



London Borough of Hillingdon

WILLOW TREE DEPOT, HAYES

Energy Statement





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Energy Statement

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

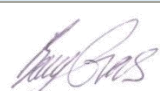
PROJECT NO. 70043538

OUR REF. NO. 70043538

DATE: JUNE 2018

WSP
4th Floor
6 Devonshire Square
London
EC2M 4YE
Phone: +44 20 7337 1700
Fax: +44 20 7337 1701
WSP.com

QUALITY CONTROL

Issue/revision	Draft	First issue	Second Issue
Remarks			Revised SOA
Date	31/01/2018	26/02/2018	04/06/2018
Prepared by	Sabbir Sidat	Sabbir Sidat	Sabbir Sidat
Signature			
Checked by	Barry Evans	Joe Chambers	Joe Chambers
Signature			
Authorised by	Barry Evans	Sabbir Sidat	Sabbir Sidat
Signature			
Project number	70043538	70043538	70043538

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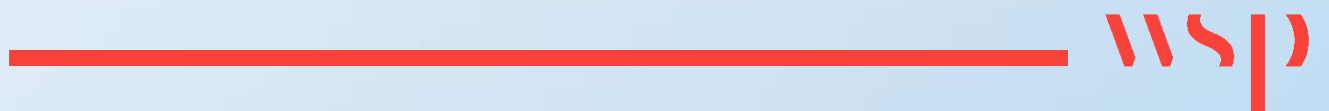
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1

EXECUTIVE SUMMARY



1 EXECUTIVE SUMMARY

WSP has been instructed by the London Borough of Hillingdon (LBH) to undertake an Energy Statement for a proposed residential development at the Former Willow Tree Depot Site, Hayes which is located on Ditchfield Road. This report will be submitted as part of the planning application in 2018.

Full planning permission is sought for the demolition of the existing depot for redevelopment of the Former Willow Tree site for 10 residential units comprising 6 x 3-bed; 4 x 4-bed; and other ancillary works.

1.1 ENERGY AND CARBON TARGETS

Multiple layers of energy and carbon requirements apply to the development at a national, regional and local level, each of which requires different targets to be met. The development will be designed to target the most onerous requirements applicable for this proposal.

On that basis, the implications of the relevant targets for the proposed development can be summarised as follows:

- All development must meet the prevailing Building Regulations requirements. The development will be brought forward under Part L 2013 and this has been used as the basis of this energy statement.
- The London Plan requires new development to achieve a 35% reduction in carbon emissions compared to the minimum requirements of Part L 2013. Remaining emissions must then be offset to zero as per of the Zero Carbon Homes requirement; typically via a carbon offset payment.
- Hillingdon Council requires that major development achieves a 20% reduction in carbon emissions through the use of low and zero carbon technologies.

1.2 ENERGY STATEMENT

The Energy Statement has been structured in accordance with the energy hierarchy: Be Lean, Be Clean, Be Green.

The proposals for the scheme have been developed in accordance with the desire to achieve an energy efficient and sustainable development. The dwellings will be designed to achieve optimum energy performance and will incorporate the following design features:

- Significantly exceed the minimum fabric requirements of Part L1A/L2A (2013) of the Building Regulations.
- All dwellings will include 100% low energy lighting.
- All dwellings will be naturally ventilated

The building will be served by a centralised heating system. Heat to the dwellings will be supplied and metered by heat interface units located in each home / tenancy.

- It is not possible to serve the development from a district heating network.
- It is also not possible to serve the development with a CHP unit.
- Subject to future legal and technical agreements, the homes will be designed for future connections into a district heating network for the import and export of heat should it prove feasible.
Renewable electricity will also be generated on site via a 13.75kWp rooftop Photovoltaic system.

1.3 RESULTS

Accredited Design SAP 2012 software was used to determine the regulated and non-regulated carbon emissions and FEE standards for a sample of typical apartments. The results were then extrapolated across the whole development to assess the total baseline carbon emissions, the carbon emissions after the application of energy efficiency measures and the carbon emissions after the application of low and zero carbon technologies. The results are shown in Table 1 below and exceed the 35% target. In addition the FEE for all the modelled units were found to exceed the target requirements.

Table 1 - Carbon emissions reductions based on the PV based solution

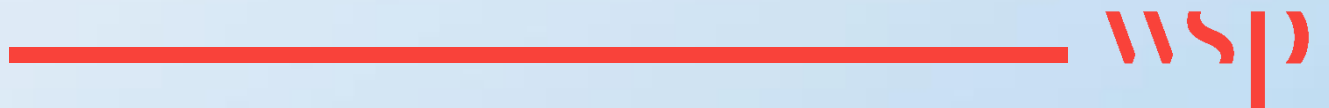
	Regulated Emissions (T CO₂)	Unregulated Emissions (T CO₂)	% Reduction in Regulated Emissions
Part L Compliant Development	18.4	8.2	0.0%
After energy demand reduction	17.7	8.2	3.6%
After energy efficient supply	17.7	8.2	3.6%
After renewable energy	11.8	8.2	35.6%

Hillingdon Council requires that major development achieves a 20% reduction in carbon emissions through the use of low and zero carbon technologies. The proposed strategy meets this requirement.

In order to comply with the Zero Carbon Homes standard, an estimated £21,240 will be paid to the council to offset the remaining carbon emissions to zero (i.e. 11.8 t CO₂ x 30 years x £60 per tonne of CO₂).

2

PROJECT BACKGROUND



2 PROJECT BACKGROUND

2.1 DEVELOPMENT DESCRIPTION

The scheme comprises of 10 residential units, including 6No. 3-bedroom terrace houses and 4No. 4-bedroom end-terrace houses.

Table 2 - Schedule of Accommodation

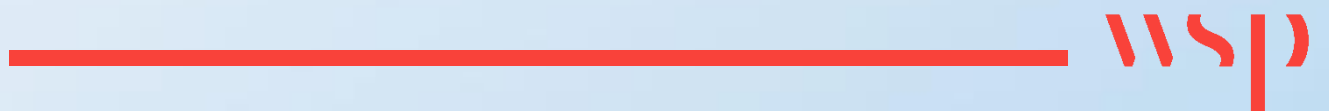
Type	Description	No.	Area
A1	3B/5P House	4	104.6 m ²
A2	3B/5P House	2	107.6 m ²
B1	4B/6P House	1	116.9 m ²
B2	4B/6P House	2	116.9 m ²
B3	4B/6P House	1	116.9 m ²

Figure 1 - Site Location Map for the Proposed Development (site boundary within red line)



3

POLICY CONTEXT



3 POLICY CONTEXT

Hillingdon's approach to sustainable development is underpinned by policies from the London Plan, the Hillingdon Local Plan Part 1 (Strategic Policies) and Part 2 (Development Management Policies).

3.1 THE LONDON PLAN

The Mayor of London published the London Plan 2016. Key policies underpinning London's approach to sustainable development include:

- Policy 5.2 – Minimising Carbon Dioxide Emissions
- Policy 5.3 – Sustainable Design and Construction
- Policy 5.5 – Decentralised Energy Networks
- Policy 5.6 – Decentralised Energy in Development Proposals
- Policy 5.7 – Renewable Energy
- Policy 5.9 – Overheating and cooling

The Mayor's London Plan sets out policy in the London context and identifies a number of objectives to improve the City as a place to work and live. Policy 5.2 sets out the requirements to minimise CO₂ emissions through the application of the energy hierarchy:

- **Be lean:** use less energy
- **Be clean:** supply energy efficiently
- **Be green:** use renewable energy

London Plan policy requires dwellings to achieve a 35% carbon emissions reduction over Part L (2013) of the Building Regulations.

The London Plan requires an assessment of energy demand that demonstrates the steps taken to apply the Mayor's energy hierarchy. The London Plan includes planning policies both for reducing energy consumption within buildings and the use of renewable energy. These policies cover the role of the boroughs in supporting the Mayor's energy strategy and the requirements of planning applications.

From 1 October 2016 the Mayor also applied a **zero carbon homes** standard to new residential developments. In addition to a reduction of at least a 35 per cent in regulated carbon dioxide emissions (beyond Part L 2013) on-site, the remaining regulated carbon dioxide emissions, to 100 per cent, are to be off-set through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere. The typical offset price within the GLA area is £60 per tonne of CO₂ spread out over 30 years; this equates to £1,800 per tonne of CO₂ in total.

The energy assessment is also required to incorporate dynamic thermal modelling in order to assess the risk of **overheating** within the proposed dwellings. The dynamic thermal modelling should be in addition to any assessment of overheating risk obtained from the Part L Building Regulation compliance tools SAP and SBEM. Evidence of how the development performs against the overheating criteria should be presented along with an outline of the assumptions made and in accordance with CIBSE Guides TM49 and TM52.

3.2 LONDON BOROUGH OF HILLINGDON LOCAL PLAN

The Hillingdon Local Plan was adopted in November 2012 and is one of the key tools to realise the vision of Hillingdon's Sustainable Community Strategy. The Local Plan is the key spatial planning document for Hillingdon, setting out the vision for the Borough over the next 15 years (to 2026) and how it will be achieved.

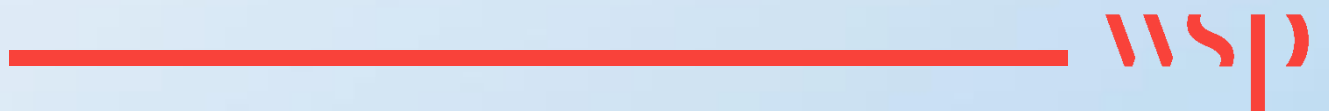
- Policy EM1 (Climate Change Adaption and Mitigation) outlines the need for 'promoting the use of decentralised energy within large scale development whilst improving local air quality levels'
- Indicator E3 (Core) which monitors Policy EM1 sets out the target for 20% of energy needs from renewable sources for larger applications

3.3 BUILDING REGULATIONS (PART L)

All new buildings constructed in England and Wales must meet the minimum requirements of the UK Building Regulations. Specifically with regards to energy and carbon compliance, all buildings must meet the building regulations Part L 'Target Emission Rate' (TER) requirements for the Part L revision which is current at the time of initial construction works for each particular developmental phase. The requirements of Part L 2013 will apply to the Willow Tree Depot Site. This includes the requirement for the dwellings to meet the new Target Fabric Energy Efficiency standards (TFEEs) as laid out in AD L1A 2013.

4

BASELINE CARBON EMISSIONS



4 BASELINE CARBON EMISSIONS

The first stage of the energy assessment is to establish the baseline site energy demand and CO₂ emissions based on accredited SAP software for the residential areas.

NHER Plan Assessor 6.2.3 SAP software was used to establish the baseline regulated carbon emissions and unregulated carbon emissions. The results for the sample apartments were then prorated to calculate the baseline carbon emissions and energy demand for the dwellings across the whole development.

Table 5 - Overall baseline regulated and unregulated carbon emissions Summarises sample of models considered

Table 3 - Summary of SAP models created

Model No	Type	Multiplier
1	A1	4
2	A2	2
3	B (south east facing roof)	2
4	B (north west facing roof)	2

In order to calculate the baseline carbon emissions, a 'notional' fabric performance has been assumed. These are described in the table below.

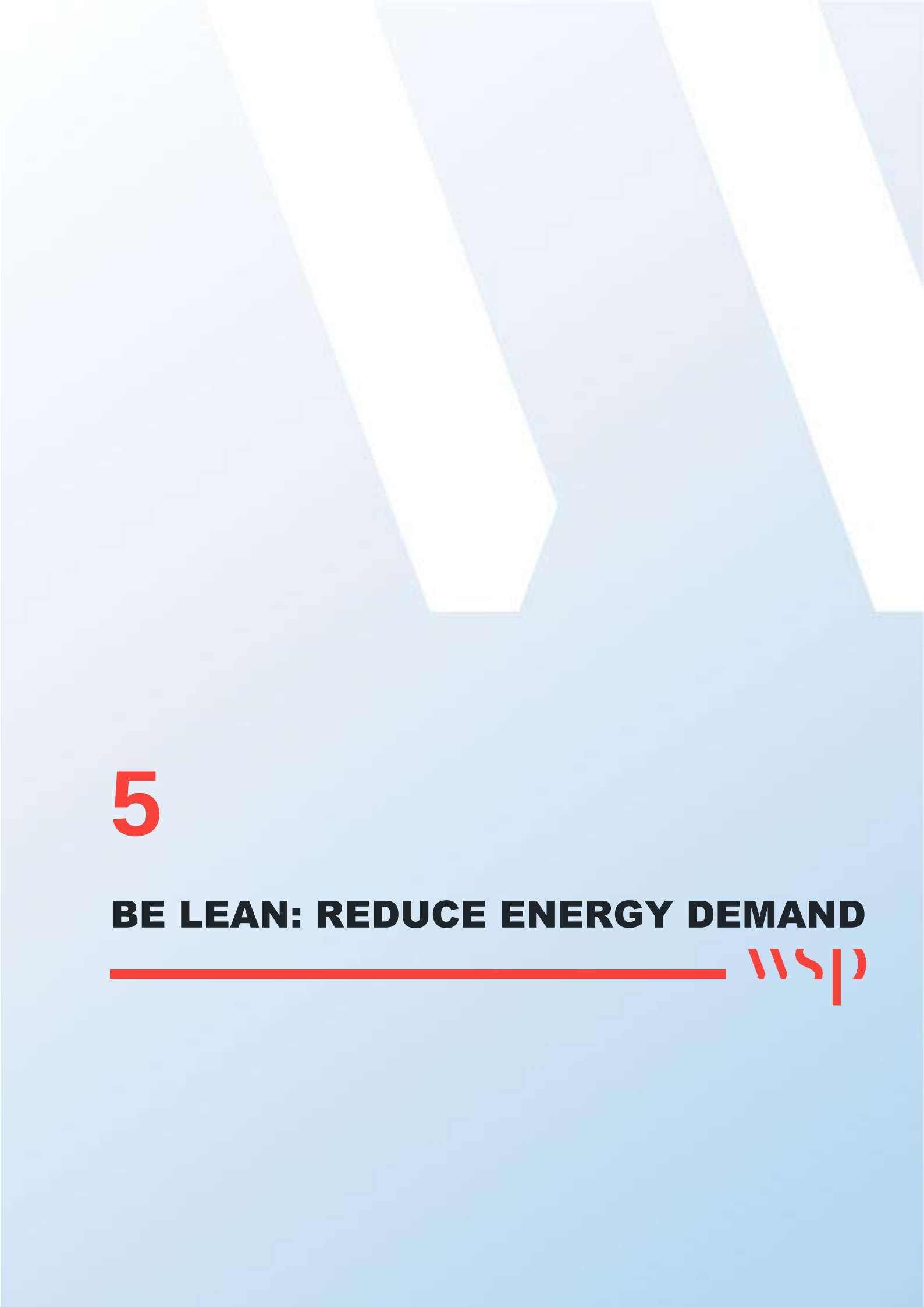
Table 4 - Fabric performance notional and backstop values

Element	Notional Fabric Performance	Fabric Performance – Backstop Values
External Wall U-value (W/m ² K)	0.18	0.30
Party wall U-value (W/m ² K)	0.00	0.20
Ground floor U-value (W/m ² K)	0.13	0.25
Roof U-value (W/m ² K)	0.13	0.20
Glazing U-value (W/m ² K)	1.40	2.00
Glazing G-value	0.70	-
Air permeability (m ³ /hr.m ² @ 50 Pa)	5.0	10.0
Thermal Mass (kJ/m ² K)	250 (medium)	-
Thermal Bridging (W/m ² K)	0.05	-

Table 5 summarises the baseline carbon emissions for the whole development.

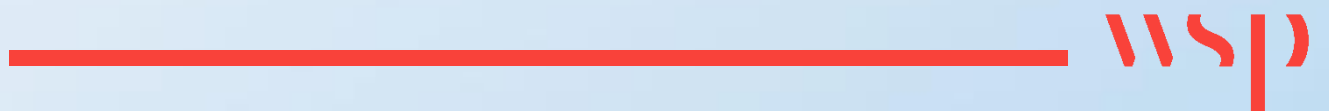
Table 5 - Overall baseline regulated and unregulated carbon emissions

	Regulated Emissions (T CO ₂)	Unregulated Emissions (T CO ₂)
Building Regulations Part L 2013 Compliant Development	18.4	8.2



5

BE LEAN: REDUCE ENERGY DEMAND



5 BE LEAN: REDUCE ENERGY DEMAND

The first step to achieving Building Regulations compliance and the targets outlined previously is to reduce energy demand. The measures associated with reducing demand can be termed as 'Energy Efficiency Measures'.

The Proposed Development will incorporate a number of relevant energy conservation measures; the benefits of which are discussed below. In summary the following measures will be included:

- Good levels of air tightness
- High performance building fabric
- High performance glazing
- 100% low energy lighting
- Natural ventilation

5.1 BUILDING FABRIC

The proposed scheme is designed as a liner block with the built form in keeping with the wider context of the site. All of the unit will comply fully with the London Design Guide and the Lifetime Homes Standard. The layout will ensure that all of the units will benefit from high levels of natural daylight while also balancing the risk of overheating.

At this stage it is anticipated that an overall U-value for the external wall will be around 1.2W/m²K or better. For the purposes of this assessment this value has been used, though solutions will be sought to reduce the U-value further where possible in order to realise further carbon reductions.

Glazing to the dwellings will be specified to achieve a g-value of around 0.42. Whilst this is worse than the notional value, this is considered to provide an appropriate year round balance between maximising daylighting and beneficial wintertime solar gain, and minimising summertime solar gains to reduce the overheating risk and need for comfort cooling. Further details of this last point can be found in the overheating assessment.

The current proposals for the building fabric performance for the Proposed Development are summarised in Table 6. Further opportunities to improve upon these will be considered at the detailed design stage.

5.2 BUILDING SERVICES

A high performance MEP building services is proposed for the scheme. Table 7 lists the general specification for the heating system, lighting and ventilation strategy for the proposed dwellings.

Table 6 - Fabric performance targets

Element	Notional Fabric Performance
External Wall U-value (W/m ² K)	0.14
Party wall U-value (W/m ² K)	0.00
Ground floor U-value (W/m ² K)	0.10
Roof U-value (W/m ² K)	0.10
Glazing U-value (W/m ² K)	1.20
Glazing G-value	0.42
Air permeability (m ³ /hr.m ² @ 50 Pa)	5.0
Thermal Mass (kJ/m ² K)	250 (medium)
Average Thermal Bridging (W/m ² K)	0.073

Table 7 - General heating, cooling, ventilation and lighting specification for dwellings

Element	General Specification
Ventilation	All units to be naturally ventilated. It is assumed that there are no acoustic concerns and windows are assumed to be openable.
Internal lighting	100% low energy, minimum 80 lumens per circuit Watt
Primary heat source	Dedicated high efficiency gas boilers with efficiency of 89.5%
Heating controls	Optimum, including weather compensation
Heat emitters	Radiators
Overheating control / cooling	Natural ventilation, large openable windows

5.3 CARBON EMISSION REDUCTION

Based upon the energy efficiency measures outlined, and excluding the contribution of low or zero carbon technologies the following total carbon emissions are calculated in Table 8.

The carbon emissions for the development are shown to be lower than the minimum requirements of the Building Regulations.

This is achieved via the use of the energy efficiency measures proposed (including a highly efficient building fabric, 100% low energy lighting and natural ventilation) which far exceed the minimum requirements of the Regulations.

Also, appropriate glazing percentages were used on the facade so that a good balance between favouring daylight levels and beneficial heat gains in winter and avoiding excessive heat gains in summer could be achieved.

Table 8 - Be Lean: Carbon emissions after the application of energy efficiency measures

	Regulated Emissions (T CO ₂)	Unregulated Emissions (T CO ₂)	% Reduction in Regulated Carbon Emissions
Building Regulations Part L 2013 Compliant Development	18.4	8.2	0.0%
After energy demand reduction	17.7	8.2	3.6%

5.4 PART L 2013 FABRIC ENERGY EFFICIENCY (FEE)

Accredited Design SAP2012 software was used to determine the FEE standards for the same sample of 4 typical dwellings. The results were then extrapolated across the whole development.

Results for the extrapolated target fabric energy efficiency (TFEE) and for the design building FEE are as follows:

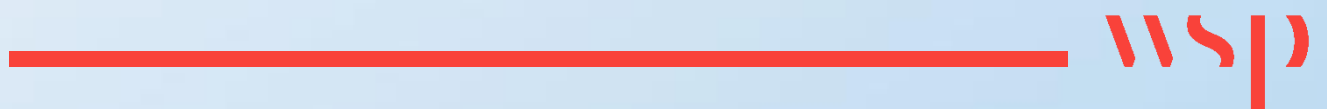
Table 9 - Fabric Energy Efficiency by Model

Model Ref	Target FEE (kWh/m ² /yr)	Design FEE (kWh/m ² /yr)	Improvement
Type A	47.7	41.5	-13.0%
Type B	53.3	47.5	-14.3%

These results show that the proposed fabric energy efficiency for all the modelled typical units improve upon the target values.

6

BE CLEAN: SUPPLY ENERGY EFFICIENTLY



6 BE CLEAN: SUPPLY ENERGY EFFICIENTLY

After consumption has been reduced through the application of energy efficiency measures, the next step is to consider low carbon technologies in order to provide further reduction in carbon dioxide emissions.

The following low carbon technologies have been investigated for the Proposed Development.

- District heating network
- Combined Heat and Power (CHP)

6.1 DISTRICT HEATING NETWORK

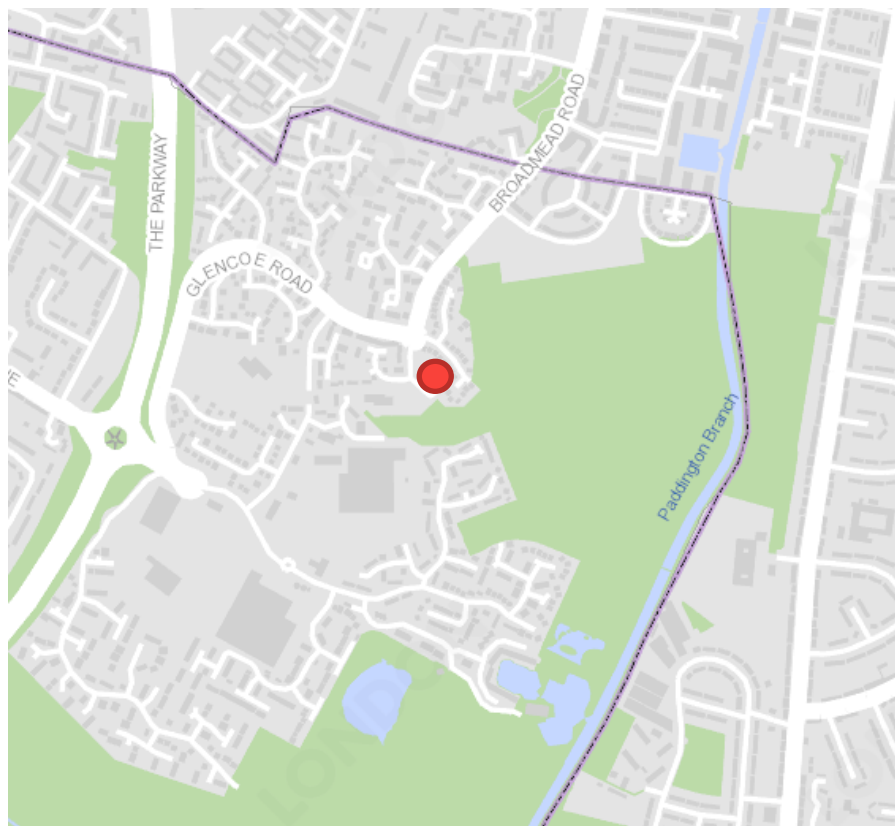
The London Heat Map identifies existing and potential opportunities for decentralised energy projects in London. It builds on the 2005 London Community Heating Development Study. An excerpt from the London Heat Map (shown in Figure 2) shows the location of any existing and proposed district heating systems within the vicinity of the development. The location of the Willow Tree Depot site development is highlighted in red.

The map shows that there are no existing district heating networks in the vicinity of the development.

FUTURE DISTRICT HEATING NETWORK CONNECTION

On the basis of the above, subject to economic and technical viability the heating systems installed will be designed such that they will be able to connect to a future heating network should this provide feasible.

Figure 2 - Excerpt from the London Heat Map



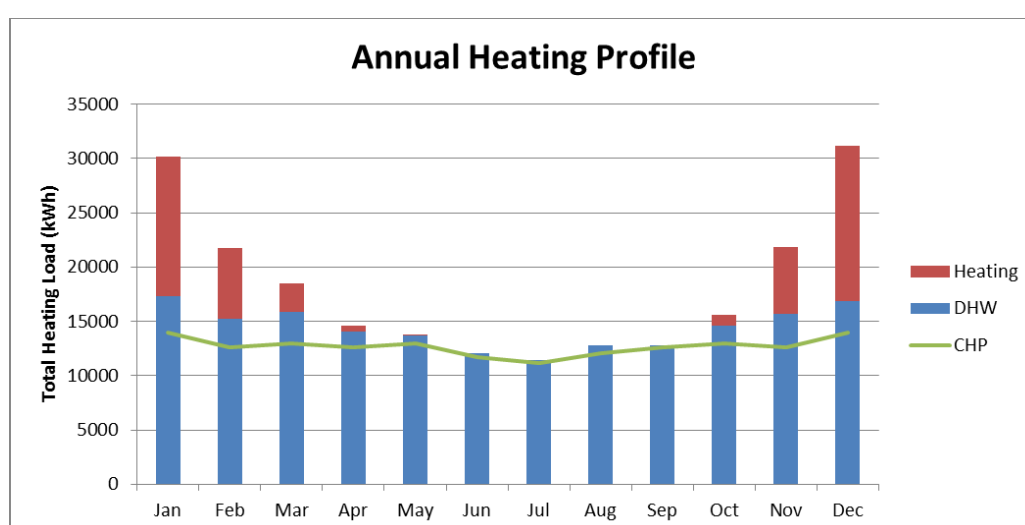
6.2 COMBINED HEAT AND POWER (CHP)

On the basis that the development cannot be supplied directly from a district heating network, in line with the requirements of Hillingdon council we have considered the use of a centralised CHP led LTHW heating system. As a primarily residential development, domestic hot water consumption is likely to make up a significant proportion of the total heat demand, however due to the small number of units this demand is not likely to be consistent and would not be sufficient for the operation of an efficient CHP unit.

Micro-CHP units, suitable for an individual property, are not as yet commercially viable therefore a communal system has been considered. However due to the limited number of housing units along with considering the cost of installing a small unit, this is also not found to be technically or economically viable for this development.

Figure 3 shows a typical annual heating profile with the heat contribution from a CHP engine.

Figure 3 - Annual heating profile showing provision from a CHP led heating system



6.3 CARBON EMISSIONS REDUCTION

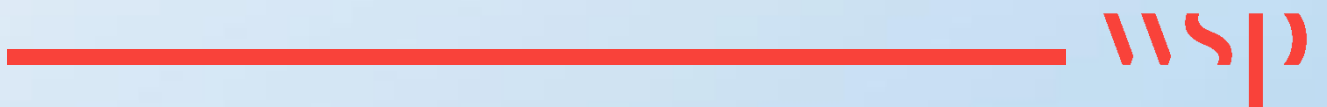
The impact of servicing the development by after the Be Clean on the overall carbon emissions for the development is shown in Table 10. This is unchanged from the previous step and both CHP and district heating have been discounted.

Table 10 - Be Clean: Carbon emissions

	Regulated Emissions (T CO ₂)	Unregulated Emissions (T CO ₂)	% Reduction in Regulated CO ₂ Emissions
Building Regulations Part L 2013 Compliant Development	18.4	8.2	0.0%
After energy demand reduction	17.7	8.2	3.6%
After energy efficient supply	17.7	8.2	3.6%

7

BE GREEN: RENEWABLE ENERGY TECHNOLOGIES



7 BE GREEN: RENEWABLE ENERGY TECHNOLOGIES

Renewable Energy Technologies are those listed below which can provide a source of energy on-site that is not primarily based on the consumption of fossil fuels or grid electricity and/or utilises a heat source that is renewable such as ground source and solar thermal systems.

- Wind Power
- Biomass Heating
- Ground Source Heating and/or Cooling
- Solar Thermal Hot Water Heating
- Photovoltaic Panels

In accordance with the requirements of Section 5.2 of the London Plan and the Hillingdon Local Plan, we have evaluated a number of renewable energy technologies and outlined how they may be applied to the development.

7.1 WIND POWER



Harnessing the kinetic energy of wind can provide a renewable source of on-site electricity generation. Wind turbines need to be positioned where a frequent and steady source of wind is available that is not too turbulent or uneven in direction. Typically wind turbines are positioned on the roof of buildings that are significantly higher than their surroundings and/or located in open areas where there is minimum disruption to prevailing winds.

The development is located within an urban environment with numerous adjacent buildings of similar height providing turbulent wind conditions unsuitable for wind power generation.

Wind conditions prevent the implementation of wind power generation from being feasible. In addition, wind turbines are not considered to be appropriate in townscape and architectural terms to provide wind turbines on top of the building. On that basis they are not proposed for the Willow Tree Depot site development.

7.2 BIOMASS HEATING



Biomass heating has embodied environmental impacts from transport and fuel combustion which makes it less desirable in Air Quality Management Areas (AQMA). A review of the potential impact on air quality from increased wood fuelled biomass use in London has been carried out by AEA Energy & Environment, and was published in December 2007. The assessment indicates that potentially increasing the contribution from small-scale wood fuelled biomass combustion may lead to a substantial increase in nitrogen dioxide and particulate matter concentrations.

The Hillingdon AQMA covers the majority of the borough and whereas previously it covered both particulate matter and nitrogen dioxide, now only includes the latter. However there are several technologies such as ceramic filters, electrostatic precipitators or bag filters which can all be used to significantly reduce the emissions to air and have successfully been used on biomass systems located within AQMAs.

Solid biomass relies on a reliable fuel supply which must be delivered and stored on site. Sites using biomass solutions therefore require good access routes both of which are viable on this site. Biomass boilers also have weekly maintenance requirements and relatively high fuel costs compared to gas.

Space is not available for the installation of an individual or communal biomass system. This has therefore been discounted for this development.

7.3 GROUND / WATER / AIR SOURCE HEAT PUMPS



Heat pumps use electricity to turn low grade heat to a higher temperature typically suitable for providing heating and domestic hot water. They work most effectively when the source temperature (whether that is external air, the ground, or a large body of water) is at a relatively high temperature while the required output temperature is relatively low, i.e. between 35°C and 45°C. Some heat pumps can also be reversed to provide cooling.

Heat pumps produce no emissions at point of use and so do not have an impact on air quality in the locality. Additionally their carbon emissions will reduce in line with the existing and expected decarbonisation of the national grid.

Heat pumps are measured by their coefficient of performance (CoP); that is the ratio of input electricity to the output of heat. Air source heat pumps (ASHPs) generally operate between a CoP of 2.5 and 3, while a good ground or water source heat pump (GSHP / WSHP) may operate between 3.5 – 4.5. These CoPs vary considerably depending on the local source temperatures and the building heat distribution system.

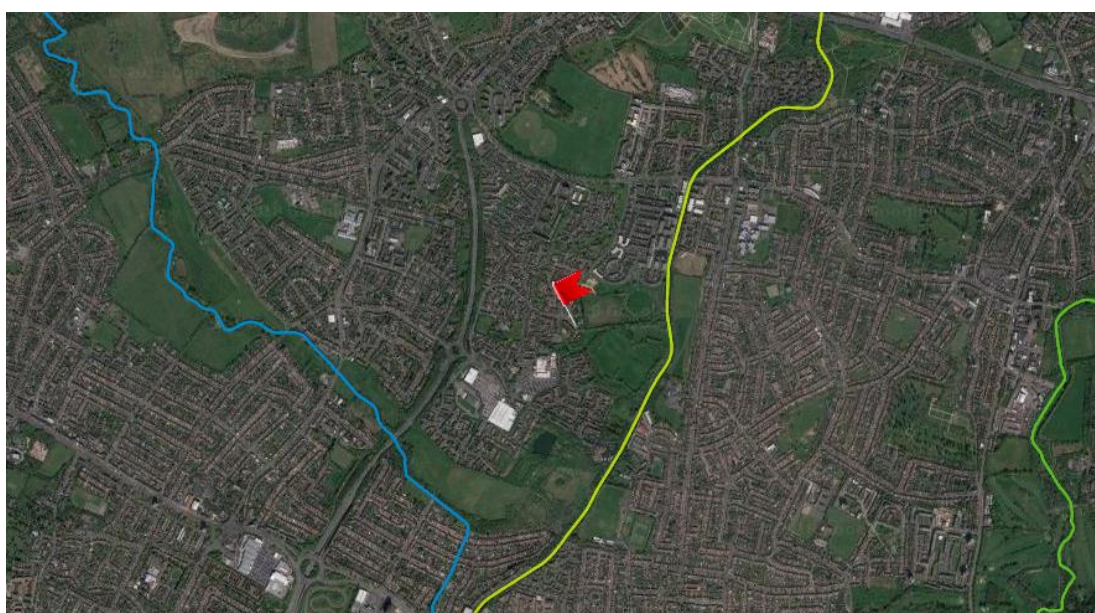
This technology operates most effectively when used to provide space heating via a very low temperature systems such as underfloor heating or low temperature radiators. If higher temperatures are required, the CoP reduces. As ground temperatures are stable year round, GSHPs provide a consistent level of performance throughout the year. Whereas the coefficient of performance of air source heat pumps is directly related to the air temperature. This means the CoP of an ASHP drops in the winter, when demand is greatest but rises in the summer when heating is not normally required.

The British Geological Society's heat pump screening tool has marked this site as being favourable for and open-loop heat pump as a concealed aquifer is present between 50-100m below the ground.

The National Heat map can also be used to assess the potential for heat pumps and has identified two water bodies (a brook and a canal) which potentially could be used in conjunction with a heat pump. However due to the distance from the site and the size of systems being proposed, this would not be a viable solution.

The site is also suitable for a closed-loop heat pump system with adequate space in the car park or garden areas for a Ground Energy Collector.

Figure 4 - National Heat Map



Therefore heat pumps (particularly ground source and air source) are considered viable for this development.

7.4 SOLAR THERMAL



Solar thermal generation involves capturing solar radiant heat to preheat or heat domestic hot water.

Correctly located and orientated, solar thermal systems can meet a proportion of a building's domestic hot water dependent on the expected demand profile and available space for locating ST collectors.

A solar thermal system is able to work well alongside a number of different heating solutions including gas boilers or heat pumps, though the majority of the benefit would be during the summer months. This technology is therefore considered viable for this scheme, though it would be competing for rooftop space against a PV system.

7.5 PHOTOVOLTAIC PANELS



The feasibility of providing photovoltaic (PV) panels has been assessed based upon estimated energy production (kWh) from the installed location along with manufacturers cost data to enable a life cycle cost analysis to be undertaken. Panels correctly oriented, maintained and not obscured by shading can be expected to provide in the region of 120kWh/m²/year in London.

Therefore Solar PV panels located on the top roof areas can be used to provide electricity generation which can contribute to the Local Authority Targets. Space is available on the rooftop sections of house types A1, B and C. House type A2 is considered to have limited potential for PV due to the use design of the roofing system.

7.6 SUITABILITY APPRAISAL

All renewable energy technologies which may be considered feasible for the scheme have been assessed and summarised in Table 11.

Table 11 - Renewable technology suitability appraisal

Technology		Appraisal
Wind		Not suitable at this site
Biomass		Not suitable at this site
Heat Pumps	Air Source	Potentially suitable at this site
	Ground Source	Potentially suitable at this site
	Water Source	Not suitable at this site
Solar Thermal		Potentially suitable at this site
Photovoltaic Panels		Potentially suitable at this site and recommended for inclusion

7.7 CARBON EMISSIONS REDUCTION

All renewable energy technologies which may be considered feasible for the scheme have been assessed, the outcomes of which are summarised above. From that exercise, it was concluded that Solar PV panels were the most suitable for this scheme. A circa 13.75 kWp system at a 30° inclination has been included in this scheme. This consists of 8No. 275Wp panels for unit Type A1 and 9No. 275Wp panels for unit Type B (with the south facing roofs). Unit types A2 and B1 (with north facing roofs) are judged less suitable for PV.

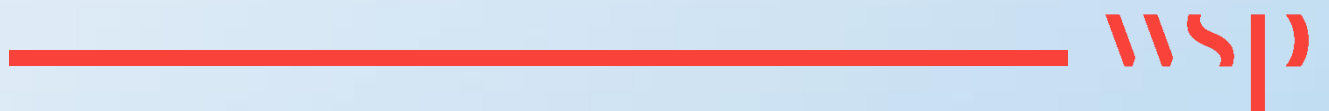
While a heat pump system is also suitable for these units, the energy requirements have been met through the PV system, which is considered more straightforward and cost effective for this development.

Table 12 - Be Green: Carbon Emissions Utilising PV

	Regulated Emissions (T CO₂)	Unregulated Emissions (T CO₂)	% Reduction in Regulated CO₂ Emissions
Building Regulations Part L 2013 Compliant Development	18.4	8.2	0.0%
After energy demand reduction	17.7	8.2	3.6%
After energy efficient supply	17.7	8.2	3.6%
After renewable energy	11.8	8.2	35.6%

8

RESULTS



8 RESULTS

The three principal steps taken; Be Lean (Use Less Energy), Be Clean (Supply Energy Efficiently) and finally Be Green (Renewable Technology measures) are summarised below. The target (Building Regulations compliant) carbon emissions for the Proposed Development are calculated to be 18.4 T CO₂ per annum.

8.1 ENERGY CONSERVATION AND ENERGY EFFICIENCY (BE LEAN)

Through the application of the measures identified in Section 4 the regulated carbon emissions are shown to be 17.7T CO₂ per annum.

8.2 SUPPLY ENERGY EFFICIENTLY (BE CLEAN)

The application of low carbon technologies has been explored; both the application of a district heating network and use of a CHP unit are not found to viable.

Following on from this stage the regulated carbon emissions are unchanged at 17.7T CO₂ per annum.

8.3 RENEWABLE TECHNOLOGY (BE GREEN)

The feasibility of a range of renewable technologies has been assessed in the context of the London Plan. A PV system has been put forward for inclusion resulting in a reduction in regulation carbon emissions by 5.9T CO₂ per annum. Overall this produces a reduction in regulated carbon emissions of 11.8 T CO₂ per annum.

Through the use of the Be Lean, Be Clean and Be Green framework, regulated carbon emissions have been shown to be reduced by 35.6% against Part L 2013, exceeding the GLA target.

8.4 PART L 2013 FABRIC ENERGY EFFICIENCY (FEE)

Accredited Design SAP2012 software was used to determine the FEE standards for a sample of typical apartments. These results show that the proposed fabric energy efficiency for all the modelled typical units exceed the target values.

8.5 LONDON PLAN – POLICY 5.2

As discussed in 3.1, we have confirmed that the GLA's Zero Carbon Homes tax will apply to the Proposed Development. As such the remaining CO₂ emissions other than those reduced on-site, are to be offset down to zero.

No direction has been provided by Hillingdon Council and therefore the GLA general offset price of £60 per tonne has been used. The total cost to offset all of the remaining carbon emission (11.8T CO₂) over 30 years is approximately £21,240.

Figure 5 - Summary of the estimated carbon emissions reductions for the whole development

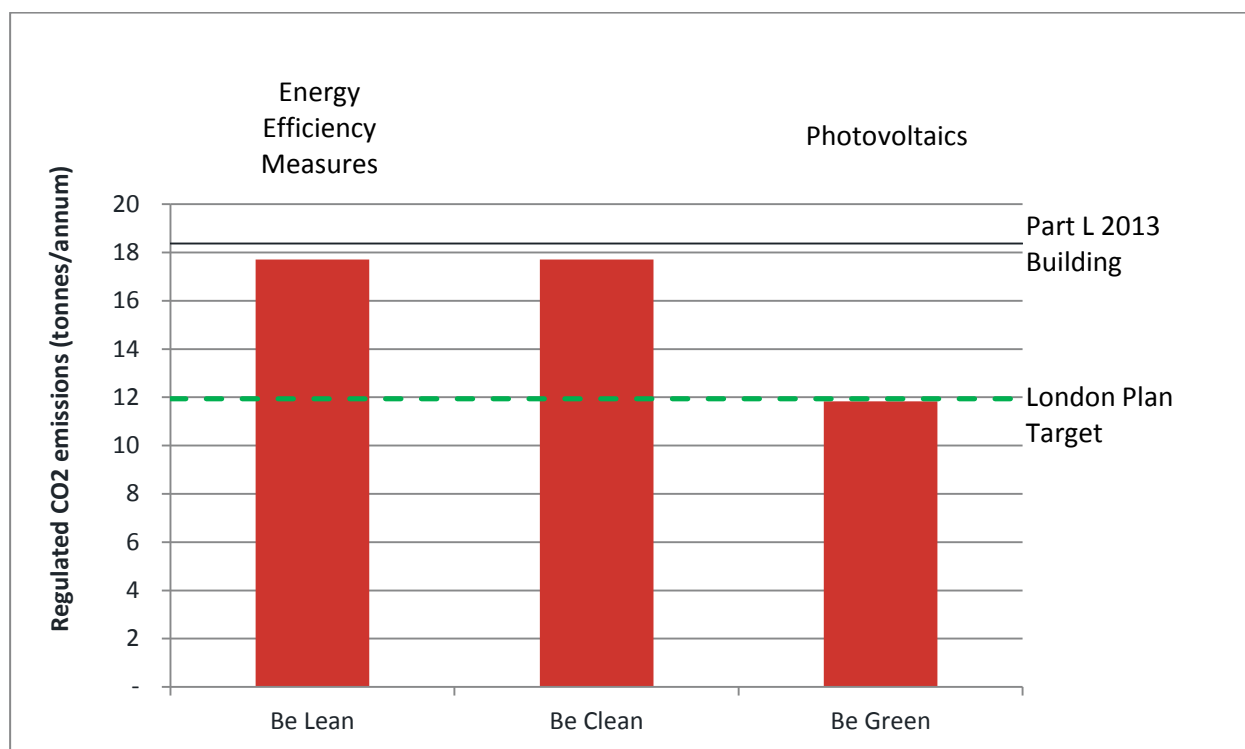


Table 13 - Regulated carbon dioxide savings from each stage of the energy hierarchy

	Regulated carbon dioxide emissions savings (T CO ₂ per annum)	Regulated carbon dioxide emissions savings (%)
Savings from energy demand reduction	0.66	3.6%
Savings from energy efficient supply	0.00	0.0%
Savings from renewable energy	5.87	32.0%
Total Cumulative Savings	6.54	35.6%
Total Target Savings	6.43	35.0%
Annual Surplus	0.11	0.6%

Appendix A

SAP OUTPUT DOCUMENT



Appendix A.1

TER

wsp

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Sabbir Sidat	Assessor number	1
Client		Last modified	31/01/2018
Address	House type A Willow Tree, Hayes		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	51.70 (1a)	x	2.50 (2a)	=	129.25 (3a)
+1	51.70 (1b)	x	2.80 (2b)	=	144.76 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 103.40 (4)				
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) = 274.01 (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	4	x 10 =	40 (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) = 40	÷ (5) =	0.15 (8)

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

Air permeability value, q ₅₀ , 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)	0.40 (18)
--	-----------

Number of sides on which the dwelling is sheltered	2 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.34 (21)
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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

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
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.43	0.42	0.41	0.37	0.36	0.32	0.32	0.31	0.34	0.36	0.38	0.40
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Calculate effective air change rate for the applicable case:

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

d) natural ventilation or whole house positive input ventilation from loft

	0.59	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.59	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K
Door			4.40	1.00	4.40		(26)
Window			10.80	1.33	14.32		(27)
Ground floor			51.70	0.13	6.72		(28a)
External wall			44.20	0.18	7.96		(29a)
Party wall			106.00	0.00	0.00		(32)
Roof			51.70	0.13	6.72		(30)
Total area of external elements ΣA, m ²			162.80				(31)
Fabric heat loss, W/K = Σ(A x U)					(26)...(30) + (32) =	40.12	(33)
Heat capacity Cm = Σ(A x κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)
Thermal bridges: Σ(L x Ψ) calculated using Appendix K						10.48	(36)
Total fabric heat loss					(33) + (36) =	50.59	(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)												
53.54	53.21	52.90	51.41	51.13	49.83	49.83	49.59	50.33	51.13	51.69	52.28	(38)

Heat transfer coefficient, W/K (37)m + (38)m	104.13	103.81	103.49	102.00	101.72	100.43	100.43	100.19	100.93	101.72	102.29	102.88	
Average = Σ(39)1...12/12 =	102.00												(39)

Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.01	1.00	1.00	0.99	0.98	0.97	0.97	0.97	0.98	0.98	0.99	0.99	
Average = Σ(40)1...12/12 =	0.99												(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)
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4. Water heating energy requirement

Assumed occupancy, N	2.77	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	99.96	(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)											
109.96	105.96	101.96	97.96	93.96	89.96	89.96	93.96	97.96	101.96	105.96	109.96
Σ(44)1...12 =										1199.52	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	163.06	142.61	147.17	128.30	123.11	106.23	98.44	112.96	114.31	133.22	145.42	157.92	
Σ(45)1...12 =	1572.76												(45)

Distribution loss 0.15 x (45)m	24.46	21.39	22.07	19.25	18.47	15.94	14.77	16.94	17.15	19.98	21.81	23.69	(46)
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Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
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If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
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Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
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Combi loss for each month from Table 3a, 3b or 3c	50.96	46.03	50.96	48.31	47.88	44.37	45.84	47.88	48.31	50.96	49.32	50.96	(61)
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Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

214.02	188.64	198.12	176.61	170.99	150.60	144.29	160.85	162.62	184.18	194.74	208.88
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(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
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(63)

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

214.02	188.64	198.12	176.61	170.99	150.60	144.29	160.85	162.62	184.18	194.74	208.88
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

$\Sigma(64)_{1...12} =$

2154.54

(64)

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

66.96	58.93	61.67	54.74	52.90	46.41	44.19	49.53	50.09	57.04	60.68	65.25
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(65)

5. Internal gains												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)												
138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												
26.69	23.71	19.28	14.60	10.91	9.21	9.95	12.94	17.37	22.05	25.74	27.44	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												
261.71	264.43	257.58	243.01	224.62	207.34	195.79	193.07	199.92	214.49	232.88	250.16	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												
36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	(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)												
-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	(71)
Water heating gains (Table 5)												
90.00	87.69	82.89	76.03	71.11	64.46	59.40	66.57	69.56	76.66	84.28	87.70	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m												
445.93	443.36	427.29	401.17	374.17	348.55	332.68	340.12	354.38	380.73	410.43	432.83	(73)

6. Solar gains													
	Access factor Table 6d			Area m ²	Solar flux W/m ²		g specific data or Table 6b		FF specific data or Table 6c		Gains W		
SouthWest	0.77	x	5.80	x	36.79	x 0.9 x	0.63	x	0.70	=	65.22	(79)	
NorthEast	0.77	x	5.00	x	11.28	x 0.9 x	0.63	x	0.70	=	17.24	(75)	
Solar gains in watts Σ(74)m...(82)m													
	82.46	146.19	215.23	292.18	350.54	358.24	341.12	296.02	241.63	165.67	99.81	69.89	(83)

Total gains - internal and solar (73)m + (83)m												
528.39	589.54	642.52	693.35	724.71	706.78	673.80	636.14	596.01	546.40	510.24	502.72	(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	1.00	1.00	0.98	0.94	0.81	0.63	0.69	0.91	0.99	1.00	1.00	(86)	
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
19.87	19.99	20.20	20.48	20.75	20.93	20.99	20.98	20.86	20.52	20.15	19.85	(87)	
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)													
20.08	20.08	20.08	20.09	20.10	20.11	20.11	20.11	20.10	20.10	20.09	20.09	(88)	

Utilisation factor for gains for rest of dwelling n2,m

1.00	1.00	0.99	0.98	0.91	0.73	0.52	0.57	0.86	0.98	1.00	1.00	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

18.55	18.73	19.03	19.46	19.83	20.06	20.10	20.10	19.97	19.51	18.97	18.54	(90)
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Living area fraction

Living area ÷ (4) = 0.23 (91)

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

18.86	19.02	19.30	19.70	20.04	20.26	20.31	20.30	20.18	19.74	19.24	18.84	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.86	19.02	19.30	19.70	20.04	20.26	20.31	20.30	20.18	19.74	19.24	18.84	(93)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

8. Space heating requirement

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

Utilisation factor for gains, ηm

1.00	1.00	0.99	0.97	0.91	0.75	0.54	0.60	0.86	0.98	1.00	1.00	(94)
------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, ηmGm, W (94)m x (84)m

527.45	587.41	636.83	674.03	658.92	527.39	366.76	381.69	514.78	535.24	508.31	502.05	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

1516.12	1466.01	1324.99	1101.12	848.83	568.51	372.30	391.10	613.48	929.95	1241.94	1506.43	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

735.57	590.42	511.99	307.50	141.29	0.00	0.00	0.00	0.00	293.66	528.21	747.26	
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Σ(98)1...5, 10...12 = 3855.90 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 37.29 (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 (%)

93.40 (206)

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

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

787.55	632.14	548.17	329.23	151.27	0.00	0.00	0.00	0.00	314.41	565.54	800.06	
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Σ(211)1...5, 10...12 = 4128.38 (211)

Water heating

Efficiency of water heater

87.91	87.73	87.34	86.43	84.58	80.30	80.30	80.30	80.30	86.22	87.44	87.98	(217)
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Water heating fuel, kWh/month

243.46	215.03	226.86	204.33	202.18	187.55	179.68	200.31	202.52	213.61	222.71	237.41	
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Σ(219a)1...12 = 2535.64 (219)

Annual totals

Space heating fuel - main system 1

4128.38

Water heating fuel

2535.64

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)	471.42	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) = 7210.45	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4128.38	x	3.48	x 0.01 =	143.67	(240)
Water heating	2535.64	x	3.48	x 0.01 =	88.24	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	471.42	x	13.19	x 0.01 =	62.18	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		423.98	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.20	(257)
SAP value	83.26	
SAP rating (section 13)	83	(258)
SAP band	B	

12a. CO₂ 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	4128.38	x	0.216	=	891.73	(261)
Water heating	2535.64	x	0.216	=	547.70	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1439.43	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	471.42	x	0.519	=	244.67	(268)
Total CO ₂ , kg/year			(265)...(271) =		1723.02	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		16.66	(273)
EI value					84.44	
EI rating (section 14)					84	(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	4128.38	x	1.22	=	5036.62	(261)
Water heating	2535.64	x	1.22	=	3093.49	(264)
Space and water heating			(261) + (262) + (263) + (264) =		8130.11	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	471.42	x	3.07	=	1447.27	(268)
Primary energy kWh/year					9807.63	(272)
Dwelling primary energy rate kWh/m ² /year					94.85	(273)

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Sabbir Sidat	Assessor number	1
Client		Last modified	31/01/2018
Address	House type B Willow Tree, Hayes		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	59.70 (1a)	x	2.50 (2a)	=	149.25 (3a)
+1	59.70 (1b)	x	2.80 (2b)	=	167.16 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 119.40 (4)				
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) = 316.41 (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	4	x 10 =	40 (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) = 40	÷ (5) =	0.13 (8)

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

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.38 (18)
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Number of sides on which the dwelling is sheltered	1 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.93 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.35 (21)
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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

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
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.44	0.44	0.43	0.38	0.37	0.33	0.33	0.32	0.35	0.37	0.39	0.41
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Calculate effective air change rate for the applicable case:

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

0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.58	0.58
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.58	0.58	(25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K
Door			2.20	1.00	2.20		(26)
Window			14.60	1.33	19.36		(27)
Ground floor			59.70	0.13	7.76		(28a)
External wall			104.40	0.18	18.79		(29a)
Party wall			55.10	0.00	0.00		(32)
Roof			59.70	0.13	7.76		(30)
Total area of external elements $\sum A$, m ²			240.60				(31)
Fabric heat loss, W/K = $\sum(A \times U)$					(26)...(30) + (32) =	55.87	(33)
Heat capacity Cm = $\sum(A \times \kappa)$					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)
Thermal bridges: $\sum(L \times \Psi)$ calculated using Appendix K						11.23	(36)
Total fabric heat loss					(33) + (36) =	67.10	(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)												
62.50	62.10	61.71	59.87	59.52	57.92	57.92	57.62	58.54	59.52	60.22	60.95	(38)

Heat transfer coefficient, W/K (37)m + (38)m												
129.60	129.20	128.81	126.97	126.62	125.02	125.02	124.72	125.64	126.62	127.32	128.05	
Average = $\sum(39)1...12/12 =$											126.96	(39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)												
1.09	1.08	1.08	1.06	1.06	1.05	1.05	1.04	1.05	1.06	1.07	1.07	
Average = $\sum(40)1...12/12 =$											1.06	(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)
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4. Water heating energy requirement

Assumed occupancy, N	2.86	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	102.15	(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)												
112.36	108.28	104.19	100.10	96.02	91.93	91.93	96.02	100.10	104.19	108.28	112.36	
										$\sum(44)1...12 =$	1225.78	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)													
166.63	145.74	150.39	131.11	125.80	108.56	100.60	115.44	116.81	136.14	148.60	161.37		
											$\Sigma(45)1...12 =$	1607.18	(45)

Distribution loss 0.15 x (45)m	24.99	21.86	22.56	19.67	18.87	16.28	15.09	17.32	17.52	20.42	22.29	24.21	(46)
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Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
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If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
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Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
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Combi loss for each month from Table 3a, 3b or 3c	50.96	46.03	50.96	49.32	48.93	45.34	46.85	48.93	49.32	50.96	49.32	50.96	(61)
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Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

217.59	191.76	201.35	180.43	174.73	153.90	147.44	164.37	166.13	187.09	197.92	212.33
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(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
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(63)

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

217.59	191.76	201.35	180.43	174.73	153.90	147.44	164.37	166.13	187.09	197.92	212.33
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$\Sigma(64)1...12 =$

2195.04

(64)

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

68.14	59.96	62.74	55.92	54.06	47.43	45.16	50.61	51.17	58.00	61.74	66.40
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(65)

5. Internal gains												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)												
143.05	143.05	143.05	143.05	143.05	143.05	143.05	143.05	143.05	143.05	143.05	143.05	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												
28.03	24.89	20.25	15.33	11.46	9.67	10.45	13.59	18.23	23.15	27.02	28.81	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												
284.43	287.38	279.94	264.11	244.12	225.34	212.79	209.84	217.27	233.11	253.09	271.88	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												
37.30	37.30	37.30	37.30	37.30	37.30	37.30	37.30	37.30	37.30	37.30	37.30	(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)												
-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	(71)
Water heating gains (Table 5)												
91.59	89.23	84.33	77.67	72.66	65.88	60.70	68.03	71.07	77.96	85.75	89.24	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m												
472.96	470.42	453.44	426.02	397.16	369.80	352.85	360.37	375.49	403.14	434.78	458.84	(73)

6. Solar gains												
	Access factor Table 6d	Area m ²	Solar flux W/m ²		g specific data or Table 6b		FF specific data or Table 6c		Gains W			
SouthWest	0.77	x	6.20	x	36.79	x	0.9	x	0.63	x	0.70	= 69.72 (79)
NorthEast	0.77	x	8.40	x	11.28	x	0.9	x	0.63	x	0.70	= 28.96 (75)
Solar gains in watts $\Sigma(74)m...(82)m$												
98.68	177.71	268.71	375.78	460.00	473.87	449.71	384.24	305.37	203.30	119.95	83.32	(83)
Total gains - internal and solar (73)m + (83)m												
571.65	648.14	722.15	801.80	857.16	843.67	802.56	744.61	680.86	606.44	554.73	542.16	(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	1.00	1.00	0.99	0.94	0.82	0.65	0.72	0.93	0.99	1.00	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)												
19.73	19.86	20.08	20.40	20.70	20.91	20.98	20.97	20.81	20.43	20.03	19.72	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)												
20.01	20.02	20.02	20.03	20.03	20.04	20.04	20.05	20.04	20.03	20.03	20.02	(88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	1.00	0.99	0.98	0.92	0.74	0.53	0.59	0.88	0.99	1.00	1.00	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

18.30	18.49	18.82	19.30	19.72	19.98	20.04	20.03	19.87	19.34	18.75	18.29	(90)
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Living area fraction

Living area ÷ (4) = 0.15 (91)

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

18.51	18.69	19.01	19.46	19.86	20.12	20.17	20.17	20.00	19.49	18.94	18.50	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.51	18.69	19.01	19.46	19.86	20.12	20.17	20.17	20.00	19.49	18.94	18.50	(93)
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8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Utilisation factor for gains, ηm

1.00	1.00	0.99	0.97	0.91	0.75	0.55	0.61	0.88	0.98	1.00	1.00	(94)
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Useful gains, ηmGm, W (94)m x (84)m

570.81	646.15	716.40	780.41	780.12	631.48	438.32	454.95	597.50	596.13	553.04	541.57	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

1841.92	1781.79	1611.07	1340.33	1033.37	689.61	446.79	469.96	741.85	1126.24	1507.04	1830.66	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

945.71	763.15	665.63	403.15	188.42	0.00	0.00	0.00	0.00	394.40	686.87	959.08	
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Σ(98)1...5, 10...12 = 5006.41 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 41.93 (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 (%)

93.40 (206)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Space heating fuel (main system 1), kWh/month

1012.53	817.08	712.67	431.63	201.73	0.00	0.00	0.00	0.00	422.27	735.41	1026.86	
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Σ(211)1...5, 10...12 = 5360.18 (211)

Water heating

Efficiency of water heater

88.32	88.17	87.83	87.02	85.24	80.30	80.30	80.30	80.30	86.88	87.93	88.38	(217)
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Water heating fuel, kWh/month

246.36	217.49	229.23	207.35	204.99	191.65	183.62	204.69	206.89	215.34	225.10	240.24	
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Σ(219a)1...12 = 2572.93 (219)

Annual totals

Space heating fuel - main system 1

5360.18

Water heating fuel

2572.93

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)	494.99	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) = 8503.10	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	5360.18	x	3.48	x 0.01 =	186.53	(240)
Water heating	2572.93	x	3.48	x 0.01 =	89.54	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	494.99	x	13.19	x 0.01 =	65.29	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		471.25	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.20	(257)
SAP value	83.21	
SAP rating (section 13)	83	(258)
SAP band	B	

12a. CO₂ 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	5360.18	x	0.216	=	1157.80	(261)
Water heating	2572.93	x	0.216	=	555.75	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1713.55	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	494.99	x	0.519	=	256.90	(268)
Total CO ₂ , kg/year			(265)...(271) =		2009.38	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		16.83	(273)
EI value					83.62	
EI rating (section 14)					84	(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	5360.18	x	1.22	=	6539.42	(261)
Water heating	2572.93	x	1.22	=	3138.97	(264)
Space and water heating			(261) + (262) + (263) + (264) =		9678.39	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	494.99	x	3.07	=	1519.62	(268)
Primary energy kWh/year					11428.26	(272)
Dwelling primary energy rate kWh/m ² /year					95.71	(273)

Appendix A.2

DER

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This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Sabbir Sidat	Assessor number	1
Client		Last modified	26/02/2018
Address	House type A1 Willow Tree, Hayes		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	51.70 (1a) x	2.50 (2a) =	129.25 (3a)
+1	51.70 (1b) x	2.80 (2b) =	144.76 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 103.40 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	274.01 (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	3 x 10 =	30 (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) = 30 ÷ (5) =	0.11 (8)
<i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>		
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)		0.36 (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) =	0.31 (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
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
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.39	0.38	0.37	0.34	0.33	0.29	0.29	0.28	0.31	0.33	0.34	0.36

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)

d) natural ventilation or whole house positive input ventilation from loft

0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.55	0.55	0.56	0.56	(25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K
Door			4.40	1.20	5.28		(26)
Window			10.80	1.15	12.37		(27)
Ground floor			51.70	0.10	5.17		(28a)
External wall			44.20	0.14	6.19		(29a)
Party wall			106.00	0.00	0.00		(32)
Roof			51.70	0.10	5.17		(30)
Total area of external elements ΣA, m ²			162.80				(31)
Fabric heat loss, W/K = Σ(A x U)					(26)...(30) + (32) =	34.17	(33)
Heat capacity Cm = Σ(A x κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)
Thermal bridges: Σ(L x Ψ) calculated using Appendix K						12.29	(36)
Total fabric heat loss					(33) + (36) =	46.46	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Ventilation heat loss calculated monthly $0.33 \times (25)\text{m} \times (5)$	52.07	51.81	51.55	50.32	50.09	49.02	49.02	48.82	49.43	50.09	50.55	51.04	(38)	
Heat transfer coefficient, W/K $(37)\text{m} + (38)\text{m}$	98.54	98.27	98.01	96.78	96.55	95.48	95.48	95.29	95.90	96.55	97.02	97.50		
	Average = $\sum(39)1...12/12 =$												96.78	(39)
Heat loss parameter (HLP), $\text{W/m}^2\text{K}$ $(39)\text{m} \div (4)$	0.95	0.95	0.95	0.94	0.93	0.92	0.92	0.92	0.93	0.93	0.94	0.94		
	Average = $\sum(40)1...12/12 =$												0.94	(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

2.77

(42)

Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$

99.96

(43)

JanFebMarAprMayJunJulAugSepOctNovDec

Hot water usage in litres per day for each month $V_{d,m}$ = factor from Table 1c x (43)

109.96	105.96	101.96	97.96	93.96	89.96	89.96	93.96	97.96	101.96	105.96	109.96
--------	--------	--------	-------	-------	-------	-------	-------	-------	--------	--------	--------

$\sum(44)_{1...12} =$

1199.52

(44)

Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)

163.06	142.61	147.17	128.30	123.11	106.23	98.44	112.96	114.31	133.22	145.42	157.92
--------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------

$\sum(45)_{1...12} =$

1572.76

(45)

Distribution loss $0.15 \times (45)m$

24.46	21.39	22.07	19.25	18.47	15.94	14.77	16.94	17.15	19.98	21.81	23.69
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(46)

Water storage loss calculated for each month $(55) \times (41)m$

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
------	------	------	------	------	------	------	------	------	------	------	------

(56)

If the vessel contains dedicated solar storage or dedicated WWHRS $(56)m \times [(47) - V_s] \div (47)$, else (56)

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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(57)

Primary circuit loss for each month from Table 3

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
------	------	------	------	------	------	------	------	------	------	------	------

(59)

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

30.54	27.57	30.50	29.46	30.40	29.37	30.32	30.37	29.42	30.45	29.52	30.53
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(61)

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

193.60	170.19	177.66	157.76	153.51	135.61	128.76	143.34	143.73	163.67	174.94	188.44
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

(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

193.60	170.19	177.66	157.76	153.51	135.61	128.76	143.34	143.73	163.67	174.94	188.44
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$\Sigma(64)1...12 =$

1931.22

(64)

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

61.85	54.31	56.56	50.03	48.53	42.67	40.31	45.15	45.36	51.91	55.73	60.14
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(65)

5. Internal gains												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)												
138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												
26.69	23.71	19.28	14.60	10.91	9.21	9.95	12.94	17.37	22.05	25.74	27.44	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												
261.71	264.43	257.58	243.01	224.62	207.34	195.79	193.07	199.92	214.49	232.88	250.16	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												
36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	(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)												
-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	(71)
Water heating gains (Table 5)												
83.14	80.82	76.02	69.48	65.23	59.26	54.18	60.69	63.01	69.77	77.41	80.83	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m												
439.07	436.49	420.41	394.62	368.30	343.34	327.46	334.24	347.82	373.84	403.55	425.96	(73)

6. Solar gains												
	Access factor Table 6d			Area m ²	Solar flux W/m ²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
SouthWest	0.77	x	5.80	x	36.79	x 0.9	0.42	x	0.70	=	43.48	(79)
NorthEast	0.77	x	5.00	x	11.28	x 0.9	0.42	x	0.70	=	11.49	(75)
Solar gains in watts Σ(74)m...(82)m												
	54.97	97.46	143.49	194.79	233.69	238.82	227.41	197.34	161.09	110.45	66.54	46.60 (83)

Total gains - internal and solar (73)m + (83)m												
494.05	533.95	563.90	589.41	601.99	582.17	554.87	531.58	508.91	484.29	470.09	472.56	(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	1.00	1.00	0.99	0.97	0.88	0.72	0.76	0.94	0.99	1.00	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)												
19.91	20.01	20.19	20.45	20.70	20.90	20.98	20.97	20.83	20.51	20.17	19.90	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)												
20.12	20.12	20.13	20.14	20.14	20.15	20.15	20.15	20.14	20.14	20.14	20.13	(88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	1.00	1.00	0.99	0.95	0.81	0.60	0.65	0.91	0.99	1.00	1.00	(89)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

19.12	19.22	19.40	19.66	19.91	20.09	20.14	20.14	20.03	19.72	19.38	19.11	(90)
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Living area fraction

Living area ÷ (4) = 0.23 (91)

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

19.30	19.40	19.58	19.84	20.09	20.28	20.34	20.33	20.22	19.90	19.57	19.29	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.15	19.25	19.43	19.69	19.94	20.13	20.19	20.18	20.07	19.75	19.42	19.14	(93)
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8. Space heating requirement

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

Utilisation factor for gains, ηm

1.00	1.00	1.00	0.99	0.95	0.81	0.60	0.66	0.90	0.99	1.00	1.00	(94)
------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, ηmGm, W (94)m x (84)m

493.48	532.84	561.22	580.69	569.57	473.09	334.91	348.37	459.06	478.11	468.97	472.15	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

1463.63	1410.33	1267.39	1044.46	795.94	528.29	342.35	360.30	572.20	883.76	1194.87	1457.06	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

721.79	589.67	525.39	333.91	168.42	0.00	0.00	0.00	0.00	301.80	522.65	732.78	
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Σ(98)1...5, 10...12 = 3896.41 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 37.68 (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 (%)

93.20 (206)

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

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

774.45	632.69	563.72	358.28	180.71	0.00	0.00	0.00	0.00	323.82	560.78	786.24	
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Σ(211)1...5, 10...12 = 4180.70 (211)

Water heating

Efficiency of water heater

89.50	89.46	89.37	89.15	88.65	87.00	87.00	87.00	87.00	89.05	89.38	89.53	(217)
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Water heating fuel, kWh/month

216.31	190.23	198.79	176.97	173.17	155.87	148.00	164.75	165.21	183.80	195.74	210.49	
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Σ(219a)1...12 = 2179.34 (219)

Annual totals

Space heating fuel - main system 1

4180.70

Water heating fuel

2179.34

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)	471.42	(232)
Energy saving/generation technologies		
electricity generated by PV (Appendix M)	-1811.37	(233)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) = 5095.10	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4180.70	x	3.48	x 0.01 =	145.49	(240)
Water heating	2179.34	x	3.48	x 0.01 =	75.84	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	471.42	x	13.19	x 0.01 =	62.18	(250)
Additional standing charges					120.00	(251)
Energy saving/generation technologies						
pv savings	-1811.37	x	13.19	x 0.01 =	-238.92	(252)
Total energy cost				(240)...(242) + (245)...(254) =	174.48	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	0.49	(257)
SAP value	93.11	
SAP rating (section 13)	93	(258)
SAP band	A	

12a. CO₂ 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	4180.70	x	0.216	=	903.03	(261)
Water heating	2179.34	x	0.216	=	470.74	(264)
Space and water heating				(261) + (262) + (263) + (264) =	1373.77	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	471.42	x	0.519	=	244.67	(268)
Energy saving/generation technologies						
pv savings	-1811.37	x	0.519	=	-940.10	(269)
Total CO ₂ , kg/year				(265)...(271) =	717.26	(272)
Dwelling CO ₂ emission rate				(272) ÷ (4) =	6.94	(273)
EI value					93.52	
EI rating (section 14)					94	(274)
EI band					A	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	4180.70	x	1.22	=	5100.46	(261)
Water heating	2179.34	x	1.22	=	2658.79	(264)
Space and water heating				(261) + (262) + (263) + (264) =	7759.25	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	471.42	x	3.07	=	1447.27	(268)

Energy saving/generation technologies

Electricity generated - PVs	-1811.37	x	3.07	=	-5560.90	(269)
Primary energy kWh/year					3875.87	(272)
Dwelling primary energy rate kWh/m2/year					37.48	(273)

DRAFT

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Sabbir Sidat	Assessor number	1
Client		Last modified	26/02/2018
Address	House type A2 Willow Tree, Hayes		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	51.70 (1a) x	2.50 (2a) =	129.25 (3a)
+1	51.70 (1b) x	2.80 (2b) =	144.76 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 103.40 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	274.01 (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	3 x 10 =	30 (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) = 30 ÷ (5) = 0.11 (8)

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

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.36 (18)
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Number of sides on which the dwelling is sheltered	2 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.31 (21)
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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

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
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.39	0.38	0.37	0.34	0.33	0.29	0.29	0.28	0.31	0.33	0.34	0.36
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Calculate effective air change rate for the applicable case:

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

	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.55	0.55	0.56	0.56	(25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K
Door			4.40	1.20	5.28		(26)
Window			10.80	1.15	12.37		(27)
Ground floor			51.70	0.10	5.17		(28a)
External wall			44.20	0.14	6.19		(29a)
Party wall			106.00	0.00	0.00		(32)
Roof			51.70	0.10	5.17		(30)
Total area of external elements ΣA, m ²			162.80				(31)
Fabric heat loss, W/K = Σ(A x U)					(26)...(30) + (32) =	34.17	(33)
Heat capacity Cm = Σ(A x κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)
Thermal bridges: Σ(L x Ψ) calculated using Appendix K						12.29	(36)
Total fabric heat loss					(33) + (36) =	46.46	(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)												
52.07	51.81	51.55	50.32	50.09	49.02	49.02	48.82	49.43	50.09	50.55	51.04	(38)

Heat transfer coefficient, W/K (37)m + (38)m												
98.54	98.27	98.01	96.78	96.55	95.48	95.48	95.29	95.90	96.55	97.02	97.50	
Average = Σ(39)1...12/12 =											96.78	(39)

Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)												
0.95	0.95	0.95	0.94	0.93	0.92	0.92	0.92	0.93	0.93	0.94	0.94	
Average = Σ(40)1...12/12 =											0.94	(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	2.77	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	99.96	(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)												
109.96	105.96	101.96	97.96	93.96	89.96	89.96	93.96	97.96	101.96	105.96	109.96	
Σ(44)1...12 =											1199.52	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)												
163.06	142.61	147.17	128.30	123.11	106.23	98.44	112.96	114.31	133.22	145.42	157.92	
Σ(45)1...12 =											1572.76	(45)

Distribution loss 0.15 x (45)m												
24.46	21.39	22.07	19.25	18.47	15.94	14.77	16.94	17.15	19.98	21.81	23.69	(46)

Water storage loss calculated for each month (55) x (41)m												
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)												
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)

Primary circuit loss for each month from Table 3												
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)

Combi loss for each month from Table 3a, 3b or 3c												
30.54	27.57	30.50	29.46	30.40	29.37	30.32	30.37	29.42	30.45	29.52	30.53	(61)

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

193.60	170.19	177.66	157.76	153.51	135.61	128.76	143.34	143.73	163.67	174.94	188.44
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(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
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(63)

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

193.60	170.19	177.66	157.76	153.51	135.61	128.76	143.34	143.73	163.67	174.94	188.44
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$\Sigma(64)1...12 =$

1931.22

(64)

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

61.85	54.31	56.56	50.03	48.53	42.67	40.31	45.15	45.36	51.91	55.73	60.14
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(65)

5. Internal gains												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)												
138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	138.44	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												
26.69	23.71	19.28	14.60	10.91	9.21	9.95	12.94	17.37	22.05	25.74	27.44	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												
261.71	264.43	257.58	243.01	224.62	207.34	195.79	193.07	199.92	214.49	232.88	250.16	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												
36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	36.84	(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)												
-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	-110.75	(71)
Water heating gains (Table 5)												
83.14	80.82	76.02	69.48	65.23	59.26	54.18	60.69	63.01	69.77	77.41	80.83	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m												
439.07	436.49	420.41	394.62	368.30	343.34	327.46	334.24	347.82	373.84	403.55	425.96	(73)

6. Solar gains												
	Access factor Table 6d			Area m ²	Solar flux W/m ²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
SouthWest		0.77	x	5.80	x	36.79	x 0.9 x	0.42	x	0.70	=	43.48 (79)
NorthEast		0.77	x	5.00	x	11.28	x 0.9 x	0.42	x	0.70	=	11.49 (75)
Solar gains in watts Σ(74)m...(82)m												
	54.97	97.46	143.49	194.79	233.69	238.82	227.41	197.34	161.09	110.45	66.54	46.60 (83)

Total gains - internal and solar (73)m + (83)m												
494.05	533.95	563.90	589.41	601.99	582.17	554.87	531.58	508.91	484.29	470.09	472.56	(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	1.00	1.00	0.99	0.97	0.88	0.72	0.76	0.94	0.99	1.00	1.00	(86)	
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
19.91	20.01	20.19	20.45	20.70	20.90	20.98	20.97	20.83	20.51	20.17	19.90	(87)	
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)													
20.12	20.12	20.13	20.14	20.14	20.15	20.15	20.15	20.14	20.14	20.14	20.13	(88)	

Utilisation factor for gains for rest of dwelling n2,m

1.00	1.00	1.00	0.99	0.95	0.81	0.60	0.65	0.91	0.99	1.00	1.00	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

19.12	19.22	19.40	19.66	19.91	20.09	20.14	20.14	20.03	19.72	19.38	19.11	(90)
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Living area fraction

Living area ÷ (4) = 0.23 (91)

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

19.30	19.40	19.58	19.84	20.09	20.28	20.34	20.33	20.22	19.90	19.57	19.29	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.15	19.25	19.43	19.69	19.94	20.13	20.19	20.18	20.07	19.75	19.42	19.14	(93)
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8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Utilisation factor for gains, ηm

1.00	1.00	1.00	0.99	0.95	0.81	0.60	0.66	0.90	0.99	1.00	1.00	(94)
------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, ηmGm, W (94)m x (84)m

493.48	532.84	561.22	580.69	569.57	473.09	334.91	348.37	459.06	478.11	468.97	472.15	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

1463.63	1410.33	1267.39	1044.46	795.94	528.29	342.35	360.30	572.20	883.76	1194.87	1457.06	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

721.79	589.67	525.39	333.91	168.42	0.00	0.00	0.00	0.00	301.80	522.65	732.78	
										Σ(98)1...5, 10...12 =	3896.41	(98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 37.68 (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 (%)

93.20 (206)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Space heating fuel (main system 1), kWh/month

774.45	632.69	563.72	358.28	180.71	0.00	0.00	0.00	0.00	323.82	560.78	786.24	
										Σ(211)1...5, 10...12 =	4180.70	(211)

Water heating

Efficiency of water heater

89.50	89.46	89.37	89.15	88.65	87.00	87.00	87.00	87.00	89.05	89.38	89.53	(217)
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Water heating fuel, kWh/month

216.31	190.23	198.79	176.97	173.17	155.87	148.00	164.75	165.21	183.80	195.74	210.49	
										Σ(219a)1...12 =	2179.34	(219)

Annual totals

Space heating fuel - main system 1

4180.70

Water heating fuel

2179.34

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)	471.42	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) = 6906.46	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4180.70	x	3.48	x 0.01 =	145.49	(240)
Water heating	2179.34	x	3.48	x 0.01 =	75.84	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	471.42	x	13.19	x 0.01 =	62.18	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		413.40	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.17	(257)
SAP value	83.68	
SAP rating (section 13)	84	(258)
SAP band	B	

12a. CO₂ 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	4180.70	x	0.216	=	903.03	(261)
Water heating	2179.34	x	0.216	=	470.74	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1373.77	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	471.42	x	0.519	=	244.67	(268)
Total CO ₂ , kg/year			(265)...(271) =		1657.36	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		16.03	(273)
EI value					85.03	
EI rating (section 14)					85	(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	4180.70	x	1.22	=	5100.46	(261)
Water heating	2179.34	x	1.22	=	2658.79	(264)
Space and water heating			(261) + (262) + (263) + (264) =		7759.25	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	471.42	x	3.07	=	1447.27	(268)
Primary energy kWh/year					9436.77	(272)
Dwelling primary energy rate kWh/m ² /year					91.26	(273)

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Sabbir Sidat	Assessor number	1
Client		Last modified	31/01/2018
Address	House type B Willow Tree, Hayes		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	59.70 (1a) x	2.50 (2a) =	149.25 (3a)
+1	59.70 (1b) x	2.80 (2b) =	167.16 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 119.40 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	316.41 (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	3 x 10 =	30 (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) = 30 ÷ (5) =	0.09 (8)
<i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>		
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)		0.34 (18)
Number of sides on which the dwelling is sheltered		1 (19)
Shelter factor	1 - [0.075 x (19)] =	0.93 (20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.32 (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

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
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m

0.41	0.40	0.39	0.35	0.34	0.30	0.30	0.30	0.32	0.34	0.36	0.37
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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)

d) natural ventilation or whole house positive input ventilation from loft

0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57	(25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K
Door			2.20	1.20	2.64		(26)
Window			14.60	1.15	16.72		(27)
Ground floor			59.70	0.10	5.97		(28a)
External wall			104.40	0.14	14.62		(29a)
Party wall			55.10	0.00	0.00		(32)
Roof			59.70	0.10	5.97		(30)
Total area of external elements $\sum A$, m ²			240.60				(31)
Fabric heat loss, W/K = $\sum(A \times U)$					(26)...(30) + (32) =	45.91	(33)
Heat capacity Cm = $\sum(A \times \kappa)$					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)
Thermal bridges: $\sum(L \times \Psi)$ calculated using Appendix K						14.62	(36)
Total fabric heat loss					(33) + (36) =	60.54	(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)												
60.84	60.51	60.18	58.63	58.35	57.00	57.00	56.75	57.52	58.35	58.93	59.54	(38)

Heat transfer coefficient, W/K (37)m + (38)m	121.38	121.04	120.72	119.17	118.88	117.54	117.54	117.29	118.06	118.88	119.47	120.08	
Average = $\sum(39)1...12/12 =$												119.17	(39)

Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.02	1.01	1.01	1.00	1.00	0.98	0.98	0.98	0.99	1.00	1.00	1.01	
Average = $\sum(40)1...12/12 =$												1.00	(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)
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4. Water heating energy requirement

Assumed occupancy, N												2.86	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36												102.15	(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)													
	112.36	108.28	104.19	100.10	96.02	91.93	91.93	96.02	100.10	104.19	108.28	112.36	
	$\sum(44)1...12 =$											1225.78	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	166.63	145.74	150.39	131.11	125.80	108.56	100.60	115.44	116.81	136.14	148.60	161.37	
$\sum(45)1...12 =$												1607.18	(45)

Distribution loss 0.15 x (45)m	24.99	21.86	22.56	19.67	18.87	16.28	15.09	17.32	17.52	20.42	22.29	24.21	(46)
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Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
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If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
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Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
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Combi loss for each month from Table 3a, 3b or 3c	30.55	27.58	30.50	29.48	30.42	29.38	30.33	30.39	29.43	30.46	29.53	30.54	(61)
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Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

197.18	173.32	180.89	160.59	156.22	137.94	130.93	145.82	146.25	166.60	178.13	191.91
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(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
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(63)

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

197.18	173.32	180.89	160.59	156.22	137.94	130.93	145.82	146.25	166.60	178.13	191.91
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$\Sigma(64)1...12 =$

1965.78

(64)

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

63.04	55.35	57.63	50.96	49.43	43.44	41.03	45.98	46.20	52.88	56.79	61.29
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(65)

5. Internal gains												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)												
143.05	143.05	143.05	143.05	143.05	143.05	143.05	143.05	143.05	143.05	143.05	143.05	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												
28.03	24.89	20.25	15.33	11.46	9.67	10.45	13.59	18.23	23.15	27.02	28.81	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												
284.43	287.38	279.94	264.11	244.12	225.34	212.79	209.84	217.27	233.11	253.09	271.88	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												
37.30	37.30	37.30	37.30	37.30	37.30	37.30	37.30	37.30	37.30	37.30	37.30	(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)												
-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	(71)
Water heating gains (Table 5)												
84.74	82.37	77.46	70.78	66.44	60.34	55.15	61.80	64.17	71.08	78.88	82.38	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m												
466.11	463.56	446.56	419.13	390.94	364.26	347.30	354.14	368.59	396.25	427.91	451.98	(73)

6. Solar gains													
	Access factor Table 6d			Area m ²	Solar flux W/m ²	g specific data or Table 6b			FF specific data or Table 6c		Gains W		
SouthWest	0.77	x	6.20	x	36.79	x 0.9	0.42	x	0.70	=	46.48	(79)	
NorthEast	0.77	x	8.40	x	11.28	x 0.9	0.42	x	0.70	=	19.31	(75)	
Solar gains in watts $\Sigma(74)m...(82)m$													
	65.79	118.48	179.14	250.52	306.67	315.91	299.80	256.16	203.58	135.53	79.97	55.54	(83)

Total gains - internal and solar (73)m + (83)m												
531.90	582.04	625.70	669.65	697.60	680.17	647.11	610.30	572.17	531.78	507.88	507.53	(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	1.00	1.00	0.99	0.97	0.89	0.74	0.79	0.96	1.00	1.00	1.00	(86)	
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
19.79	19.90	20.09	20.37	20.65	20.88	20.97	20.96	20.78	20.43	20.07	19.78	(87)	
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)													
20.07	20.07	20.07	20.08	20.09	20.10	20.10	20.10	20.09	20.09	20.08	20.08	(88)	

Utilisation factor for gains for rest of dwelling n2,m

1.00	1.00	1.00	0.99	0.96	0.83	0.62	0.68	0.92	0.99	1.00	1.00	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

18.96	19.06	19.26	19.54	19.82	20.03	20.09	20.08	19.95	19.60	19.24	18.95	(90)
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Living area fraction

Living area ÷ (4) = 0.15 (91)

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

19.08	19.18	19.38	19.66	19.94	20.15	20.22	20.21	20.07	19.72	19.36	19.07	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.93	19.03	19.23	19.51	19.79	20.00	20.07	20.06	19.92	19.57	19.21	18.92	(93)
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8. Space heating requirement

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

Utilisation factor for gains, ηm

1.00	1.00	1.00	0.99	0.95	0.82	0.61	0.67	0.92	0.99	1.00	1.00	(94)
------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, ηmGm, W (94)m x (84)m

531.44	581.08	623.23	660.79	662.22	557.84	396.05	410.38	524.23	526.51	506.97	507.19	(95)
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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]

1775.46	1710.55	1536.36	1264.83	961.91	635.10	407.32	429.19	687.06	1066.58	1446.70	1767.48	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

925.55	759.00	679.37	434.91	222.97	0.00	0.00	0.00	0.00	401.82	676.61	937.65	
										Σ(98)1...5, 10...12 =	5037.88	(98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 42.19 (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 (%)

93.20 (206)

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

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

993.08	814.37	728.94	466.64	239.24	0.00	0.00	0.00	0.00	431.13	725.98	1006.07	
										Σ(211)1...5, 10...12 =	5405.45	(211)

Water heating

Efficiency of water heater

89.62	89.59	89.51	89.31	88.85	87.00	87.00	87.00	87.00	89.24	89.51	89.64	(217)
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Water heating fuel, kWh/month

220.02	193.46	202.10	179.80	175.82	158.55	150.49	167.61	168.10	186.69	199.00	214.09	
										Σ(219a)1...12 =	2215.74	(219)

Annual totals

Space heating fuel - main system 1

5405.45

Water heating fuel

2215.74

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)	494.99	(232)
Energy saving/generation technologies		
electricity generated by PV (Appendix M)	-2037.79	(233)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	6153.39 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	5405.45	x	3.48	x 0.01 =	188.11	(240)
Water heating	2215.74	x	3.48	x 0.01 =	77.11	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	494.99	x	13.19	x 0.01 =	65.29	(250)
Additional standing charges					120.00	(251)
Energy saving/generation technologies						
pv savings	-2037.79	x	13.19	x 0.01 =	-268.78	(252)
Total energy cost			(240)...(242) + (245)...(254) =		191.61	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	0.49	(257)
SAP value	93.17	
SAP rating (section 13)	93	(258)
SAP band	A	

12a. CO₂ 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	5405.45	x	0.216	=	1167.58	(261)
Water heating	2215.74	x	0.216	=	478.60	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1646.18	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	494.99	x	0.519	=	256.90	(268)
Energy saving/generation technologies						
pv savings	-2037.79	x	0.519	=	-1057.61	(269)
Total CO ₂ , kg/year			(265)...(271) =		884.39	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		7.41	(273)
EI value					92.79	
EI rating (section 14)					93	(274)
EI band					A	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	5405.45	x	1.22	=	6594.65	(261)
Water heating	2215.74	x	1.22	=	2703.20	(264)
Space and water heating			(261) + (262) + (263) + (264) =		9297.85	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	494.99	x	3.07	=	1519.62	(268)

Energy saving/generation technologies

Electricity generated - PVs	-2037.79	x	3.07	=	-6256.01	(269)
Primary energy kWh/year					4791.71	(272)
Dwelling primary energy rate kWh/m2/year					40.13	(273)

DRAFT

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Sabbir Sidat	Assessor number	1
Client		Last modified	31/01/2018
Address	House type B Willow Tree, Hayes		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	59.70 (1a)	x	2.50 (2a)	=	149.25 (3a)
+1	59.70 (1b)	x	2.80 (2b)	=	167.16 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 119.40 (4)				
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) = 316.41 (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	3	x 10 =	30	(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) =	30	÷ (5) =	0.09 (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)				0.34 (18)
Number of sides on which the dwelling is sheltered				1 (19)
Shelter factor	1 - [0.075 x (19)] =			0.93 (20)
Infiltration rate incorporating shelter factor	(18) x (20) =			0.32 (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

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
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m

0.41	0.40	0.39	0.35	0.34	0.30	0.30	0.30	0.32	0.34	0.36	0.37
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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)

d) natural ventilation or whole house positive input ventilation from loft

0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57	(25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K
Door			2.20	1.20	2.64		(26)
Window			14.60	1.15	16.72		(27)
Ground floor			59.70	0.10	5.97		(28a)
External wall			104.40	0.14	14.62		(29a)
Party wall			55.10	0.00	0.00		(32)
Roof			59.70	0.10	5.97		(30)
Total area of external elements ΣA, m ²			240.60				(31)
Fabric heat loss, W/K = Σ(A x U)					(26)...(30) + (32) =	45.91	(33)
Heat capacity Cm = Σ(A x κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)
Thermal bridges: Σ(L x Ψ) calculated using Appendix K						14.62	(36)
Total fabric heat loss					(33) + (36) =	60.54	(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)												
60.84	60.51	60.18	58.63	58.35	57.00	57.00	56.75	57.52	58.35	58.93	59.54	(38)

Heat transfer coefficient, W/K (37)m + (38)m	121.38	121.04	120.72	119.17	118.88	117.54	117.54	117.29	118.06	118.88	119.47	120.08	
Average = Σ(39)1...12/12 =	119.17												(39)

Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.02	1.01	1.01	1.00	1.00	0.98	0.98	0.98	0.99	1.00	1.00	1.01	
Average = Σ(40)1...12/12 =	1.00												(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)
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4. Water heating energy requirement

Assumed occupancy, N	2.86	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	102.15	(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)											
112.36	108.28	104.19	100.10	96.02	91.93	91.93	96.02	100.10	104.19	108.28	112.36
Σ(44)1...12 =										1225.78	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	166.63	145.74	150.39	131.11	125.80	108.56	100.60	115.44	116.81	136.14	148.60	161.37	
Σ(45)1...12 =	1607.18												(45)

Distribution loss 0.15 x (45)m	24.99	21.86	22.56	19.67	18.87	16.28	15.09	17.32	17.52	20.42	22.29	24.21	(46)
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Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
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If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
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Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
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Combi loss for each month from Table 3a, 3b or 3c	30.55	27.58	30.50	29.48	30.42	29.38	30.33	30.39	29.43	30.46	29.53	30.54	(61)
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Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

197.18	173.32	180.89	160.59	156.22	137.94	130.93	145.82	146.25	166.60	178.13	191.91
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(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
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(63)

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

197.18	173.32	180.89	160.59	156.22	137.94	130.93	145.82	146.25	166.60	178.13	191.91
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$\Sigma(64)1...12 =$

1965.78

(64)

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

63.04	55.35	57.63	50.96	49.43	43.44	41.03	45.98	46.20	52.88	56.79	61.29
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(65)

5. Internal gains												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)												(66)
171.66	171.66	171.66	171.66	171.66	171.66	171.66	171.66	171.66	171.66	171.66	171.66	
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												(67)
70.07	62.24	50.61	38.32	28.64	24.18	26.13	33.96	45.59	57.88	67.56	72.02	
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												(68)
424.52	428.93	417.83	394.19	364.36	336.32	317.59	313.19	324.29	347.92	377.75	405.79	
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												(69)
55.03	55.03	55.03	55.03	55.03	55.03	55.03	55.03	55.03	55.03	55.03	55.03	
Pump and fan gains (Table 5a)												(70)
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	
Losses e.g. evaporation (Table 5)												(71)
-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	-114.44	
Water heating gains (Table 5)												(72)
84.74	82.37	77.46	70.78	66.44	60.34	55.15	61.80	64.17	71.08	78.88	82.38	
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m												(73)
694.58	688.78	661.15	618.54	574.69	536.09	514.12	524.20	549.29	592.13	639.44	675.44	

6. Solar gains												
	Access factor Table 6d			Area m ²	Solar flux W/m ²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
SouthWest		0.77	x	6.20	x	36.79	x 0.9 x	0.42	x	0.70	=	46.48 (79)
NorthEast		0.77	x	8.40	x	11.28	x 0.9 x	0.42	x	0.70	=	19.31 (75)
Solar gains in watts $\Sigma(74)m...(82)m$												
	65.79	118.48	179.14	250.52	306.67	315.91	299.80	256.16	203.58	135.53	79.97	55.54 (83)
Total gains - internal and solar (73)m + (83)m												
	760.36	807.26	840.29	869.06	881.36	852.00	813.92	780.36	752.87	727.66	719.40	730.98 (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)												(86)
1.00	1.00	0.99	0.98	0.93	0.79	0.62	0.66	0.88	0.98	0.99	1.00	
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)												(87)
19.98	20.08	20.26	20.52	20.77	20.94	20.99	20.98	20.88	20.58	20.24	19.96	
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)												(88)
20.07	20.07	20.07	20.08	20.09	20.10	20.10	20.10	20.09	20.09	20.08	20.08	

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.99	0.97	0.90	0.71	0.50	0.55	0.82	0.97	0.99	1.00	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

19.14	19.24	19.42	19.69	19.92	20.07	20.09	20.09	20.02	19.74	19.41	19.13	(90)
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Living area fraction

Living area ÷ (4) = 0.15 (91)

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

19.26	19.36	19.54	19.81	20.04	20.19	20.22	20.22	20.15	19.87	19.53	19.25	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.11	19.21	19.39	19.66	19.89	20.04	20.07	20.07	20.00	19.72	19.38	19.10	(93)
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8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Utilisation factor for gains, ηm

1.00	0.99	0.98	0.96	0.89	0.71	0.50	0.54	0.82	0.96	0.99	1.00	(94)
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Useful gains, ηmGm, W (94)m x (84)m

756.66	801.07	827.66	835.24	783.20	603.28	404.24	424.11	613.64	700.55	712.69	728.10	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

1797.58	1732.16	1556.50	1282.03	974.02	639.71	408.26	430.71	696.08	1083.69	1466.72	1788.98	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

774.45	625.69	542.25	321.69	141.97	0.00	0.00	0.00	0.00	285.06	542.90	789.29	
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Σ(98)1...5, 10...12 = 4023.30 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 33.70 (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 (%)

93.20 (206)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Space heating fuel (main system 1), kWh/month

830.95	671.34	581.82	345.16	152.32	0.00	0.00	0.00	0.00	305.86	582.52	846.88	
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Σ(211)1...5, 10...12 = 4316.85 (211)

Water heating

Efficiency of water heater

89.53	89.49	89.38	89.11	88.49	87.00	87.00	87.00	87.00	88.99	89.39	89.56	(217)
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Water heating fuel, kWh/month

220.24	193.68	202.39	180.22	176.53	158.55	150.49	167.61	168.10	187.20	199.28	214.29	
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Σ(219a)1...12 = 2218.59 (219)

Annual totals

Space heating fuel - main system 1

4316.85

Water heating fuel

2218.59

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)	494.99	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) = 7105.43	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4316.85	x	3.48	x 0.01 =	150.23	(240)
Water heating	2218.59	x	3.48	x 0.01 =	77.21	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	494.99	x	13.19	x 0.01 =	65.29	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		422.62	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.08	(257)
SAP value	84.94	
SAP rating (section 13)	85	(258)
SAP band	B	

12a. CO₂ 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	4316.85	x	0.216	=	932.44	(261)
Water heating	2218.59	x	0.216	=	479.22	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1411.66	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	494.99	x	0.519	=	256.90	(268)
Total CO ₂ , kg/year			(265)...(271) =		1707.48	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		14.30	(273)
EI value					86.08	
EI rating (section 14)					86	(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	4316.85	x	1.22	=	5266.55	(261)
Water heating	2218.59	x	1.22	=	2706.68	(264)
Space and water heating			(261) + (262) + (263) + (264) =		7973.24	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	494.99	x	3.07	=	1519.62	(268)
Primary energy kWh/year					9723.11	(272)
Dwelling primary energy rate kWh/m ² /year					81.43	(273)



4th Floor
6 Devonshire Square
London
EC2M 4YE

wsp.com