Space heating

Main heating category:	Community scheme		
Secondary heating:	No	Open flue or chimney:	N/A
Unconnected gas point:	N/A	Smoke control area:	N/A

Heat source: Mains gas - Boilers

Fraction of heat:	1.00	Efficiency (%):	97.10

Community system:

User entered distribution loss factor:	No
Heat distribution system:	Pre-insulated low temp variable flow (1991 or later)
Controls:	Charging system linked to use, programmer and TRVs
Emitter:	Radiators

Water heating

Type:	From main	Cylinder in dwelling:	No

Renewables

Photovoltaic panels system 1

Installed power peak (kWp):	0.42	Collector orientation:	South West
Collector tilt:	30°	Overshading:	None or Very Little < 20%
Connected to:	Connected to landlord supply		

Other

Internal lighting

Standard fittings:	0	Low energy fittings:	1	Total fittings:	1

Summer overheating

Thermal mass parameter (TMP):	250.00		
User defined air change rate:	No	Air change rate (ach):	N/A
Cross ventilation on most floors:	Yes	Window ventilation:	Fully open half the time
Source of user defined values:	N/A		
Curtains closed in daylight hours:	No	Fraction curtains closed:	N/A
Blind/curtain type:	N/A		

Special features (Appendix Q)

No Appendix Q special features present

Cooling details

No space cooling present

TER Worksheet
As Built - Draft

This as built submission has been carried out using Approved SAP software. The assessor has confirmed any changes from the design submission with the builder.

Assessor name	Mr Neil Rothon	Assessor number	4282
Client		Last modified	28/08/2018
Address	G01 Agar Grove, London, NW1		

1. Overall dwelling dimensions

		Area (m^2)			Average storey height (m)			Volume (m^3)	
Lowest occupied		59.30	(1a)	x	4.08	(2a)	=	241.94	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	59.30	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			241.94	(5)

2. Ventilation rate

			m^3 per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) =	20	÷ (5) =	0.08	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.33	(18)
Number of sides on which the dwelling is sheltered		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.28	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.36	0.35	0.35	0.31	0.30	0.27	0.27	0.26	0.28	0.30	0.32	0.33	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
d) natural ventilation or whole house positive input ventilation from loft	0.56	0.56	0.56	0.55	0.55	0.54	0.54	0.53	0.54	0.55	0.55	0.56	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.56	0.56	0.56	0.55	0.55	0.54	0.54	0.53	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			11.43	x	1.33	=	15.15			(27)
Door			3.39	x	1.20	=	4.07			(26)
Ground floor			59.30	x	0.13	=	7.71			(28a)
External wall			25.73	x	0.18	=	4.63			(29a)
Party wall			84.60	x	0.00	=	0.00			(32)
Roof			6.24	x	0.13	=	0.81			(30)
Total area of external elements ∑A, m²			106.09							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	32.37	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		8.00	(36)
Total fabric heat loss	(33) + (36) =	40.37	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	45.11	44.91	44.71	43.78	43.61	42.80	42.80	42.65	43.11	43.61	43.96	44.33	(38)
Heat transfer coefficient, W/K (37)m + (38)m	85.48	85.28	85.08	84.16	83.98	83.17	83.17	83.02	83.49	83.98	84.33	84.70	
Average = ∑(39)1...12/12 =												84.15	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.44	1.44	1.43	1.42	1.42	1.40	1.40	1.40	1.41	1.42	1.42	1.43	
Average = ∑(40)1...12/12 =												1.42	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.96	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	80.79	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	88.87	85.64	82.41	79.18	75.94	72.71	72.71	75.94	79.18	82.41	85.64	88.87	
∑(44)1...12 =												969.51	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	131.79	115.27	118.95	103.70	99.50	85.86	79.56	91.30	92.39	107.67	117.53	127.64	
∑(45)1...12 =												1271.18	(45)
Distribution loss 0.15 x (45)m	19.77	17.29	17.84	15.55	14.93	12.88	11.93	13.70	13.86	16.15	17.63	19.15	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	1.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	0.21	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)	0.12	(50)
Enter (50) or (54) in (55)	0.12	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	3.57	3.23	3.57	3.46	3.57	3.46	3.57	3.57	3.46	3.57	3.46	3.57	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

3.57	3.23	3.57	3.46	3.57	3.46	3.57	3.57	3.46	3.57	3.46	3.57	(57)

Primary circuit loss for each month from Table 3

23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

Combi loss for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

158.63	139.50	145.78	129.67	126.34	111.83	106.40	118.14	118.36	134.51	143.50	154.47	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

158.63	139.50	145.78	129.67	126.34	111.83	106.40	118.14	118.36	134.51	143.50	154.47

∑(64)1...12 = 1587.12 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

65.29	57.72	61.02	55.25	54.55	49.32	47.92	51.82	51.50	57.27	59.85	63.91	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	15.43	13.71	11.15	8.44	6.31	5.33	5.76	7.48	10.04	12.75	14.88	15.86	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	171.18	172.95	168.48	158.95	146.92	135.61	128.06	126.29	130.76	140.29	152.32	163.63	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	(71)
Water heating gains (Table 5)	87.75	85.89	82.01	76.74	73.32	68.51	64.41	69.66	71.52	76.97	83.13	85.89	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	329.79	327.98	317.06	299.56	281.98	264.87	253.66	258.85	267.75	285.44	305.76	320.81	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
West	0.77	x	5.36	x	19.64	x 0.9 x	0.63	x	0.70	=	32.17	(80)
NorthWest	0.77	x	2.08	x	11.28	x 0.9 x	0.63	x	0.70	=	7.17	(81)
East	0.77	x	3.99	x	19.64	x 0.9 x	0.63	x	0.70	=	23.95	(76)

Solar gains in watts ∑(74)m...(82)m

63.29	124.39	207.11	306.89	381.23	392.72	372.86	316.70	242.33	148.11	79.00	52.01	(83)

Total gains - internal and solar (73)m + (83)m

393.09	452.36	524.17	606.44	663.20	657.59	626.51	575.55	510.08	433.55	384.76	372.82	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Utilisation factor for gains for living area n1,m (see Table 9a)

1.00	0.99	0.98	0.95	0.87	0.72	0.56	0.62	0.86	0.97	0.99	1.00	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.44	19.61	19.92	20.33	20.69	20.91	20.98	20.96	20.79	20.32	19.81	19.42	(87)

Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

19.73	19.73	19.74	19.75	19.75	19.76	19.76	19.76	19.76	19.75	19.75	19.74	(88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.98	0.93	0.82	0.61	0.41	0.47	0.78	0.96	0.99	1.00	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

17.69	17.93	18.38	18.98	19.46	19.70	19.75	19.75	19.59	18.97	18.23	17.66	(90)

Living area fraction — Living area ÷ (4) = 0.61 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

18.76	18.96	19.33	19.81	20.21	20.44	20.50	20.49	20.33	19.80	19.20	18.74	(92)

Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.76	18.96	19.33	19.81	20.21	20.44	20.50	20.49	20.33	19.80	19.20	18.74	(93)

8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	

Utilisation factor for gains, ηm

0.99	0.99	0.98	0.93	0.84	0.67	0.50	0.56	0.82	0.96	0.99	1.00	(94)

Useful gains, ηmGm, W (94)m x (84)m

390.93	447.73	511.62	566.85	556.68	442.69	315.10	324.52	417.49	416.58	380.96	371.18	(95)

Monthly average external temperature from Table U1

4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)

Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

1236.44	1199.28	1091.28	918.29	715.01	485.91	324.65	339.85	519.80	772.47	1020.37	1231.15	(97)

Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

629.06	505.04	431.27	253.04	117.80	0.00	0.00	0.00	0.00	264.78	460.37	639.82

∑(98)1...5, 10...12 = 3301.18 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 55.67 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00	(202)
Fraction of space heat from main system 2		0.00	(202)
Fraction of total space heat from main system 1	(202) x [1- (203)] =	1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) =	0.00	(205)
Efficiency of main system 1 (%)		93.50	(206)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Space heating fuel (main system 1), kWh/month

672.79	540.15	461.25	270.63	125.99	0.00	0.00	0.00	0.00	283.18	492.38	684.30

∑(211)1...5, 10...12 = 3530.67 (211)

Water heating

Efficiency of water heater

88.12	87.95	87.53	86.57	84.63	79.80	79.80	79.80	79.80	86.59	87.71	88.20	(217)

Water heating fuel, kWh/month

180.01	158.62	166.54	149.79	149.28	140.14	133.33	148.04	148.32	155.34	163.62	175.13

			∑(219a)1...12 =	1868.17 (219)

Annual totals

Space heating fuel - main system 1		3530.67
Water heating fuel		1868.17
Electricity for pumps, fans and electric keep-hot (Table 4f)		
central heating pump or water pump within warm air heating unit	30.00	(230c)
boiler flue fan	45.00	(230e)
Total electricity for the above, kWh/year		75.00 (231)
Electricity for lighting (Appendix L)		272.57 (232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	5746.41 (238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	3530.67	x	3.48	x 0.01 =	122.87	(240)
Water heating	1868.17	x	3.48	x 0.01 =	65.01	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	272.57	x	13.19	x 0.01 =	35.95	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		353.72	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.42	(257)
SAP value	80.13	
SAP rating (section 13)	80	(258)
SAP band	C	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	3530.67	x	0.216	=	762.62	(261)
Water heating	1868.17	x	0.216	=	403.53	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1166.15	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	272.57	x	0.519	=	141.46	(268)
Total CO_2, kg/year				(265)...(271) =	1346.54	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	22.71	(273)
EI value					82.70	
EI rating (section 14)					83	(274)
EI band					B	

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	3530.67	x	1.22	=	4307.42	(261)
Water heating	1868.17	x	1.22	=	2279.17	(264)
Space and water heating			(261) + (262) + (263) + (264) =		6586.59	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	272.57	x	3.07	=	836.78	(268)

Primary energy kWh/year	7653.62	(272)
Dwelling primary energy rate kWh/m2/year	129.07	(273)

DER Worksheet
As Built - Draft

This as built submission has been carried out using Approved SAP software. The assessor has confirmed any changes from the design submission with the builder.

Assessor name	Mr Neil Rothon	Assessor number	4282
Client		Last modified	28/08/2018
Address	G01 Agar Grove, London, NW1		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		59.30	(1a)	x	4.08	(2a)	=	241.94	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	59.30	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			241.94	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(18)
Number of sides on which the dwelling is sheltered		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.13	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	79.05	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	0.27	0.26	0.26	0.25	0.24	0.23	0.23	0.22	0.23	0.24	0.25	0.25	(24a)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.27	0.26	0.26	0.25	0.24	0.23	0.23	0.22	0.23	0.24	0.25	0.25	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			12.59	x	0.90	=	11.29			(27)
Door			3.39	x	0.93	=	3.15			(26)
Ground floor			59.30	x	0.09	=	5.34			(28a)
External wall			24.58	x	0.15	=	3.69			(29a)
Party wall			84.60	x	0.00	=	0.00			(32)
Roof			6.24	x	0.20	=	1.25			(30)
Total area of external elements ∑A, m²			106.10							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	24.71	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		9.56	(36)
Total fabric heat loss	(33) + (36) =	34.27	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	21.34	21.09	20.83	19.56	19.31	18.03	18.03	17.78	18.54	19.31	19.82	20.32	(38)
Heat transfer coefficient, W/K (37)m + (38)m	55.61	55.36	55.10	53.83	53.58	52.30	52.30	52.05	52.81	53.58	54.08	54.59	
Average = ∑(39)1...12/12 =												53.77	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.94	0.93	0.93	0.91	0.90	0.88	0.88	0.88	0.89	0.90	0.91	0.92	
Average = ∑(40)1...12/12 =												0.91	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.96	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	80.79	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	88.87	85.64	82.41	79.18	75.94	72.71	72.71	75.94	79.18	82.41	85.64	88.87	
∑(44)1...12 =												969.51	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	131.79	115.27	118.95	103.70	99.50	85.86	79.56	91.30	92.39	107.67	117.53	127.64	
∑(45)1...12 =												1271.18	(45)
Distribution loss 0.15 x (45)m	19.77	17.29	17.84	15.55	14.93	12.88	11.93	13.70	13.86	16.15	17.63	19.15	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	1.00	(47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
Volume factor from Table 2a	4.93	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	0.12	(54)
Enter (50) or (54) in (55)	0.12	(55)

Water storage loss calculated for each month (55) x (41)m

3.66	3.31	3.66	3.55	3.66	3.55	3.66	3.66	3.55	3.66	3.55	3.66	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

3.66	3.31	3.66	3.55	3.66	3.55	3.66	3.66	3.55	3.66	3.55	3.66	(57)

Primary circuit loss for each month from Table 3

23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

Combi loss for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

158.72	139.59	145.87	129.76	126.43	111.92	106.49	118.23	118.45	134.60	143.59	154.56	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

158.72	139.59	145.87	129.76	126.43	111.92	106.49	118.23	118.45	134.60	143.59	154.56	
										∑(64)1...12 =	1588.22	(64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

65.36	57.78	61.09	55.33	54.63	49.40	48.00	51.90	51.57	57.34	59.93	63.98	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	98.09	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	15.29	13.58	11.05	8.36	6.25	5.28	5.70	7.41	9.95	12.63	14.74	15.72	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	171.18	172.95	168.48	158.95	146.92	135.61	128.06	126.29	130.76	140.29	152.32	163.63	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	32.81	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	-78.47	(71)
Water heating gains (Table 5)	87.85	85.99	82.11	76.84	73.42	68.61	64.51	69.76	71.62	77.07	83.23	85.99	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	326.75	324.95	314.06	296.58	279.02	261.92	250.70	255.88	264.76	282.42	302.72	317.76	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
West	0.77	x	5.90	x	19.64	x 0.9 x	0.52	x	0.80	=	33.41	(80)
NorthWest	0.77	x	2.30	x	11.28	x 0.9 x	0.52	x	0.80	=	7.48	(81)
East	0.77	x	4.39	x	19.64	x 0.9 x	0.52	x	0.80	=	24.86	(76)

Solar gains in watts ∑(74)m...(82)m

65.74	129.20	215.14	318.81	396.06	408.00	387.37	329.01	251.73	153.85	82.06	54.02	(83)

Total gains - internal and solar (73)m + (83)m

392.49	454.15	529.20	615.39	675.08	669.93	638.07	584.89	516.49	436.27	384.78	371.79	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C)	21.00	(85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	1.00	0.99	0.97	0.88	0.70	0.50	0.36	0.41	0.68	0.94	0.99	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	20.11	20.27	20.53	20.82	20.96	21.00	21.00	21.00	20.98	20.76	20.39	20.10	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C)	20.14	20.14	20.14	20.16	20.16	20.18	20.18	20.19	20.18	20.16	20.16	20.15	(88)
Utilisation factor for gains for rest of dwelling n2,m	1.00	0.99	0.96	0.85	0.65	0.43	0.29	0.34	0.61	0.92	0.99	1.00	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	18.95	19.19	19.55	19.96	20.13	20.18	20.18	20.19	20.16	19.89	19.37	18.94	(90)

Living area fraction	Living area ÷ (4) =	0.61	(91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	19.67	19.85	20.15	20.49	20.64	20.68	20.68	20.68	20.66	20.42	19.99	19.65	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate	19.67	19.85	20.15	20.49	20.64	20.68	20.68	20.68	20.66	20.42	19.99	19.65	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.99	0.96	0.86	0.68	0.47	0.33	0.38	0.65	0.93	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	390.39	448.33	508.26	532.28	460.38	316.46	213.45	222.70	336.34	404.18	380.06	370.29	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	854.51	827.73	752.25	623.84	479.01	318.06	213.60	223.02	346.52	526.28	697.31	843.44	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	345.30	254.96	181.53	65.93	13.86	0.00	0.00	0.00	0.00	90.84	228.42	352.02	

	∑(98)1...5, 10...12 =	1532.86	(98)
Space heating requirement kWh/m²/year	(98) ÷ (4)	25.85	(99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)	'0' if none	0.00	(301)
Fraction of space heat from community system	1 - (301) =	1.00	(302)
Fraction of community heat from boilers		1.00	(303a)
Fraction of total space heat from community boilers	(302) x (303a) =	1.00	(304a)
Factor for control and charging method (Table 4c(3)) for community space heating		1.00	(305)
Factor for charging method (Table 4c(3)) for community water heating		1.00	(305a)
Distribution loss factor (Table 12c) for community heating system		1.05	(306)

Space heating

Annual space heating requirement	1532.86			(98)
Space heat from boilers		(98) x (304a) x (305) x (306) =	1609.50	(307a)

Water heating

Annual water heating requirement	1588.22	(64)

Water heat from boilers	(64) x (303a) x (305a) x (306) =	1667.63	(310a)
Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	32.77	(313)
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	335.76		(330a)
Total electricity for the above, kWh/year		335.76	(331)
Electricity for lighting (Appendix L)		270.05	(332)
Energy saving/generation technologies			
electricity generated by PV (Appendix M)		-346.63	(333)
Total delivered energy for all uses	(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	3536.31	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from boilers	1609.50	x	4.24	x 0.01 =	68.24	(340a)
Water heating from boilers	1667.63	x	4.24	x 0.01 =	70.71	(342a)
Pumps and fans	335.76	x	13.19	x 0.01 =	44.29	(349)
Electricity for lighting	270.05	x	13.19	x 0.01 =	35.62	(350)
Additional standing charges					120.00	(351)
Energy saving/generation technologies						
pv savings	-346.63	x	13.19	x 0.01 =	0.00	(352)
Total energy cost			(340a)...(342e) + (345)...(354) =		338.86	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.36	(357)
SAP value	80.96	
SAP rating (section 13)	81	(358)
SAP band	B	

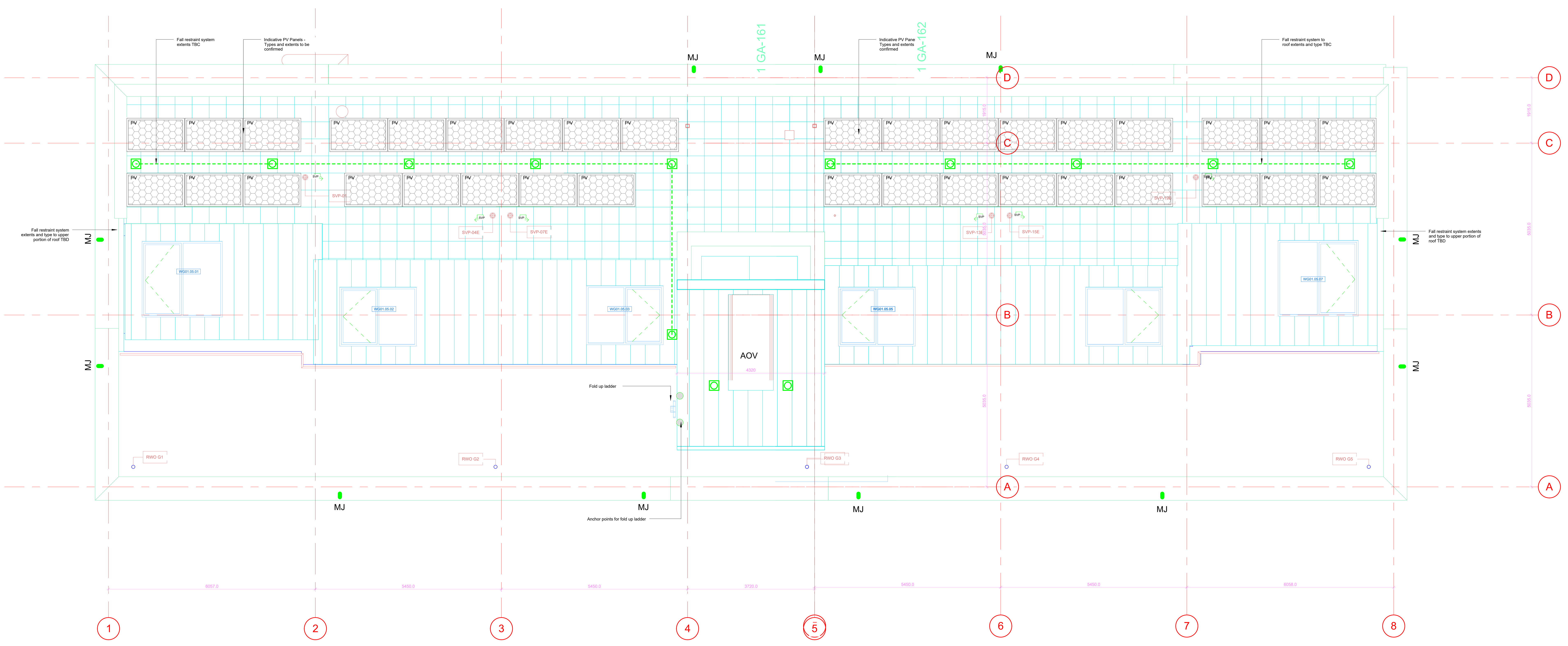
12b. CO_2 emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of boilers	97.10					(367a)
CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) =	3375.01	x	0.216	=	729.00	(367)
Electrical energy for community heat distribution	32.77	x	0.519	=	17.01	(372)
Total CO2 associated with community systems					746.01	(373)
Total CO2 associated with space and water heating					746.01	(376)
Pumps and fans	335.76	x	0.519	=	174.26	(378)
Electricity for lighting	270.05	x	0.519	=	140.16	(379)
Energy saving/generation technologies						
pv savings	-346.63	x	0.519	=	-179.90	(380)
Total CO_2, kg/year				(376)..(382) =	880.52	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	14.85	(384)
EI value					88.69	
EI rating (section 14)					89	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary energy from other sources (space heating)						
Efficiency of boilers	97.10					(367a)
Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) =	3375.01	x	1.22	=	4117.51	(367)
Electrical energy for community heat distribution	32.77	x	3.07	=	100.61	(372)
Total primary energy associated with community systems					4218.12	(373)
Total primary energy associated with space and water heating					4218.12	(376)
Pumps and fans	335.76	x	3.07	=	1030.78	(378)
Electricity for lighting	270.05	x	3.07	=	829.06	(379)
Energy saving/generation technologies						
Electricity generated - PVs	-346.63	x	3.07	=	-1064.15	(380)
Primary energy kWh/year					5013.80	(383)
Dwelling primary energy rate kWh/m2/year					84.55	(384)

Appendix 4



General Notes

35 x 320wp LG Monocrystalline.
Solar Panel shown in landscape.@15°Pitch
Panel Dims
1016mm x 1686mm
Total PV Array size
59.96m²
Total Weight
2029Kg
@ 33.84Kg/M²
System designed for landlord electrical supply 3 phase.
PV mounting system Aframe ballast set at 15°

PV inverter position TBC area required to mount PV electrical equipment 1200 x 610 x 300mm

Drawing Title
PV Roofing Layout

Issue No	Drawing By	Checked By	
1	PO		23/08/2018
No.	Revision/Issue		Date

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Project Name and Address
Client: Hill Partnership
Project : Agar Grove 1B

Drawing No. PV40572-QD
Date 15/08.2018
Scale NTS
Sheet 1

LG
Life's Good

Innovation for
a Better Life

LG NeON® 2 *Black*

LG320N1K-A5

60 cell

LG's new module, LG NeON® 2, ado pts Cello technology. Cello technology replaces 3 busbars with 12 thin wires to enhance power output and reliability. LG NeON® 2 demonstrates LG's efforts to increase customer's values beyond efficiency. It features enhanced warranty, durability, performance under real environment, and aesthetic design suitable for roofs.

Intertek
APPROVED PRODUCT
KM 564573 BS EN 61215
Photovoltaic Modules

Enhanced Performance Warranty

LG NeON® 2 *Black* has an enhanced performance warranty. The annual degradation has fallen from -0.6%/yr to -0.55%/yr. Even after 25 years, the cell guarantees 1.2%p more output than the previous LG NeON® 2 *Black* modules.

Aesthetic Roof

LG NeON® 2 *Black* has been designed with aesthetics in mind; thinner wires that appear all black at a distance. The product may help increase the value of a property with its modern design.

Better Performance on a Sunny Day

LG NeON® 2 *Black* now performs better on sunny days thanks to its improved temperature coefficiency.

High Power Output

Compared with previous models, the LG NeON® 2 *Black* has been designed to significantly enhance its output efficiency, thereby making it efficient even in limited space.

Outstanding Durability

With its newly reinforced frame design, LG has extended the warranty of the LG NeON® 2 *Black* for an additional 2 years. Additionally, LG NeON® 2 *Black* can endure a front load up to 6000 Pa, and a rear load up to 5400 Pa.

Double-Sided Cell Structure

The rear of the cell used in LG NeON® 2 *Black* will contribute to generation, just like the front; the light beam reflected from the rear of the module is reabsorbed to generate a great amount of additional power.

About LG Electronics

LG Electronics is a global player who has been committed to expanding its capacity, based on solar energy business as its future growth engine. We embarked on a solar energy source research program in 1985, supported by LG Group's rich experience in semi-conductor, LCD, chemistry, and materials industry. We successfully released the first Mono X® series to the market in 2010, which were exported to 32 countries in the following 2 years, thereafter. In 2013, LG NeON® (previously known as Mono X® NeON) won "Intersolar Award", which proved LG is the leader of innovation in the industry.

LG NeON® 2 Black LG320N1K-A5

Mechanical Properties

Cells	6 x 10
Cell Vendor	LG
Cell Type	Monocrystalline / N-type
Cell Dimensions	161.7 x 161.7 mm / 6 inches
# of Busbar	12 (Multi Wire Busbar)
Dimensions (L x W x H)	1686 x 1016 x 40 mm
	66.38 x 40 x 1.57 inch
Front Load	6000Pa
Rear Load	5400Pa
Weight	18 kg
Connector Type	MC4
Junction Box	IP68 with 3 Bypass Diodes
Cables	1000 mm x 2 ea
Glass	High Transmission Tempered Glass
Frame	Anodized Aluminium

Certifications and Warranty

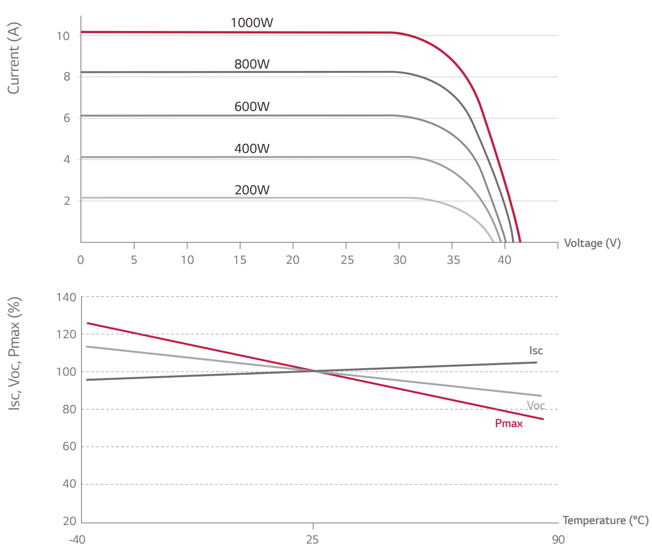
Certifications	IEC 61215, IEC 61730-1/-2
	UL 1703
	IEC 61701 (Salt mist corrosion test)
	IEC 62716 (Ammonia corrosion test)
	ISO 9001
Module Fire Performance (USA)	Type 2
Fire Rating (CANADA)	Class C
Product Warranty	12 years
Output Warranty of Pmax	Linear warranty**

** 1) 1st year : 98%, 2) After 1st year : 0.55% annual degradation, 3) 25 years : 84.8%

Temperature Characteristics

NOCT	45 ± 3 °C
Pmpp	-0.37%/°C
Voc	-0.27%/°C
Isc	0.03 %/°C

Characteristic Curves



Electrical Properties (STC *)

Module	LG320N1K-A5
Maximum Power (Pmax)	320
MPP Voltage (Vmpp)	33.3
MPP Current (Impp)	9.62
Open Circuit Voltage (Voc)	40.8
Short Circuit Current (Isc)	10.19
Module Efficiency	18.7
Operating Temperature	-40 ~ +90
Maximum System Voltage	1,000
Maximum Series Fuse Rating	20
Power Tolerance (%)	0 ~ +3

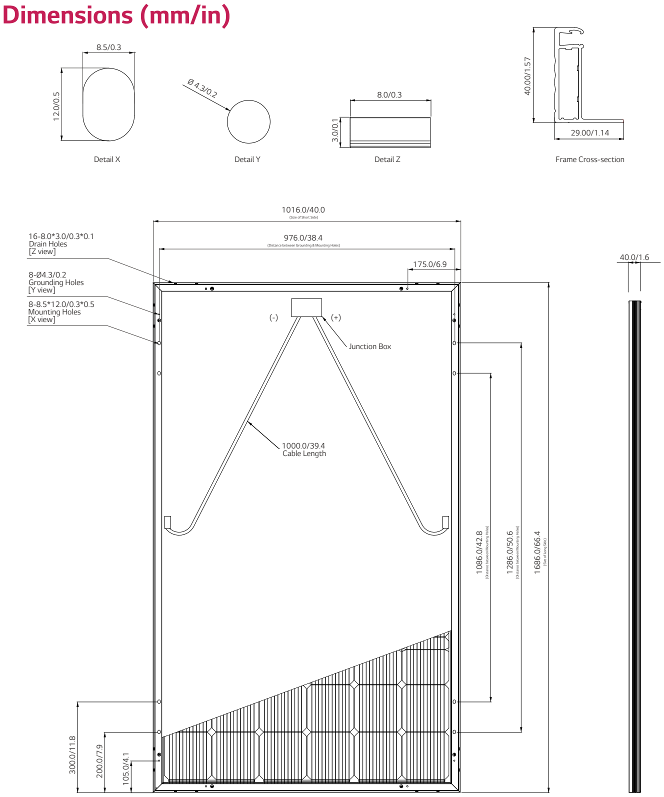
* STC (Standard Test Condition): Irradiance 1,000 W/m², Ambient Temperature 25 °C, AM 1.5
* The nameplate power output is measured and determined by LG Electronics at its sole and absolute discretion.
* The typical change in module efficiency at 200 W/m² in relation to 1000 W/m² is -2.0%.

Electrical Properties (NOCT*)

Module	LG320N1K-A5
Maximum Power (Pmax)	236
MPP Voltage (Vmpp)	30.8
MPP Current (Impp)	7.67
Open Circuit Voltage (Voc)	38.0
Short Circuit Current (Isc)	8.20

* NOCT (Nominal Operating Cell Temperature): Irradiance 800W/m², ambient temperature 20 °C, wind speed 1m/s

Dimensions (mm/in)



LG Life's Good

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Product specifications are subject to change without notice.

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