HODKINSON

Energy Statement

Quantum Group

Former ICL Ground

Final

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ABOUT HODKINSON CONSULTANCY

Our team of technical specialists offer advanced levels of expertise and experience to our clients. We have a wide experience of the construction and development industry and tailor teams to suit each individual project.

We are able to advise at all stages of projects from planning applications to handover.

Our emphasis is to provide innovative and cost effective solutions that respond to increasing demands for quality and construction efficiency.

Executive Summary

The purpose of this Energy Statement is to demonstrate that the proposed development on the Former Imperial Collage London (ICL) Private Ground on Udney Park Road, Teddington in the London Borough of Richmond upon Thames is considered sustainable, as measured against relevant local, regional and national planning policies.

The proposed development consists of 101 new assisted living units and extra care community between Plots A and C, 7 refurbished assisted living units (Plot B), a new GP surgery, and a new community sports Pavilion.

The Energy Strategy for the Former ICL Ground development has been formulated following the London Plan Energy Hierarchy: ***Be Lean***, ***Be Clean*** and ***Be Green***. The overriding objective in the formulation of the strategy is to maximise the reductions in CO_2 emissions through the application of this Hierarchy with a cost-effective and technically appropriate approach and to minimise the emission of other pollutants.

The strategy targets, as a minimum, a 35% reduction in Regulated carbon dioxide above the baseline emissions rate.

For the purpose of this Energy Statement and calculating CO_2 emissions assisted living units have been assessed under Part L (2013) of the Building Regulations. In line with the London Plan, this strategy uses the Part L1A (2013) Target Emission Rate (TER) as the baseline for the new assisted living units and a baseline based on the previous building specification for the refurbished units. Both of these Calculations will use SAP 2012 to calculated CO_2 emission reductions. 'Zero Carbon' will apply to these residential units; therefore all remaining Regulated CO_2 emission will be offset though a cash-in-lieu Carbon Offsetting Payment.

Plot A's associated facilities, the GP surgery, and the new sports Pavilion will be assessed under Part L2A using SBEM calculations. These non-residential areas are required to meet the London Plans 35% reduction in Regulated CO_2 emissions and BREEAM '*Excellent*' minimum energy criteria.

Domestic Strategy

The proposed new build dwellings (plots A and C) to meet the Part L1A 2013 Target Emission Rate (TER) through ***Be Lean*** measures alone and ensure the refurbished units (Plot B) meet the requirements of Part L1B. Plot B will promote energy efficiency whilst still preserving the character and appearance of the building. A **41%** reduction in Regulated CO_2 emissions is predicted over the Part L (2013) baseline for alll domestic units.

In line with the London Plan, the feasibility of decentralised energy production as a ***Be Clean*** measure has been carefully examined. There are no existing or planned heat networks in the vicinity of the proposed development. However a highly efficient on-site communal heating system is the Applicants preferred method for providing heat and hot water to the units in Plots A and C. For other areas individual high efficiency heating systems will be utilised due to the low density or heating demand.

Photovoltaic (PV) panels have been selected as the most appropriate ***Be Green*** technology to meet a 35% reduction in Regulated CO_2 emissions. It has been estimated that 113kWp (904m^2 of panel area) will be required between the roofs of Plot A and C. It is expected that Regulated CO_2 emissions will be reduced by **59%** over the Part L (2013) baseline; this represents a high level of sustainable design and construction.

The residential units will be required to pay into the Councils ring-fenced Carbon Offset fund to comply with the London Plan 'Zero Carbon' Policy. It is estimated that 102.7 tonnes of Regulated CO_2 emissions will need to be offset though a cash in lieu payment of £184,860 to be paid to the London Borough of Richmond upon Thames.

Summary Table (i): Domestic Regulated CO_2 emissions reductions

	Regulated CO_2 Emissions	**% Reduction over Baseline**
	kg CO_2/year	-
Domestic Building Regulations (Part L) Baseline	251,220	
Domestic After Be Lean Measures	147,317	41.4%
Domestic After Be Clean Measures	147,317	41.4%
Domestic After Be Green Measures	102,717	59.1%
Domestic After Zero Carbon Offset Payment	0	100.0%

Non-residential areas

A range of ***Be Lean*** energy efficiency measures are proposed. They enable each of the proposed non-residential areas to meet the Part L2 (2013) Target Emission Rate (TER) through energy efficiency measures alone. An average **14%** reduction in Regulated CO_2 emissions is predicted over the Part L (2013) baseline for the new build elements. This represents a high level of sustainable design and construction.

Air Source Heat Pumps have been utilised as the first ***Be Green*** measure to provide heating and cooling efficiently. This improved the non-residential areas Regulated CO_2 reductions to **16%**. Following the ASHP, PV has been selected as the most appropriate ***Be Green*** measure to achieve further CO_2 reductions. It is expected that **58kWp** (464m^2 panel area) of PV panels will be distributed between the Non-residential areas (see Paragraph 6.24 for more information).

The allocated PV above allows the Non-residential areas to achieve a **30.5%** reduction in Regulated CO_2 emissions. However this is expected to be the maximum capacity of PV the roof space will allow. Further reductions in CO_2 are considered unfeasible. Therefore Carbon Offsetting cash-in-lieu payment of £13,140 is proposed to ensure the Non-Residential areas together achieve a 35% reduction.

Summary Table (ii):Non-Domestic Regulated CO_2 emissions reductions

	Regulated CO_2 Emissions	% Reduction over Baseline
	kg CO_2/year	-
Non-Domestic Building Regulations (Part L) Baseline	164,134	
Non-Domestic After Be Lean Measures	141,393	13.9%
Non-Domestic After Be Clean Measures	141,393	13.9%
Non-Domestic After Be Green Measures	**114,003**	**30.5%**
Non-Domestic after Shortfall Carbon Offset Payment	**106,687**	**35.0%**

Development Wide Strategy

The measured detailed above ensure the site-wide energy strategy achieves in excess of the 35% target.

The Summary Table (iii) below summarises the site-wide reductions in CO_2 emissions for each level of the London Plan Energy Hierarchy of the Proposed Development. ***Be Lean*** measures are expected to reduce the Site-wide Regulated CO2 emissions by 31%. Maximising ***Be Green*** measures will result in a site wide reduction of **49%** in Regulated CO_2 compared to the Baseline emissions.

A total of **£198,000** Cash-in-lieu payment into the Boroughs Carbon Offsetting fund is calculated from the £13,140 non-domestic CO_2 shortfall and the £184,860 Zero carbon payments. This results in the effective Regulated CO_2 emissions of the Proposed Development to be reduced by 74% over the Building Regulations Part L (2013) Baseline.

Summary Table (ii): Site wide Regulated CO_2 emissions reduction

	Regulated CO_2 Emissions	% Reduction over Baseline
	kg CO_2/year	-
Building Regulations (Part L) Baseline	415,354	
After Be Lean Measures	288,710	30.5%
After Be Clean Measures	288,710	30.5%
After Be Green Measures	216,720	47.8%
After Carbon Offset and Zero Carbon Payments	106,687	74.3%

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1. INTRODUCTION

1.1 This Energy Statement has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development, appointed by the Quantum Group (hereafter referred to as 'the Applicant'). This statement is in support of the planning application for the proposed development at the Former ICL Ground on Udney Park Road in the London Borough of Richmond upon Thames.

1.2 The formulation of the energy strategy for the Proposed Development takes into account several important concerns and priorities. These include:

> To achieve the maximum viable reduction in carbon dioxide (CO_2) emissions through the application of the London Plan Energy Hierarchy with an affordable, deliverable and technically appropriate strategy;

> Provision of high quality low energy buildings that are adapted to future changes in climate;

> To minimise, to the lowest possible extent, emissions of pollutants such as oxides of nitrogen (NO_X) and particulate matter, thereby minimising the effects on local air quality.

1.3 This statement first establishes two baseline assessments of the energy demands and associated CO_2 emissions for the Proposed Development; one for the new builds and one for the refurbishment. The report will then follow The London Plan Energy Hierarchy approach of ***Be Lean***, ***Be Clean*** and ***Be Green*** to enable the maximum viable reductions in Regulated and Total CO_2 emissions over the baseline.

Development Description

1.4 The proposed scheme will see the former Imperial College London Private Ground on Udney Park Road, Teddington, London, TW11 9BB, regenerated for a mixed-use development that will deliver high-quality sports and community facilities, alongside new public open space and affordable, care led accommodation for Older People and a new GP surgery. This triple approach secures a sustainable, inclusive future for the site, the benefits of which underpin national and local planning policy.

1.5 With the creation of the Teddington Community Sports Ground Community Interest Company, three areas will be established;

> Assisted living, extra care community with new GP surgery;

> Open parkland with community Orchard and outdoor gym; and

> Community sports facilities.

1.6 The proposed community sports facilities will comprise of the following:

> A full-size Third Generation artificial grass pitch (3G AGP)

> Natural grass playing pitch provision

> Tennis Courts / MUGA

> Community pavilion containing changing rooms, kitchen, bar and server, flexible-use community rooms and crèche.

Site Location

1.7 The proposed development is located between Udney Park Road and Kingston Lane in the London Borough of Richmond upon Thames.

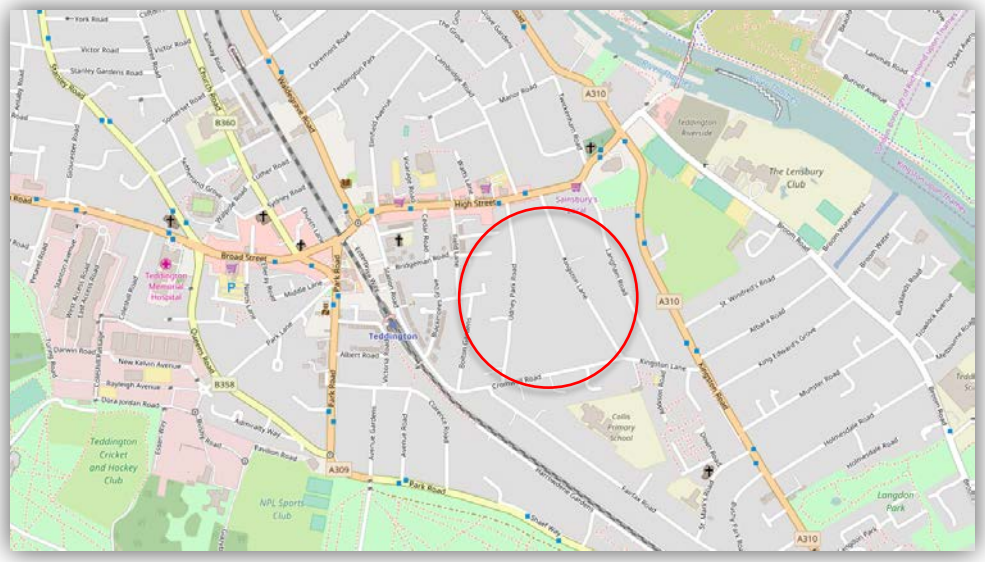

Figure 1: The Development Site (© OpenStreetMap Contributors. Go to www.openstreetmap.org/copyright)

2. PLANNING POLICIES AND PROPOSED DEVELOPMENT REQUIREMENTS

2.1 The following planning policies and requirements will inform the Energy Strategy for the proposed development.

National Planning Policy

2.2 **The National Planning Policy Framework (NPPF)** was published on 27 March 2012. This document sets the overarching policies for development in England and states that:

"At the heart of the NPPF is a presumption in favour of sustainable development, which should be seen as a golden thread running through both plan-making and decision-taking.

For decision-taking this means:

- *Approving development proposals that accord with the development plan without delay; and*
- *Where the development plan is absent, silent or relevant policies are out-of-date, granting permission unless:*
  - *Any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in this Framework taken as a whole; or*
  - *Specific policies in this Framework indicate development should be restricted."*

2.3 Paragraph 95 of the NPPF states that:

"To support the move to a low carbon future, local planning authorities should:

- *Plan for new development in locations and ways which reduce greenhouse gas emissions;*
- *Actively support energy efficiency improvements to existing buildings; and*
- *When setting any local requirement for a building's sustainability, do so in a way consistent with the Government's zero carbon buildings policy and adopt nationally described standards."*

Regional Policy

2.4 **The London Plan** sets out an integrated economic, environmental, transport and social framework for the development of London over the next 20 – 25 years.

2.5 On 10th March 2015, the Mayor adopted the **Further Alterations to the London Plan (FALP)**. From this date, the FALP are operative as formal alterations to the London Plan and form part of the development plan for Greater London. Where the London Plan is referenced within this document, this comprises the FALP as published in March 2015.

2.6 On 16th December 2015 the Mayor of London published two sets of **Minor Alterations to the London Plan (MALP)** – on Housing Standards and on Parking Standards. These minor alterations bring the London Plan in line with the new national housing standards and car parking policy.

2.7 The following outlines key policies set out in the London Plan which must be addressed by new developments and which are relevant to the Proposed Development.

2.8 **Policy 5.2 – Minimising Carbon Dioxide Emissions** requires that all residential and non-residential major development between 2013 – 2016 achieve a 40% improvement on 2010 Building Regulations. The London Plan Sustainable Design and Construction SPG (2014) updates this target stating that the Mayor will adopt a carbon dioxide improvement target beyond Part L 2013 of 35%.

2.9 **Policy 5.3 – Sustainable Design and Construction** states that the highest standards of sustainable design and construction should be achieved in London to improve the environmental performance of new developments. Major development should meet the minimum standards outlined in the London Plan Supplementary Planning Guidance on this stop and this should be clearly demonstrated. The standards includes the following sustainable design principles (summarised):

> Minimising CO_2 emissions;

> Avoiding internal overheating and contributing to the urban heat island effect;

2.10 **Policy 5.5 – Decentralised Energy Networks** states that the Mayor expects 25 per cent of the heat and power used in London to be generated through the use of localised decentralised energy systems by 2025. The Mayor will prioritise the development of decentralised heating and cooling networks at the development and area wide levels, including larger scale heat transmission networks.

2.11 **Policy 5.6 - Decentralised Energy** – requires that all developments should evaluate the feasibility of Combined Heat and Power (CHP) systems, and examine the opportunities to extend the system beyond the site boundary to adjacent sites.

2.12 **Policy 5.7 – Renewable Energy** states that within the framework of the energy hierarchy, major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.

2.13 **Policy 5.8 – Innovative Energy Technologies** encourages the more widespread use of innovative energy technologies to reduce use of fossil fuels and carbon dioxide emissions.

2.14 **Policy 5.9 – Overheating and Cooling** seeks to reduce the impact of the urban heat island effect, reduce potential overheating and reduce reliance on air conditioning systems.

2.15 **The London Plan Supplementary Planning Guidance – Sustainable Design and Construction (2014)** was adopted in April 2014. The SPG provides relevant guidance on:

> Energy efficient design;

> Meeting carbon dioxide reduction targets;

> Decentralised energy;

> How to off-set carbon dioxide where the targets set out in the London Plan are not met.

2.16 Each section of the Supplementary Planning Guidance sets out the Mayor's priorities for the particular topic area, which the Mayor seeks developers to address in all development proposals. Some sections also contain best practice ambitions, which the Mayor strongly encourages be delivered in appropriate developments. To support these approaches, the Supplementary Planning Guidance includes detailed guidance for boroughs and developers, signposts to further information and best practice examples.

Local Policy: LB Richmond Upon Thames

Core Strategy

2.17 The London Borough of Richmond Upon Thames Core Strategy was adopted in April 2009. The following polices from this adopted document are considered to be relevant to this report:

2.18 **Policy CP1 Sustainable Development**: The policy seeks to maximise the effective use of resources including land, water and energy, and assist in reducing any long term adverse environmental impacts of development. Development will be required to conform to the Sustainable Construction checklist, including the requirement to meet the Code for Sustainable Homes Level 3 (for new homes), Ecohomes "Excellent" (for conversion) or BREEAM "Excellent" (for other types of development). This requirement will be adjusted in future years through subsequent DPDs, to take into account the then prevailing standards in the Code for Sustainable Homes and any other National Guidance, and ensure that these standards are met or exceeded.

2.19 **Policy CP2 Reducing Carbon Emissions**: The Borough will reduce its carbon dioxide emissions by requiring measures that minimise energy consumption in new development and promoting these measures in existing development, particularly in its own buildings.

2.20 The Council will require the evaluation, development and use of decentralised energy in appropriate development.

2.21 The Council will increase the use of renewable energy by requiring all new development to achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation unless it can be demonstrated that such provision is not feasible, and by promoting its use in existing development.

Development Management Plan

2.22 The London Borough of Richmond Upon Thames Development Management Plan was adopted in November 2011. The following policies from this document are considered to be relevant to this Statement:

2.23 **Policy DM SD 1 Sustainable Construction**: All development in terms of materials, design, landscaping, standard of construction and operation should include measures capable of mitigating and adapting to climate change to meet future needs.

2.24 New buildings should be flexible to respond to future social, technological and economic needs by conforming to the Borough's Sustainable Construction Checklist SPD.

2.25 New homes will be required to meet or exceed requirements of the Code for Sustainable Homes Level 3.

2.26 They must also achieve a minimum 25 per cent reduction in carbon dioxide emissions over Building Regulations (2010) in line with best practice 2010 to 2013, 40 per cent improvement from 2013 to 2016, and 'zero carbon' standards from 2016. It is expected that efficiency measures will be prioritised as a means towards meeting these targets. These requirements may be adjusted in future years to take into account the then prevailing standards and any other national guidance to ensure the standards are met or exceeded.

2.27 New non-residential buildings over 100sqm will be required to meet the relevant BREEAM "Excellent" standards.

2.28 **Policy DM SD 2 Renewable Energy and Decentralised Energy Networks**: New development will be required to conform with the Sustainable Construction Checklist SPD and:

> Maximise opportunities for the micro-generation of renewable energy. Some form of low carbon renewable and/or de-centralised energy will be expected in all new development, and

> Developments of 1 dwelling unit or more, or 100sqm of non-residential floor space or more will be required to reduce their total carbon dioxide emissions by following a hierarchy that first requires an efficient design to minimise the amount of energy used, secondly, by using low carbon technologies and finally, where feasible and viable, including a contribution from renewable sources.

> Local opportunities to contribute towards decentralised energy supply from renewable and low-carbon technologies will be encouraged where there is no over-riding adverse local impact.

> All new development will be required to connect to existing or planned decentralised energy networks where on exists. In all major developments and large Proposals Sites identified in the Site Allocations DPD, provision should be made for future connection to a local energy network should one become available.

2.29 **Policy DM SD 3 Retrofitting**: High standards of energy and water efficiency in existing developments will be supported wherever possible through retrofitting. Proposals for conversions and extensions will be encouraged to comply with the Sustainable Construction Checklist SPD as far as possible and opportunities for micro-generation of renewable energy will be supported. Development in an area susceptible to flooding should include flood resistant and/or resilient measures to mitigate potential flood risks.

2.30 **Policy DM SD 4 Adapting to Higher Temperatures and Need for Cooling**: All new developments, in their layout, design, construction, materials, landscaping and operation, are required to take into account and adapt to higher temperatures, avoid and mitigate overheating and excessive heat generation to counteract the urban heat island effect, and meet the need for cooling.

2.31 All new development proposals should reduce reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy:

> Minimise internal heat generation through energy efficient design;

> Reduce the amount of heat entering a building in summer through shading, reducing solar reflectance, fenestration, insulation and green roofs and walls;

> Manage the heat within the building through exposed internal thermal mass and high ceilings;

> Passive ventilation;

> Mechanical ventilation;

> Active cooling systems (ensuring they are the lowest carbon options).

2.32 Opportunities to adapt existing buildings, places and spaces to manage higher temperatures should be maximised and will be supported.

Sustainability Targets

BREEAM 2014

2.33 In accordance with the London Borough of Richmond upon Thames Core Strategy CP1 and Development Management Plan policy DM SD 1 the non-residential uses across the site will target a BREEAM rating of 'Excellent'.

2.34 In order to reflect the different building types across the development, the following BREEAM assessments will be undertaken.

> Appendix C - Plots A & C – BREEAM Multi-residential New Construction 'Excellent';

> Appendix D – Plot B – BREEAM Domestic Refurbishment 'Excellent';

> Appendix E - GP Surgery – BREEAM New Construction Shell only 'Excellent';

> Appendix F - New Clubhouse – BREEAM Other Buildings New Construction 'Excellent'.

2.35 The attainment of BREEAM Excellent represents a high level of sustainable design and construction.

2.36 Further information can be seen in the Sustainability Statement undertaken by Hodkinson Consultancy submitted under the same cover.

3. BUILDING REGULATIONS BASELINE

Methodology

3.1 In line with London Plan policy, this statement first establishes a baseline assessment of the energy demands and associated CO_2 emissions for the Proposed Development.

3.2 The development site is anticipated to be built under Part L (2013) of the Building Regulations.

3.3 The report will then follow The London Plan Energy Hierarchy approach of ***Be Lean***, ***Be Clean*** and ***Be Green*** to enable the maximum viable reductions in Regulated and Total CO_2 emissions over the baseline.

3.4 The estimated annual energy demand for the Proposed Development has been calculated using Standard Assessment Procedure (SAP 2012) and Simplified Building Energy Model (SBEM 2013) methodology. SAP calculates the Regulated energy demands associated with hot water, space heating and fixed electrical items. The unregulated dwelling energy demands for appliances and cooking are taken from BRE standard occupancy calculations. SBEM calculates the Regulated energy demands associated with hot water, space heating and fixed electrical items. The unregulated energy demands are taken from additional SBEM output documents

Part L Building Regulations Baseline

3.5 **Residential (Part L1A)** SAP calculations have been performed on representative dwelling types, as detailed in Appendix A. These encompass ground, mid and top floor apartments of different orientations; therefore representing a fair aggregation of the unit mix of the Proposed Development.

3.6 A Part L1A (2013) Building Regulations compliant baseline is used for the development. It requires that all homes meet or exceed the Target Emission Rate (TER), as well as the new Target Fabric Energy Efficiency (TFEE) standard. See the Compliance Reports in Appendix D and the ***Be Lean*** worksheets in Appendices E and F.

3.7 For the **Refurbishment (Part L1B)** unit a Part L1B 2013 Building Regulations calculation will be compared to a SAP (2012) calculation using the pre-refurbishment specification. The pre-refurbishment calculation includes the following existing and default performance standards:

> Single glazing with a U-value of 4.8 W/m^2K with a g-factor of 0.85;

> External wall U-value – 2.1 W/m^2K (290mm solid brick uninsulated wall);

> Sheltered wall to corridor – 1.17 W/m^{2}K (as above with ISO 6946 shelter factor);

> Party wall – Solid brick to have an effective 0.00W/m^{2}K;

> Ground floor U-value – 1.2 W/m^{2}K;

> Roof U-value – 1.2 W/m^{2}K;

> Air leakage – 15m^3/m^2/hr (default untested); and

> Heating by radiators supplied from electric water storage boiler with TRVs and bypass.

3.8 The Baseline Regulated CO2 emissions are calculated form the DER calculation in Appendix E.

3.9 Table 1 shows the development baseline Regulated & Total (Regulated plus Unregulated) CO_2 emissions.

Table 1: Residential and Commercial Baseline Emissions

Unit Type Description	Baseline Emissions	Total Emissions
Domestic	kg CO_2/year	kg CO_2/year
101 New Build dwellings (Plot A and C)	129,510	278,555
7 Converted dwellings (Plot B)	121,710	133,427
Domestic totals	251,220	411,982
Non-Domestic	kg CO_2/year	kg CO_2/year
GP clinic	34,350	85,950
Pavilion	94,408	116,659
Residential Facilities	35,375	86,482
Non-Domestic totals	**164,134**	**289,091**

3.10 Summary CO_2 calculations can be found in Appendix A.

4. 'BE LEAN': ENERGY EFFICIENCY MEASURES

4.1 In line with the London Plan Energy Hierarchy, the following energy efficient, ***Be Lean*** measures are proposed to be applied to the Proposed Development. These measures will ensure that the Building Regulations Part L (2013) baseline is met through energy efficiency measures alone for the new build elements.

New Build - Domestic

Insulation Standards

4.2 The new build elements (plot A and C) of the development will incorporate enhanced insulation in the building envelope (walls, roofs, floors and glazing) to achieve average U-Values better than those required by Part L (2013) Building Regulations. These are likely to include:

> Whole window U-value of 1.4 W/m^{2}K with a g-factor of 0.50;

> External wall U-values of 0.16 W/m^{2}K or better (c.~430mm wall thickness depending on construction);

> Ground and exposed floor U-values of 0.12 W/m^{2}K;

> Flat roof U-values of 0.15 W/m^{2}K.

Air Tightness and Ventilation

4.3 Air tightness standards will conform to, and exceed, Approved Document Part L requirements. By reducing air leakage loss and convective bypass of insulation, an improvement of design air permeability rate from 10m^3/hm^2 to less than 5m^3/hm^2 will further reduce space heating requirements.

4.4 It is proposed to install Parts L & F compliant centralised Mechanical Extract Ventilation (cMEV) systems.

4.5 The selected units will typically have a low Specific Fan Power (SFP) of <0.18 W/l/s for a kitchen plus 2 wet rooms, <0.24 W/l/s for kitchen and 1 wet room.

4.6 Additionally, all dwellings will have openable windows and therefore the ability to naturally ventilate should the occupant desire. Convective ventilation and night purging of heat will therefore be facilitated.

Thermal Bridging

4.7 In well insulated buildings, as much as 30% of heat loss can occur through thermal bridges, which occur when highly conductive elements (e.g. metal studs) in the wall construction enable a low resistance escape route for heat.

4.8 Where possible full fill Airecrete Products Association (APA) constructive details will be used, if not available bespoke calculated values or Accredited Construction Details (ACDs) will be used in the design to reduce thermal bridging.

4.9 Figure 2 illustrates the benefits of reducing thermal bridges.

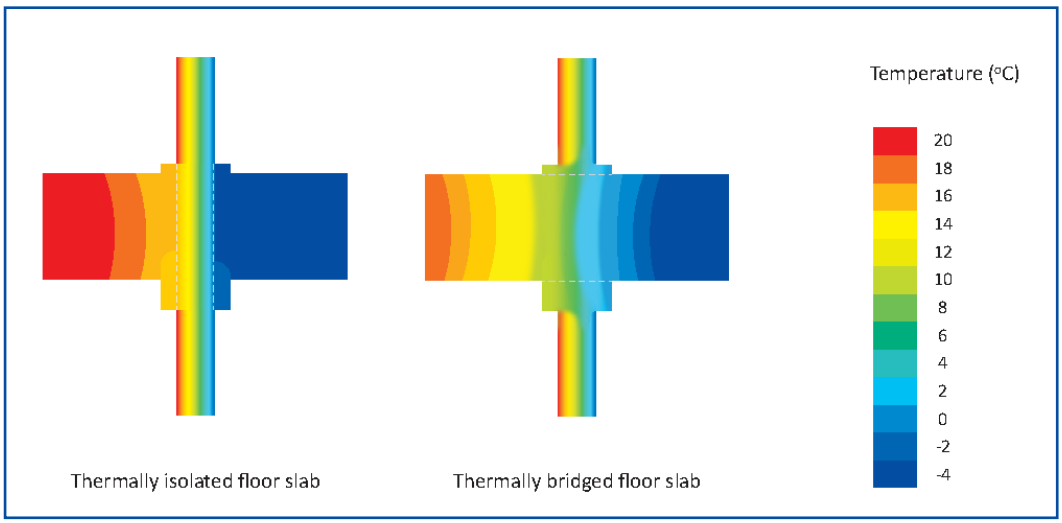

Figure 2: Thermal Bridging

Space Heating & Hot Water

4.10 The space heating requirement of the new build elements will be reduced by the fabric, air tightness and ventilation measures detailed above.

4.11 It is intended to take advantage of winter solar gain to reduce the space heating demands of the homes.

4.12 The combination of the above measures will create highly energy efficient homes.

4.13 All new dwellings will be connected to high efficiency communal boiler. These systems should have at least a 95% SBEM seasonal efficiency. This efficiency has been used within the Be Lean calculation in line with the GLA guidance on energy statements.

4.14 The space heating systems will include time and zoning controls where appropriate and low loss dwelling metered heat interface units. This will allow the occupants to have a flexible and efficient way of controlling heating throughout the dwelling.

Lighting and Appliances

4.15 It is very challenging to design and construct living spaces to reduce the unregulated electricity demands, because this is almost entirely dependent on the occupant of a home and can vary substantially. However, the Applicant is committed to ensuring that all efforts are made to enable the residents to minimise their unregulated electricity consumption and will ensure all appliances supplied to the apartments are of a high standard of energy efficiency.

4.16 Low energy lighting, >40 lumens per Watt, will be installed throughout the new build flats.

Conversions - Domestic

Insulation Standards

4.17 Although not protected, maintaining the character of the historic building will be carefully balanced with the need to promote energy efficiency.

4.18 Upgraded and new thermal elements of the fabric should target or improve on the performance U-values detailed in Building Regulations Part L1B. These are detailed below in Table 2 and Table 3.

Table 2: Upgrading retained thermal elements (Part L1B)

Element	Threshold U-value	Minimum improvement value U-value
External Wall - Cavity insulation	0.70 W/m^{2}K	0.55 W/m^{2}K
External Wall - External or internal insulation	0.70 W/m^{2}K	0.30 W/m^{2}K
Floor	0.70 W/m^{2}K	0.25 W/m^{2}K
Pitched Roof – insulation at ceiling level	0.70 W/m^{2}K	0.16 W/m^{2}K
Pitched Roof – insulation between rafters	0.35 W/m^{2}K	0.18 W/m^{2}K
Flat Roof	0.35 W/m^{2}K	0.18 W/m^{2}K

4.19 It is not expected that there will be new thermal elements, if there are, they should meet the U-Values detailed in Table 3 below.

Table 3: Standards for new thermal elements (Part L1B)

Element	Limiting U-value
Wall	0.28 W/m²K
Pitched Roof – insulation at ceiling level	0.16 W/m²K
Pitched Roof – insulation between rafters	0.18 W/m²K
Flat Roof	0.18 W/m²K
Floors	0.22 W/m²K

4.20 It is expected that the following U-values will be achieved on the refurbished units:

> External Wall U-value 0.30 W/m²K;

> Sheltered wall to corridor 0.15 W/m²K;

> Dormer walls U-value 0.16 W/m²K;

> Pitched roofs - 0.16 W/m²K (insulated at joists) and 0.18 W/m²K (insulated at rafters, dormer);

> Ground Floor 0.25 W/m²K.

Air Tightness and Ventilation

4.21 Air tightness standards are likely to be improved through the refurbishment of glazing, and draught proofing and sealing. However further improvements will be made by ensuring the air leakage rate is 10m³/m².hr a significant improvement over the default untested unit (15m³/m².hr.)

4.22 Natural ventilation with intermittent mechanical extract to wet rooms will be implemented.

4.23 All refurbished dwellings will have openable windows and therefore the ability to naturally ventilate should the occupant desire. Convective ventilation and night purging of heat will therefore be facilitated.

Space Heating & Hot Water

4.24 The space heating requirement of the refurbishment will be reduced by the fabric, air tightness and ventilation measures detailed above.

4.25 The combination of the above measures will create highly energy efficient homes.

4.26 Where possible, dwellings will have a High efficiency SEDBUK 'A' rated boiler installed. These systems have at least an 89% efficiency rating (SAP 2012).

4.27 The efficiency of the boiler if further improved through the installation of a compatible weather compensator. These reduce the heating demand by sensing the outside temperature and limiting the temperature of the circulation water through the heating system in relation to the outside.

4.28 The space heating systems will include a programmer, room thermostat and TRV controls where appropriate. This will allow the occupants to have a flexible and efficient way of controlling heating throughout the dwelling.

Lighting and Appliances

4.29 Low energy lighting will be installed within the refurbished units.

4.30 The combination of fabric improvements and upgrading of building services to the historic parts of the development result in significant reductions in CO_2 emissions which exceed the requirements of the London Plan for this Plot.

4.31 The refurbished units also achieve the minimum requirement of BREEAM Domestic Refurbishment 2014 of an Energy Efficiency Rating (EER) greater than 70.

Non-residential areas

Insulation standards

4.32 All non-residential units should meet the same U-values of the new residential units. The windows will require a g-factor of 0.27.

Air Tightness and Ventilation

4.33 To ensure the supply of fresh air a System 3 Mechanical Ventilation with heat Recovery unit (MVHR) with demand control ventilation will be installed. The Specific Fan Power (SFP) should target 1.4W/l/s or lower and a heat recovery efficiency of 85%.

4.34 These units will remove stale moist air and efficiently re-use the heat to pre-heat the incoming fresh air.

4.35 An air permeability of 7 m^3/m^2.hr will further reduce heat losses through the building fabric.

Space Heating & Hot Water

4.36 In line with GLA guidance the ***Be Lean*** case will utilise gas boilers for heating and electric cooling systems.

4.37 Space heating and cooling to be provided by a multi-split system fed by Air Source Heat Pumps (CoP of 4.59, SEER/EER of 6.85/3.58 respectively). Hot water is to be provided by gas fed boilers (91% efficient) with hot water storage (68 MJ/month storage losses)

4.38 To allow the occupant to efficiently use the systems a central time control with local temperature control should be installed. Sub-metering with alarm for out of range values for the HVAC and Lighting should also be considered;

Lighting and Appliances

4.39 Light Emitting Diodes (LEDs) will be used throughout (110 lumens/W) with photoelectric control (dimming, 0.1W/m^2 parasitic power).

4.40 For highly glazed areas and occupancy sensing for zones with transient occupancy (0.1W/m^2 parasitic power).

Limiting the Risk of Summer Overheating

4.41 In line with the Cooling Hierarchy within London Plan Policy 5.9, it is proposed to reduce the need for active cooling as far as possible and will not require the installation of mechanical cooling. All homes will therefore be subject to measures to minimise the risk of summer overheating to an acceptable level.

4.42 This will be done through the specification of passive measures such as low fabric U-values and ventilation systems capable of maintaining airflow through the dwelling, as well as internal blinds to reduce solar heat gains in peak summer months.

4.43 A g-factor of 0.50 has been used for the glazing for the new build homes; this is reduced to 0.27 for the highly glazed non-residential areas. This will further lower the risk of summer overheating

4.44 The dwellings will allow cross-ventilation (where possible), convective-ventilation and night purging through open-able windows. These natural ventilation concepts are illustrated in Figure 3 and will reduce the build-up of heat within homes.

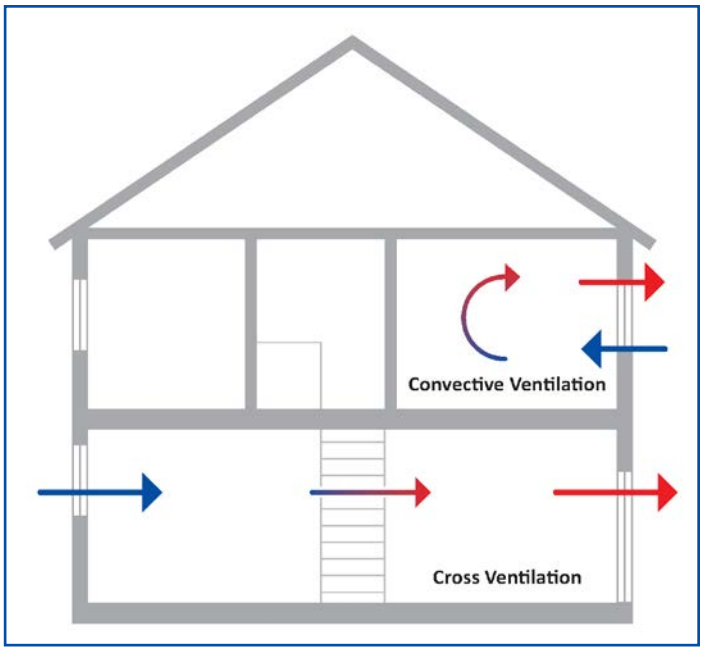

Figure 3: Natural Ventilation

4.45 The sample unit types modelled do not show a high risk of summer overheating (SAP Criterion 3).

CO_2 Emissions Following Be Lean Measures

4.46 The above measures result in the on-site CO_2 emissions as detailed in Table 4, reducing site-wide Regulated & Total CO_2 emissions beyond baseline emissions.

Table 4: Be Lean Regulated and Total CO_2 Emissions

Unit Type Description	Be Lean Emissions	Total Emissions
Domestic	kg CO_2/year	kg CO_2/year
101 New Build dwellings (Plot A and C)	128,332	277,378
7 Converted dwellings (Plot B)	18,985	30,702
Domestic totals	147,317	308,080
Be Lean Reduction over the Baseline	41%	25%
Non-Domestic	kg CO_2/year	kg CO_2/year
GP clinic	26,101	77,701
Pavilion	87,945	110,195
Residential Facilities	27,347	78,453
Non-Domestic totals	141,393	266,349
Be Lean Reduction over the Baseline	14%	8%

4.47 It can be seen from Table 4 that Building Regulations Part L (2013) has been exceeded through ***Be Lean*** measures alone. To meet the site-wide London Plan Target of a 35% reduction in Regulated CO_2 emissions further measured are required.

4.48 ***Be Lean*** summary calculations can be seen in Appendix A. Emission calculations are presented in Appendix F (Domestic) and G (Non-Domestic).

5. BE CLEAN: DECENTRALISED ENERGY

5.1 In line with Policy 5.6 of the London Plan, the feasibility of decentralised heating networks as ***a Be Clean*** measure has been evaluated. This is the next step in the Energy Hierarchy after ***Be Lean***. The London Plan outlines the following order of preference:

> Connection to existing heating or cooling networks;

> Site wide CHP network;

> Communal heating and cooling.

5.2 The inclusion of decentralised heating has been investigated in terms of appropriateness to the Proposed Development and, to be in line with the priorities for this energy strategy, whether decentralised heating is the best technology to provide the greatest reductions in CO_2 emissions.

Connection to existing network

5.3 The development location falls outside any heat opportunity (purple polygon) area or physical or planned networks (not visible). This is outlined in Figure 4.

Figure 4: London Heat Map - Opportunity Areas and Networks (www.londonheatmap.org.uk/Mapping)

Site wide CHP network

5.4 Recent GLA guidance states that it is not expected for smaller sites (less than 500 dwellings) to carry out a full feasibility analysis for the use of CHP.

5.5 It has therefore been concluded that, due to the size and density of the proposed development, CHP cannot be recommended for the scheme.

Communal heating and cooling

5.6 With CHP considered as unfeasible the next step is to consider communal heating (and cooling) for the possibility of connecting to a future heat network.

5.7 The Applicant proposes communal heating for the Plot A and C development. To counteract the heat losses from the network the communal boiler will have a high seasonal efficiency.

5.8 Heat Interface Units (HIU) will be provided within in each unit.

5.9 Due to the low demand, it is not expected that the non-residential units connect to the communal heating system unless deemed appropriate.

CO_2 Emissions Following Be Clean Measures

5.10 The measures detailed above have been included within the ***Be Lea***n case in line with GLA Guidance. Therefore the reduction in Regulated CO_2 emissions is as per the ***Be Lean*** case (see Table 4). ***Be Green*** Measures will be assessed in line with the London Plan hierarchy.

6. BE GREEN: RENEWABLE ENERGY TECHNOLOGIES

6.1 It can be seen from Table 4 that Building Regulations (2013) have been exceeded with energy efficiency measures alone. However to ensure the 35% reduction in Regulated CO_2 emissions is met site-wide further measures have been investigated.

6.2 Low and Zero Carbon Technologies (LZCT) have been assessed for their feasibility within the Proposed Development. The details are summarised in this chapter but further information can be found in Appendix K.

Biomass Boiler

6.3 Biomass boilers generate heat on a renewable basis as they are run on biomass fuel which can be considered carbon neutral. A biomass boiler would require a central plant room and heat distribution network which is available on site.

6.4 Expensive NO_X and Particular Matter filters will be required as will bespoke maintenance and fuel management services. Therefore it is expected that both the capital and running costs will be high, which will be distributed between a low number of units.

6.5 Whilst technically feasible, a biomass boiler is not appropriate for this development due to the high running costs.

Ground Source Heat Pumps (GSHPs)

6.6 As a heat generating technology, heat pumps are an alternative to the CHP engine.

6.7 GSHPs are able to provide substantial reductions in energy. However, they are generally limited to sites with large amount of space. It is expected that the Proposed Development will have sufficient space for the installation of ground coils and further feasibility analysis may be undertaken at the detailed design stage to supplement the gas fired communal heating.

6.8 GSHPs are most efficient when providing low temperature heat and therefore the heat provided from the GSHP will be fed into the communal heating system to supplement the heat from the gas boilers or as a pre-heat mechanism. A SAP default efficient has been used in the calculations to provide flexibility of unit choice at the detailed design stage.

6.9 However GSHPs replace gas as the heating fuel with electricity, which is more carbon intensive. The result of this is that CO_2 emissions are not reduced as substantially as other technologies are able to achieve therefore another renewable technology will be preferred at this stage.

Air Source Heat Pumps (ASHPs)

6.10 Air Heat pumps are most efficient when providing low temperature heat, for example to fan coil units in a commercial space. They can also provide cooling efficiently making them viable for the non-residential areas. Therefore they have been included within SBEM calculations.

6.11 The following target specification will enable the ASHP to be as efficient as possible:

> Multi split system;

> CoP of 4.59;

> SEER/EER of 6.85/3.58 respectively.

6.12 The ASHP reduce the cooling demand consumption over the notional value, this is dependent on the CoP and SEER/EER detailed above.

6.13 The use of ASHPs within the Non-Domestic areas reduces Regulated CO_2 over the baseline by **16.4%** (see Appendix B), a 3% improvement over the ***Be Lean*** case.

Table 5: HVAC Cooling Performance

Area weighted average building cooling demand	Actual (MJ/m^2)	Nominal (MJ/m^2)
Plot A Residents facilities	199.8	208.2
GP Surgery	128.2	156.8
New clubhouse (Pavilion)	48.3	66.7

Wind Turbines

6.14 Small rooftop wind turbines are designed to generate electricity from the wind for use within each dwelling.

6.15 Urban rooftop wind turbines do not generally perform sufficiently to well to warrant their installation, due to the low and turbulent wind conditions present. They are therefore likely to remain technically unfeasible.

6.16 It has therefore been concluded that wind turbines are not a suitable technology for the Proposed Development.

Solar Thermal Panels

6.17 Solar thermal panels use the sun's energy to generate hot water for each dwelling. Due to the seasonality of solar radiation, solar thermal panels can provide up to ~60% of a dwellings hot water demand, with the remainder being provided as top-up by the conventional gas boiler. They are a robust technology that provides substantial benefits to residents in terms of 'free' energy.

6.18 Solar thermal panels are generally installed on the roofs of dwellings, with panels facing as close to south as possible to maximise their efficiency. A 100m^2 dwelling would typically require ~4m^2 of solar panels.

6.19 Solar thermal panels are a technically viable strategy, although it is unlikely that they would enable sufficient CO_2 reductions for policy compliance.

6.20 It has therefore been concluded that PV panels represent a more appropriate solar technology for this development.

Photovoltaic (PV) Panels

6.21 PV panels generate electricity from solar radiation. The generating potential of PV panels is not dependent on development demand, but only on available roof space for installation and ensuring that they are not overshadowed. For this reason and their current low cost, it has been concluded that PV panels are the most appropriate renewable energy technology for the new build residential units on the development.

6.22 The roof of the refurbished units is considered inappropriate for PV panels, as it has already met the London Plan Target as well as assuming a requirement of sensitivity towards the Historic aesthetics if the building.

6.23 A significant amount of PV will be required to meet the London Plan target of 35% reduction in Regulated CO_2 emissions and to go beyond.

6.24 Therefore, the following PV array capacities are required:

> Plots A and C: a total of 113kWp south facing, horizontal pitch (840m^2 panel area) connected into the landlord supply;

> Surgery GP: 7 kWp, south-east facing panels, horizontal pitch (56m^2 panel area);

> Residents facilities: 9 kWp, south-east facing panels, flat pitch (72m^2 panel area); and

> Pavilion: a total of 42kWp (336m^2 panel area), 20 kWp, south facing panels, horizontal pitch and 22 kWp, south facing panels, 15 degrees pitch.

6.25 This Equates to 163kWp across the Proposed Development site. The calculations are included within the ***Be Green*** SBEM calculations (Appendix H). The Domestic PV calculation can be seen in Appendix J.

CO_2 Emissions Following Be Green Measures

6.26 Following the application of all the ***Be Green*** measures, detailed above, the London Plan target of a 35% reduction in Regulated CO_2 emissions has been achieved for the Domestic and Non-Domestic areas with the exception of the Sport Pavilion which with maximised PV capacity achieves a 26% reduction.

Unit Type Description	*Be Green* Emissions	Baseline Emissions	Emission Reduction
Domestic	kg CO_2/year	kg CO_2/year	-
101 New Build dwellings (Plot A and C)	83,732	129,510	35.3%
7 Converted dwellings (Plot B)	18,985	121,710	84.4%
Domestic totals	102,717	251,220	59.1%
Non-Domestic	kg CO_2/year	kg CO_2/year	-
GP clinic	21,792	34,350	36.6%
Pavilion	69,464	94,408	26.4%
Residential Facilities	22,747	35,375	35.7%
Non-Domestic totals	114,003	164,134	30.5%
Site-wide Totals	216,720	415,354	47.8%

6.27 The above ***Be Green*** measures, which includes ASHP and PV panels, shows a **25%** site-wide improvement over the ***Be Clean*** case.

7. CARBON OFFSETTING

Shortfall payment

7.1 With all measures maximised to feasible levels the Non-Domestic units do not achieve the London Plan Requirement of a 35% reduction in Regulated CO_2. This is due to the inherent high demand for hot water associated with showers this facility will require. The non-Domestic units achieve, together, a 30.5% reduction over the baseline.

7.2 This is proposed that the remaining 4.5% (7.3 tonnes) is offset through a cash-in-lieu contribution to the local authorities Carbon Offsetting fund. The Carbon offset cash in lieu cost is calculated at £60 per tonne CO_2 for 30 years .Therefore the shortfall in CO_2 reductions will equated to a payment of £13,140.

Table 6: Shortfall in Regulated Carbon Dioxide Savings

Unit Type Description	*Be Green* Emissions	Baseline Emissions	Emission Reduction
	kg CO2/year	kg CO2/year	-
Non-Domestic totals	114,003	164,134	30.5%
Targeted Emissions	106,687	164,134	35.0%
Shortfall	7,316 (7.3 tonnes)		
Shortfall offset cost (@£60/tonnes for 30 years)	**£13,140**		

Zero Carbon Payment

7.3 In line with the London Plans Housing SPG (March 2016) the development is required to offset all remaining dwelling Regulated CO_2 Emissions to be 'Zero Carbon' once a minimum 35% has been mitigated on site.

7.4 The 'Zero Carbon' Policy will only apply to Domestic units (Plot A, B and C). The dwellings Regulated CO_2 emission after the application of ***Be Lean*** and ***Be Green*** measures totals 102.7 tonnes of CO_2 see Table 7 below.

Table 7 Zero Carbon Calculation

Unit Type Description	*Be Green* Emissions	Baseline Emissions	Emission Reduction
Domestic totals	102,717	251,220	59.1%
Targeted Emissions	0	251,220	100.0%
Shortfall	102,717 (102.7 tonnes)		
Shortfall offset cost (@£60/tonnes for 30 years)	**£184,860**		

7.5 Therefore a **total** Carbon offset payment of **£198,000.00** is the estimated to be paid to the London Borough of Richmond upon Thames.

7.6 The carbon offsetting payment will ensure that the development is London Plan compliant, including Zero Carbon, compliance for both the Domestic and Non-Domestic is detailed in Table 8, Table 9 respectively.

Table 8: Domestic Regulated CO_2 emissions reductions

	Regulated Emissions	% Reduction over baseline
Domestic	kg CO_2/year	-
Domestic Building Regulations (Part L) Baseline	251,220	
Domestic After Be Lean Measures	147,317	41.4%
Domestic After Be Clean Measures	147,317	41.4%
Domestic After Be Green Measures	102,717	59.1%
Domestic After Zero Carbon Offset Payment	0	100.0%

Table 9: Non-Domestic Regulated CO_2 emissions reductions

	Regulated Emissions	% Reduction over baseline
Non-Domestic	kg CO_2/year	-
Non-Domestic Building Regulations (Part L) Baseline	164,134	
Non-Domestic After Be Lean Measures	141,393	13.9%
Non-Domestic After Be Clean Measures	141,393	13.9%
Non-Domestic After Be Green Measures	114,003	30.5%
Non-Domestic after Shortfall Carbon Offset Payment	**106,687**	**35.0%**

8. SUMMARY

8.1 The purpose of this Energy Statement is to demonstrate that the proposed development on the Former Imperial Collage London (ICL) Private Ground on Udney Park Road, Teddington in the London Borough of Richmond upon Thames is considered sustainable, as measured against relevant local, regional and national planning policies.

8.2 The proposed development consists of 101 new assisted living units and extra care community between Plots A and C, 7 refurbished assisted living units (Plot B), a new GP surgery, and a new community sports Pavilion.

8.3 The Energy Strategy for the Former ICL Ground development has been formulated following the London Plan Energy Hierarchy: ***Be Lean***, ***Be Clean*** and ***Be Green***. The overriding objective in the formulation of the strategy is to maximise the reductions in CO_2 emissions through the application of this Hierarchy with a cost-effective and technically appropriate approach and to minimise the emission of other pollutants.

8.4 The strategy targets, as a minimum, a 35% reduction in Regulated carbon dioxide above the baseline emissions rate.

8.5 For the purpose of this Energy Statement and calculating CO_2 emissions assisted living units have been assed under Part L (2013) of the Building Regulations. In line with the London Plan, this strategy uses the Part L1A (2013) Target Emission Rate (TER) as the baseline for the new assisted living units and a baseline based on the previous building specification for the refurbished units. Both of these Calculations will use SAP 2012 to calculated CO_2 emission reductions. 'Zero Carbon' will apply to these residential units; therefore all remaining Regulated CO_2 emission be will offset though a cash-in-lieu Carbon Offsetting Payment.

8.6 Plot A's associated facilities, the GP surgery, and the new sports Pavilion will be assessed under Part L2A using SBEM calculations. These non-residential areas are required to meet the London Plans 35% reduction in Regulated CO_2 emissions and BREEAM '*Excellent*' minimum energy criteria.

Domestic Strategy

8.7 The proposed new build dwellings (plots A and C) to meet the Part L1A 2013 Target Emission Rate (TER) through ***Be Lean*** measures alone and ensure the refurbished units (Plot B) meet the requirements of Part L1B. Plot B will promote energy efficiency whilst still preserving the character and appearance of the building. A **41%** reduction in Regulated CO_2 emissions is predicted over the Part L (2013) baseline all domestic units.

8.8 In line with the London Plan, the feasibility of decentralised energy production as a ***Be Clean*** measure has been carefully examined. There are no existing or planned heat networks in the vicinity of the proposed development. However a highly efficient on-site communal heating system is the

Applicants preferred method for providing heat and hot water to the units in Plots A and C. For other areas individual high efficiency heating systems will be utilised due to the low density or heating demand.

8.9 Photovoltaic (PV) panels have been selected as the most appropriate ***Be Green*** technology to meet a 35% reduction in Regulated CO_2 emissions. It has been estimated that 113kWp (904m^2 of panel area) will be required between the roofs of Plot A and C. it is expected that Regulated CO_2 emissions will be reduced by **59%** over the Part L (2013) baseline; this represents a high level of sustainable design and construction.

8.10 The residential units will be required to pay into the Councils ring-fenced Carbon Offset fund to comply with the London Plan 'Zero Carbon' Policy. It is estimated that 102.7 tonnes of Regulated CO_2 emissions will need to be offset though a cash in lieu payment of £184,860 to be paid to the LBorough of Richmond upon Thames.

Summary Table (i): Domestic Regulated CO_2 emissions reductions

	Regulated CO_2 Emissions	% Reduction over Baseline
	kg CO_2/year	-
Domestic Building Regulations (Part L) Baseline	251,220	
Domestic After Be Lean Measures	147,317	41.4%
Domestic After Be Clean Measures	147,317	41.4%
Domestic After Be Green Measures	102,717	59.1%
Domestic After Zero Carbon Offset Payment	0	100.0%

Non-residential areas

8.11 A range of ***Be Lean*** energy efficiency measures are proposed. They enable each of the proposed non-residential areas to meet the Part L2 (2013) Target Emission Rate (TER) through energy efficiency measures alone. An average **14%** reduction in Regulated CO_2 emissions is predicted over the Part L (2013) baseline for the new build elements. This represents a high level of sustainable design and construction.

8.12 Air Source Heat Pumps have been utilised as the first ***Be Green*** measure to provide heating and cooling efficiently. This improved the non-residential areas Regulated CO_2 reductions to **16%**. Following the ASHP, PV has been selected as the most appropriate ***Be Green*** measure to achieve further CO_2 reductions. It is expected that **58kWp** (464m^2 panel area) of PV panels will be distributed between the Non-residential areas (see Paragraph 6.24 for more information).

8.13 The allocated PV above allows the Non-residential areas to achieve a **30.5%** reduction in Regulated CO_2 emissions. However this is expected to be the maximum capacity of PV the roof space will allow.

Further reductions in CO_2 are considered unfeasible. Therefore Carbon Offsetting cash-in-lieu payment of £13,140 is proposed to ensure the Non-Residential areas together achieve a 35% reduction.

Summary Table (ii):Non-Domestic Regulated CO_2 emissions reductions

	Regulated CO_2 Emissions	% Reduction over Baseline
	kg CO_2/year	-
Non-Domestic Building Regulations (Part L) Baseline	164,134	
Non-Domestic After Be Lean Measures	141,393	13.9%
Non-Domestic After Be Clean Measures	141,393	13.9%
Non-Domestic After Be Green Measures	114,003	30.5%
Non-Domestic after Shortfall Carbon Offset Payment	106,687	35.0%

Development Wide Strategy

8.14 The measured detailed above ensure the site-wide energy strategy achieves in excess of the 35% target.

8.15 The Summary Table (iii) below summarises the site-wide reductions in CO_2 emissions for each level of the London Plan Energy Hierarchy of the Proposed Development. ***Be Lean*** measures are expected to reduce the Site-wide Regulated CO2 emissions by 31%. Maximising ***Be Green*** measures will result in a site wide reduction of **49%** in Regulated CO_2 compared to the Baseline emissions.

8.16 A total of **£198,000** Cash-in-lieu payment into the Boroughs Carbon Offsetting fund is calculated from the £13,140 non-domestic CO_2 shortfall and the £184,860 Zero carbon payments. This results in the effective Regulated CO_2 emissions of the Proposed Development to be reduced by 74% over the Building Regulations Part L (2013) Baseline.

Summary Table (ii): Site wide Regulated CO_2 emissions reduction

	Regulated CO_2 Emissions	% Reduction over Baseline
	kg CO_2/year	-
Building Regulations (Part L) Baseline	415,354	
After Be Lean Measures	288,710	30.5%
After Be Clean Measures	288,710	30.5%
After Be Green Measures	216,720	47.8%
After Carbon Offset and Zero Carbon Payments	106,687	74.3%

APPENDICES

Appendix A
Be Lean CO_2 Calculations Summary Sheet

Appendix B
Be Green (ASHP) CO_2 Calculations Summary Sheet

Appendix C
Be Green (ASHP and PV) CO_2 Calculations Summary Sheet

Appendix D
Part L1A Compliance Reports (Plot A and C)

Appendix E
Plot B (Refurbishment) Baseline calculation Dwelling Emission Rate Worksheets

Appendix F
Be Lean Dwelling Emission Rate Worksheets

Appendix G
Be Lean BRUKL Worksheets (Non-Domestic)

Appendix H
Be Green (ASHP) BRUKL Worksheets (Non-Domestic)

Appendix I
Be Green (ASHP and PV) BRUKL Worksheets (Non-Domestic)

Appendix J
SAP 2012 PV Calculation

Appendix K
Low and Zero Carbon Technologies

Appendix A

Be Lean CO_2 Calculations Summary Sheet

CO_2 Emissions at Be Lean Stage

Unit Type Description	Individual			Total				Emissions Improvement
	Unit Floor Area	Dwelling Emissions Rate	Target Emissions Rate	Number of Units	Total Floor Area	Dwelling Emissions	Target Emissions	
	m^2	kg CO^2/m^2/year	kg CO^2/m^2/year		m^2	kg CO^2/year	kg CO^2/year	-
Domestic - Refurbishement								
Maisonette (1B2P)	120	23.4	17.1	2	241	5,629	36,557	84.6%
Ground Floor Flat (1B2P)	65	31.6	23.4	1	65	2,072	10,729	80.7%
Ground Floor Flat (2B4P)	107	29.6	21.3	3	322	9,530	63,004	84.9%
Top Floor Flat (1B2P)	65	26.8	20.4	1	65	1,754	11,421	84.6%
			Subtotal	7	693	18,985	121,710	84.4%
Domestic - New Dwellings								
Basement Unit (1B2P)	63	17.9	17.7	17	1,070	19,136	18,956	-0.9%
Ground Floor Unit (2B4P)	79	17.6	17.4	11	873	15,382	15,230	-1.0%
Mid Floor Unit (2B4P)	79	14.6	14.7	57	4,526	66,044	66,691	1.0%
Top Floor unit (2B4P)	96	18.0	18.6	16	1,544	27,771	28,633	3.0%
			Subtotal	101	8,013	128,332	129,510	0.9%
			Domestic Subtotal			147,317	251,220	41.4%
Non-Domestic								
GP clinic	1,231	21.2	27.9	1	1,231	26,101	34,350	24.0%
Pavillion	910	96.6	103.7	1	910	87,945	94,408	6.8%
Residential Facilities	836	32.7	42.3	1	836	27,347	35,375	22.7%
			Non-Domestic Subtotal		2,978	141,393	164,134	13.9%
			Be Lean Site-wide total			288,710	415,354	30.5%

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Appendix B

Be Green (ASHP) CO_2 Calculations Summary Sheet

CO_2 Emissions at Be Green Stage (Showing ASHP improvement only)

Unit Type Description	Individual			Total				Emissions Improvement
	Unit Floor Area	Dwelling Emissions Rate	Target Emissions Rate	Number of Units	Total Floor Area	Dwelling Emissions	Target Emissions	
	m^2	kg CO^2/m^2/year	kg CO^2/m^2/year		m^2	kg CO^2/year	kg CO^2/year	-
Domestic - Refurbishement								
Maisonette (1B2P)	120	23.4	17.1	2	241	5,629	36,557	84.6%
Ground Floor Flat (1B2P)	65	31.6	23.4	1	65	2,072	10,729	80.7%
Ground Floor Flat (2B4P)	107	29.6	21.3	3	322	9,530	63,004	84.9%
Top Floor Flat (1B2P)	65	26.8	20.4	1	65	1,754	11,421	84.6%
			Subtotal	7	693	18,985	121,710	84.4%
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Mid Floor Unit (2B4P)	79	14.6	14.7	57	4,526	66,044	66,691	1.0%
Top Floor unit (2B4P)	96	18.0	18.6	16	1,544	27,771	28,633	3.0%
			Subtotal	101	8,013	128,332	129,510	0.9%
			Domestic Subtotal			147,317	251,220	41.4%
Non-Domestic								
GP clinic	1,231	20.0	27.9	1	1,231	24,624	34,350	28.3%
Pavillion	910	94.9	103.7	1	910	86,397	94,408	8.5%
Residential Facilities	836	31.4	42.3	1	836	26,260	35,375	25.8%
			Non- Domestic Subtotal		2,978	137,281	164,134	16.4%
			Be Green (ASHP only) Site-wide total			284,598	415,354	31.5%

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Appendix C

Be Green (ASHP and PV) CO_2 Calculations Summary Sheet

CO_2 Emissions at Be Green Stage (ASHP and PV)

Unit Type Description	Individual			Total				
	Unit Floor Area	Dwelling Emissions Rate	Target Emissions Rate	Number of Units	Total Floor Area	Dwelling Emissions	Target Emissions	Emissions Improvement
	m^2	kg CO^2/m^2/year	kg CO^2/m^2/year		m^2	kg CO^2/year	kg CO^2/year	-
Domestic - Refurbishement								
Maisonette (1B2P)	120	23.4	17.1	2	241	5,629	36,557	84.6%
Ground Floor Flat (1B2P)	65	31.6	23.4	1	65	2,072	10,729	80.7%
Ground Floor Flat (2B4P)	107	29.6	21.3	3	322	9,530	63,004	84.9%
Top Floor Flat (1B2P)	65	26.8	20.4	1	65	1,754	11,421	84.6%
			Subtotal	7	693	18,985	121,710	84.4%
Domestic - New Dwellings								
Basement Unit (1B2P)	63	17.9	17.7	17	1,070	19,136	18,956	-0.9%
Ground Floor Unit (2B4P)	79	17.6	17.4	11	873	15,382	15,230	-1.0%
Mid Floor Unit (2B4P)	79	14.6	14.7	57	4,526	66,044	66,691	1.0%
Top Floor unit (2B4P)	96	18.0	18.6	16	1,544	27,771	28,633	3.0%
			Total CO_2 Emissions Offset by PV			44,601		
			Subtotal	101	8,013	83,732	129,510	35.3%
			Domestic Subtotal			102,716	251,220	59.1%
Non-Domestic								
GP clinic	1,231	17.7	27.9	1	1,231	21,792	34,350	36.6%
Pavillion	910	76.3	103.7	1	910	69,464	94,408	26.4%
Residential Facilities	836	27.2	42.3	1	836	22,747	35,375	35.7%
			Non-Domestic Subtotal		2,978	114,003	164,134	30.5%
			Be Green Site-wide total			216,720	415,354	47.8%

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Appendix D

Part L1A Compliance Reports (Plot A and C)

L1A 2013 - Regulations Compliance Report

Design - Draft

This design draft submission provides evidence towards compliance with Part L of the Building Regulations, in accordance with Appendix C of AD L1A. It has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the 'as built' property. This report covers only items included within the SAP and is not a complete report of regulations compliance.

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	12/07/2017
Address	DB01 Udney Park Road, Teddington, TW11		

Check	Evidence	Produced by	OK?
Criterion 1: predicted carbon dioxide emission from proposed dwelling does not exceed the target			
TER (kg $CO_2/m^2.a$)	Fuel = N/A Fuel factor = 1.00 TER = 17.72	Authorised SAP Assessor	
DER for dwelling as designed (kg $CO_2/m^2.a$)	DER = 17.89	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 17.89 > TER 17.72 Excess emissions = 0.17 kg/m² (0.96%)	Authorised SAP Assessor	Failed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 43.8 < TFEE 47.2	Authorised SAP Assessor	Passed
Criterion 2: the performance of the building fabric and the heating, hot water and fixed lighting systems should be no worse than the design limits			
Fabric U-values			
Are all U-values better than the design limits in Table 2?	**Element** — **Weighted average** — **Highest** Wall — 0.16 (max 0.30) — 0.16 (max 0.70) Party wall — 0.00 (max 0.20) — N/A Floor — 0.12 (max 0.25) — 0.12 (max 0.70) Roof — (no roof) Openings — 1.40 (max 2.00) — 1.40 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
How has the loss from thermal bridges been calculated?	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
Does the efficiency of the heating systems meet the minimum value set out in the Domestic Heating Compliance Guide?	Community heating scheme Secondary heating system: None	Authorised SAP Assessor	N/A
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder in the dwelling	Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Charging system linked to use, programmer and at least 2 room thermostats No hot water cylinder in the dwelling	Authorised SAP Assessor	Passed
Fixed internal lighting			
Does fixed internal lighting comply with paragraphs 42 to 44?	Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 10 Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has appropriate passive control measures to limit solar gains			
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Slight (21.37°) Overheating risk (July) = Medium (23.03°) Overheating risk (August) = Medium (22.72°) Region = Thames Thermal mass parameter = 250.00 Ventilation rate in hot weather = 2.00 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of the dwelling, as designed, is consistent with the DER			
Design air permeability ($m^3/(h.m^2)$ at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Mechanical extract ventilation: SFP = 0.24 W/(litre/sec) Max SFP = 0.7 W/(litre/sec)	Authorised SAP Assessor	Passed
Have the key features of the design been included (or bettered) in practice?	The following party walls have a U-value less than 0.2W/m²K: • To Corridor (0.00) The following floors have a U-value less than 0.13W/m²K: • Ground (0.12)	Authorised SAP Assessor	

L1A 2013 - Regulations Compliance Report

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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	12/07/2017
Address	E002 Udney Park Road, Teddington, TW11		

Check	Evidence	Produced by	OK?
Criterion 1: predicted carbon dioxide emission from proposed dwelling does not exceed the target			
TER (kg $CO_2/m^2.a$)	Fuel = N/A Fuel factor = 1.00 TER = 17.44	Authorised SAP Assessor	
DER for dwelling as designed (kg $CO_2/m^2.a$)	DER = 17.61	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 17.61 > TER 17.44 Excess emissions = 0.17 kg/m² (0.97%)	Authorised SAP Assessor	Failed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 48.0 < TFEE 52.3	Authorised SAP Assessor	Passed
Criterion 2: the performance of the building fabric and the heating, hot water and fixed lighting systems should be no worse than the design limits			
Fabric U-values			
Are all U-values better than the design limits in Table 2?	**Element** — **Weighted average** — **Highest** Wall — 0.16 (max 0.30) — 0.16 (max 0.70) Party wall — 0.00 (max 0.20) — N/A Floor — 0.15 (max 0.25) — 0.15 (max 0.70) Roof — (no roof) Openings — 1.40 (max 2.00) — 1.40 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
How has the loss from thermal bridges been calculated?	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
Does the efficiency of the heating systems meet the minimum value set out in the Domestic Heating Compliance Guide?	Community heating scheme Secondary heating system: None	Authorised SAP Assessor	N/A
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder in the dwelling	Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Charging system linked to use, programmer and at least 2 room thermostats No hot water cylinder in the dwelling	Authorised SAP Assessor	Passed
Fixed internal lighting			
Does fixed internal lighting comply with paragraphs 42 to 44?	Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 10 Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has appropriate passive control measures to limit solar gains			
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (19.69°) Overheating risk (July) = Slight (21.4°) Overheating risk (August) = Slight (21.04°) Region = Thames Thermal mass parameter = 250.00 Ventilation rate in hot weather = 4.00 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of the dwelling, as designed, is consistent with the DER			
Design air permeability ($m^3/(h.m^2)$ at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Mechanical extract ventilation: SFP = 0.24 W/(litre/sec) Max SFP = 0.7 W/(litre/sec)	Authorised SAP Assessor	Passed
Have the key features of the design been included (or bettered) in practice?	The following party walls have a U-value less than 0.2W/m²K: • To Corridor (0.00) • To Stair Core (0.00) • Party (0.00)	Authorised SAP Assessor	

L1A 2013 - Regulations Compliance Report

Design - Draft

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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	12/07/2017
Address	E102 Udney Park Road, Teddington, TW11		

Check	Evidence	Produced by	OK?
Criterion 1: predicted carbon dioxide emission from proposed dwelling does not exceed the target			
TER (kg $CO_2/m^2.a$)	Fuel = N/A Fuel factor = 1.00 TER = 14.74	Authorised SAP Assessor	
DER for dwelling as designed (kg $CO_2/m^2.a$)	DER = 14.59	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 14.59 < TER 14.74	Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 35.6 < TFEE 38.6	Authorised SAP Assessor	Passed
Criterion 2: the performance of the building fabric and the heating, hot water and fixed lighting systems should be no worse than the design limits			
Fabric U-values			
Are all U-values better than the design limits in Table 2?	**Element** — **Weighted average** — **Highest** Wall — 0.16 (max 0.30) — 0.16 (max 0.70) Party wall — 0.00 (max 0.20) — N/A Floor — (no floor) Roof — (no roof) Openings — 1.40 (max 2.00) — 1.40 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
How has the loss from thermal bridges been calculated?	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
Does the efficiency of the heating systems meet the minimum value set out in the Domestic Heating Compliance Guide?	Community heating scheme Secondary heating system: None	Authorised SAP Assessor	N/A
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder in the dwelling	Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Charging system linked to use, programmer and at least 2 room thermostats No hot water cylinder in the dwelling	Authorised SAP Assessor	Passed
Fixed internal lighting			
Does fixed internal lighting comply with paragraphs 42 to 44?	Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 10 Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has appropriate passive control measures to limit solar gains			
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (19.89°) Overheating risk (July) = Slight (21.59°) Overheating risk (August) = Slight (21.22°) Region = Thames Thermal mass parameter = 250.00 Ventilation rate in hot weather = 4.00 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of the dwelling, as designed, is consistent with the DER			
Design air permeability ($m^3/(h.m^2)$ at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Mechanical extract ventilation: SFP = 0.24 W/(litre/sec) Max SFP = 0.7 W/(litre/sec)	Authorised SAP Assessor	Passed
Have the key features of the design been included (or bettered) in practice?	The following party walls have a U-value less than $0.2W/m^2K$: • To Corridor (0.00) • To Stair Core (0.00) • Party (0.00)	Authorised SAP Assessor	

L1A 2013 - Regulations Compliance Report

Design - Draft

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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	12/07/2017
Address	E301 Udney Park Road, Teddington, TW11		

Check	Evidence	Produced by	OK?
Criterion 1: predicted carbon dioxide emission from proposed dwelling does not exceed the target			
TER (kg $CO_2/m^2.a$)	Fuel = N/A Fuel factor = 1.00 TER = 18.55	Authorised SAP Assessor	
DER for dwelling as designed (kg $CO_2/m^2.a$)	DER = 17.99	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 17.99 < TER 18.55	Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 52.8 < TFEE 62.9	Authorised SAP Assessor	Passed
Criterion 2: the performance of the building fabric and the heating, hot water and fixed lighting systems should be no worse than the design limits			
Fabric U-values			
Are all U-values better than the design limits in Table 2?	**Element** — **Weighted average** — **Highest** Wall — 0.18 (max 0.30) — 0.18 (max 0.70) Party wall — 0.00 (max 0.20) — N/A Floor — (no floor) Roof — 0.15 (max 0.20) — 0.15 (max 0.35) Openings — 1.40 (max 2.00) — 1.40 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
How has the loss from thermal bridges been calculated?	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
Does the efficiency of the heating systems meet the minimum value set out in the Domestic Heating Compliance Guide?	Community heating scheme Secondary heating system: None	Authorised SAP Assessor	**N/A**
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder in the dwelling	Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Charging system linked to use, programmer and at least 2 room thermostats No hot water cylinder in the dwelling	Authorised SAP Assessor	Passed
Fixed internal lighting			
Does fixed internal lighting comply with paragraphs 42 to 44?	Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 10 Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has appropriate passive control measures to limit solar gains			
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (19.55°) Overheating risk (July) = Slight (21.28°) Overheating risk (August) = Slight (20.96°) Region = Thames Thermal mass parameter = 250.00 Ventilation rate in hot weather = 4.00 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of the dwelling, as designed, is consistent with the DER			
Design air permeability ($m^3/(h.m^2)$ at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Mechanical extract ventilation: SFP = 0.18 W/(litre/sec) Max SFP = 0.7 W/(litre/sec)	Authorised SAP Assessor	Passed
Have the key features of the design been included (or bettered) in practice?	The following party walls have a U-value less than 0.2W/m^2K: • To Corridor (0.00) • To Stair Core (0.00) • Party (0.00) • To Lift Core (0.00)	Authorised SAP Assessor	

Appendix E

Plot B (Refurbishment) Baseline calculation Dwelling Emission Rate Worksheets

DER Worksheet
Design - 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 Simon Gowing	Assessor number	9641
Client		Last modified	14/06/2017
Address	B Udney Park Road, Teddington, TW11		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		44.19	(1a) x	3.32	(2a) =	146.71	(3a)
+1		76.24	(1b) x	2.04	(2b) =	155.53	(3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	120.43	(4)				
Dwelling volume				(3a) + (3b) + (3c) + (3d)...(3n) =		302.24	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	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) =	0.10	(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		10.00 (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.60 (18)
Number of sides on which the dwelling is sheltered		3 (19)
Shelter factor	1 - [0.075 x (19)] =	0.78 (20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.46 (21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.59	0.58	0.57	0.51	0.50	0.44	0.44	0.43	0.46	0.50	0.52	0.55	(22b)

Calculate effective air change rate for the applicable case:

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

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

	0.68	0.67	0.66	0.63	0.62	0.60	0.60	0.59	0.61	0.62	0.64	0.65	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

	0.68	0.67	0.66	0.63	0.62	0.60	0.60	0.59	0.61	0.62	0.64	0.65	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²	U-value W/m²K	A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			4.52 x	1.00 =	4.52			(26)
Window			15.50 x	1.42 =	21.93			(27)
Ground floor			44.19 x	0.25 =	11.05			(28a)
External wall			67.35 x	0.30 =	20.21			(29a)
External wall			0.47 x	0.15 =	0.07			(29a)
External wall			6.85 x	0.20 =	1.37			(29a)
Roof			77.95 x	0.16 =	12.47			(30)
Roof			52.78 x	0.18 =	9.50			(30)
Total area of external elements ∑A, m²			269.61					(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	81.12 (33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m²K		250.00 (35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		40.44 (36)
Total fabric heat loss	(33) + (36) =	121.56 (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)	67.36	66.68	66.01	62.88	62.30	59.58	59.58	59.07	60.63	62.30	63.48	64.72	(38)
Heat transfer coefficient, W/K (37)m + (38)m	188.92	188.24	187.57	184.45	183.86	181.14	181.14	180.63	182.19	183.86	185.04	186.28	

Average = ∑(39)1...12/12 = 184.44 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.57	1.56	1.56	1.53	1.53	1.50	1.50	1.50	1.51	1.53	1.54	1.55	

Average = ∑(40)1...12/12 = 1.53 (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	2.86 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	102.24 (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)	112.47	108.38	104.29	100.20	96.11	92.02	92.02	96.11	100.20	104.29	108.38	112.47	

∑(44)1...12 = 1226.91 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	166.79	145.87	150.53	131.23	125.92	108.66	100.69	115.54	116.92	136.26	148.74	161.52	

∑(45)1...12 = 1608.68 (45)

Distribution loss 0.15 x (45)m	25.02	21.88	22.58	19.68	18.89	16.30	15.10	17.33	17.54	20.44	22.31	24.23	(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

67.80	61.24	67.79	65.59	67.76	65.56	67.73	67.75	65.57	67.77	65.60	67.80 (61)

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

234.59	207.11	218.31	196.82	193.68	174.22	168.42	183.29	182.50	204.04	214.35	229.32 (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

234.59	207.11	218.31	196.82	193.68	174.22	168.42	183.29	182.50	204.04	214.35	229.32

∑(64)1...12 = 2406.64 (64)

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

72.41	63.81	67.00	60.03	58.81	52.52	50.41	55.36	55.27	62.25	65.86	70.66 (65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	143.25	143.25	143.25	143.25	143.25	143.25	143.25	143.25	143.25	143.25	143.25	143.25	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	27.04	24.02	19.53	14.79	11.05	9.33	10.08	13.11	17.59	22.34	26.07	27.79	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	285.77	288.74	281.26	265.36	245.27	226.40	213.79	210.83	218.30	234.21	254.29	273.16	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	(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)	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	(71)
Water heating gains (Table 5)	97.32	94.96	90.05	83.38	79.04	72.94	67.76	74.40	76.76	83.67	91.47	94.97	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	479.11	476.69	459.82	432.50	404.35	377.65	360.61	367.31	381.63	409.19	440.80	464.90	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
East	0.77	x	7.49	x	19.64	x 0.9 x	0.50	x	0.80	=	40.78	(76)
South	0.77	x	2.41	x	46.75	x 0.9 x	0.50	x	0.80	=	31.23	(78)
North	0.77	x	2.08	x	10.63	x 0.9 x	0.50	x	0.80	=	6.13	(74)
West	0.77	x	3.52	x	19.64	x 0.9 x	0.50	x	0.80	=	19.16	(80)

Solar gains in watts ∑(74)m...(82)m

97.31	180.13	278.17	387.26	464.97	473.30	451.60	393.18	316.59	208.26	119.32	81.39 (83)

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

576.42	656.82	738.00	819.75	869.32	850.95	812.20	760.49	698.22	617.45	560.13	546.29 (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	0.90	0.80	0.84	0.96	0.99	1.00	1.00	(86)

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

19.13	19.28	19.56	19.96	20.37	20.71	20.89	20.86	20.57	20.05	19.53	19.12	(87)

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

19.64	19.64	19.64	19.66	19.67	19.68	19.68	19.69	19.68	19.67	19.66	19.65	(88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	1.00	0.99	0.98	0.95	0.83	0.63	0.69	0.92	0.99	1.00	1.00	(89)

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

17.95	18.10	18.39	18.80	19.20	19.53	19.65	19.64	19.40	18.90	18.37	17.96	(90)

Living area fraction — Living area ÷ (4) = 0.37 (91)

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

18.39	18.53	18.82	19.23	19.63	19.96	20.11	20.09	19.83	19.32	18.80	18.38	(92)

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

18.24	18.38	18.67	19.08	19.48	19.81	19.96	19.94	19.68	19.17	18.65	18.23	(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	0.98	0.94	0.84	0.67	0.73	0.92	0.99	1.00	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	575.30	654.51	732.34	803.03	819.43	716.99	546.99	553.55	642.35	608.78	558.21	545.46	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	2632.75	2538.22	2282.25	1877.55	1429.89	944.51	607.88	638.76	1016.93	1575.75	2137.16	2614.17	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	1530.74	1265.85	1153.13	773.66	454.18	0.00	0.00	0.00	0.00	719.43	1136.84	1539.12	

∑(98)1...5, 10...12 = 8572.95 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) = 71.19 (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 (%) 93.70 (206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	1633.66	1350.96	1230.66	825.68	484.72	0.00	0.00	0.00	0.00	767.80	1213.28	1642.60	

∑(211)1...5, 10...12 = 9149.36 (211)

Water heating

Efficiency of water heater	91.79	91.85	92.01	92.37	93.19	99.60	99.60	99.60	99.60	92.53	92.00	91.76	(217)
Water heating fuel, kWh/month	255.57	225.48	237.28	213.07	207.83	174.92	169.10	184.03	183.23	220.52	232.97	249.91	

∑(219a)1...12 = 2553.89 (219)

Annual totals

Space heating fuel - main system 1		9149.36	
Water heating fuel		2553.89	
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)		477.59	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	12255.84	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	9149.36	x	3.48	x 0.01 =	318.40	(240)
Water heating	2553.89	x	3.48	x 0.01 =	88.88	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	477.59	x	13.19	x 0.01 =	62.99	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	600.16	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.52	(257)
SAP value	78.74	
SAP rating (section 13)	79	(258)
SAP band	C	

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

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	9149.36	x	0.216	=	1976.26	(261)
Water heating	2553.89	x	0.216	=	551.64	(264)
Space and water heating			(261) + (262) + (263) + (264) =		2527.90	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	477.59	x	0.519	=	247.87	(268)
Total CO_2, kg/year			(265)...(271) =		2814.69	(272)
Dwelling CO_2 emission rate			(272) ÷ (4) =		23.37	(273)
EI value					77.20	
EI rating (section 14)					77	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	9149.36	x	1.22	=	11162.22	(261)
Water heating	2553.89	x	1.22	=	3115.75	(264)
Space and water heating			(261) + (262) + (263) + (264) =		14277.96	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	477.59	x	3.07	=	1466.19	(268)
Primary energy kWh/year					15974.40	(272)
Dwelling primary energy rate kWh/m2/year					132.64	(273)

DER Worksheet
Design - 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 Simon Gowing	Assessor number	9641
Client		Last modified	14/06/2017
Address	B 2 Udney Park Road, Teddington, TW11		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		65.47	(1a)	x 3.32	(2a) =	217.36	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	65.47	(4)				
Dwelling volume				(3a) + (3b) + (3c) + (3d)...(3n) =		217.36	(5)

2. Ventilation rate

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

			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	20	÷ (5) =	0.09	(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	10.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.59	(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) = 0.50	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.64	0.63	0.62	0.55	0.54	0.48	0.48	0.47	0.50	0.54	0.57	0.59	(22b)

Calculate effective air change rate for the applicable case:

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.71	0.70	0.69	0.65	0.65	0.61	0.61	0.61	0.63	0.65	0.66	0.67	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.71	0.70	0.69	0.65	0.65	0.61	0.61	0.61	0.63	0.65	0.66	0.67	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			2.52	x	1.00	=	2.52			(26)
Window			9.95	x	1.42	=	14.08			(27)
Ground floor			65.47	x	0.25	=	16.37			(28a)
External wall			74.48	x	0.30	=	22.34			(29a)
External wall			19.76	x	0.15	=	2.96			(29a)
Party wall			19.42	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			172.18							(31)

Fabric heat loss, W/K = ∑(A x U)	(26)...(30) + (32) =	58.28 (33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m²K		250.00 (35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		25.83 (36)
Total fabric heat loss	(33) + (36) =	84.10 (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)	50.63	50.05	49.49	46.85	46.36	44.06	44.06	43.63	44.95	46.36	47.36	48.40	(38)
Heat transfer coefficient, W/K (37)m + (38)m	134.73	134.16	133.60	130.96	130.46	128.16	128.16	127.74	129.05	130.46	131.46	132.51	
Average = ∑(39)1...12/12 = 130.95 (39)													
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	2.06	2.05	2.04	2.00	1.99	1.96	1.96	1.95	1.97	1.99	2.01	2.02	
Average = ∑(40)1...12/12 = 2.00 (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)

4. Water heating energy requirement

Assumed occupancy, N	2.13 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	84.82 (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)	93.30	89.91	86.52	83.12	79.73	76.34	76.34	79.73	83.12	86.52	89.91	93.30	
∑(44)1...12 = 1017.83 (44)													
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	138.36	121.01	124.87	108.87	104.46	90.14	83.53	95.85	97.00	113.04	123.39	134.00	
∑(45)1...12 = 1334.54 (45)													
Distribution loss 0.15 x (45)m	20.75	18.15	18.73	16.33	15.67	13.52	12.53	14.38	14.55	16.96	18.51	20.10	(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	67.77	61.20	67.75	65.55	67.72	65.52	67.70	67.71	65.54	67.74	65.57	67.76	(61)

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

	206.13	182.21	192.62	174.42	172.18	155.67	151.23	163.57	162.53	180.78	188.96	201.76 (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	206.13	182.21	192.62	174.42	172.18	155.67	151.23	163.57	162.53	180.78	188.96	201.76

∑(64)1...12 = 2132.06 (64)

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

	62.95	55.54	58.46	52.59	51.66	46.35	44.70	48.80	48.64	54.52	57.42	61.49 (65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	17.08	15.17	12.34	9.34	6.98	5.90	6.37	8.28	11.11	14.11	16.47	17.56	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	186.50	188.44	183.56	173.18	160.07	147.75	139.53	137.59	142.47	152.85	165.96	178.27	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	(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)	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	(71)
Water heating gains (Table 5)	84.61	82.64	78.57	73.04	69.44	64.38	60.08	65.59	67.55	73.28	79.75	82.65	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	346.16	344.23	332.44	313.53	294.47	276.00	263.95	269.43	279.10	298.21	320.15	336.46	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
West	0.77	x	2.44	x	19.64	x 0.9 x	0.63	x	0.80	=	16.74	(80)
North	0.77	x	7.51	x	10.63	x 0.9 x	0.63	x	0.80	=	27.89	(74)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains in watts ∑(74)m...(82)m	44.63	86.05	144.50	224.13	292.36	308.47	289.81	236.09	171.61	102.30	55.28	37.02	(83)
Total gains - internal and solar (73)m + (83)m	390.79	430.27	476.94	537.65	586.83	584.47	553.76	505.52	450.72	400.51	375.42	373.47	(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	0.99	0.98	0.95	0.88	0.78	0.83	0.95	0.99	1.00	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	18.71	18.87	19.19	19.69	20.19	20.62	20.83	20.79	20.42	19.80	19.20	18.71	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	19.30	19.30	19.31	19.33	19.34	19.36	19.36	19.37	19.35	19.34	19.33	19.32	(88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.99	0.97	0.92	0.79	0.58	0.65	0.90	0.98	0.99	1.00

(89)

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

17.29	17.45	17.78	18.29	18.77	19.17	19.32	19.30	19.01	18.41	17.80	17.30

(90)

Living area fraction — Living area ÷ (4) = 0.45 (91)

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

17.93	18.09	18.41	18.92	19.41	19.82	20.00	19.97	19.65	19.04	18.43	17.93

(92)

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

17.78	17.94	18.26	18.77	19.26	19.67	19.85	19.82	19.50	18.89	18.28	17.78

(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation factor for gains, ηm	0.99	0.99	0.99	0.97	0.92	0.81	0.65	0.71	0.90	0.98	0.99	1.00
	(94)											
Useful gains, ηmGm, W (94)m x (84)m	388.71	426.90	470.16	520.09	539.45	473.52	360.98	360.06	407.09	391.08	372.34	371.79
	(95)											
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20
	(96)											
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	1815.84	1748.77	1571.64	1292.02	986.00	650.28	416.70	436.98	696.32	1081.10	1469.29	1799.74
	(97)											
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	1061.79	888.29	819.50	555.79	332.23	0.00	0.00	0.00	0.00	513.37	789.80	1062.39

∑(98)1...5, 10...12 = 6023.17 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 92.00 (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 (%) — 93.70 (206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	1133.18	948.02	874.60	593.16	354.57	0.00	0.00	0.00	0.00	547.89	842.91	1133.83

∑(211)1...5, 10...12 = 6428.14 (211)

Water heating

Efficiency of water heater	92.04	92.10	92.27	92.68	93.55	99.60	99.60	99.60	99.60	92.86	92.29	92.01
	(217)											
Water heating fuel, kWh/month	223.96	197.84	208.76	188.19	184.05	156.29	151.84	164.22	163.19	194.67	204.74	219.28

∑(219a)1...12 = 2257.04 (219)

Annual totals

Space heating fuel - main system 1 — 6428.14

Water heating fuel — 2257.04

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) — 301.70 (232)

Total delivered energy for all uses — (211)...(221) + (231) + (232)...(237b) = 9061.88 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	6428.14	x	3.48	x 0.01 =	223.70	(240)
Water heating	2257.04	x	3.48	x 0.01 =	78.55	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	301.70	x	13.19	x 0.01 =	39.79	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	471.93	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.79	(257)
SAP value	74.97	
SAP rating (section 13)	75	(258)
SAP band	C	

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

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	6428.14	x	0.216	=	1388.48	(261)
Water heating	2257.04	x	0.216	=	487.52	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1876.00	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	301.70	x	0.519	=	156.58	(268)
Total CO_2, kg/year			(265)...(271) =		2071.50	(272)
Dwelling CO_2 emission rate			(272) ÷ (4) =		31.64	(273)
EI value					74.87	
EI rating (section 14)					75	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	6428.14	x	1.22	=	7842.33	(261)
Water heating	2257.04	x	1.22	=	2753.59	(264)
Space and water heating			(261) + (262) + (263) + (264) =		10595.92	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	301.70	x	3.07	=	926.21	(268)
Primary energy kWh/year					11752.38	(272)
Dwelling primary energy rate kWh/m2/year					179.51	(273)

DER Worksheet
Design - 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 Simon Gowing	Assessor number	9641
Client		Last modified	14/06/2017
Address	B 1 Udney Park Road, Teddington, TW11		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		107.23	(1a) x	3.32	(2a) =	356.00	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	107.23	(4)				
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =	356.00	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	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) =	0.08	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	10.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.58	(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) = 0.50	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.63	0.62	0.61	0.55	0.53	0.47	0.47	0.46	0.50	0.53	0.56	0.58	(22b)

Calculate effective air change rate for the applicable case:

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

	0.70	0.69	0.69	0.65	0.64	0.61	0.61	0.61	0.62	0.64	0.66	0.67	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)													
	0.70	0.69	0.69	0.65	0.64	0.61	0.61	0.61	0.62	0.64	0.66	0.67	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			16.68	x	1.42	=	23.60			(27)
Door			2.52	x	1.00	=	2.52			(26)
Ground floor			107.23	x	0.25	=	26.81			(28a)
External wall			103.60	x	0.30	=	31.08			(29a)
External wall			13.75	x	0.15	=	2.06			(29a)
Party wall			42.26	x	0.00	=	0.00			(32)
Roof			105.84	x	0.16	=	16.93			(30)
Roof			1.39	x	0.18	=	0.25			(30)
Total area of external elements ∑A, m²			351.01							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) = 103.26	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) = N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K	52.65	(36)
Total fabric heat loss	(33) + (36) = 155.91	(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)	82.29	81.38	80.48	76.27	75.48	71.82	71.82	71.14	73.23	75.48	77.08	78.74	(38)
Heat transfer coefficient, W/K (37)m + (38)m	238.20	237.29	236.39	232.18	231.39	227.73	227.73	227.05	229.14	231.39	232.99	234.65	

Average = ∑(39)1...12/12 = 232.18 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	2.22	2.21	2.20	2.17	2.16	2.12	2.12	2.12	2.14	2.16	2.17	2.19	

Average = ∑(40)1...12/12 = 2.17 (40)

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

4. Water heating energy requirement

Assumed occupancy, N	2.80	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	100.63	(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)	110.70	106.67	102.64	98.62	94.59	90.57	90.57	94.59	98.62	102.64	106.67	110.70	

∑(44)1...12 = 1207.58 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	164.16	143.57	148.15	129.17	123.94	106.95	99.10	113.72	115.08	134.12	146.40	158.98	

∑(45)1...12 = 1583.33 (45)

Distribution loss 0.15 x (45)m	24.62	21.54	22.22	19.37	18.59	16.04	14.87	17.06	17.26	20.12	21.96	23.85	(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													

67.80	61.24	67.79	65.58	67.75	65.55	67.73	67.75	65.57	67.77	65.60	67.80	(61)

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

231.96	204.81	215.94	194.75	191.69	172.50	166.83	181.47	180.65	201.89	212.00	226.77	(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

231.96	204.81	215.94	194.75	191.69	172.50	166.83	181.47	180.65	201.89	212.00	226.77	

∑(64)1...12 = 2381.26 (64)

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

71.53	63.05	66.21	59.34	58.15	51.95	49.88	54.75	54.66	61.54	65.08	69.81	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	139.86	139.86	139.86	139.86	139.86	139.86	139.86	139.86	139.86	139.86	139.86	139.86	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	24.41	21.68	17.63	13.35	9.98	8.42	9.10	11.83	15.88	20.16	23.53	25.09	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	267.51	270.29	263.30	248.40	229.60	211.94	200.13	197.36	204.35	219.24	238.04	255.71	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	(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)	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	(71)
Water heating gains (Table 5)	96.15	93.82	88.99	82.42	78.16	72.15	67.05	73.59	75.91	82.71	90.39	93.83	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

456.03	453.75	437.87	412.13	385.69	360.47	344.24	350.73	364.10	390.07	419.92	442.58	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
South	0.77	x	7.75	x	46.75	x 0.9 x	0.63	x	0.80	=	126.55	(78)
East	0.77	x	3.61	x	19.64	x 0.9 x	0.63	x	0.80	=	24.76	(76)
West	0.77	x	5.32	x	19.64	x 0.9 x	0.63	x	0.80	=	36.49	(80)

Solar gains in watts ∑(74)m...(82)m

187.81	327.09	461.36	586.21	663.68	660.33	636.14	579.23	505.31	365.74	226.39	159.73	(83)

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

643.83	780.84	899.23	998.34	1049.37	1020.79	980.38	929.96	869.41	755.81	646.31	602.31	(84)

7. Mean internal temperature (heating season)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	1.00	0.99	0.99	0.97	0.94	0.88	0.77	0.80	0.93	0.98	0.99	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	18.56	18.77	19.13	19.64	20.14	20.58	20.82	20.78	20.42	19.77	19.08	18.54	(87)

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

19.19	19.20	19.20	19.23	19.23	19.25	19.25	19.26	19.24	19.23	19.22	19.21	(88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.98	0.96	0.91	0.77	0.56	0.61	0.86	0.97	0.99	1.00	(89)

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

17.06	17.27	17.64	18.16	18.65	19.05	19.21	19.20	18.92	18.30	17.61	17.06	(90)

Living area fraction Living area ÷ (4) = 0.34 (91)

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

17.57	17.78	18.15	18.67	19.15	19.57	19.76	19.73	19.43	18.80	18.11	17.56	(92)

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

17.42	17.63	18.00	18.52	19.00	19.42	19.61	19.58	19.28	18.65	17.96	17.41	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.99	0.98	0.95	0.90	0.79	0.61	0.66	0.86	0.96	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	639.91	771.98	879.53	952.55	946.23	804.15	599.71	612.32	750.19	728.82	639.57	599.36	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	3124.97	3021.13	2718.79	2232.74	1690.16	1098.14	684.52	723.12	1187.95	1861.85	2530.43	3100.28	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	1848.88	1511.43	1368.41	921.73	553.49	0.00	0.00	0.00	0.00	842.97	1361.42	1860.68	

∑(98)1...5, 10...12 = 10269.02 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) = 95.77 (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 (%) 93.70 (206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	1973.19	1613.06	1460.42	983.71	590.70	0.00	0.00	0.00	0.00	899.65	1452.96	1985.78	

∑(211)1...5, 10...12 = 10959.47 (211)

Water heating

Efficiency of water heater

91.61	91.68	91.82	92.14	92.83	99.60	99.60	99.60	99.60	92.29	91.81	91.59	(217)

Water heating fuel, kWh/month

253.20	223.40	235.18	211.37	206.49	173.19	167.50	182.20	181.38	218.74	230.92	247.60	

∑(219a)1...12 = 2531.17 (219)

Annual totals

Space heating fuel - main system 1 10959.47

Water heating fuel 2531.17

Electricity for pumps, fans and electric keep-hot (Table 4f)			
central heating pump or water pump within warm air heating unit	30.00		(230c)
boiler flue fan	45.00		(230e)
Total electricity for the above, kWh/year		75.00	(231)
Electricity for lighting (Appendix L)		431.05	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	13996.68	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	10959.47	x	3.48	x 0.01 =	381.39	(240)
Water heating	2531.17	x	3.48	x 0.01 =	88.08	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	431.05	x	13.19	x 0.01 =	56.85	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		656.22	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.81	(257)
SAP value	74.74	
SAP rating (section 13)	75	(258)
SAP band	C	

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

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	10959.47	x	0.216	=	2367.24	(261)
Water heating	2531.17	x	0.216	=	546.73	(264)
Space and water heating			(261) + (262) + (263) + (264) =		2913.98	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	431.05	x	0.519	=	223.71	(268)
Total CO_2, kg/year			(265)...(271) =		3176.62	(272)
Dwelling CO_2 emission rate			(272) ÷ (4) =		29.62	(273)
EI value					72.04	
EI rating (section 14)					72	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	10959.47	x	1.22	=	13370.55	(261)
Water heating	2531.17	x	1.22	=	3088.03	(264)
Space and water heating			(261) + (262) + (263) + (264) =		16458.58	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	431.05	x	3.07	=	1323.31	(268)
Primary energy kWh/year					18012.14	(272)
Dwelling primary energy rate kWh/m2/year					167.98	(273)

DER Worksheet
Design - 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 Simon Gowing	Assessor number	9641
Client		Last modified	14/06/2017
Address	B 3 Udney Park Road, Teddington, TW11		

1. Overall dwelling dimensions

		Area (m^2)		Average storey height (m)		Volume (m^3)	
Lowest occupied		65.47	(1a) x	2.40	(2a) =	157.13	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	65.47	(4)				
Dwelling volume				(3a) + (3b) + (3c) + (3d)...(3n) =		157.13	(5)

2. Ventilation rate

		m^3 per hour		
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	20	÷ (5) =	0.13 (8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	10.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.63	(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) = 0.53	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.68	0.67	0.65	0.59	0.57	0.51	0.51	0.49	0.53	0.57	0.60	0.63	(22b)

Calculate effective air change rate for the applicable case:

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

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

	0.73	0.72	0.71	0.67	0.66	0.63	0.63	0.62	0.64	0.66	0.68	0.70	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

	0.73	0.72	0.71	0.67	0.66	0.63	0.63	0.62	0.64	0.66	0.68	0.70	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			2.52	x	1.00	=	2.52			(26)
Window			9.93	x	1.42	=	14.05			(27)
External wall			64.61	x	0.30	=	19.38			(29a)
External wall			13.49	x	0.15	=	2.02			(29a)
Roof			65.47	x	0.16	=	10.48			(30)
Total area of external elements ∑A, m²			156.02							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	48.45 (33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m²K		250.00 (35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		23.40 (36)
Total fabric heat loss	(33) + (36) =	71.86 (37)

Ventilation heat loss calculated monthly 0.33 x (25)m x (5)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
37.91	37.44	36.99	34.84	34.44	32.58	32.58	32.23	33.30	34.44	35.25	36.10	(38)

Heat transfer coefficient, W/K (37)m + (38)m

109.76	109.30	108.84	106.70	106.30	104.43	104.43	104.09	105.15	106.30	107.11	107.96	

Average = ∑(39)1...12/12 = 106.70 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

1.68	1.67	1.66	1.63	1.62	1.60	1.60	1.59	1.61	1.62	1.64	1.65	

Average = ∑(40)1...12/12 = 1.63 (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	2.13 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	84.82 (43)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
93.30	89.91	86.52	83.12	79.73	76.34	76.34	79.73	83.12	86.52	89.91	93.30	

∑(44)1...12 = 1017.83 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

138.36	121.01	124.87	108.87	104.46	90.14	83.53	95.85	97.00	113.04	123.39	134.00	

∑(45)1...12 = 1334.54 (45)

Distribution loss 0.15 x (45)m

20.75	18.15	18.73	16.33	15.67	13.52	12.53	14.38	14.55	16.96	18.51	20.10	(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

67.77	61.20	67.75	65.55	67.72	65.52	67.70	67.71	65.54	67.74	65.57	67.76	(61)

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

206.13	182.21	192.62	174.42	172.18	155.67	151.23	163.57	162.53	180.78	188.96	201.76	(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

206.13	182.21	192.62	174.42	172.18	155.67	151.23	163.57	162.53	180.78	188.96	201.76	

∑(64)1...12 = 2132.06 (64)

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

62.95	55.54	58.46	52.59	51.66	46.35	44.70	48.80	48.64	54.52	57.42	61.49	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	17.25	15.32	12.46	9.43	7.05	5.95	6.43	8.36	11.22	14.25	16.63	17.73	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	186.50	188.44	183.56	173.18	160.07	147.75	139.53	137.59	142.47	152.85	165.96	178.27	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	(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)	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	(71)
Water heating gains (Table 5)	84.61	82.64	78.57	73.04	69.44	64.38	60.08	65.59	67.55	73.28	79.75	82.65	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	346.33	344.37	332.56	313.62	294.53	276.06	264.01	269.51	279.21	298.35	320.31	336.63	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
West	0.77	x	2.19	x	19.64	x 0.9 x	0.63	x	0.80	=	15.02	(80)
North	0.77	x	5.19	x	10.63	x 0.9 x	0.63	x	0.80	=	19.28	(74)
South	0.54	x	1.79	x	46.75	x 0.9 x	0.63	x	0.80	=	20.50	(78)
East	0.54	x	0.76	x	19.64	x 0.9 x	0.63	x	0.80	=	3.66	(76)

Solar gains in watts ∑(74)m...(82)m

58.45	106.95	165.53	236.64	293.36	303.57	287.55	243.43	189.92	123.42	71.37	49.14	(83)

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

404.78	451.32	498.10	550.25	587.90	579.62	551.56	512.94	469.13	421.76	391.67	385.77	(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	0.99	0.98	0.94	0.85	0.72	0.77	0.93	0.98	1.00	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)												
19.13	19.28	19.58	20.01	20.42	20.77	20.92	20.89	20.61	20.09	19.55	19.12	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)												
19.56	19.56	19.57	19.59	19.60	19.62	19.62	19.62	19.61	19.60	19.59	19.58	(88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.99	0.97	0.91	0.75	0.54	0.60	0.87	0.98	0.99	1.00

(89)

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

17.89	18.05	18.35	18.79	19.19	19.50	19.60	19.59	19.38	18.88	18.34	17.90

(90)

Living area fraction — Living area ÷ (4) = 0.45 (91)

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

18.45	18.60	18.90	19.34	19.75	20.07	20.19	20.17	19.94	19.42	18.88	18.45

(92)

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

18.30	18.45	18.75	19.19	19.60	19.92	20.04	20.02	19.79	19.27	18.73	18.30

(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	1.00	0.99	0.98	0.96	0.91	0.78	0.60	0.66	0.88	0.97	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	402.80	447.77	490.52	530.20	533.56	451.44	332.43	338.61	412.37	410.24	388.47	384.22	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	1536.64	1481.55	1333.40	1097.63	839.43	555.63	359.20	377.05	597.96	921.83	1246.11	1522.19	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	843.57	694.70	627.10	408.55	227.57	0.00	0.00	0.00	0.00	380.62	617.50	846.65	

∑(98)1...5, 10...12 = 4646.26 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 70.97 (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 (%) — 93.70 (206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	900.29	741.41	669.27	436.02	242.87	0.00	0.00	0.00	0.00	406.21	659.02	903.57	

∑(211)1...5, 10...12 = 4958.66 (211)

Water heating

Efficiency of water heater

92.32	92.42	92.65	93.19	94.33	99.60	99.60	99.60	99.60	93.39	92.64	92.29

(217)

Water heating fuel, kWh/month

223.28	197.17	207.91	187.16	182.53	156.29	151.84	164.22	163.19	193.58	203.97	218.62

∑(219a)1...12 = 2249.76 (219)

Annual totals

Space heating fuel - main system 1 — 4958.66

Water heating fuel — 2249.76

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) — 304.61 (232)

Total delivered energy for all uses — (211)...(221) + (231) + (232)...(237b) = 7588.03 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4958.66	x	3.48	x 0.01 =	172.56	(240)
Water heating	2249.76	x	3.48	x 0.01 =	78.29	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	304.61	x	13.19	x 0.01 =	40.18	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	420.92	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.60	(257)
SAP value	77.68	
SAP rating (section 13)	78	(258)
SAP band	C	

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

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	4958.66	x	0.216	=	1071.07	(261)
Water heating	2249.76	x	0.216	=	485.95	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1557.02	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	304.61	x	0.519	=	158.09	(268)
Total CO_2, kg/year			(265)...(271) =		1754.04	(272)
Dwelling CO_2 emission rate			(272) ÷ (4) =		26.79	(273)
EI value					78.72	
EI rating (section 14)					79	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	4958.66	x	1.22	=	6049.56	(261)
Water heating	2249.76	x	1.22	=	2744.71	(264)
Space and water heating			(261) + (262) + (263) + (264) =		8794.27	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	304.61	x	3.07	=	935.15	(268)
Primary energy kWh/year					9959.67	(272)
Dwelling primary energy rate kWh/m2/year					152.13	(273)

Appendix F

Be Lean Dwelling Emission Rate Worksheets

DER Worksheet
Design - 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 Simon Gowing	Assessor number	9641
Client		Last modified	11/07/2017
Address	DB01 Udney Park Road, Teddington, TW11		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		62.93	(1a) x	2.40	(2a) =	151.03	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	62.93	(4)				
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =	151.03	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.25	(18)
Number of sides on which the dwelling is sheltered	4	(19)
Shelter factor	1 - [0.075 x (19)] = 0.70	(20)
Infiltration rate incorporating shelter factor	(18) x (20) = 0.18	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.22	0.22	0.21	0.19	0.19	0.17	0.17	0.16	0.18	0.19	0.20	0.21	(22b)

Calculate effective air change rate for the applicable case:

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

c) whole house extract ventilation or positive input ventilation from outside

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			12.19	x	1.33	=	16.16			(27)
Ground floor			62.93	x	0.12	=	7.55			(28a)
External wall			33.15	x	0.16	=	5.30			(29a)
Party wall			30.96	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			108.27							(31)
Fabric heat loss, W/K = ∑(A x U)								(26)...(30) + (32) =	29.02	(33)
Heat capacity Cm = ∑(A x κ)								(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K									250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K									10.87	(36)
Total fabric heat loss								(33) + (36) =	39.89	(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)	24.92	24.92	24.92	24.92	24.92	24.92	24.92	24.92	24.92	24.92	24.92	24.92		(38)
Heat transfer coefficient, W/K (37)m + (38)m	64.81	64.81	64.81	64.81	64.81	64.81	64.81	64.81	64.81	64.81	64.81	64.81		
													Average = ∑(39)1...12/12 = 64.81	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03		
													Average = ∑(40)1...12/12 = 1.03	(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	2.06	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	83.20	(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)	91.52	88.19	84.86	81.54	78.21	74.88	74.88	78.21	81.54	84.86	88.19	91.52		
													∑(44)1...12 = 998.40	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	135.72	118.70	122.49	106.79	102.47	88.42	81.94	94.02	95.15	110.88	121.04	131.44		
													∑(45)1...12 = 1309.06	(45)
Distribution loss 0.15 x (45)m	20.36	17.81	18.37	16.02	15.37	13.26	12.29	14.10	14.27	16.63	18.16	19.72		(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	2.00	(47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
Volume factor from Table 2a	3.91	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	0.17	(54)
Enter (50) or (54) in (55)	0.17	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	5.14	4.64	5.14	4.97	5.14	4.97	5.14	5.14	4.97	5.14	4.97	5.14	(56)

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

5.14	4.64	5.14	4.97	5.14	4.97	5.14	5.14	4.97	5.14	4.97	5.14	(57)

Primary circuit loss for each month from Table 3

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

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

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

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

164.12	144.36	150.89	134.28	130.87	115.91	110.34	122.42	122.63	139.29	148.52	159.84	(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

164.12	144.36	150.89	134.28	130.87	115.91	110.34	122.42	122.63	139.29	148.52	159.84	

∑(64)1...12 = 1643.47 (64)

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

67.85	59.99	63.45	57.50	56.79	51.39	49.97	53.98	53.62	59.59	62.23	66.43	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	103.16	103.16	103.16	103.16	103.16	103.16	103.16	103.16	103.16	103.16	103.16	103.16	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	16.43	14.60	11.87	8.99	6.72	5.67	6.13	7.97	10.69	13.58	15.84	16.89	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	180.27	182.14	177.43	167.39	154.72	142.82	134.86	132.99	137.71	147.74	160.41	172.32	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	33.32	33.32	33.32	33.32	33.32	33.32	33.32	33.32	33.32	33.32	33.32	33.32	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-82.53	-82.53	-82.53	-82.53	-82.53	-82.53	-82.53	-82.53	-82.53	-82.53	-82.53	-82.53	(71)
Water heating gains (Table 5)	91.20	89.27	85.28	79.86	76.33	71.37	67.16	72.56	74.48	80.09	86.44	89.28	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	341.85	339.96	328.53	310.18	291.72	273.81	262.10	267.47	276.83	295.36	316.64	332.44	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
East	0.54	x	12.19	x	19.64	x 0.9 x	0.50	x	0.80	=	46.54	(76)

Solar gains in watts ∑(74)m...(82)m

46.54	91.05	149.94	218.68	268.00	274.35	261.19	224.36	174.39	108.03	58.03	38.27	(83)

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

388.39	431.01	478.47	528.86	559.72	548.16	523.29	491.82	451.21	403.39	374.67	370.71	(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	0.99	0.96	0.88	0.71	0.54	0.59	0.84	0.98	1.00	1.00	(86)

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

19.94	20.06	20.29	20.58	20.83	20.96	20.99	20.99	20.90	20.57	20.19	19.90	(87)

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

20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	20.06	(88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.98	0.94	0.83	0.62	0.43	0.48	0.77	0.96	0.99	1.00	(89)

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

18.64	18.82	19.15	19.56	19.89	20.03	20.06	20.05	19.98	19.56	19.01	18.59	(90)

Living area fraction — Living area ÷ (4) = 0.50 (91)

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

19.29	19.44	19.71	20.07	20.36	20.49	20.52	20.52	20.43	20.06	19.60	19.24	(92)

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

19.29	19.44	19.71	20.07	20.36	20.49	20.52	20.52	20.43	20.06	19.60	19.24	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	1.00	0.99	0.98	0.94	0.85	0.66	0.48	0.53	0.80	0.96	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	386.87	427.81	469.65	499.64	474.08	364.36	251.67	262.58	362.50	388.60	371.74	369.58	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	971.30	942.20	856.37	723.62	560.97	381.95	254.17	266.90	410.50	613.20	810.16	974.87	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	434.81	345.67	287.72	161.27	64.65	0.00	0.00	0.00	0.00	167.10	315.66	450.34	

∑(98)1...5, 10...12 = 2227.22 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) = 35.39 (99)

9b. Energy requirements - community heating scheme

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

Space heating

Annual space heating requirement	2227.22		(98)
Space heat from boilers	(98) x (304a) x (305) x (306) =	2338.58	(307a)

Water heating

Annual water heating requirement	1643.47		(64)
Water heat from boilers	(64) x (303a) x (305a) x (306) =	1725.65	(310a)
Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	40.64	(313)

Electricity for pumps, fans and electric keep-hot (Table 4f)

mechanical ventilation fans - balanced, extract or positive input from outside			57.49			(330a)
Total electricity for the above, kWh/year					57.49	(331)
Electricity for lighting (Appendix L)					290.22	(332)
Total delivered energy for all uses		(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =			4411.93	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from boilers	2338.58	x	4.24	x 0.01 =	99.16	(340a)
Water heating from boilers	1725.65	x	4.24	x 0.01 =	73.17	(342a)
Pumps and fans	57.49	x	13.19	x 0.01 =	7.58	(349)
Electricity for lighting	290.22	x	13.19	x 0.01 =	38.28	(350)
Additional standing charges					120.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354) =		338.19	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.32	(357)
SAP value	81.64	
SAP rating (section 13)	82	(358)
SAP band	B	

12b. CO_2 emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of boilers	95.00					(367a)
CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) =	4278.13	x	0.216	=	924.08	(367)
Electrical energy for community heat distribution	40.64	x	0.519	=	21.09	(372)
Total CO2 associated with community systems					945.17	(373)
Total CO2 associated with space and water heating					945.17	(376)
Pumps and fans	57.49	x	0.519	=	29.84	(378)
Electricity for lighting	290.22	x	0.519	=	150.63	(379)
Total CO_2, kg/year				(376)..(382) =	1125.63	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	17.89	(384)
EI value					86.02	
EI rating (section 14)					86	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary energy from other sources (space heating)						
Efficiency of boilers	95.00					(367a)
Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) =	4278.13	x	1.22	=	5219.32	(367)
Electrical energy for community heat distribution	40.64	x	3.07	=	124.77	(372)
Total primary energy associated with community systems					5344.09	(373)
Total primary energy associated with space and water heating					5344.09	(376)
Pumps and fans	57.49	x	3.07	=	176.49	(378)
Electricity for lighting	290.22	x	3.07	=	890.99	(379)

Primary energy kWh/year	6411.57	(383)
Dwelling primary energy rate kWh/m2/year	101.88	(384)

DER Worksheet
Design - 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 Simon Gowing	Assessor number	9641
Client		Last modified	11/07/2017
Address	E002 Udney Park Road, Teddington, TW11		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		79.40	(1a) x	2.40	(2a) =	190.56	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	79.40	(4)				
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =	190.56	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.25	(18)
Number of sides on which the dwelling is sheltered	3	(19)
Shelter factor	1 - [0.075 x (19)] = 0.78	(20)
Infiltration rate incorporating shelter factor	(18) x (20) = 0.19	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.25	0.24	0.24	0.21	0.21	0.18	0.18	0.18	0.19	0.21	0.22	0.23	(22b)

Calculate effective air change rate for the applicable case:

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

c) whole house extract ventilation or positive input ventilation from outside

	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			21.57	x	1.33	=	28.60			(27)
Exposed floor			79.40	x	0.15	=	11.91			(28b
External wall			31.25	x	0.16	=	5.00			(29a)
Party wall			32.89	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			132.22							(31)

Fabric heat loss, W/K = ∑(A x U)	(26)...(30) + (32) = 45.51	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) = N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K	12.61	(36)
Total fabric heat loss	(33) + (36) = 58.12	(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)	31.44	31.44	31.44	31.44	31.44	31.44	31.44	31.44	31.44	31.44	31.44	31.44	(38)
Heat transfer coefficient, W/K (37)m + (38)m	89.56	89.56	89.56	89.56	89.56	89.56	89.56	89.56	89.56	89.56	89.56	89.56	

Average = ∑(39)1...12/12 = 89.56 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	

Average = ∑(40)1...12/12 = 1.13 (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	2.45	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	92.42	(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)	101.66	97.97	94.27	90.57	86.88	83.18	83.18	86.88	90.57	94.27	97.97	101.66	

∑(44)1...12 = 1109.04 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	150.76	131.86	136.07	118.62	113.82	98.22	91.02	104.44	105.69	123.17	134.45	146.01	

∑(45)1...12 = 1454.13 (45)

Distribution loss 0.15 x (45)m	22.61	19.78	20.41	17.79	17.07	14.73	13.65	15.67	15.85	18.48	20.17	21.90	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	2.00	(47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
Volume factor from Table 2a	3.91	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	0.17	(54)
Enter (50) or (54) in (55)	0.17	(55)

Water storage loss calculated for each month (55) x (41)m	5.14	4.64	5.14	4.97	5.14	4.97	5.14	5.14	4.97	5.14	4.97	5.14	(56)

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

5.14	4.64	5.14	4.97	5.14	4.97	5.14	5.14	4.97	5.14	4.97	5.14	(57)

Primary circuit loss for each month from Table 3

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

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

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

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

179.16	157.51	164.47	146.11	142.23	125.71	119.42	132.84	133.18	151.57	161.94	174.41	(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

179.16	157.51	164.47	146.11	142.23	125.71	119.42	132.84	133.18	151.57	161.94	174.41	

∑(64)1...12 = 1788.55 (64)

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

72.85	64.37	67.96	61.43	60.57	54.65	52.98	57.45	57.13	63.68	66.69	71.27	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	122.57	122.57	122.57	122.57	122.57	122.57	122.57	122.57	122.57	122.57	122.57	122.57	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	19.45	17.28	14.05	10.64	7.95	6.71	7.25	9.43	12.65	16.07	18.75	19.99	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	218.18	220.45	214.74	202.59	187.26	172.85	163.23	160.96	166.67	178.81	194.15	208.56	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	35.26	35.26	35.26	35.26	35.26	35.26	35.26	35.26	35.26	35.26	35.26	35.26	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	(71)
Water heating gains (Table 5)	97.92	95.78	91.35	85.32	81.41	75.90	71.22	77.22	79.35	85.59	92.63	95.79	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	395.32	393.28	379.91	358.32	336.39	315.24	301.47	307.38	318.44	340.24	365.30	384.11	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
North	0.77	x	12.64	x	10.63	x 0.9 x	0.50	x	0.80	=	37.26	(74)
East	0.77	x	8.93	x	19.64	x 0.9 x	0.50	x	0.80	=	48.62	(76)

Solar gains in watts ∑(74)m...(82)m

85.87	166.31	277.61	422.77	541.74	566.83	534.49	441.95	327.63	197.61	106.58	71.04	(83)

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

481.20	559.58	657.52	781.09	878.13	882.07	835.95	749.33	646.07	537.84	471.88	455.15	(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	0.98	0.94	0.81	0.62	0.47	0.54	0.82	0.97	1.00	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	19.79	19.95	20.23	20.58	20.86	20.97	20.99	20.99	20.89	20.52	20.08	19.75	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	(88)
Utilisation factor for gains for rest of dwelling n2,m	1.00	0.99	0.98	0.92	0.76	0.53	0.36	0.42	0.74	0.96	0.99	1.00	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	18.37	18.60	19.00	19.50	19.85	19.96	19.98	19.97	19.89	19.42	18.79	18.31	(90)

Living area fraction — Living area ÷ (4) = 0.36 (91)

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

18.89	19.09	19.44	19.89	20.21	20.33	20.35	20.34	20.26	19.82	19.26	18.83	(92)

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

18.89	19.09	19.44	19.89	20.21	20.33	20.35	20.34	20.26	19.82	19.26	18.83	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	1.00	0.99	0.98	0.92	0.77	0.57	0.40	0.47	0.76	0.96	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	479.34	554.79	641.27	715.67	678.01	499.00	333.64	349.10	493.39	515.13	468.11	453.80	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	1306.53	1270.70	1159.36	984.66	762.60	513.01	335.55	353.16	551.49	825.37	1088.84	1310.71	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	615.43	481.09	385.45	193.67	62.94	0.00	0.00	0.00	0.00	230.82	446.92	637.54	

∑(98)1...5, 10...12 = 3053.87 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) = 38.46 (99)

9b. Energy requirements - community heating scheme

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

Space heating

Annual space heating requirement	3053.87		(98)
Space heat from boilers	(98) x (304a) x (305) x (306) =	3206.56	(307a)

Water heating

Annual water heating requirement	1788.55		(64)
Water heat from boilers	(64) x (303a) x (305a) x (306) =	1877.97	(310a)
Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	50.85	(313)

Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside	72.53			(330a)
Total electricity for the above, kWh/year			72.53	(331)
Electricity for lighting (Appendix L)			343.51	(332)
Total delivered energy for all uses	(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =		5500.58	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from boilers	3206.56	x	4.24	x 0.01 =	135.96	(340a)
Water heating from boilers	1877.97	x	4.24	x 0.01 =	79.63	(342a)
Pumps and fans	72.53	x	13.19	x 0.01 =	9.57	(349)
Electricity for lighting	343.51	x	13.19	x 0.01 =	45.31	(350)
Additional standing charges					120.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354) =		390.46	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.32	(357)
SAP value	81.61	
SAP rating (section 13)	82	(358)
SAP band	B	

12b. CO_2 emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of boilers	95.00					(367a)
CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) =	5352.14	x	0.216	=	1156.06	(367)
Electrical energy for community heat distribution	50.85	x	0.519	=	26.39	(372)
Total CO2 associated with community systems					1182.45	(373)
Total CO2 associated with space and water heating					1182.45	(376)
Pumps and fans	72.53	x	0.519	=	37.65	(378)
Electricity for lighting	343.51	x	0.519	=	178.28	(379)
Total CO_2, kg/year				(376)..(382) =	1398.38	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	17.61	(384)
EI value					84.94	
EI rating (section 14)					85	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary energy from other sources (space heating)						
Efficiency of boilers	95.00					(367a)
Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) =	5352.14	x	1.22	=	6529.61	(367)
Electrical energy for community heat distribution	50.85	x	3.07	=	156.10	(372)
Total primary energy associated with community systems					6685.71	(373)
Total primary energy associated with space and water heating					6685.71	(376)
Pumps and fans	72.53	x	3.07	=	222.68	(378)

Electricity for lighting	343.51	x	3.07	=	1054.58	(379)
Primary energy kWh/year					7962.97	(383)
Dwelling primary energy rate kWh/m2/year					100.29	(384)

DER Worksheet
Design - 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 Simon Gowing	Assessor number	9641
Client		Last modified	11/07/2017
Address	E102 Udney Park Road, Teddington, TW11		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		79.40	(1a) x	2.40	(2a) =	190.56	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	79.40	(4)				
Dwelling volume				(3a) + (3b) + (3c) + (3d)...(3n) =		190.56	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.00 (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.25 (18)
Number of sides on which the dwelling is sheltered		3 (19)
Shelter factor	1 - [0.075 x (19)] =	0.78 (20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.19 (21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.25	0.24	0.24	0.21	0.21	0.18	0.18	0.18	0.19	0.21	0.22	0.23	(22b)

Calculate effective air change rate for the applicable case:

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

c) whole house extract ventilation or positive input ventilation from outside

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			21.57	x	1.33	=	28.60			(27)
External wall			31.25	x	0.16	=	5.00			(29a)
Party wall			32.89	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			52.82							(31)

Fabric heat loss, W/K = ∑(A x U)	(26)...(30) + (32) =	33.60 (33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m²K		250.00 (35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		7.02 (36)
Total fabric heat loss	(33) + (36) =	40.61 (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)	31.44	31.44	31.44	31.44	31.44	31.44	31.44	31.44	31.44	31.44	31.44	31.44	(38)
Heat transfer coefficient, W/K (37)m + (38)m	72.05	72.05	72.05	72.05	72.05	72.05	72.05	72.05	72.05	72.05	72.05	72.05	

Average = ∑(39)1...12/12 = 72.05 (39)

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

Average = ∑(40)1...12/12 = 0.91 (40)

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

4. Water heating energy requirement

Assumed occupancy, N	2.45 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	92.42 (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)	101.66	97.97	94.27	90.57	86.88	83.18	83.18	86.88	90.57	94.27	97.97	101.66	

∑(44)1...12 = 1109.04 (44)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	150.76	131.86	136.07	118.62	113.82	98.22	91.02	104.44	105.69	123.17	134.45	146.01	

∑(45)1...12 = 1454.13 (45)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Distribution loss 0.15 x (45)m	22.61	19.78	20.41	17.79	17.07	14.73	13.65	15.67	15.85	18.48	20.17	21.90	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	2.00 (47)
Water storage loss:	
b) Manufacturer's declared loss factor is not known	
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02 (51)
Volume factor from Table 2a	3.91 (52)
Temperature factor from Table 2b	1.00 (53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	0.17 (54)
Enter (50) or (54) in (55)	0.17 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	5.14	4.64	5.14	4.97	5.14	4.97	5.14	5.14	4.97	5.14	4.97	5.14	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	5.14	4.64	5.14	4.97	5.14	4.97	5.14	5.14	4.97	5.14	4.97	5.14	(57)

Primary circuit loss for each month from Table 3

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

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

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

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

179.16	157.51	164.47	146.11	142.23	125.71	119.42	132.84	133.18	151.57	161.94	174.41	(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

179.16	157.51	164.47	146.11	142.23	125.71	119.42	132.84	133.18	151.57	161.94	174.41	

∑(64)1...12 = 1788.55 (64)

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

72.85	64.37	67.96	61.43	60.57	54.65	52.98	57.45	57.13	63.68	66.69	71.27	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	122.57	122.57	122.57	122.57	122.57	122.57	122.57	122.57	122.57	122.57	122.57	122.57	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	19.45	17.28	14.05	10.64	7.95	6.71	7.25	9.43	12.65	16.07	18.75	19.99	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	218.18	220.45	214.74	202.59	187.26	172.85	163.23	160.96	166.67	178.81	194.15	208.56	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	35.26	35.26	35.26	35.26	35.26	35.26	35.26	35.26	35.26	35.26	35.26	35.26	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	-98.06	(71)
Water heating gains (Table 5)	97.92	95.78	91.35	85.32	81.41	75.90	71.22	77.22	79.35	85.59	92.63	95.79	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	395.32	393.28	379.91	358.32	336.39	315.24	301.47	307.38	318.44	340.24	365.30	384.11	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
North	0.77	x	12.64	x	10.63	x 0.9 x	0.50	x	0.80	=	37.26	(74)
East	0.77	x	8.93	x	19.64	x 0.9 x	0.50	x	0.80	=	48.62	(76)

Solar gains in watts ∑(74)m...(82)m

85.87	166.31	277.61	422.77	541.74	566.83	534.49	441.95	327.63	197.61	106.58	71.04	(83)

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

481.20	559.58	657.52	781.09	878.13	882.07	835.95	749.33	646.07	537.84	471.88	455.15	(84)

7. Mean internal temperature (heating season)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	1.00	0.99	0.98	0.90	0.72	0.52	0.38	0.44	0.73	0.96	0.99	1.00	(86)

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

20.11	20.25	20.50	20.79	20.96	20.99	21.00	21.00	20.97	20.71	20.34	20.06	(87)

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

20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	(88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.97	0.88	0.67	0.45	0.31	0.36	0.65	0.94	0.99	1.00	(89)

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

18.96	19.17	19.53	19.93	20.12	20.16	20.16	20.16	20.14	19.83	19.30	18.90	(90)

Living area fraction — Living area ÷ (4) = 0.36 (91)

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

19.38	19.57	19.89	20.24	20.43	20.46	20.47	20.47	20.44	20.15	19.68	19.32	(92)

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

19.38	19.57	19.89	20.24	20.43	20.46	20.47	20.47	20.44	20.15	19.68	19.32	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	1.00	0.99	0.97	0.88	0.69	0.48	0.33	0.39	0.68	0.94	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	479.33	554.08	635.89	685.72	603.05	419.93	278.33	292.34	439.06	506.24	467.63	453.86	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	1086.30	1056.79	964.49	817.34	628.68	422.40	278.55	292.92	456.68	688.16	906.56	1089.71	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	451.59	337.82	244.47	94.76	19.07	0.00	0.00	0.00	0.00	135.35	316.03	473.07	

∑(98)1...5, 10...12 = 2072.17 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 26.10 (99)

9b. Energy requirements - community heating scheme

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

Space heating

Annual space heating requirement	2072.17		(98)
Space heat from boilers	(98) x (304a) x (305) x (306) =	2175.78	(307a)

Water heating

Annual water heating requirement	1788.55		(64)
Water heat from boilers	(64) x (303a) x (305a) x (306) =	1877.97	(310a)
Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	40.54	(313)

Electricity for pumps, fans and electric keep-hot (Table 4f)

mechanical ventilation fans - balanced, extract or positive input from outside			72.53		(330a)
Total electricity for the above, kWh/year				72.53	(331)
Electricity for lighting (Appendix L)				343.51	(332)
Total delivered energy for all uses	(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =			4469.80	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from boilers	2175.78	x	4.24	x 0.01 =	92.25	(340a)
Water heating from boilers	1877.97	x	4.24	x 0.01 =	79.63	(342a)
Pumps and fans	72.53	x	13.19	x 0.01 =	9.57	(349)
Electricity for lighting	343.51	x	13.19	x 0.01 =	45.31	(350)
Additional standing charges					120.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354) =		346.76	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.17	(357)
SAP value	83.67	
SAP rating (section 13)	84	(358)
SAP band	B	

12b. CO_2 emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of boilers	95.00					(367a)
CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) =	4267.10	x	0.216	=	921.69	(367)
Electrical energy for community heat distribution	40.54	x	0.519	=	21.04	(372)
Total CO2 associated with community systems					942.73	(373)
Total CO2 associated with space and water heating					942.73	(376)
Pumps and fans	72.53	x	0.519	=	37.65	(378)
Electricity for lighting	343.51	x	0.519	=	178.28	(379)
Total CO_2, kg/year				(376)..(382) =	1158.66	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	14.59	(384)
EI value					87.52	
EI rating (section 14)					88	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary energy from other sources (space heating)						
Efficiency of boilers	95.00					(367a)
Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) =	4267.10	x	1.22	=	5205.87	(367)
Electrical energy for community heat distribution	40.54	x	3.07	=	124.45	(372)
Total primary energy associated with community systems					5330.32	(373)
Total primary energy associated with space and water heating					5330.32	(376)
Pumps and fans	72.53	x	3.07	=	222.68	(378)
Electricity for lighting	343.51	x	3.07	=	1054.58	(379)

Primary energy kWh/year	6607.58	(383)
Dwelling primary energy rate kWh/m2/year	83.22	(384)

DER Worksheet
Design - 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 Simon Gowing	Assessor number	9641
Client		Last modified	11/07/2017
Address	E301 Udney Park Road, Teddington, TW11		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		96.47	(1a) x	2.40	(2a) =	231.53	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	96.47	(4)				
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =	231.53	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.25	(18)
Number of sides on which the dwelling is sheltered	3	(19)
Shelter factor	1 - [0.075 x (19)] = 0.78	(20)
Infiltration rate incorporating shelter factor	(18) x (20) = 0.19	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.25	0.24	0.24	0.21	0.21	0.18	0.18	0.18	0.19	0.21	0.22	0.23	(22b)

Calculate effective air change rate for the applicable case:

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

c) whole house extract ventilation or positive input ventilation from outside

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			23.93	x	1.33	=	31.73			(27)
External wall			56.09	x	0.18	=	10.10			(29a)
Party wall			45.24	x	0.00	=	0.00			(32)
Roof			96.47	x	0.15	=	14.47			(30)
Total area of external elements ∑A, m²			176.49							(31)

Fabric heat loss, W/K = ∑(A x U)	(26)...(30) + (32) = 56.29	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) = N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K	23.86	(36)
Total fabric heat loss	(33) + (36) = 80.16	(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)	38.20	38.20	38.20	38.20	38.20	38.20	38.20	38.20	38.20	38.20	38.20	38.20	(38)
Heat transfer coefficient, W/K (37)m + (38)m	118.36	118.36	118.36	118.36	118.36	118.36	118.36	118.36	118.36	118.36	118.36	118.36	

Average = ∑(39)1...12/12 = 118.36 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	

Average = ∑(40)1...12/12 = 1.23 (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	2.70	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	98.43	(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)	108.27	104.33	100.40	96.46	92.52	88.59	88.59	92.52	96.46	100.40	104.33	108.27	

∑(44)1...12 = 1181.14 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	160.56	140.43	144.91	126.34	121.22	104.61	96.93	111.23	112.56	131.18	143.19	155.50	

∑(45)1...12 = 1548.66 (45)

Distribution loss 0.15 x (45)m	24.08	21.06	21.74	18.95	18.18	15.69	14.54	16.68	16.88	19.68	21.48	23.32	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	2.00	(47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
Volume factor from Table 2a	3.91	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	0.17	(54)
Enter (50) or (54) in (55)	0.17	(55)

Water storage loss calculated for each month (55) x (41)m	5.14	4.64	5.14	4.97	5.14	4.97	5.14	5.14	4.97	5.14	4.97	5.14	(56)

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

	5.14	4.64	5.14	4.97	5.14	4.97	5.14	5.14	4.97	5.14	4.97	5.14 (57)

Primary circuit loss for each month from Table 3

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

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

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

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

	188.97	166.08	173.31	153.82	149.63	132.09	125.34	139.63	140.05	159.58	170.68	183.90 (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

	188.97	166.08	173.31	153.82	149.63	132.09	125.34	139.63	140.05	159.58	170.68	183.90

∑(64)1...12 = 1883.08 (64)

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

	76.11	67.22	70.90	64.00	63.03	56.77	54.95	59.71	59.42	66.34	69.60	74.42 (65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	135.22	135.22	135.22	135.22	135.22	135.22	135.22	135.22	135.22	135.22	135.22	135.22	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	22.33	19.83	16.13	12.21	9.13	7.71	8.33	10.82	14.53	18.45	21.53	22.95	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	250.49	253.09	246.54	232.60	214.99	198.45	187.40	184.80	191.35	205.29	222.90	239.44	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.52	36.52	36.52	36.52	36.52	36.52	36.52	36.52	36.52	36.52	36.52	36.52	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-108.17	-108.17	-108.17	-108.17	-108.17	-108.17	-108.17	-108.17	-108.17	-108.17	-108.17	-108.17	(71)
Water heating gains (Table 5)	102.30	100.02	95.30	88.88	84.72	78.85	73.86	80.25	82.52	89.17	96.67	100.03	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	438.69	436.51	421.54	397.26	372.40	348.57	333.15	339.44	351.96	376.47	404.66	425.99	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
North	0.77	x	4.97	x	10.63	x 0.9 x	0.50	x	0.80	=	14.65	(74)
East	0.77	x	13.99	x	19.64	x 0.9 x	0.50	x	0.80	=	76.17	(76)
West	0.77	x	4.97	x	19.64	x 0.9 x	0.50	x	0.80	=	27.06	(80)

Solar gains in watts ∑(74)m...(82)m

	117.87	229.92	380.12	561.41	697.32	718.65	682.16	579.21	443.96	272.93	146.78	97.10 (83)

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

	556.56	666.44	801.66	958.67	1069.72	1067.22	1015.31	918.65	795.92	649.40	551.44	523.09 (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	0.99	0.95	0.84	0.66	0.50	0.57	0.84	0.98	1.00	1.00 (86)

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

	19.64	19.81	20.11	20.50	20.80	20.95	20.99	20.98	20.86	20.43	19.95	19.59 (87)

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

	19.90	19.90	19.90	19.90	19.90	19.90	19.90	19.90	19.90	19.90	19.90	19.90 (88)

Utilisation factor for gains for rest of dwelling n2,m

	1.00	0.99	0.98	0.93	0.78	0.57	0.38	0.45	0.76	0.97	0.99	1.00 (89)

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

	18.08	18.33	18.77	19.32	19.71	19.87	19.90	19.89	19.78	19.23	18.54	18.02 (90)

Living area fraction — Living area ÷ (4) = 0.31 (91)

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

	18.57	18.79	19.19	19.68	20.05	20.21	20.24	20.23	20.12	19.61	18.98	18.51 (92)

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

	18.57	18.79	19.19	19.68	20.05	20.21	20.24	20.23	20.12	19.61	18.98	18.51 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	1.00	0.99	0.98	0.92	0.79	0.60	0.42	0.48	0.78	0.96	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	554.69	661.09	782.48	883.39	847.99	635.80	426.24	445.43	619.22	624.12	547.57	521.76	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	1688.66	1644.41	1502.07	1276.41	988.73	663.56	430.39	453.47	712.35	1065.82	1405.98	1693.76	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	843.68	660.79	535.37	282.97	104.71	0.00	0.00	0.00	0.00	328.63	618.05	871.97	

∑(98)1...5, 10...12 = 4246.16 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) = 44.02 (99)

9b. Energy requirements - community heating scheme

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

Space heating

Annual space heating requirement	4246.16	(98)
Space heat from boilers	(98) x (304a) x (305) x (306) =	4458.47 (307a)

Water heating

Annual water heating requirement	1883.08	(64)
Water heat from boilers	(64) x (303a) x (305a) x (306) =	1977.23 (310a)
Electricity used for heat distribution	0.01 × [(307a)...(307e) + (310a)...(310e)] =	64.36 (313)

Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	66.10		(330a)
Total electricity for the above, kWh/year		66.10	(331)
Electricity for lighting (Appendix L)		394.38	(332)
Total delivered energy for all uses	(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	6896.18	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from boilers	4458.47	x	4.24	x 0.01 =	189.04	(340a)
Water heating from boilers	1977.23	x	4.24	x 0.01 =	83.83	(342a)
Pumps and fans	66.10	x	13.19	x 0.01 =	8.72	(349)
Electricity for lighting	394.38	x	13.19	x 0.01 =	52.02	(350)
Additional standing charges					120.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354) =		453.61	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.35	(357)
SAP value	81.21	
SAP rating (section 13)	81	(358)
SAP band	B	

12b. CO_2 emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of boilers	95.00					(367a)
CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) =	6774.43	x	0.216	=	1463.28	(367)
Electrical energy for community heat distribution	64.36	x	0.519	=	33.40	(372)
Total CO2 associated with community systems					1496.68	(373)
Total CO2 associated with space and water heating					1496.68	(376)
Pumps and fans	66.10	x	0.519	=	34.30	(378)
Electricity for lighting	394.38	x	0.519	=	204.68	(379)
Total CO_2, kg/year				(376)..(382) =	1735.67	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	17.99	(384)
EI value					83.56	
EI rating (section 14)					84	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary energy from other sources (space heating)						
Efficiency of boilers	95.00					(367a)
Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) =	6774.43	x	1.22	=	8264.80	(367)
Electrical energy for community heat distribution	64.36	x	3.07	=	197.58	(372)
Total primary energy associated with community systems					8462.38	(373)
Total primary energy associated with space and water heating					8462.38	(376)

Pumps and fans	66.10	x	3.07	=	202.92	(378)
Electricity for lighting	394.38	x	3.07	=	1210.75	(379)
Primary energy kWh/year					9876.04	(383)
Dwelling primary energy rate kWh/m2/year					102.37	(384)

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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	13/06/2017
Address	B Udney Park Road, Teddington, TW11		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		44.19	(1a) x	3.32	(2a) =	146.71	(3a)
+1		76.24	(1b) x	2.04	(2b) =	155.53	(3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	120.43	(4)				
Dwelling volume				(3a) + (3b) + (3c) + (3d)...(3n) =		302.24	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	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) =	0.10	(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		10.00 (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.60 (18)
Number of sides on which the dwelling is sheltered		3 (19)
Shelter factor	1 - [0.075 x (19)] =	0.78 (20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.46 (21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.59	0.58	0.57	0.51	0.50	0.44	0.44	0.43	0.46	0.50	0.52	0.55	(22b)

Calculate effective air change rate for the applicable case:

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

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

	0.68	0.67	0.66	0.63	0.62	0.60	0.60	0.59	0.61	0.62	0.64	0.65	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

	0.68	0.67	0.66	0.63	0.62	0.60	0.60	0.59	0.61	0.62	0.64	0.65	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²	U-value W/m²K	A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			2.52 x	1.40 =	3.53			(26)
Window			15.50 x	4.03 =	62.42			(27)
Door			2.00 x	3.00 =	6.00			(26)
Ground floor			44.19 x	1.20 =	53.03			(28a)
External wall			67.35 x	2.10 =	141.44			(29a)
External wall			0.47 x	1.17 =	0.55			(29a)
External wall			6.85 x	1.00 =	6.85			(29a)
Roof			130.73 x	2.30 =	300.68			(30)
Total area of external elements ∑A, m²			269.61					(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	574.49 (33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m²K		250.00 (35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		40.44 (36)
Total fabric heat loss	(33) + (36) =	614.93 (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)	67.36	66.68	66.01	62.88	62.30	59.58	59.58	59.07	60.63	62.30	63.48	64.72	(38)
Heat transfer coefficient, W/K (37)m + (38)m	682.28	681.60	680.94	677.81	677.23	674.50	674.50	674.00	675.55	677.23	678.41	679.65	

Average = ∑(39)1...12/12 = 677.81 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	5.67	5.66	5.65	5.63	5.62	5.60	5.60	5.60	5.61	5.62	5.63	5.64	

Average = ∑(40)1...12/12 = 5.63 (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	2.86 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	102.24 (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)	112.47	108.38	104.29	100.20	96.11	92.02	92.02	96.11	100.20	104.29	108.38	112.47	

∑(44)1...12 = 1226.91 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	166.79	145.87	150.53	131.23	125.92	108.66	100.69	115.54	116.92	136.26	148.74	161.52	

∑(45)1...12 = 1608.68 (45)

Distribution loss 0.15 x (45)m	25.02	21.88	22.58	19.68	18.89	16.30	15.10	17.33	17.54	20.44	22.31	24.23	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	117.00 (47)
Water storage loss:	
b) Manufacturer's declared loss factor is not known	
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02 (51)
Volume factor from Table 2a	1.01 (52)
Temperature factor from Table 2b	0.87 (53)

Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 2.19 | (54)

Enter (50) or (54) in (55) | 2.19 | (55)

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

67.76	61.20	67.76	65.57	67.76	65.57	67.76	67.76	65.57	67.76	65.57	67.76

(56)

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

67.76	61.20	67.76	65.57	67.76	65.57	67.76	67.76	65.57	67.76	65.57	67.76

(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

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(61)

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

234.55	207.07	218.29	196.81	193.68	174.23	168.45	183.30	182.50	204.02	214.32	229.28

(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

234.55	207.07	218.29	196.81	193.68	174.23	168.45	183.30	182.50	204.02	214.32	229.28

∑(64)1...12 = 2406.50 (64)

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

109.66	97.46	104.26	96.09	96.08	88.59	87.69	92.63	91.34	99.52	101.92	107.91

(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	143.25	143.25	143.25	143.25	143.25	143.25	143.25	143.25	143.25	143.25	143.25	143.25	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	26.41	23.45	19.07	14.44	10.79	9.11	9.85	12.80	17.18	21.81	25.46	27.14	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	285.77	288.74	281.26	265.36	245.27	226.40	213.79	210.83	218.30	234.21	254.29	273.16	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	37.32	(69)
Pump and fan gains (Table 5a)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	(70)
Losses e.g. evaporation (Table 5)	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	-114.60	(71)
Water heating gains (Table 5)	147.40	145.04	140.13	133.46	129.14	123.04	117.86	124.50	126.86	133.76	141.55	145.05	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	535.55	533.20	516.45	489.24	461.18	434.53	417.47	424.10	438.31	465.75	497.27	521.32	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
East	0.77	x	7.49	x	19.64	x 0.9 x	0.85	x	0.80	=	69.32	(76)
South	0.77	x	2.41	x	46.75	x 0.9 x	0.85	x	0.80	=	53.10	(78)
North	0.77	x	2.08	x	10.63	x 0.9 x	0.85	x	0.80	=	10.42	(74)
West	0.77	x	3.52	x	19.64	x 0.9 x	0.85	x	0.80	=	32.58	(80)

Solar gains in watts ∑(74)m...(82)m

165.42	306.21	472.90	658.34	790.46	804.61	767.72	668.41	538.21	354.03	202.85	138.37

(83)

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

700.97	839.42	989.34	1147.57	1251.64	1239.13	1185.19	1092.51	976.52	819.79	700.13	659.69

(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)	0.99	0.99	0.99	0.98	0.96	0.92	0.88	0.90	0.95	0.98	0.99	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	17.45	17.63	18.02	18.59	19.23	19.84	20.24	20.18	19.66	18.86	18.07	17.42	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.99	0.99	0.98	0.96	0.92	0.82	0.57	0.64	0.89	0.97	0.99	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	15.11	15.28	15.68	16.25	16.87	17.46	17.78	17.75	17.30	16.52	15.72	15.08	(90)

Living area fraction | Living area ÷ (4) = 0.37 | (91)

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

15.97	16.14	16.54	17.11	17.73	18.33	18.68	18.64	18.17	17.38	16.58	15.94

(92)

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

15.97	16.14	16.54	17.11	17.73	18.33	18.68	18.64	18.17	17.38	16.58	15.94

(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.98	0.97	0.95	0.92	0.84	0.70	0.74	0.90	0.96	0.98	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	693.24	825.98	964.07	1095.69	1147.57	1039.83	829.30	813.31	875.85	790.44	689.14	653.21	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	7962.12	7664.19	6835.18	5563.63	4086.89	2516.90	1405.25	1508.70	2747.74	4590.10	6434.12	7979.95	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	5408.05	4595.28	4368.10	3216.92	2186.85	0.00	0.00	0.00	0.00	2826.95	4136.39	5451.09	

∑(98)1...5, 10...12 = 32189.62 (98)

Space heating requirement kWh/m²/year | (98) ÷ (4) = 267.29 | (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 (%) | 100.00 | (206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	5408.05	4595.28	4368.10	3216.92	2186.85	0.00	0.00	0.00	0.00	2826.95	4136.39	5451.09	

∑(211)1...5, 10...12 = 32189.62 (211)

Water heating

Efficiency of water heater

100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	(217)

Water heating fuel, kWh/month

234.55	207.07	218.29	196.81	193.68	174.23	168.45	183.30	182.50	204.02	214.32	229.28

∑(219a)1...12 = 2406.50 (219)

Annual totals

Space heating fuel - main system 1	32189.62	
Water heating fuel	2406.50	
Electricity for pumps, fans and electric keep-hot (Table 4f)		
central heating pump or water pump within warm air heating unit	156.00	(230c)
Total electricity for the above, kWh/year	156.00	(231)
Electricity for lighting (Appendix L)	466.36	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =	35218.48	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1						
high-rate cost	0.00	x	15.29	x 0.01 =	0.00	(240)
low-rate cost	32189.62	x	5.50	x 0.01 =	1770.43	(240)
Water heating						
high-rate fraction			0.00			(243)
low-rate fraction			1.00			(244)
high-rate cost	0.00	x	15.29	x 0.01 =	0.00	(245)
low-rate cost	2406.50	x	5.50	x 0.01 =	132.36	(246)
Central heating pump						
high-rate cost	140.40	x	15.29	x 0.01 =	21.47	(249)
low-rate cost	15.60	x	5.50	x 0.01 =	0.86	(249)
Electricity for lighting						
high-rate cost	419.72	x	15.29	x 0.01 =	64.18	(250)
low-rate cost	46.64	x	5.50	x 0.01 =	2.56	(250)
Additional standing charges					24.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		2015.85	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	5.12	(257)
SAP value	31.20	
SAP rating (section 13)	31	(258)
SAP band	F	

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

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	32189.62	x	0.519	=	16706.41	(261)
Water heating	2406.50	x	0.519	=	1248.97	(264)
Space and water heating			(261) + (262) + (263) + (264) =		17955.39	(265)
Pumps and fans	156.00	x	0.519	=	80.96	(267)

Electricity for lighting	466.36	x	0.519	=	242.04 (268)
Total CO_2, kg/year				(265)...(271) =	18278.39 (272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	151.78 (273)
EI value					5.88
EI rating (section 14)					6 (274)
EI band					G

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	32189.62	x	3.07	=	98822.14	(261)
Water heating	2406.50	x	3.07	=	7387.95	(264)
Space and water heating			(261) + (262) + (263) + (264) =		106210.09	(265)
Pumps and fans	156.00	x	3.07	=	478.92	(267)
Electricity for lighting	466.36	x	3.07	=	1431.72	(268)
Primary energy kWh/year					108120.73	(272)
Dwelling primary energy rate kWh/m2/year					897.79	(273)

DER Worksheet
Design - 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 Simon Gowing	Assessor number	9641
Client		Last modified	11/07/2017
Address	B 2 Udney Park Road, Teddington, TW11		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		65.47	(1a) x	3.32	(2a) =	217.36	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	65.47	(4)				
Dwelling volume				(3a) + (3b) + (3c) + (3d)...(3n) =		217.36	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 20	÷ (5) =	0.09	(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	10.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.59	(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) = 0.50	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.64	0.63	0.62	0.55	0.54	0.48	0.48	0.47	0.50	0.54	0.57	0.59	(22b)

Calculate effective air change rate for the applicable case:

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.71	0.70	0.69	0.65	0.65	0.61	0.61	0.61	0.63	0.65	0.66	0.67	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.71	0.70	0.69	0.65	0.65	0.61	0.61	0.61	0.63	0.65	0.66	0.67	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			2.52	x	1.40	=	3.53			(26)
Window			9.95	x	4.03	=	40.07			(27)
Ground floor			65.47	x	1.20	=	78.56			(28a)
External wall			74.48	x	2.10	=	156.41			(29a)
External wall			19.76	x	1.17	=	23.12			(29a)
Party wall			19.42	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			172.18							(31)

Fabric heat loss, W/K = ∑(A x U)	(26)...(30) + (32) = 301.69	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) = N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K	25.83	(36)
Total fabric heat loss	(33) + (36) = 327.51	(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)	50.63	50.05	49.49	46.85	46.36	44.06	44.06	43.63	44.95	46.36	47.36	48.40	(38)
Heat transfer coefficient, W/K (37)m + (38)m	378.14	377.57	377.01	374.37	373.87	371.57	371.57	371.15	372.46	373.87	374.87	375.92	

Average = ∑(39)1...12/12 = 374.36 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	5.78	5.77	5.76	5.72	5.71	5.68	5.68	5.67	5.69	5.71	5.73	5.74	

Average = ∑(40)1...12/12 = 5.72 (40)

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

4. Water heating energy requirement

Assumed occupancy, N	2.13	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	84.82	(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)	93.30	89.91	86.52	83.12	79.73	76.34	76.34	79.73	83.12	86.52	89.91	93.30	

∑(44)1...12 = 1017.83 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	138.36	121.01	124.87	108.87	104.46	90.14	83.53	95.85	97.00	113.04	123.39	134.00	

∑(45)1...12 = 1334.54 (45)

Distribution loss 0.15 x (45)m	20.75	18.15	18.73	16.33	15.67	13.52	12.53	14.38	14.55	16.96	18.51	20.10	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	117.00	(47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
Volume factor from Table 2a	1.01	(52)
Temperature factor from Table 2b	0.54	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	1.35	(54)
Enter (50) or (54) in (55)	1.35	(55)

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

41.83	37.78	41.83	40.48	41.83	40.48	41.83	41.83	40.48	41.83	40.48	41.83	(56)

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

41.83	37.78	41.83	40.48	41.83	40.48	41.83	41.83	40.48	41.83	40.48	41.83	(57)

Primary circuit loss for each month from Table 3

43.31	39.12	43.31	41.92	43.31	41.92	43.31	43.31	41.92	43.31	41.92	43.31	(59)

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

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

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

223.50	197.91	210.02	191.26	189.60	172.54	168.67	180.99	179.39	198.18	205.79	219.14	(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

223.50	197.91	210.02	191.26	189.60	172.54	168.67	180.99	179.39	198.18	205.79	219.14	

∑(64)1...12 = 2337.00 (64)

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

114.12	101.76	109.63	102.11	102.85	95.89	95.89	99.98	98.17	105.70	106.94	112.67	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	16.79	14.91	12.13	9.18	6.86	5.79	6.26	8.14	10.92	13.87	16.19	17.25	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	186.50	188.44	183.56	173.18	160.07	147.75	139.53	137.59	142.47	152.85	165.96	178.27	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	(69)
Pump and fan gains (Table 5a)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	(70)
Losses e.g. evaporation (Table 5)	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	(71)
Water heating gains (Table 5)	153.38	151.43	147.36	141.83	138.23	133.18	128.88	134.39	136.34	142.07	148.53	151.43	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	421.64	419.74	408.01	389.15	370.14	351.70	339.64	345.08	354.70	373.76	395.64	411.93	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
West	0.77	x	2.44	x	19.64	x 0.9 x	0.85	x	0.80	=	22.58	(80)
North	0.77	x	7.51	x	10.63	x 0.9 x	0.85	x	0.80	=	37.63	(74)

Solar gains in watts ∑(74)m...(82)m

60.21	116.09	194.96	302.40	394.46	416.19	391.01	318.53	231.54	138.03	74.58	49.94	(83)

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

481.86	535.84	602.97	691.55	764.60	767.88	730.65	663.62	586.24	511.78	470.23	461.87	(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)	0.99	0.99	0.98	0.97	0.95	0.91	0.86	0.88	0.95	0.98	0.99	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	17.48	17.64	18.03	18.61	19.25	19.87	20.27	20.20	19.68	18.88	18.10	17.46	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	18.00	18.00	18.00	18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.99	0.98	0.98	0.96	0.91	0.79	0.53	0.61	0.88	0.96	0.98	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	15.14	15.30	15.69	16.26	16.89	17.48	17.79	17.75	17.31	16.54	15.75	15.11	(90)

Living area fraction — Living area ÷ (4) = 0.45 (91)

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

16.19	16.36	16.74	17.32	17.96	18.56	18.90	18.85	18.38	17.59	16.81	16.17	(92)

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

16.19	16.36	16.74	17.32	17.96	18.56	18.90	18.85	18.38	17.59	16.81	16.17	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.98	0.97	0.95	0.91	0.82	0.69	0.74	0.89	0.96	0.98	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	474.15	524.93	585.02	656.37	693.55	633.48	507.35	491.84	521.96	490.08	460.08	455.07	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	4496.73	4325.04	3861.49	3151.79	2338.60	1469.95	855.33	910.48	1593.30	2614.05	3639.03	4498.87	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	2992.80	2553.68	2437.70	1796.70	1223.92	0.00	0.00	0.00	0.00	1580.24	2288.84	3008.58	

∑(98)1...5, 10...12 = 17882.46 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) = 273.14 (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 (%) 100.00 (206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	2992.80	2553.68	2437.70	1796.70	1223.92	0.00	0.00	0.00	0.00	1580.24	2288.84	3008.58	

∑(211)1...5, 10...12 = 17882.46 (211)

Water heating

Efficiency of water heater

100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	(217)

Water heating fuel, kWh/month

223.50	197.91	210.02	191.26	189.60	172.54	168.67	180.99	179.39	198.18	205.79	219.14

∑(219a)1...12 = 2337.00 (219)

Annual totals

Space heating fuel - main system 1	17882.46	
Water heating fuel	2337.00	
Electricity for pumps, fans and electric keep-hot (Table 4f)		
central heating pump or water pump within warm air heating unit	156.00	(230c)
Total electricity for the above, kWh/year	156.00	(231)
Electricity for lighting (Appendix L)	296.47	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =	20671.93	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1						
high-rate cost	0.00	x	15.29	x 0.01 =	0.00	(240)
low-rate cost	17882.46	x	5.50	x 0.01 =	983.54	(240)
Water heating						
high-rate fraction			0.00			(243)
low-rate fraction			1.00			(244)
high-rate cost	0.00	x	15.29	x 0.01 =	0.00	(245)
low-rate cost	2337.00	x	5.50	x 0.01 =	128.54	(246)
Central heating pump						
high-rate cost	140.40	x	15.29	x 0.01 =	21.47	(249)
low-rate cost	15.60	x	5.50	x 0.01 =	0.86	(249)
Electricity for lighting						
high-rate cost	266.83	x	15.29	x 0.01 =	40.80	(250)
low-rate cost	29.65	x	5.50	x 0.01 =	1.63	(250)
Additional standing charges					24.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		1200.82	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	4.57	(257)
SAP value	37.20	
SAP rating (section 13)	37	(258)
SAP band	F	

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

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	17882.46	x	0.519	=	9281.00	(261)
Water heating	2337.00	x	0.519	=	1212.90	(264)
Space and water heating			(261) + (262) + (263) + (264) =		10493.90	(265)
Pumps and fans	156.00	x	0.519	=	80.96	(267)
Electricity for lighting	296.47	x	0.519	=	153.87	(268)
Total CO_2, kg/year				(265)...(271) =	10728.73	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	163.87	(273)
EI value					11.21	

EI rating (section 14)	11 (274)
EI band	G

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	17882.46	x	3.07	=	54899.15	(261)
Water heating	2337.00	x	3.07	=	7174.59	(264)
Space and water heating			(261) + (262) + (263) + (264) =		62073.74	(265)
Pumps and fans	156.00	x	3.07	=	478.92	(267)
Electricity for lighting	296.47	x	3.07	=	910.17	(268)
Primary energy kWh/year					63462.83	(272)
Dwelling primary energy rate kWh/m2/year					969.34	(273)

DER Worksheet
Design - 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 Simon Gowing	Assessor number	9641
Client		Last modified	13/06/2017
Address	B 1 Udney Park Road, Teddington, TW11		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		107.23	(1a) x	3.32	(2a) =	356.00	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	107.23	(4)				
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =	356.00	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	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) =	0.08	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	10.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.58	(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) = 0.50	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.63	0.62	0.61	0.55	0.53	0.47	0.47	0.46	0.50	0.53	0.56	0.58	(22b)

Calculate effective air change rate for the applicable case:

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.70	0.69	0.69	0.65	0.64	0.61	0.61	0.61	0.62	0.64	0.66	0.67	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.70	0.69	0.69	0.65	0.64	0.61	0.61	0.61	0.62	0.64	0.66	0.67	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			16.68	x	4.03	=	67.17			(27)
Door			2.52	x	1.40	=	3.53			(26)
Ground floor			107.23	x	1.20	=	128.68			(28a)
External wall			103.60	x	2.10	=	217.56			(29a)
External wall			13.75	x	1.17	=	16.09			(29a)
Party wall			42.26	x	0.00	=	0.00			(32)
Roof			107.23	x	2.30	=	246.63			(30)
Total area of external elements ∑A, m²			351.01							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) = 679.65	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) = N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K	52.65	(36)
Total fabric heat loss	(33) + (36) = 732.30	(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)	82.29	81.38	80.48	76.27	75.48	71.82	71.82	71.14	73.23	75.48	77.08	78.74	(38)	
Heat transfer coefficient, W/K (37)m + (38)m	814.59	813.68	812.78	808.57	807.78	804.12	804.12	803.44	805.53	807.78	809.38	811.04		
										Average = ∑(39)1...12/12 =		808.57	(39)	
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	7.60	7.59	7.58	7.54	7.53	7.50	7.50	7.49	7.51	7.53	7.55	7.56		
										Average = ∑(40)1...12/12 =		7.54	(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	2.80	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	100.63	(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)	110.70	106.67	102.64	98.62	94.59	90.57	90.57	94.59	98.62	102.64	106.67	110.70		
											∑(44)1...12 =		1207.58	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	164.16	143.57	148.15	129.17	123.94	106.95	99.10	113.72	115.08	134.12	146.40	158.98		
											∑(45)1...12 =		1583.33	(45)
Distribution loss 0.15 x (45)m	24.62	21.54	22.22	19.37	18.59	16.04	14.87	17.06	17.26	20.12	21.96	23.85		(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	117.00	(47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
Volume factor from Table 2a	1.01	(52)
Temperature factor from Table 2b	0.54	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	1.35	(54)
Enter (50) or (54) in (55)	1.35	(55)

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

41.83	37.78	41.83	40.48	41.83	40.48	41.83	41.83	40.48	41.83	40.48	41.83	(56)

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

41.83	37.78	41.83	40.48	41.83	40.48	41.83	41.83	40.48	41.83	40.48	41.83	(57)

Primary circuit loss for each month from Table 3

43.31	39.12	43.31	41.92	43.31	41.92	43.31	43.31	41.92	43.31	41.92	43.31	(59)

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

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

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

249.30	220.47	233.30	211.56	209.08	189.34	184.24	198.86	197.47	219.26	228.79	244.12	(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

249.30	220.47	233.30	211.56	209.08	189.34	184.24	198.86	197.47	219.26	228.79	244.12	

∑(64)1...12 = 2585.79 (64)

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

122.69	109.26	117.37	108.86	109.32	101.48	101.06	105.93	104.18	112.71	114.59	120.97	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	139.86	139.86	139.86	139.86	139.86	139.86	139.86	139.86	139.86	139.86	139.86	139.86	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	24.02	21.33	17.35	13.13	9.82	8.29	8.96	11.64	15.62	19.84	23.16	24.68	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	267.51	270.29	263.30	248.40	229.60	211.94	200.13	197.36	204.35	219.24	238.04	255.71	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	(69)
Pump and fan gains (Table 5a)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	(70)
Losses e.g. evaporation (Table 5)	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	-111.89	(71)
Water heating gains (Table 5)	164.91	162.59	157.76	151.20	146.94	140.94	135.84	142.37	144.69	151.49	159.16	162.60	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	531.40	529.17	513.36	487.69	461.32	436.12	419.88	426.33	439.63	465.53	495.31	517.95	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
South	0.77	x	7.75	x	46.75	x 0.9 x	0.85	x	0.80	=	170.74	(78)
East	0.77	x	3.61	x	19.64	x 0.9 x	0.85	x	0.80	=	33.41	(76)
West	0.77	x	5.32	x	19.64	x 0.9 x	0.85	x	0.80	=	49.24	(80)

Solar gains in watts ∑(74)m...(82)m

253.39	441.31	622.47	790.92	895.44	890.92	858.29	781.50	681.77	493.46	305.44	215.51	(83)

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

784.79	970.48	1135.83	1278.61	1356.75	1327.03	1278.17	1207.83	1121.40	958.99	800.76	733.46	(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)	0.99	0.99	0.98	0.97	0.95	0.91	0.87	0.88	0.94	0.97	0.99	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	17.10	17.29	17.72	18.33	19.01	19.68	20.13	20.07	19.52	18.65	17.77	17.06	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.99	0.98	0.97	0.95	0.91	0.81	0.58	0.64	0.87	0.96	0.98	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	14.81	15.00	15.43	16.04	16.71	17.35	17.73	17.69	17.20	16.35	15.48	14.77	(90)

Living area fraction — Living area ÷ (4) = 0.34 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	15.59	15.78	16.21	16.82	17.49	18.15	18.54	18.50	17.99	17.13	16.26	15.55	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate	15.59	15.78	16.21	16.82	17.49	18.15	18.54	18.50	17.99	17.13	16.26	15.55	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.97	0.96	0.94	0.90	0.82	0.68	0.72	0.87	0.95	0.98	0.98	(94)
Useful gains, ηmGm, W (94)m x (84)m	771.10	945.83	1092.72	1201.46	1220.89	1088.96	867.20	864.89	974.63	908.42	781.00	722.01	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	9193.96	8854.89	7891.02	6402.53	4679.21	2851.20	1562.94	1685.85	3133.69	5278.50	7415.62	9207.84	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	6266.61	5314.89	5057.93	3744.77	2572.99	0.00	0.00	0.00	0.00	3251.34	4776.92	6313.45	

∑(98)1...5, 10...12 = 37298.90 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 347.84 (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 (%) 100.00 (206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	6266.61	5314.89	5057.93	3744.77	2572.99	0.00	0.00	0.00	0.00	3251.34	4776.92	6313.45	

∑(211)1...5, 10...12 = 37298.90 (211)

Water heating

Efficiency of water heater

	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00 (217)
Water heating fuel, kWh/month												
	249.30	220.47	233.30	211.56	209.08	189.34	184.24	198.86	197.47	219.26	228.79	244.12

∑(219a)1...12 = 2585.79 (219)

Annual totals

Space heating fuel - main system 1		37298.90
Water heating fuel		2585.79
Electricity for pumps, fans and electric keep-hot (Table 4f)		
central heating pump or water pump within warm air heating unit	156.00	(230c)
Total electricity for the above, kWh/year		156.00 (231)
Electricity for lighting (Appendix L)		424.15 (232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	40464.85 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1						
high-rate cost	0.00	x	15.29	x 0.01 =	0.00	(240)
low-rate cost	37298.90	x	5.50	x 0.01 =	2051.44	(240)
Water heating						
high-rate fraction			0.00			(243)
low-rate fraction			1.00			(244)
high-rate cost	0.00	x	15.29	x 0.01 =	0.00	(245)
low-rate cost	2585.79	x	5.50	x 0.01 =	142.22	(246)
Central heating pump						
high-rate cost	140.40	x	15.29	x 0.01 =	21.47	(249)
low-rate cost	15.60	x	5.50	x 0.01 =	0.86	(249)
Electricity for lighting						
high-rate cost	381.74	x	15.29	x 0.01 =	58.37	(250)
low-rate cost	42.42	x	5.50	x 0.01 =	2.33	(250)
Additional standing charges					24.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		2300.68	(255)

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

Energy cost deflator (Table 12)	0.42 (256)
Energy cost factor (ECF)	6.35 (257)
SAP value	19.88
SAP rating (section 13)	20 (258)
SAP band	G

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

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	37298.90	x	0.519	=	19358.13	(261)
Water heating	2585.79	x	0.519	=	1342.03	(264)
Space and water heating			(261) + (262) + (263) + (264) =		20700.16	(265)
Pumps and fans	156.00	x	0.519	=	80.96	(267)
Electricity for lighting	424.15	x	0.519	=	220.13	(268)
Total CO_2, kg/year			(265)...(271) =		21001.25	(272)

Dwelling CO_2 emission rate	(272) ÷ (4) =	195.85 (273)
EI value		-3.28
EI rating (section 14)		1 (274)
EI band		G

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	37298.90	x	3.07	=	114507.63	(261)
Water heating	2585.79	x	3.07	=	7938.39	(264)
Space and water heating			(261) + (262) + (263) + (264) =		122446.01	(265)
Pumps and fans	156.00	x	3.07	=	478.92	(267)
Electricity for lighting	424.15	x	3.07	=	1302.14	(268)
Primary energy kWh/year					124227.08	(272)
Dwelling primary energy rate kWh/m2/year					1158.51	(273)

DER Worksheet
Design - 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 Simon Gowing	Assessor number	9641
Client		Last modified	13/06/2017
Address	B 2 Udney Park Road, Teddington, TW11		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		65.47	(1a) x	2.40	(2a) =	157.13	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	65.47	(4)				
Dwelling volume				(3a) + (3b) + (3c) + (3d)...(3n) =		157.13	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 20	÷ (5) =	0.13	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	10.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.63	(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) = 0.53	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.68	0.67	0.65	0.59	0.57	0.51	0.51	0.49	0.53	0.57	0.60	0.63	(22b)

Calculate effective air change rate for the applicable case:

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.73	0.72	0.71	0.67	0.66	0.63	0.63	0.62	0.64	0.66	0.68	0.70	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

	0.73	0.72	0.71	0.67	0.66	0.63	0.63	0.62	0.64	0.66	0.68	0.70	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Door			2.52	x	1.40	=	3.53			(26)
Window			9.93	x	4.03	=	39.99			(27)
External wall			64.61	x	2.10	=	135.68			(29a)
External wall			13.49	x	1.17	=	15.78			(29a)
Roof			65.47	x	2.30	=	150.58			(30)
Total area of external elements ∑A, m²			156.02							(31)

Fabric heat loss, W/K = ∑(A x U)	(26)...(30) + (32) = 345.56	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) = N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K	23.40	(36)
Total fabric heat loss	(33) + (36) = 368.96	(37)

Ventilation heat loss calculated monthly 0.33 x (25)m x (5)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
37.91	37.44	36.99	34.84	34.44	32.58	32.58	32.23	33.30	34.44	35.25	36.10	(38)

Heat transfer coefficient, W/K (37)m + (38)m

406.87	406.41	405.95	403.81	403.41	401.54	401.54	401.20	402.26	403.41	404.22	405.07	

Average = ∑(39)1...12/12 = 403.81 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

6.21	6.21	6.20	6.17	6.16	6.13	6.13	6.13	6.14	6.16	6.17	6.19	

Average = ∑(40)1...12/12 = 6.17 (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	2.13	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	84.82	(43)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
93.30	89.91	86.52	83.12	79.73	76.34	76.34	79.73	83.12	86.52	89.91	93.30	

∑(44)1...12 = 1017.83 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

138.36	121.01	124.87	108.87	104.46	90.14	83.53	95.85	97.00	113.04	123.39	134.00	

∑(45)1...12 = 1334.54 (45)

Distribution loss 0.15 x (45)m

20.75	18.15	18.73	16.33	15.67	13.52	12.53	14.38	14.55	16.96	18.51	20.10	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	117.00	(47)
Water storage loss:		
b) Manufacturer's declared loss factor is not known		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
Volume factor from Table 2a	1.01	(52)
Temperature factor from Table 2b	0.54	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	1.35	(54)
Enter (50) or (54) in (55)	1.35	(55)

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

41.83	37.78	41.83	40.48	41.83	40.48	41.83	41.83	40.48	41.83	40.48	41.83	(56)

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

41.83	37.78	41.83	40.48	41.83	40.48	41.83	41.83	40.48	41.83	40.48	41.83	(57)

Primary circuit loss for each month from Table 3

43.31	39.12	43.31	41.92	43.31	41.92	43.31	43.31	41.92	43.31	41.92	43.31	(59)

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

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

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

223.50	197.91	210.02	191.26	189.60	172.54	168.67	180.99	179.39	198.18	205.79	219.14	(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

223.50	197.91	210.02	191.26	189.60	172.54	168.67	180.99	179.39	198.18	205.79	219.14	

∑(64)1...12 = 2337.00 (64)

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

114.12	101.76	109.63	102.11	102.85	95.89	95.89	99.98	98.17	105.70	106.94	112.67	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	106.57	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	16.91	15.02	12.21	9.24	6.91	5.83	6.30	8.19	11.00	13.97	16.30	17.38	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	186.50	188.44	183.56	173.18	160.07	147.75	139.53	137.59	142.47	152.85	165.96	178.27	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	33.66	(69)
Pump and fan gains (Table 5a)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	(70)
Losses e.g. evaporation (Table 5)	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	-85.25	(71)
Water heating gains (Table 5)	153.38	151.43	147.36	141.83	138.23	133.18	128.88	134.39	136.34	142.07	148.53	151.43	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	421.76	419.85	408.10	389.22	370.19	351.74	339.68	345.14	354.78	373.85	395.76	412.05	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
West	0.77	x	2.19	x	19.64	x 0.9 x	0.85	x	0.80	=	20.27	(80)
North	0.77	x	5.19	x	10.63	x 0.9 x	0.85	x	0.80	=	26.01	(74)
South	0.54	x	1.79	x	46.75	x 0.9 x	0.85	x	0.80	=	27.66	(78)
East	0.54	x	0.76	x	19.64	x 0.9 x	0.85	x	0.80	=	4.93	(76)

Solar gains in watts ∑(74)m...(82)m

78.87	144.29	223.34	319.27	395.81	409.57	387.96	328.44	256.24	166.51	96.29	66.30	(83)

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

500.63	564.14	631.44	708.49	765.99	761.31	727.64	673.58	611.02	540.37	492.05	478.36	(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)	0.99	0.99	0.98	0.97	0.95	0.91	0.86	0.88	0.94	0.98	0.99	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	17.38	17.55	17.94	18.52	19.17	19.81	20.22	20.16	19.63	18.82	18.01	17.35	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.99	0.98	0.97	0.95	0.91	0.80	0.55	0.62	0.87	0.96	0.98	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	15.05	15.22	15.61	16.19	16.83	17.43	17.76	17.73	17.28	16.48	15.68	15.02	(90)

Living area fraction — Living area ÷ (4) = 0.45 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	16.10	16.27	16.66	17.24	17.88	18.50	18.87	18.82	18.34	17.53	16.73	16.07	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate	16.10	16.27	16.66	17.24	17.88	18.50	18.87	18.82	18.34	17.53	16.73	16.07	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.98	0.97	0.95	0.91	0.83	0.71	0.75	0.89	0.95	0.98	0.98	(94)
Useful gains, ηmGm, W (94)m x (84)m	491.93	551.50	611.16	671.46	696.17	633.49	513.63	502.57	542.02	515.61	480.48	470.72	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	4800.15	4619.73	4125.03	3367.95	2494.83	1566.49	910.48	970.87	1703.70	2797.03	3891.53	4807.91	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	3205.31	2733.85	2614.32	1941.47	1338.21	0.00	0.00	0.00	0.00	1697.38	2455.95	3226.87	

∑(98)1...5, 10...12 = 19213.36 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 293.47 (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 (%) 100.00 (206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	3205.31	2733.85	2614.32	1941.47	1338.21	0.00	0.00	0.00	0.00	1697.38	2455.95	3226.87	

∑(211)1...5, 10...12 = 19213.36 (211)

Water heating

Efficiency of water heater

100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	(217)

Water heating fuel, kWh/month

223.50	197.91	210.02	191.26	189.60	172.54	168.67	180.99	179.39	198.18	205.79	219.14

∑(219a)1...12 = 2337.00 (219)

Annual totals

Space heating fuel - main system 1	19213.36	
Water heating fuel	2337.00	
Electricity for pumps, fans and electric keep-hot (Table 4f)		
central heating pump or water pump within warm air heating unit	156.00	(230c)
Total electricity for the above, kWh/year	156.00	(231)
Electricity for lighting (Appendix L)	298.56	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =	22004.92	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1						
high-rate cost	0.00	x	15.29	x 0.01 =	0.00	(240)
low-rate cost	19213.36	x	5.50	x 0.01 =	1056.73	(240)
Water heating						
high-rate fraction			0.00			(243)
low-rate fraction			1.00			(244)
high-rate cost	0.00	x	15.29	x 0.01 =	0.00	(245)
low-rate cost	2337.00	x	5.50	x 0.01 =	128.54	(246)
Central heating pump						
high-rate cost	140.40	x	15.29	x 0.01 =	21.47	(249)
low-rate cost	15.60	x	5.50	x 0.01 =	0.86	(249)
Electricity for lighting						
high-rate cost	268.71	x	15.29	x 0.01 =	41.09	(250)
low-rate cost	29.86	x	5.50	x 0.01 =	1.64	(250)
Additional standing charges					24.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		1274.32	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	4.84	(257)
SAP value	34.08	
SAP rating (section 13)	34	(258)
SAP band	F	

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

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	19213.36	x	0.519	=	9971.73	(261)
Water heating	2337.00	x	0.519	=	1212.90	(264)
Space and water heating			(261) + (262) + (263) + (264) =		11184.64	(265)
Pumps and fans	156.00	x	0.519	=	80.96	(267)
Electricity for lighting	298.56	x	0.519	=	154.95	(268)
Total CO_2, kg/year				(265)...(271) =	11420.55	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	174.44	(273)

EI value	8.63	
EI rating (section 14)	9	(274)
EI band	G	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	19213.36	x	3.07	=	58985.01	(261)
Water heating	2337.00	x	3.07	=	7174.59	(264)
Space and water heating			(261) + (262) + (263) + (264) =		66159.60	(265)
Pumps and fans	156.00	x	3.07	=	478.92	(267)
Electricity for lighting	298.56	x	3.07	=	916.59	(268)
Primary energy kWh/year					67555.10	(272)
Dwelling primary energy rate kWh/m2/year					1031.85	(273)

Appendix G

Be Lean BRUKL Worksheets (Non-Domestic)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Former ICL GP

As designed

Date: Wed Jul 12 17:23:48 2017

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.3.a.0

Interface to calculation engine: DesignBuilder SBEM

Interface to calculation engine version: v5.0.3

BRUKL compliance check version: v5.3.a.0

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Donald Sinclair

Telephone number:

Address: , Harrow,

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	27.9
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	27.9
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	21.2
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{e\text{-}Limit}$	$U_{e\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.17	0.18	GP 0F - Circulation_W_17
Floor	0.25	0.1	0.25	GP 1F - Circulation_F_4
Roof	0.25	0.15	0.15	GP 0F - Circulation_R_5
Windows***, roof windows, and rooflights	2.2	1.4	1.4	GP 0F - Circulation_G_18
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{e\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{e\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	7

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Gas Water and ASHP heating/cooling

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.5	3.58	-	-	-
Standard value	2.5*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <= 12 kW output, refer to EN 14825 for limiting standards.

1- Gas HW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	0.001
Standard value	0.8	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
GP 0F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
GP 0F - Consultation 1	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Reception	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Consultation 2	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Interview office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Cleaner store	-	-	-	-	-	-	-	-	-	-	N/A
GP 0F - Toilets	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Lift	-	-	-	-	-	-	-	-	-	-	N/A
GP 0F - Consultation 3	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Pharmacy	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Physio - Baby clinic	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Consultation	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
GP 1F - General office 1	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Library	-	-	-	1.4	-	-	-	-	-	0.85	0.5

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
GP 1F - General Office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Meeting room	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Training	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Reception	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Store	-	-	-	-	-	-	-	-	-	-	N/A
GP 1F - Showers	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Practise manager office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Staff room	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Consultation 1	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Record store	-	-	-	-	-	-	-	-	-	-	N/A
GP 1F - Lift	-	-	-	-	-	-	-	-	-	-	N/A
GP 1F - Toilets	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Minor surgery	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Consultation	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Treatment	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Utility store	-	-	-	-	-	-	-	-	-	-	N/A
Surgey GP 0F - Store	-	-	-	-	-	-	-	-	-	-	N/A
Surgey GP 0F - Plantroom	-	-	-	-	-	-	-	-	-	-	N/A
Surgey GP 0F - Circluation	-	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
GP 0F - Circulation	-	110	-	215
GP 0F - Consultation 1	110	-	-	549
GP 0F - Reception	-	110	75	211
GP 0F - Consultation 2	110	-	-	470
GP 0F - Interview office	110	-	-	116
GP 0F - Cleaner store	110	-	-	11
GP 0F - Toilets	-	110	-	66
GP 0F - Lift	-	110	-	14
GP 0F - Consultation 3	110	-	-	249
GP 0F - Pharmacy	110	-	-	600
GP 0F - Physio - Baby clinic	-	110	-	182
GP 0F - Consultation	110	-	-	145
GP 1F - Circulation	-	110	-	178
GP 1F - General office 1	110	-	-	126
GP 1F - Library	110	-	-	196
GP 1F - General Office	110	-	-	128
GP 1F - Meeting room	110	-	-	236
GP 1F - Training	110	-	-	185
GP 1F - Reception	-	110	75	110
GP 1F - Store	110	-	-	9

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
GP 1F - Showers	-	110	-	43
GP 1F - Practise manager office	110	-	-	128
GP 1F - Staff room	-	110	-	57
GP 1F - Consultation 1	110	-	-	128
GP 1F - Record store	110	-	-	14
GP 1F - Lift	-	110	-	11
GP 1F - Toilets	-	110	-	61
GP 1F - Minor surgery	-	110	-	288
GP 1F - Consultation	110	-	-	129
GP 1F - Treatment	110	-	-	425
GP 1F - Utility store	110	-	-	16
Surgey GP 0F - Store	110	-	-	165
Surgey GP 0F - Plantroom	110	-	-	466
Surgey GP 0F - Circluation	110	-	-	170

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GP 0F - Circulation	NO (-77%)	NO
GP 0F - Consultation 1	NO (-75.9%)	NO
GP 0F - Reception	NO (-49.3%)	NO
GP 0F - Consultation 2	NO (-82%)	NO
GP 0F - Interview office	N/A	N/A
GP 0F - Cleaner store	N/A	N/A
GP 0F - Toilets	N/A	N/A
GP 0F - Lift	N/A	N/A
GP 0F - Consultation 3	NO (-72.4%)	NO
GP 0F - Pharmacy	NO (-67.4%)	NO
GP 0F - Physio - Baby clinic	NO (-71.4%)	NO
GP 0F - Consultation	NO (-77.5%)	NO
GP 1F - Circulation	NO (-93.3%)	NO
GP 1F - General office 1	NO (-75.6%)	NO
GP 1F - Library	NO (-69.7%)	NO
GP 1F - General Office	NO (-74.4%)	NO
GP 1F - Meeting room	NO (-56%)	NO
GP 1F - Training	NO (-54.4%)	NO
GP 1F - Reception	NO (-51.2%)	NO
GP 1F - Store	N/A	N/A
GP 1F - Showers	NO (-86.3%)	NO
GP 1F - Practise manager office	NO (-82.8%)	NO
GP 1F - Staff room	NO (-80.4%)	NO
GP 1F - Consultation 1	NO (-71.7%)	NO
GP 1F - Record store	NO (-80.2%)	NO
GP 1F - Lift	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GP 1F - Toilets	NO (-79.4%)	NO
GP 1F - Minor surgery	NO (-71.8%)	NO
GP 1F - Consultation	NO (-79.4%)	NO
GP 1F - Treatment	NO (-77%)	NO
GP 1F - Utility store	NO (-65.3%)	NO
Surgey GP 0F - Store	N/A	N/A
Surgey GP 0F - Plantroom	N/A	N/A
Surgey GP 0F - Circluation	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1231.2	1231.2
External area [m²]	2159.6	2159.6
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	7	3
Average conductance [W/K]	554.12	908.7
Average U-value [W/m²K]	0.26	0.42
Alpha value* [%]	23.82	15.3

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
10	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
17	**C2 Residential Institutions: Hospitals and Care Homes**
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
72	**D1 Non-residential Institutions: Primary Health Care Building**
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure: Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	5.11	7.07
Cooling	6.96	12.1
Auxiliary	12.85	8.81
Lighting	13.77	23.98
Hot water	7.36	7.53
Equipment*	41.91	41.91
TOTAL**	46.04	59.49

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	173.33	218.63
Primary energy* [kWh/m²]	124.77	164.72
Total emissions [kg/m²]	21.2	27.9

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type	Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity									
Actual	45.1	128.2	5.1	7	12.8	2.45	5.12	2.5	6.85
Notional	61.9	156.8	7.1	12.1	8.8	2.43	3.6	---	---

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{k\text{-}Typ}$	$U_{k\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.13	Surgey GP 0F - Store_W_7
Floor	0.2	0.08	GP 0F - Circulation_S_4
Roof	0.15	0.15	GP 0F - Circulation_R_5
Windows, roof windows, and rooflights	1.5	1.4	GP 0F - Circulation_G_18
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{k\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{k\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	7

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Former ICL Pavillion

As designed

Date: Wed Jul 12 17:28:03 2017

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.3.a.0

Interface to calculation engine: DesignBuilder SBEM

Interface to calculation engine version: v5.0.3

BRUKL compliance check version: v5.3.a.0

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Donald Sinclair

Telephone number:

Address: , Harrow,

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	103.7
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	103.7
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	96.6
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	Pavillion 0F - Creche_W_9
Floor	0.25	0.09	0.13	Pavillion 0F - Office_S_3
Roof	0.25	0.15	0.15	Pavillion 0F - Reception_R_4
Windows***, roof windows, and rooflights	2.2	1.4	1.4	Pavillion 0F - Creche_G_10
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	7

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Gas Water and ASHP heating/cooling_Pavillion

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.5	4.6	-	-	-
Standard value	2.5*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <= 12 kW output, refer to EN 14825 for limiting standards.

1- Gas HW Pavillion

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	0
Standard value	0.8	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Pavillion 0F - Creche	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Store	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Reception	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Changing	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Store	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Changing	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Cafe seating	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Bar Store	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - WC	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Kitchen	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Plant room	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Pavillion 1F - Kitchen	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 1F - Store 1	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 1F - Bar	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 1F - Community - Club rooms	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 1F - Store 2	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 1F - WC	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 1F - Store 3	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 1F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 1F - Store	-	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Pavillion 0F - Creche	110	-	-	175
Pavillion 0F - Store	110	-	-	8
Pavillion 0F - Office	110	-	-	109
Pavillion 0F - Reception	-	110	75	264
Pavillion 0F - Changing	-	110	-	142
Pavillion 0F - Circulation	-	110	-	44
Pavillion 0F - Office	110	-	-	97
Pavillion 0F - Store	110	-	-	8
Pavillion 0F - Changing	-	110	-	115
Pavillion 0F - Cafe seating	-	110	-	38
Pavillion 0F - Bar Store	110	-	-	13
Pavillion 0F - WC	-	110	-	88
Pavillion 0F - Kitchen	-	110	-	127
Pavillion 0F - Plant room	110	-	-	96
Pavillion 0F - Circulation	-	110	-	66
Pavillion 1F - Kitchen	-	110	-	279
Pavillion 1F - Store 1	110	-	-	8
Pavillion 1F - Bar	-	110	-	143
Pavillion 1F - Community - Club rooms	-	110	-	579
Pavillion 1F - Store 2	110	-	-	13
Pavillion 1F - WC	-	110	-	124
Pavillion 1F - Store 3	110	-	-	13
Pavillion 1F - Circulation	-	110	-	161
Pavillion 1F - Store	110	-	-	7

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Pavillion 0F - Creche	NO (-72.3%)	NO
Pavillion 0F - Store	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Pavillion 0F - Office	N/A	N/A
Pavillion 0F - Reception	NO (-54.5%)	NO
Pavillion 0F - Changing	NO (-95.7%)	NO
Pavillion 0F - Circulation	NO (-14.9%)	NO
Pavillion 0F - Office	N/A	N/A
Pavillion 0F - Store	N/A	N/A
Pavillion 0F - Changing	N/A	N/A
Pavillion 0F - Cafe seating	NO (-58.2%)	NO
Pavillion 0F - Bar Store	N/A	N/A
Pavillion 0F - WC	NO (-97.6%)	NO
Pavillion 0F - Kitchen	NO (-80.8%)	NO
Pavillion 0F - Plant room	NO (-86.3%)	NO
Pavillion 0F - Circulation	NO (-16.5%)	NO
Pavillion 1F - Kitchen	N/A	N/A
Pavillion 1F - Store 1	N/A	N/A
Pavillion 1F - Bar	NO (-67.1%)	NO
Pavillion 1F - Community - Club rooms	NO (-73%)	NO
Pavillion 1F - Store 2	N/A	N/A
Pavillion 1F - WC	NO (-96.4%)	NO
Pavillion 1F - Store 3	NO (-89.6%)	NO
Pavillion 1F - Circulation	NO (-45.6%)	NO
Pavillion 1F - Store	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	910.4	910.4
External area [m²]	1669.8	1669.8
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	7	3
Average conductance [W/K]	461.42	608.53
Average U-value [W/m²K]	0.28	0.36
Alpha value* [%]	16.02	13.87

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
96	**D1 Non-residential Institutions: Community/Day Centre**
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
4	**D1 Non-residential Institutions: Education**
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	7.22	6.86
Cooling	2.39	5.14
Auxiliary	3.97	1.95
Lighting	6.47	11.36
Hot water	400.02	420.8
Equipment*	24.44	24.44
TOTAL**	420.07	446.12

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	112	126.65
Primary energy* [kWh/m²]	548.04	589.15
Total emissions [kg/m²]	96.6	103.7

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	63.7	48.3	7.2	2.4	4	2.45	5.61	2.5	7.5
	Notional	60	66.7	6.9	5.1	1.9	2.43	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.18	Pavillion 0F - Creche_W_9
Floor	0.2	0.05	Pavillion 0F - Reception_S_3
Roof	0.15	0.15	Pavillion 0F - Reception_R_4
Windows, roof windows, and rooflights	1.5	1.4	Pavillion 0F - Creche_G_10
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	7

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Former ICL Residents Facilities

As designed

Date: Wed Jul 12 17:32:51 2017

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.3.a.0

Interface to calculation engine: DesignBuilder SBEM

Interface to calculation engine version: v5.0.3

BRUKL compliance check version: v5.3.a.0

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Donald Sinclair

Telephone number:

Address: , Harrow,

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	42.3
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	42.3
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	32.7
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{e\text{-}Limit}$	$U_{e\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	Residents Facilities 0F - Circulation - Reception_W_8
Floor	0.25	0.08	0.13	Residents Facilities 0F - Reception_S_3
Roof	0.25	0.15	0.15	Residents Facilities 0F - Circulation - Reception_R_5
Windows***, roof windows, and rooflights	2.2	1.4	1.4	Residents Facilities 0F - Circulation - Reception_G_10
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{e\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{e\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	7

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Gas Water and ASHP heating/cooling

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.5	3.58	-	-	-
Standard value	2.5*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- Gas HW residents fac.

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	-
Standard value	0.8	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Residents Facilities 0F - Circulation - Reception	-	-	-	-	-	-	-	-	-	-	N/A
Residents Facilities 0F - Multi-function room	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Restaurant	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Bar	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Private Lounge	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Care Manager	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Reception	-	-	-	-	-	-	-	-	-	-	N/A
Residents Facilities 0F - Toilets	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Toilets	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Kitchen	-	-	-	-	-	-	-	-	0.5	-	N/A
Residents Facilities 0F - Residents shop-office	-	-	-	-	-	-	-	-	-	-	N/A
Residents Facilities 0F - Hairdressing	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Treatement	-	-	-	-	-	-	-	-	-	-	N/A
Residents Facilities 0F - Store	-	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Residents Facilities 0F - Circulation - Reception	-	110	-	302
Residents Facilities 0F - Multi-function room	-	110	-	446
Residents Facilities 0F - Restaurant	-	110	75	281
Residents Facilities 0F - Bar	-	110	75	187
Residents Facilities 0F - Private Lounge	-	110	-	152
Residents Facilities 0F - Care Manager	110	-	-	90
Residents Facilities 0F - Reception	-	110	75	58
Residents Facilities 0F - Toilets	-	110	-	103
Residents Facilities 0F - Toilets	-	110	-	88
Residents Facilities 0F - Kitchen	-	110	-	483
Residents Facilities 0F - Residents shop-office	110	-	-	218
Residents Facilities 0F - Hairdressing	-	110	-	71
Residents Facilities 0F - Treatement	110	-	-	127
Residents Facilities 0F - Store	110	-	-	9

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Residents Facilities 0F - Circulation - Reception	NO (-65.4%)	NO
Residents Facilities 0F - Multi-function room	NO (-65.3%)	NO
Residents Facilities 0F - Restaurant	NO (-17.7%)	NO
Residents Facilities 0F - Bar	NO (-12.3%)	NO
Residents Facilities 0F - Private Lounge	N/A	N/A
Residents Facilities 0F - Care Manager	NO (-67.5%)	NO
Residents Facilities 0F - Reception	N/A	N/A
Residents Facilities 0F - Toilets	N/A	N/A
Residents Facilities 0F - Toilets	NO (-83.1%)	NO
Residents Facilities 0F - Kitchen	NO (-81%)	NO
Residents Facilities 0F - Residents shop-office	NO (-79.5%)	NO
Residents Facilities 0F - Hairdressing	NO (-81.2%)	NO
Residents Facilities 0F - Treatement	NO (-72%)	NO
Residents Facilities 0F - Store	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	836.3	836.3
External area [m²]	1392.5	1392.5
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	7	3
Average conductance [W/K]	343.53	534.69
Average U-value [W/m²K]	0.25	0.38
Alpha value* [%]	24.07	14.66

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
35	**A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways**
9	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
16	**C2 Residential Institutions: Residential schools**
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
39	**D1 Non-residential Institutions: Community/Day Centre**
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
2	**D1 Non-residential Institutions: Primary Health Care Building**
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	5.46	6.73
Cooling	10.84	16.07
Auxiliary	16.16	13.58
Lighting	14.63	28.8
Hot water	40.95	43.11
Equipment*	61.11	61.11
TOTAL**	88.04	108.28

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	247.97	267.08
Primary energy* [kWh/m²]	190.91	247.66
Total emissions [kg/m²]	32.7	42.3

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	48.2	199.8	5.5	10.8	16.2	2.45	5.12	2.5	6.85
	Notional	58.8	208.2	6.7	16.1	13.6	2.43	3.6	---	---

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.18	Residents Facilities 0F - Circulation - Reception_W_8
Floor	0.2	0.08	Residents Facilities 0F - Restaurant_S_3
Roof	0.15	0.15	Residents Facilities 0F - Circulation - Reception_R_5
Windows, roof windows, and rooflights	1.5	1.4	Residents Facilities 0F - Circulation - Reception_G_10
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	7

Appendix H

Be Green (ASHP) BRUKL Worksheets (Non-Domestic)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Former ICL GP

As designed

Date: Wed Jul 12 17:22:39 2017

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.3.a.0

Interface to calculation engine: DesignBuilder SBEM

Interface to calculation engine version: v5.0.3

BRUKL compliance check version: v5.3.a.0

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Donald Sinclair

Telephone number:

Address: , Harrow,

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	27.9
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	27.9
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	20
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{i\text{-}Limit}$	$U_{i\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.17	0.18	GP 0F - Circulation_W_17
Floor	0.25	0.1	0.25	GP 1F - Circulation_F_4
Roof	0.25	0.15	0.15	GP 0F - Circulation_R_5
Windows***, roof windows, and rooflights	2.2	1.4	1.4	GP 0F - Circulation_G_18
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{i\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
m³/(h.m²) at 50 Pa	10	7

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Gas Water and ASHP heating/cooling

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.59	3.58	-	-	-
Standard value	2.5*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- Gas HW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	0.001
Standard value	0.8	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
GP 0F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
GP 0F - Consultation 1	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Reception	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Consultation 2	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Interview office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Cleaner store	-	-	-	-	-	-	-	-	-	-	N/A
GP 0F - Toilets	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Lift	-	-	-	-	-	-	-	-	-	-	N/A
GP 0F - Consultation 3	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Pharmacy	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Physio - Baby clinic	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Consultation	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
GP 1F - General office 1	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Library	-	-	-	1.4	-	-	-	-	-	0.85	0.5

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
GP 1F - General Office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Meeting room	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Training	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Reception	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Store	-	-	-	-	-	-	-	-	-	-	N/A
GP 1F - Showers	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Practise manager office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Staff room	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Consultation 1	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Record store	-	-	-	-	-	-	-	-	-	-	N/A
GP 1F - Lift	-	-	-	-	-	-	-	-	-	-	N/A
GP 1F - Toilets	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Minor surgery	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Consultation	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Treatment	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Utility store	-	-	-	-	-	-	-	-	-	-	N/A
Surgey GP 0F - Store	-	-	-	-	-	-	-	-	-	-	N/A
Surgey GP 0F - Plantroom	-	-	-	-	-	-	-	-	-	-	N/A
Surgey GP 0F - Circluation	-	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
GP 0F - Circulation	-	110	-	215
GP 0F - Consultation 1	110	-	-	549
GP 0F - Reception	-	110	75	211
GP 0F - Consultation 2	110	-	-	470
GP 0F - Interview office	110	-	-	116
GP 0F - Cleaner store	110	-	-	11
GP 0F - Toilets	-	110	-	66
GP 0F - Lift	-	110	-	14
GP 0F - Consultation 3	110	-	-	249
GP 0F - Pharmacy	110	-	-	600
GP 0F - Physio - Baby clinic	-	110	-	182
GP 0F - Consultation	110	-	-	145
GP 1F - Circulation	-	110	-	178
GP 1F - General office 1	110	-	-	126
GP 1F - Library	110	-	-	196
GP 1F - General Office	110	-	-	128
GP 1F - Meeting room	110	-	-	236
GP 1F - Training	110	-	-	185
GP 1F - Reception	-	110	75	110
GP 1F - Store	110	-	-	9

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
GP 1F - Showers	-	110	-	43
GP 1F - Practise manager office	110	-	-	128
GP 1F - Staff room	-	110	-	57
GP 1F - Consultation 1	110	-	-	128
GP 1F - Record store	110	-	-	14
GP 1F - Lift	-	110	-	11
GP 1F - Toilets	-	110	-	61
GP 1F - Minor surgery	-	110	-	288
GP 1F - Consultation	110	-	-	129
GP 1F - Treatment	110	-	-	425
GP 1F - Utility store	110	-	-	16
Surgey GP 0F - Store	110	-	-	165
Surgey GP 0F - Plantroom	110	-	-	466
Surgey GP 0F - Circluation	110	-	-	170

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GP 0F - Circulation	NO (-77%)	NO
GP 0F - Consultation 1	NO (-75.9%)	NO
GP 0F - Reception	NO (-49.3%)	NO
GP 0F - Consultation 2	NO (-82%)	NO
GP 0F - Interview office	N/A	N/A
GP 0F - Cleaner store	N/A	N/A
GP 0F - Toilets	N/A	N/A
GP 0F - Lift	N/A	N/A
GP 0F - Consultation 3	NO (-72.4%)	NO
GP 0F - Pharmacy	NO (-67.4%)	NO
GP 0F - Physio - Baby clinic	NO (-71.4%)	NO
GP 0F - Consultation	NO (-77.5%)	NO
GP 1F - Circulation	NO (-93.3%)	NO
GP 1F - General office 1	NO (-75.6%)	NO
GP 1F - Library	NO (-69.7%)	NO
GP 1F - General Office	NO (-74.4%)	NO
GP 1F - Meeting room	NO (-56%)	NO
GP 1F - Training	NO (-54.4%)	NO
GP 1F - Reception	NO (-51.2%)	NO
GP 1F - Store	N/A	N/A
GP 1F - Showers	NO (-86.3%)	NO
GP 1F - Practise manager office	NO (-82.8%)	NO
GP 1F - Staff room	NO (-80.4%)	NO
GP 1F - Consultation 1	NO (-71.7%)	NO
GP 1F - Record store	NO (-80.2%)	NO
GP 1F - Lift	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GP 1F - Toilets	NO (-79.4%)	NO
GP 1F - Minor surgery	NO (-71.8%)	NO
GP 1F - Consultation	NO (-79.4%)	NO
GP 1F - Treatment	NO (-77%)	NO
GP 1F - Utility store	NO (-65.3%)	NO
Surgey GP 0F - Store	N/A	N/A
Surgey GP 0F - Plantroom	N/A	N/A
Surgey GP 0F - Circluation	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1231.2	1231.2
External area [m²]	2159.6	2159.6
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	7	3
Average conductance [W/K]	554.12	908.7
Average U-value [W/m²K]	0.26	0.42
Alpha value* [%]	23.82	15.3

* Percentage of the buildings average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
10	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
17	**C2 Residential Institutions: Hospitals and Care Homes**
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
72	**D1 Non-residential Institutions: Primary Health Care Building**
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	2.78	7.07
Cooling	6.96	12.1
Auxiliary	12.85	8.81
Lighting	13.77	23.98
Hot water	7.36	7.53
Equipment*	41.91	41.91
TOTAL**	43.72	59.49

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	173.33	218.63
Primary energy* [kWh/m²]	117.8	164.72
Total emissions [kg/m²]	20	27.9

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	45.1	128.2	2.8	7	12.8	4.5	5.12	4.59	6.85
	Notional	61.9	156.8	7.1	12.1	8.8	2.43	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.13	Surgey GP 0F - Store_W_7
Floor	0.2	0.08	GP 0F - Circulation_S_4
Roof	0.15	0.15	GP 0F - Circulation_R_5
Windows, roof windows, and rooflights	1.5	1.4	GP 0F - Circulation_G_18
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	7

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Former ICL Pavillion

As designed

Date: Wed Jul 12 17:27:06 2017

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.3.a.0

Interface to calculation engine: DesignBuilder SBEM

Interface to calculation engine version: v5.0.3

BRUKL compliance check version: v6.3.a.0

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Donald Sinclair

Telephone number:

Address: , Harrow,

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	103.7
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	103.7
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	94.9
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{i\text{-}Limit}$	$U_{i\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	Pavillion 0F - Creche_W_9
Floor	0.25	0.09	0.13	Pavillion 0F - Office_S_3
Roof	0.25	0.15	0.15	Pavillion 0F - Reception_R_4
Windows***, roof windows, and rooflights	2.2	1.4	1.4	Pavillion 0F - Creche_G_10
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{i\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	7

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Gas Water and ASHP heating/cooling_Pavillion

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.59	4.6	-	-	-
Standard value	2.5*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- Gas HW Pavillion

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	0
Standard value	0.8	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Pavillion 0F - Creche	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Store	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Reception	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Changing	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Store	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Changing	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Cafe seating	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Bar Store	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - WC	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Kitchen	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Plant room	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Pavilion 1F - Kitchen	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavilion 1F - Store 1	-	-	-	-	-	-	-	-	-	-	N/A
Pavilion 1F - Bar	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavilion 1F - Community - Club rooms	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavilion 1F - Store 2	-	-	-	-	-	-	-	-	-	-	N/A
Pavilion 1F - WC	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavilion 1F - Store 3	-	-	-	-	-	-	-	-	-	-	N/A
Pavilion 1F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
Pavilion 1F - Store	-	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Pavilion 0F - Creche	110	-	-	175
Pavilion 0F - Store	110	-	-	8
Pavilion 0F - Office	110	-	-	109
Pavilion 0F - Reception	-	110	75	264
Pavilion 0F - Changing	-	110	-	142
Pavilion 0F - Circulation	-	110	-	44
Pavilion 0F - Office	110	-	-	97
Pavilion 0F - Store	110	-	-	8
Pavilion 0F - Changing	-	110	-	115
Pavilion 0F - Cafe seating	-	110	-	38
Pavilion 0F - Bar Store	110	-	-	13
Pavilion 0F - WC	-	110	-	88
Pavilion 0F - Kitchen	-	110	-	127
Pavilion 0F - Plant room	110	-	-	96
Pavilion 0F - Circulation	-	110	-	66
Pavilion 1F - Kitchen	-	110	-	279
Pavilion 1F - Store 1	110	-	-	8
Pavilion 1F - Bar	-	110	-	143
Pavilion 1F - Community - Club rooms	-	110	-	579
Pavilion 1F - Store 2	110	-	-	13
Pavilion 1F - WC	-	110	-	124
Pavilion 1F - Store 3	110	-	-	13
Pavilion 1F - Circulation	-	110	-	161
Pavilion 1F - Store	110	-	-	7

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Pavilion 0F - Creche	NO (-72.3%)	NO
Pavilion 0F - Store	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Pavilion 0F - Office	N/A	N/A
Pavilion 0F - Reception	NO (-54.5%)	NO
Pavilion 0F - Changing	NO (-95.7%)	NO
Pavilion 0F - Circulation	NO (-14.9%)	NO
Pavilion 0F - Office	N/A	N/A
Pavilion 0F - Store	N/A	N/A
Pavilion 0F - Changing	N/A	N/A
Pavilion 0F - Cafe seating	NO (-58.2%)	NO
Pavilion 0F - Bar Store	N/A	N/A
Pavilion 0F - WC	NO (-97.6%)	NO
Pavilion 0F - Kitchen	NO (-80.8%)	NO
Pavilion 0F - Plant room	NO (-86.3%)	NO
Pavilion 0F - Circulation	NO (-16.5%)	NO
Pavilion 1F - Kitchen	N/A	N/A
Pavilion 1F - Store 1	N/A	N/A
Pavilion 1F - Bar	NO (-67.1%)	NO
Pavilion 1F - Community - Club rooms	NO (-73%)	NO
Pavilion 1F - Store 2	N/A	N/A
Pavilion 1F - WC	NO (-98.4%)	NO
Pavilion 1F - Store 3	NO (-89.6%)	NO
Pavilion 1F - Circulation	NO (-45.6%)	NO
Pavilion 1F - Store	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	910.4	910.4
External area [m²]	1669.8	1669.8
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	7	3
Average conductance [W/K]	461.42	608.53
Average U-value [W/m²K]	0.28	0.36
Alpha value* [%]	18.02	13.87

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
96	**D1 Non-residential Institutions: Community/Day Centre**
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
4	**D1 Non-residential Institutions: Education**
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	3.93	6.86
Cooling	2.39	5.14
Auxiliary	3.97	1.95
Lighting	6.47	11.36
Hot water	400.02	420.8
Equipment*	24.44	24.44
TOTAL**	416.78	446.12

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	112	126.65
Primary energy* [kWh/m²]	536.2	589.15
Total emissions [kg/m²]	94.9	103.7

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type	Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity									
Actual	63.7	48.3	3.9	2.4	4	4.5	5.61	4.59	7.5
Notional	60	66.7	6.9	5.1	1.9	2.43	3.6	---	---

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.18	Pavillion 0F - Creche_W_9
Floor	0.2	0.05	Pavillion 0F - Reception_S_3
Roof	0.15	0.15	Pavillion 0F - Reception_R_4
Windows, roof windows, and rooflights	1.5	1.4	Pavillion 0F - Creche_G_10
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	7

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Former ICL Residents Facilities

As designed

Date: Wed Jul 12 17:32:06 2017

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.3.a.0

Interface to calculation engine: DesignBuilder SBEM

Interface to calculation engine version: v5.0.3

BRUKL compliance check version: v5.3.a.0

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Donald Sinclair

Telephone number:

Address: , Harrow,

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	42.3
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	42.3
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	31.4
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{k\text{-}Limit}$	$U_{k\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	Residents Facilities 0F - Circulation - Reception_W_8
Floor	0.25	0.08	0.13	Residents Facilities 0F - Reception_S_3
Roof	0.25	0.15	0.15	Residents Facilities 0F - Circulation - Reception_R_5
Windows***, roof windows, and rooflights	2.2	1.4	1.4	Residents Facilities 0F - Circulation - Reception_G_10
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{k\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{k\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	7

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Gas Water and ASHP heating/cooling

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.59	3.58	-	-	-
Standard value	2.5*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- Gas HW residents fac.

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	-
Standard value	0.8	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Residents Facilities 0F - Circulation - Reception	-	-	-	-	-	-	-	-	-	-	N/A
Residents Facilities 0F - Multi-function room	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Restaurant	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Bar	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Private Lounge	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Care Manager	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Reception	-	-	-	-	-	-	-	-	-	-	N/A
Residents Facilities 0F - Toilets	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Toilets	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Kitchen	-	-	-	-	-	-	-	-	0.5	-	N/A
Residents Facilities 0F - Residents shop-office	-	-	-	-	-	-	-	-	-	-	N/A
Residents Facilities 0F - Hairdressing	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Treatement	-	-	-	-	-	-	-	-	-	-	N/A
Residents Facilities 0F - Store	-	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Residents Facilities 0F - Circulation - Reception	-	110	-	302
Residents Facilities 0F - Multi-function room	-	110	-	446
Residents Facilities 0F - Restaurant	-	110	75	281
Residents Facilities 0F - Bar	-	110	75	187
Residents Facilities 0F - Private Lounge	-	110	-	152
Residents Facilities 0F - Care Manager	110	-	-	90
Residents Facilities 0F - Reception	-	110	75	58
Residents Facilities 0F - Toilets	-	110	-	103
Residents Facilities 0F - Toilets	-	110	-	88
Residents Facilities 0F - Kitchen	-	110	-	483
Residents Facilities 0F - Residents shop-office	110	-	-	218
Residents Facilities 0F - Hairdressing	-	110	-	71
Residents Facilities 0F - Treatement	110	-	-	127
Residents Facilities 0F - Store	110	-	-	9

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Residents Facilities 0F - Circulation - Reception	NO (-65.4%)	NO
Residents Facilities 0F - Multi-function room	NO (-65.3%)	NO
Residents Facilities 0F - Restaurant	NO (-17.7%)	NO
Residents Facilities 0F - Bar	NO (-12.3%)	NO
Residents Facilities 0F - Private Lounge	N/A	N/A
Residents Facilities 0F - Care Manager	NO (-67.5%)	NO
Residents Facilities 0F - Reception	N/A	N/A
Residents Facilities 0F - Toilets	N/A	N/A
Residents Facilities 0F - Toilets	NO (-83.1%)	NO
Residents Facilities 0F - Kitchen	NO (-81%)	NO
Residents Facilities 0F - Residents shop-office	NO (-79.5%)	NO
Residents Facilities 0F - Hairdressing	NO (-81.2%)	NO
Residents Facilities 0F - Treatement	NO (-72%)	NO
Residents Facilities 0F - Store	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	836.3	836.3
External area [m²]	1392.5	1392.5
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	7	3
Average conductance [W/K]	343.53	534.69
Average U-value [W/m²K]	0.25	0.38
Alpha value* [%]	24.07	14.66

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
35	**A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways**
9	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
16	**C2 Residential Institutions: Residential schools**
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
30	**D1 Non-residential institutions: Community/Day Centre**
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
2	**D1 Non-residential institutions: Primary Health Care Building**
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	2.97	6.73
Cooling	10.84	16.07
Auxiliary	16.16	13.58
Lighting	14.63	28.8
Hot water	40.95	43.11
Equipment*	61.11	61.11
TOTAL**	**85.56**	**108.28**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	247.97	287.08
Primary energy* [kWh/m²]	183.47	247.66
Total emissions [kg/m²]	31.4	42.3

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	48.2	199.8	3	10.8	16.2	4.5	5.12	4.59	6.85
	Notional	58.8	208.2	6.7	16.1	13.8	2.43	3.6	---	---

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}min}$	Surface where the minimum value occurs*
Wall	0.23	0.18	Residents Facilities 0F - Circulation - Reception_W_8
Floor	0.2	0.08	Residents Facilities 0F - Restaurant_S_3
Roof	0.15	0.15	Residents Facilities 0F - Circulation - Reception_R_5
Windows, roof windows, and rooflights	1.5	1.4	Residents Facilities 0F - Circulation - Reception_G_10
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	7

Appendix I

Be Green (ASHP and PV) BRUKL Worksheets (Non-Domestic)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Former ICL GP

As designed

Date: Wed Jul 12 17:20:41 2017

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.3.a.0

Interface to calculation engine: DesignBuilder SBEM

Interface to calculation engine version: v5.0.3

BRUKL compliance check version: v6.3.a.0

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Donald Sinclair

Telephone number:

Address: , Harrow,

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	27.9
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	27.9
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	17.7
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{k\text{-}Limit}$	$U_{k\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.17	0.18	GP 0F - Circulation_W_17
Floor	0.25	0.1	0.25	GP 1F - Circulation_F_4
Roof	0.25	0.15	0.15	GP 0F - Circulation_R_5
Windows***, roof windows, and rooflights	2.2	1.4	1.4	GP 0F - Circulation_G_18
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{k\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{k\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	7

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Gas Water and ASHP heating/cooling

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.59	3.58	-	-	-
Standard value	2.5*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- Gas HW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	0.001
Standard value	0.8	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
GP 0F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
GP 0F - Consultation 1	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Reception	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Consultation 2	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Interview office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Cleaner store	-	-	-	-	-	-	-	-	-	-	N/A
GP 0F - Toilets	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Lift	-	-	-	-	-	-	-	-	-	-	N/A
GP 0F - Consultation 3	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Pharmacy	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Physio - Baby clinic	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 0F - Consultation	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
GP 1F - General office 1	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Library	-	-	-	1.4	-	-	-	-	-	0.85	0.5

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
GP 1F - General Office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Meeting room	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Training	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Reception	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Store	-	-	-	-	-	-	-	-	-	-	N/A
GP 1F - Showers	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Practise manager office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Staff room	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Consultation 1	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Record store	-	-	-	-	-	-	-	-	-	-	N/A
GP 1F - Lift	-	-	-	-	-	-	-	-	-	-	N/A
GP 1F - Toilets	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Minor surgery	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Consultation	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Treatment	-	-	-	1.4	-	-	-	-	-	0.85	0.5
GP 1F - Utility store	-	-	-	-	-	-	-	-	-	-	N/A
Surgey GP 0F - Store	-	-	-	-	-	-	-	-	-	-	N/A
Surgey GP 0F - Plantroom	-	-	-	-	-	-	-	-	-	-	N/A
Surgey GP 0F - Circluation	-	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
GP 0F - Circulation	-	110	-	215
GP 0F - Consultation 1	110	-	-	549
GP 0F - Reception	-	110	75	211
GP 0F - Consultation 2	110	-	-	470
GP 0F - Interview office	110	-	-	116
GP 0F - Cleaner store	110	-	-	11
GP 0F - Toilets	-	110	-	66
GP 0F - Lift	-	110	-	14
GP 0F - Consultation 3	110	-	-	249
GP 0F - Pharmacy	110	-	-	600
GP 0F - Physio - Baby clinic	-	110	-	182
GP 0F - Consultation	110	-	-	145
GP 1F - Circulation	-	110	-	178
GP 1F - General office 1	110	-	-	126
GP 1F - Library	110	-	-	196
GP 1F - General Office	110	-	-	128
GP 1F - Meeting room	110	-	-	236
GP 1F - Training	110	-	-	185
GP 1F - Reception	-	110	75	110
GP 1F - Store	110	-	-	9

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
GP 1F - Showers	-	110	-	43
GP 1F - Practise manager office	110	-	-	128
GP 1F - Staff room	-	110	-	57
GP 1F - Consultation 1	110	-	-	128
GP 1F - Record store	110	-	-	14
GP 1F - Lift	-	110	-	11
GP 1F - Toilets	-	110	-	61
GP 1F - Minor surgery	-	110	-	288
GP 1F - Consultation	110	-	-	129
GP 1F - Treatment	110	-	-	425
GP 1F - Utility store	110	-	-	16
Surgey GP 0F - Store	110	-	-	165
Surgey GP 0F - Plantroom	110	-	-	466
Surgey GP 0F - Circluation	110	-	-	170

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GP 0F - Circulation	NO (-77%)	NO
GP 0F - Consultation 1	NO (-75.9%)	NO
GP 0F - Reception	NO (-49.3%)	NO
GP 0F - Consultation 2	NO (-82%)	NO
GP 0F - Interview office	N/A	N/A
GP 0F - Cleaner store	N/A	N/A
GP 0F - Toilets	N/A	N/A
GP 0F - Lift	N/A	N/A
GP 0F - Consultation 3	NO (-72.4%)	NO
GP 0F - Pharmacy	NO (-67.4%)	NO
GP 0F - Physio - Baby clinic	NO (-71.4%)	NO
GP 0F - Consultation	NO (-77.5%)	NO
GP 1F - Circulation	NO (-93.3%)	NO
GP 1F - General office 1	NO (-75.6%)	NO
GP 1F - Library	NO (-69.7%)	NO
GP 1F - General Office	NO (-74.4%)	NO
GP 1F - Meeting room	NO (-56%)	NO
GP 1F - Training	NO (-54.4%)	NO
GP 1F - Reception	NO (-51.2%)	NO
GP 1F - Store	N/A	N/A
GP 1F - Showers	NO (-86.3%)	NO
GP 1F - Practise manager office	NO (-82.8%)	NO
GP 1F - Staff room	NO (-80.4%)	NO
GP 1F - Consultation 1	NO (-71.7%)	NO
GP 1F - Record store	NO (-80.2%)	NO
GP 1F - Lift	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GP 1F - Toilets	NO (-79.4%)	NO
GP 1F - Minor surgery	NO (-71.8%)	NO
GP 1F - Consultation	NO (-79.4%)	NO
GP 1F - Treatment	NO (-77%)	NO
GP 1F - Utility store	NO (-65.3%)	NO
Surgey GP 0F - Store	N/A	N/A
Surgey GP 0F - Plantroom	N/A	N/A
Surgey GP 0F - Circluation	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1231.2	1231.2
External area [m²]	2159.6	2159.6
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	7	3
Average conductance [W/K]	554.12	908.7
Average U-value [W/m²K]	0.26	0.42
Alpha value* [%]	23.82	15.3

* Percentage of the buildings average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
10	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
17	**C2 Residential Institutions: Hospitals and Care Homes**
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
72	**D1 Non-residential Institutions: Primary Health Care Building**
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	2.78	7.07
Cooling	6.96	12.1
Auxiliary	12.85	8.81
Lighting	13.77	23.98
Hot water	7.36	7.53
Equipment*	41.91	41.91
TOTAL**	**43.72**	**59.49**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	4.47	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	173.33	218.63
Primary energy* [kWh/m²]	117.8	164.72
Total emissions [kg/m²]	17.7	27.9

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	45.1	128.2	2.8	7	12.8	4.5	5.12	4.59	6.85
	Notional	61.9	156.8	7.1	12.1	8.8	2.43	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}min}$	Surface where the minimum value occurs*
Wall	0.23	0.13	Surgey GP 0F - Store_W_7
Floor	0.2	0.08	GP 0F - Circulation_S_4
Roof	0.15	0.15	GP 0F - Circulation_R_5
Windows, roof windows, and rooflights	1.5	1.4	GP 0F - Circulation_G_18
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	7

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Former ICL Pavillion

As designed

Date: Wed Jul 12 17:25:58 2017

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.3.a.0

Interface to calculation engine: DesignBuilder SBEM

Interface to calculation engine version: v5.0.3

BRUKL compliance check version: v5.3.a.0

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Donald Sinclair

Telephone number:

Address: , Harrow,

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	103.7
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	103.7
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	76.3
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{e\text{-}Limit}$	$U_{e\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	Pavillion 0F - Creche_W_9
Floor	0.25	0.09	0.13	Pavillion 0F - Office_S_3
Roof	0.25	0.15	0.15	Pavillion 0F - Reception_R_4
Windows***, roof windows, and rooflights	2.2	1.4	1.4	Pavillion 0F - Creche_G_10
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{e\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{e\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	7

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Gas Water and ASHP heating/cooling_Pavillion

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.59	4.6	-	-	-
Standard value	2.5*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- Gas HW Pavillion

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	0
Standard value	0.8	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Pavillion 0F - Creche	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Store	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Reception	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Changing	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Office	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Store	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Changing	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Cafe seating	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Bar Store	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - WC	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Kitchen	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 0F - Plant room	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 0F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Pavillion 1F - Kitchen	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 1F - Store 1	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 1F - Bar	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 1F - Community - Club rooms	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 1F - Store 2	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 1F - WC	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Pavillion 1F - Store 3	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 1F - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
Pavillion 1F - Store	-	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Pavillion 0F - Creche	110	-	-	175
Pavillion 0F - Store	110	-	-	8
Pavillion 0F - Office	110	-	-	109
Pavillion 0F - Reception	-	110	75	264
Pavillion 0F - Changing	-	110	-	142
Pavillion 0F - Circulation	-	110	-	44
Pavillion 0F - Office	110	-	-	97
Pavillion 0F - Store	110	-	-	8
Pavillion 0F - Changing	-	110	-	115
Pavillion 0F - Cafe seating	-	110	-	38
Pavillion 0F - Bar Store	110	-	-	13
Pavillion 0F - WC	-	110	-	88
Pavillion 0F - Kitchen	-	110	-	127
Pavillion 0F - Plant room	110	-	-	96
Pavillion 0F - Circulation	-	110	-	66
Pavillion 1F - Kitchen	-	110	-	279
Pavillion 1F - Store 1	110	-	-	8
Pavillion 1F - Bar	-	110	-	143
Pavillion 1F - Community - Club rooms	-	110	-	579
Pavillion 1F - Store 2	110	-	-	13
Pavillion 1F - WC	-	110	-	124
Pavillion 1F - Store 3	110	-	-	13
Pavillion 1F - Circulation	-	110	-	161
Pavillion 1F - Store	110	-	-	7

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Pavillion 0F - Creche	NO (-72.3%)	NO
Pavillion 0F - Store	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Pavillion 0F - Office	N/A	N/A
Pavillion 0F - Reception	NO (-54.5%)	NO
Pavillion 0F - Changing	NO (-95.7%)	NO
Pavillion 0F - Circulation	NO (-14.9%)	NO
Pavillion 0F - Office	N/A	N/A
Pavillion 0F - Store	N/A	N/A
Pavillion 0F - Changing	N/A	N/A
Pavillion 0F - Cafe seating	NO (-58.2%)	NO
Pavillion 0F - Bar Store	N/A	N/A
Pavillion 0F - WC	NO (-97.6%)	NO
Pavillion 0F - Kitchen	NO (-80.8%)	NO
Pavillion 0F - Plant room	NO (-86.3%)	NO
Pavillion 0F - Circulation	NO (-16.5%)	NO
Pavillion 1F - Kitchen	N/A	N/A
Pavillion 1F - Store 1	N/A	N/A
Pavillion 1F - Bar	NO (-67.1%)	NO
Pavillion 1F - Community - Club rooms	NO (-73%)	NO
Pavillion 1F - Store 2	N/A	N/A
Pavillion 1F - WC	NO (-96.4%)	NO
Pavillion 1F - Store 3	NO (-89.6%)	NO
Pavillion 1F - Circulation	NO (-45.6%)	NO
Pavillion 1F - Store	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	910.4	910.4
External area [m²]	1669.8	1669.8
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	7	3
Average conductance [W/K]	461.42	608.53
Average U-value [W/m²K]	0.28	0.36
Alpha value* [%]	18.02	13.87

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
96	**D1 Non-residential Institutions: Community/Day Centre**
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
4	**D1 Non-residential Institutions: Education**
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	3.93	6.86
Cooling	2.39	5.14
Auxiliary	3.97	1.95
Lighting	6.47	11.36
Hot water	400.02	420.8
Equipment*	24.44	24.44
TOTAL**	**416.78**	**446.12**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	35.79	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	112	126.65
Primary energy* [kWh/m²]	538.2	589.15
Total emissions [kg/m²]	78.3	103.7

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	63.7	48.3	3.9	2.4	4	4.5	5.61	4.59	7.5
	Notional	60	66.7	6.9	5.1	1.9	2.43	3.6	---	---

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Page 5 of 7

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.18	Pavilion 0F - Creche_W_9
Floor	0.2	0.05	Pavilion 0F - Reception_S_3
Roof	0.15	0.15	Pavilion 0F - Reception_R_4
Windows, roof windows, and rooflights	1.5	1.4	Pavilion 0F - Creche_G_10
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	7

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Former ICL Residents Facilities

As designed

Date: Wed Jul 12 17:30:48 2017

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.3.a.0

Interface to calculation engine: DesignBuilder SBEM

Interface to calculation engine version: v5.0.3

BRUKL compliance check version: v5.3.a.0

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Donald Sinclair

Telephone number:

Address: , Harrow,

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	42.3
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	42.3
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	27.2
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{k\text{-}Limit}$	$U_{k\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	Residents Facilities 0F - Circulation - Reception_W_8
Floor	0.25	0.08	0.13	Residents Facilities 0F - Reception_S_3
Roof	0.25	0.15	0.15	Residents Facilities 0F - Circulation - Reception_R_5
Windows***, roof windows, and rooflights	2.2	1.4	1.4	Residents Facilities 0F - Circulation - Reception_G_10
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{k\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{k\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	7

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Gas Water and ASHP heating/cooling

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.59	3.58	-	-	-
Standard value	2.5*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- Gas HW residents fac.

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	-
Standard value	0.8	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Residents Facilities 0F - Circulation - Reception	-	-	-	-	-	-	-	-	-	-	N/A
Residents Facilities 0F - Multi-function room	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Restaurant	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Bar	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Private Lounge	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Care Manager	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Reception	-	-	-	-	-	-	-	-	-	-	N/A
Residents Facilities 0F - Toilets	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Toilets	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Kitchen	-	-	-	-	-	-	-	-	0.5	-	N/A
Residents Facilities 0F - Residents shop-office	-	-	-	-	-	-	-	-	-	-	N/A
Residents Facilities 0F - Hairdressing	-	-	-	1.4	-	-	-	-	-	0.85	0.5
Residents Facilities 0F - Treatement	-	-	-	-	-	-	-	-	-	-	N/A
Residents Facilities 0F - Store	-	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Residents Facilities 0F - Circulation - Reception	-	110	-	302
Residents Facilities 0F - Multi-function room	-	110	-	446
Residents Facilities 0F - Restaurant	-	110	75	281
Residents Facilities 0F - Bar	-	110	75	187
Residents Facilities 0F - Private Lounge	-	110	-	152
Residents Facilities 0F - Care Manager	110	-	-	90
Residents Facilities 0F - Reception	-	110	75	58
Residents Facilities 0F - Toilets	-	110	-	103
Residents Facilities 0F - Toilets	-	110	-	88
Residents Facilities 0F - Kitchen	-	110	-	483
Residents Facilities 0F - Residents shop-office	110	-	-	218
Residents Facilities 0F - Hairdressing	-	110	-	71
Residents Facilities 0F - Treatement	110	-	-	127
Residents Facilities 0F - Store	110	-	-	9

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Residents Facilities 0F - Circulation - Reception	NO (-65.4%)	NO
Residents Facilities 0F - Multi-function room	NO (-65.3%)	NO
Residents Facilities 0F - Restaurant	NO (-17.7%)	NO
Residents Facilities 0F - Bar	NO (-12.3%)	NO
Residents Facilities 0F - Private Lounge	N/A	N/A
Residents Facilities 0F - Care Manager	NO (-67.5%)	NO
Residents Facilities 0F - Reception	N/A	N/A
Residents Facilities 0F - Toilets	N/A	N/A
Residents Facilities 0F - Toilets	NO (-83.1%)	NO
Residents Facilities 0F - Kitchen	NO (-81%)	NO
Residents Facilities 0F - Residents shop-office	NO (-79.5%)	NO
Residents Facilities 0F - Hairdressing	NO (-81.2%)	NO
Residents Facilities 0F - Treatement	NO (-72%)	NO
Residents Facilities 0F - Store	N/A	N/A

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	836.3	836.3
External area [m²]	1392.5	1392.5
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	7	3
Average conductance [W/K]	343.53	534.69
Average U-value [W/m²K]	0.25	0.38
Alpha value* [%]	24.07	14.66

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
35	**A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways**
9	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
16	**C2 Residential Institutions: Residential schools**
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
30	**D1 Non-residential Institutions: Community/Day Centre**
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
2	**D1 Non-residential Institutions: Primary Health Care Building**
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	2.97	6.73
Cooling	10.84	16.07
Auxiliary	16.16	13.58
Lighting	14.63	28.8
Hot water	40.95	43.11
Equipment*	61.11	61.11
TOTAL**	**85.56**	**108.28**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	8.1	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	247.97	267.08
Primary energy* [kWh/m²]	183.47	247.66
Total emissions [kg/m²]	27.2	42.3

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	48.2	199.8	3	10.8	16.2	4.5	5.12	4.59	6.85
	Notional	58.8	208.2	6.7	16.1	13.6	2.43	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.18	Residents Facilities 0F - Circulation - Reception_W_8
Floor	0.2	0.08	Residents Facilities 0F - Restaurant_S_3
Roof	0.15	0.15	Residents Facilities 0F - Circulation - Reception_R_5
Windows, roof windows, and rooflights	1.5	1.4	Residents Facilities 0F - Circulation - Reception_G_10
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	7

Appendix J
SAP 2012 PV Calculation

Photovoltaic Generation

PV Array 1			
Required Roof Area	904 m^2	Peak Power Output	113.00 kWp
Overshading	None	Solar Radiation	951 kWh/m^2
Angle from North	180 °	Energy Generation	85,936 kWh/year
Pitch from Horizontal	0 °	CO_2 Emissions Offset	44,601 kg CO_2/year

Appendix K
Low and Zero Carbon Technologies

APPENDIX K: LOW CARBON AND RENEWABLE ENERGY TECHNOLOGIES

1. INTRODUCTION

> This Appendix is intended to provide the background information for the low carbon and renewable energy technologies that have been considered in the formulation of this Energy Statement.

> The information provided here forms the basis for the project specific technical selection of low carbon/renewable energy technologies contained in the main section of this Energy Statement.

2. COMBINED HEAT AND POWER (CHP)

> CHP is a form of decentralised energy generation that generally uses gas to generate electricity for local consumption, reducing the need for grid electricity and its associated high CO_2 emissions. As the CHP system is close to the point of energy demand, it is possible to use the heat that is generated during the electricity generation process. As both the electricity and heat from the generator is used, the efficiency of the system is increased above that of a conventional power plant where the heat is not utilised.

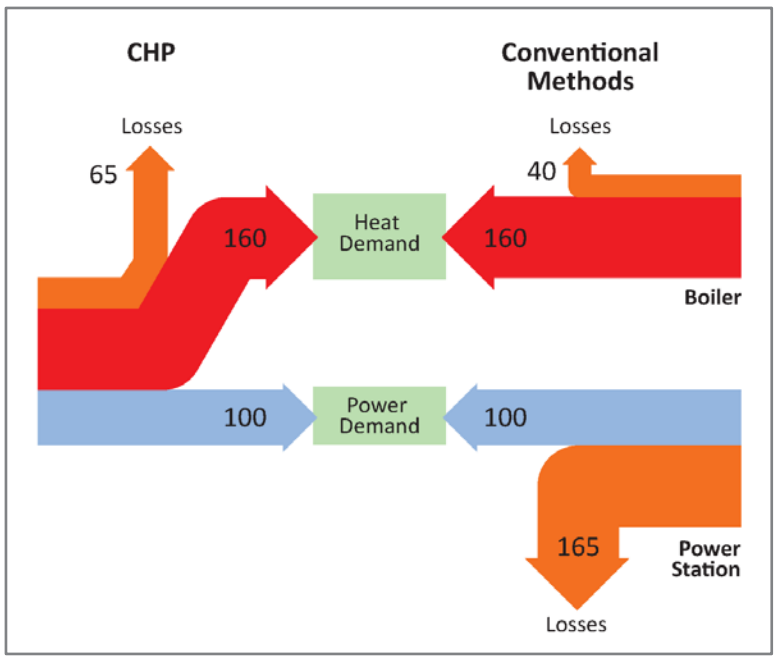

Diagram 1 – CHP Diagram

> However, the overall efficiency of ~80% is still lower than the ~90% efficiency of a heat only gas boiler.

> Where there are high thermal loads, CHP can be used within district heating networks to supply the required heat.

> **Performance and Calculation Methodology: -**

  > Most commonly sized on the heat load of a development, not the electrical load. This prevents an over-generation of heat.

  > Require a high and relatively constant heat demand to be viable.

  > CHP engines are best suited to providing the base heating load of a development (~year round hot water demand) with conventional gas boilers responding to the peak heating demand (~winter space heating). CHP engines are not able to effectively respond to peaks in demand.

- In general, CHP engines have an electrical efficiency of ~30% and a thermal efficiency of ~45%. Larger engines have a better heat to power ratio and are therefore able to reduce CO_2 emissions by greater amount.
- Electricity produced by the CHP engine displaces grid electricity which is given a carbon intensity of 0.519 kg per kWh.

- **Capital Cost: -**
  - Around £1,000 per kW of electrical output.
  - Relative cost reduces as the size of engine increases.
  - Generally best suited to larger sites, where there is a suitable economy of scale.
- **Running Costs/Savings: -**
  - CHP engines often struggle to provide cost-effective energy to dwellings on smaller residential schemes compared to conventional individual gas boilers.
  - Onsite use of CHP generated electricity; power Purchase Agreement with electricity Supply Company or Private Wire arrangement to local large non-domestic demand enhances economic case.
- **Land Use Issues and Space Required: -**
  - CHP engines require a plant room, and possibly an energy centre for large residential developments.
  - CHP engines require a flue to effectively disperse pollutants. This is best to rise to a minimum of 2m above the roofline of the tallest building.
  - Route for district heating pipe around the site must be safeguarded.
- **Operational Impacts/Issues: -**
  - Often run by Energy Services Company (ESCo) who maybe unenthusiastic about getting involved in small – medium scale schemes.
  - Can also be run in-house with specialist maintenance and customer services activities contracted out.
  - Issues with rights to dig up roads for district heating networks.
  - Emissions of oxides of nitrogen – ~500mg/kWh – 10 times higher than for a gas boiler. Specialist technologies exist (e.g. selective catalytic reduction) to reduce this to ~20mg/kWh if air quality issues require.
- **Embodied Energy:** - Comparable to that of a conventional gas boiler.
- **Funding Opportunities: -**
  - Tax relief for businesses under the Enhanced Capital Allowances scheme..
- **Reductions in Energy Achievable: -** Can provide some reductions in effective primary energy, but when distribution losses and other local losses are included more fuel is required.

- **Reductions in CO_2 Achievable: -** Can provide greater reductions in CO_2 than energy, aided by the emissions factor of grid displaced electricity of 0.519 kg CO_2/kWh. CO_2 reduction increase as size of engine increases.
- **Advantages: -**
    - Good reductions in overall primary energy and CO_2 emissions.
    - Most cost effective and appropriate strategy to achieve substantial CO_2 reductions on large schemes.
- **Disadvantages: -**
    - On smaller schemes often do not supply energy cost-effectively in comparison to conventional individual gas boilers.
    - Requires sale of generated electricity to maximise cost effectiveness.

Application: - Best suited to larger developments.

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3. COMBINED COOLING HEAT AND POWER (CCHP)

- CCHP is a CHP system which additionally has the facility to transform heat into energy for cooling. This is done with an absorption chiller which utilises a heat source to provide the energy needed to drive a cooling system. As absorption chillers are far less efficient than conventional coolers (CoP of 0.7 compared to >4) they are generally only used where there is a current excess generation of heat. New CHP systems are generally sized to provide the year round base heating load only.
- For this reason it is generally not suitable for new CHP systems to include cooling.
- Where there are high thermal loads, CCHP can be used within district heating and cooling networks to supply the required heat and coolth.
- **Performance and Calculation Methodology: -**
    - Most commonly sized on the heat load of a development, not the electrical load. This prevents an over-generation of heat.
    - Require a high and relatively constant heat and cooling demand to be viable.
    - CCHP systems are best suited to providing the base loads of a development with conventional gas boilers and chillers responding to the peak demands. CCHP systems are not able to effectively respond to peaks in demand.

- In general, CHP engines have an electrical efficiency of ~30% and a thermal efficiency of ~45%.
- Absorption chillers have a CoP of ~0.7.
- Electricity produced by the CHP engine displaces grid electricity which is given a carbon intensity of 0.519 kg per kWh.

- **Capital Cost: -**
  - High in comparison to biomass boilers and increased further by inclusion of absorption chiller.
- **Running Costs/Savings: -**
  - Coolth from absorption chillers is more expensive than from conventional systems unless heat used is genuine waste heat.
- **Land Use Issues and Space Required: -**
  - CCHP systems require a plant room, and possibly an energy centre for large residential developments.
  - CHP engines require a flue to effectively disperse pollutants. This is best to rise to a minimum of 2m above the roofline of the tallest building. Additionally the absorption chiller requires either a cooling tower or dry cooler bed for heat rejection purposes.
  - Heating and cooling distribution pipework required around the site.
- **Operational Impacts/Issues: -**
  - Often run by an ESCo who are unenthusiastic about getting involved in small – medium scale schemes.
  - Can also be run in-house with specialist maintenance and customer services activities contracted out.
  - Issues with rights to dig up roads for heat networks.
  - Emissions of oxides of nitrogen– ~500mg/kWh – 10 times higher than for gas boilers. Specialist technologies exist (e.g. selective catalytic reduction) to reduce this ~20mg/kWh if air quality issues require.
  - Rejection of heat is higher than for conventional cooling, thus enforcing the urban heat island effect.
  - Embodied Energy: - Comparable to conventional gas boilers.
- **Funding Opportunities: -**
  - Tax relief for businesses under Enhanced Capital Allowance scheme.
  - Reductions in Energy Achievable: - Absorption cooling generally requires more energy than conventional chillers.

- Reductions in CO_2 Achievable: - Can provide greater reductions in CO_2 than energy, aided by the emissions factor of grid displaced electricity of 0.519 kg CO_2/kWh.

- **Advantages: -**
  - Reasonable reductions in overall primary energy and CO_2 emissions.
  - Disadvantages: - More expensive to install than conventional chillers.
  - Operational costs higher than for conventional chillers.
- **Application: -** Best suited where there is genuine waste heat available.

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4. BIOMASS BOILERS

- Biomass boilers generate heat on a renewable basis as they are run on biomass fuel which is almost carbon neutral. Fuel is generally wood chip or wood pellets. Wood pellets are slightly more expensive than wood chips but have a significantly higher calorific value and enable greater automation of the system.
- Various other suitable fuels are available including organic materials including straw, dedicated energy crops, sewage sludge and animal litter. Each fuel tends to have its own advantages dependant on site requirements.
- Can be used with district heating networks or as individual boilers on a house-by-house basis.
- **Performance and Calculation Methodology: -**
  - Biomass boilers are best suited to providing the base heating load of a development (~year round hot water demand) with conventional gas boilers responding to the peak heating demand (~winter space heating).
  - Operate with an efficiency of around 90%.
  - Small models available.
  - Conflicts with CHP they are both best suited to providing the base heating load of a development. As such they should not be installed in tandem unless surplus hot water capacity is available. Special control measures would be required in this case.
- **Capital Cost: -**
  - Low in comparison to CHP.
  - More suitable to smaller developments than CHP as installed cost is lower.

- **Running Costs/Savings: -**
  - Biomass fuel is more expensive than gas and as such heat being provided to dwellings is generally more expensive than alternatives.
- **Land Use Issues and Space Required: -**
  - Biomass boilers require a plant room and possibly separate energy centre for large residential developments.
  - Require a flue to effectively disperse pollutants. This is best to rise to a minimum of 2m above the roofline of the tallest building. Additionally the absorption chiller requires either a cooling tower or dry cooler bed for heat rejection purposes.
  - Fuel store will be required. This should be maximised to reduce fuel delivery frequency.
  - Space must be available for delivery vehicle to park close to plant room.
  - Route for district heating pipe around the site must be safeguarded.
- **Operational Impacts/Issues: -**
  - Normally run on biomass, but can also work with biogas.
  - Require some operational support and maintenance.
  - Fuel deliveries required.
  - Boiler and fuel store must be sited in proximity to space for delivery vehicle to park.
  - Issues with rights to dig up roads, etc (for heat networks).
  - Emissions of oxides of nitrogen – ~80-100mg/kWh.
  - Emissions of particulate matter. To minimise this ceramic filter systems are required.
  - Embodied Energy: - Comparable to conventional gas boiler.
- **Funding Opportunities: -**
  - Renewable Heat Incentive (RHI) provides incentive funds to developers of small or medium installations with a reasonable heat load that meet a minimum energy efficiency standard & meet the RHI eligibility criteria.
  - Reductions in Energy Achievable: - No reduction in energy demand, but energy generated from a renewable fuel. Significant long term running costs (fuel).
  - Reductions in CO_2 Achievable: - Can provide significant reductions in CO_2, but generally limited by the hot water load (base heating load).
  - Advantages: - Reductions in CO_2 at low installed cost.

- **Disadvantages: -**
  - High long-term running costs, unless receiving RHI.
  - Often do not supply energy cost-effectively in comparison to gas boilers.

5. SOLAR THERMAL PANELS

- Solar Thermal Heating Systems contribute to the hot water demand of a dwelling or building. Water or glycol (heat transfer fluid) is circulated to roof level where it is heated using solar energy before being returned to a thermal store in the plant room where heat is exchanged with water from the conventional system. Due to the seasonal availability of heat, solar thermal panels should be scaled to provide no more than 1/2 of the hot water load.

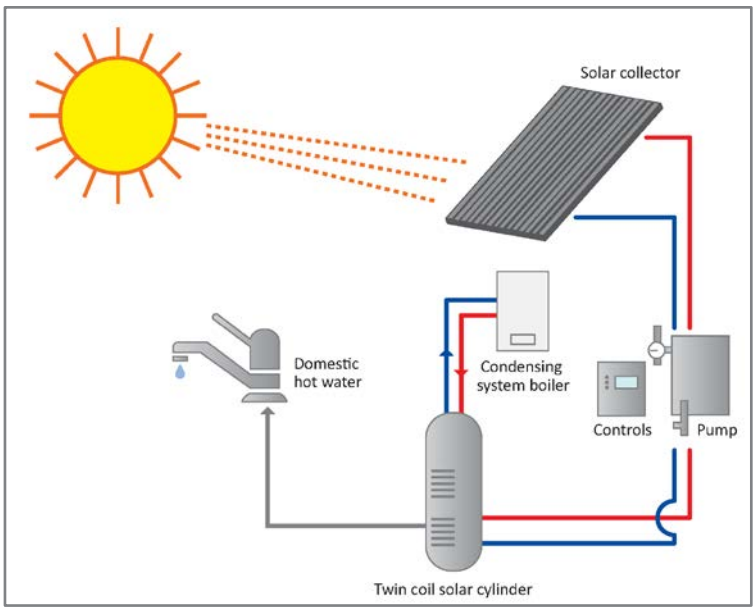

Diagram 2 – Solar Thermal System

- Can also be used to provide energy for space heating in highly insulated dwellings.
- There are two types of solar thermal panel: evacuated tube collectors and flat plate collectors.
- **Performance and Calculation Methodology: -**
  - Evacuated Tube Collectors: ~60% efficiency.
  - Flat Plate Collectors: ~50% efficiency.
  - SAP Table H2 used for solar irradiation at different angles.

- Operate best on south facing roofs angled at 30-450 and free of shading, or on flat roofs on frames. East/West facing panels suffer a loss in performance of 15-20% depending on the angle of installation.
- Flat plate collectors cannot be installed horizontally as this would prevent operation of the water pump. Must therefore be angled and separated to avoid overshadowing each other.

- **Capital Cost: -** Typically £2,500 per 4m^2 plus installation. Costs higher for evacuated tubes than flat plate collectors.
- **Running Costs/Savings: -**
  - Reduce reliance on gas and therefore reduce costs.
  - Payback period of ~20 years per dwelling.
- **Land Use Issues and Space Required: -**
  - Installed on roof so no impact on land use.
  - Requires hot water cylinders in dwellings.
  - Due to amount of roof space required and distance from tank to panels, less suitable for dense developments of relatively high rise flats.
  - Within permitted development rights unless in a conservation area where they must not be visible from the public highways.
  - Dormer and Velux windows may conflict if energy/CO_2 reduction required is large.
- **Operational Impacts/Issues:** - Biggest reductions achieved by people who operate their hot water system with consideration of the panels.
  - Embodied Energy: - Carbon payback is ~2 years.
  - Funding Opportunities: - none
- **Reductions in Energy Achievable:** - Reduce primary energy demand by more per standard panel area than solar PV panels.
  - Reductions in CO_2 Achievable: - Comparable to solar PV per m^2.
- **Advantages: -** Virtually free fuel, low maintenance and reductions in energy/CO_2.
- **Disadvantages: -** Benefits limited to maximum ~50% of hot water load.
  - Higher Costs in comparison to PV
- **Application: -** Best suited for small to medium housing developments ~1-100

6. SOLAR PHOTOVOLTAIC (PV) PANELS

- Solar PV panels generate electricity by harnessing the power of the sun. They convert solar radiation into electricity which can be used on site or exported to the grid in times of excess generation.
- **Performance and Calculation Methodology: -**
  - The best PV panels operate with an efficiency approaching 20%. ~7m^2 of these high performance panels will produce 1kWp of electricity.
  - Operate best on south facing roofs angled at 30-450 or on flat roofs on frames. Panels orientated east/west suffer from a loss in performance of 15-20% depending on the angle of installation.
  - Must be free of any potential shading.
  - Cannot be installed horizontally as would prevent self-cleaning. Must therefore be angled and separated to avoid overshadowing each other.
  - Electricity produced displaces grid electricity which has a carbon intensity of 0.519 kg CO_2 per kWh.
- **Capital Cost:** - ~£2,000 per kWp.
- **Running Costs/Savings: -**
  - Reduce reliance on grid electricity and therefore reduce running costs.
  - At current electricity prices, payback period of ~60-70 years per dwelling.
  - Feed-in tariff and Renewables Obligation Certificates (ROCs) payments required for maximum financial benefit.
- **Land Use Issues and Space Required: -**
  - Installed on roof so no impact on land use.
  - Due to amount of roof space required are less suitable for dense developments of relatively high rise flats.
  - Within permitted development rights unless in a conservation area where they must not be visible from the public highways.
  - Dormer and Velux windows may conflict if energy/CO_2 reduction required is large.
- **Operational Impacts/Issues: -**
  - Proportionately large arrays may need electrical infrastructure upgrade.

- Virtually maintenance free and panels are self-cleaning at angles in excess of 10 degrees.
- Provision for access to solar panels installed on flat roofs needs to be incorporated into the design of PV arrays layout as well as inclusion of spaces for inverters within the development.
- Quality of PV panels varies dramatically.

- **Embodied Energy: -** Carbon payback of 2-5 years.
- **Funding Opportunities: -** Financier utilising Feed-in-Tariffs.
- **Reductions in Energy Achievable:** - Reduce energy demand by less per m^2 than solar thermal panels.
- **Reductions in CO_2 Achievable:** - Provide greater percentage reductions in CO_2 than energy. Comparable to solar thermal per square metre.
- **Advantages: -** Virtually free fuel, very low maintenance and good reductions in CO_2.
  - Cheaper in comparison to solar thermal panels.
- **Disadvantages: -**
  - Slightly greater loss in performance than solar thermal panels when orientated away from south.
- **Application:** Best suited for a variety of developments from single houses to multi apartment blocks and even whole estates.

7. GROUND SOURCE HEAT PUMPS (GSHPS)

- Ground Source Heat Pumps work in much the same way as a refrigerator, converting low grade heat from a large 'reservoir' into higher temperature heat for input in a smaller space. Electricity drives the pump which circulates a fluid (water/antifreeze mix or refrigerant) through a closed loop of underground pipe. This fluid absorbs the solar

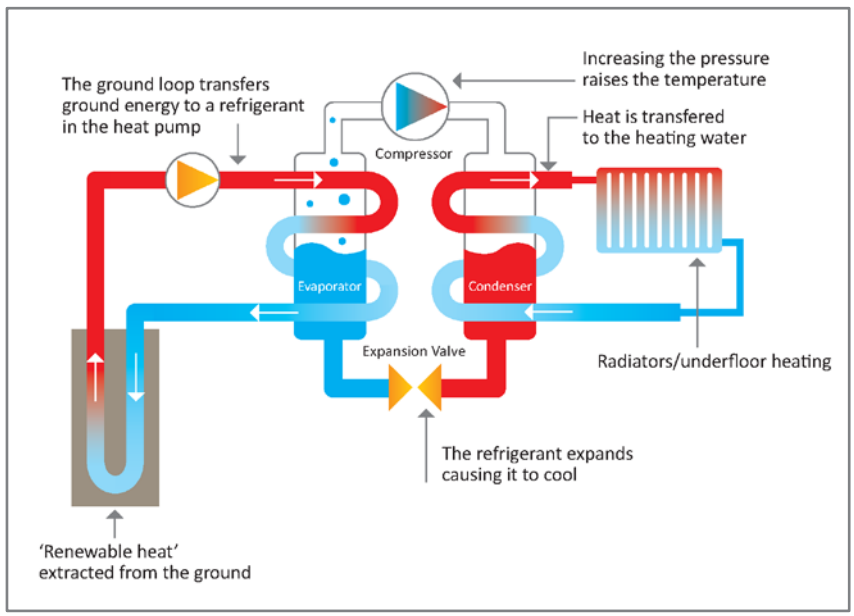

Diagram 3 – Ground Source Heat Pump

energy that is stored in the earth (which in the UK remains at a near constant temperature of 12oC throughout the year) and carries it to a pump. A compressor in the heat pump upgrades the temperature of the fluid which can then be used for space heating and hot water.

- **Performance and Calculation Methodology: -**
  - System requires electricity to drive the pump. Therefore displaces gas heating with electric, which has higher carbon intensity (gas: 0.216; electricity: 0.519).
  - As they are upgrading heat energy from the earth, GSHPs operate at 'efficiencies' in excess of 350%. This is limited in SAP unless Appendix Q rated model used.
  - Due to the lower temperature of the output of GSHPs compared to traditional gas boilers, GSHPs work best in well insulated buildings and with underfloor heating. They can, however, also be installed with oversized radiators, albeit with a consequent reduction in performance.
- **Capital Cost: -** ~£7,500 per house. Additional costs if underfloor heating is to be installed.
- **Running Costs/Savings: -**
  - Electricity more expensive than gas, thus fuel costs not reduced as much as energy is reduced.
  - Payback period of ~20 years per dwelling.
- **Land Use Issues and Space Required: -**
  - Require extensive ground works to bury the coils that extract the low grade heat from the earth. They therefore require a large area for horizontal burial (40-100m long trench) or a vertical bore (50-100m) which is considerably more expensive but can be used where space is limited.
  - Best suited to new developments that have provision for large ground works already in place, to minimise ground work costs.
  - Must be sized correctly to prevent freezing of the ground during winter and consequent shutdown of the system.
  - May require planning permission for engineering works. Once buried, there is no external evidence of the GSHPs.
- **Operational Impacts/Issues: -**
  - Work best in well insulated houses.
  - Need immersion backup for hot water.

- Highly reliable and require virtually no maintenance.
- Problems if ground bore fails.

- **Embodied Energy:** - Low, but as gas is being replaced with the more carbon intensive electricity, carbon payback is slowed. Carbon payback depends on CoP.
- **Funding Opportunities:** - Renewable Heat Incentive (RHI) provides incentive funds to developers of small or medium installations with a reasonable heat load that meet a minimum energy efficiency standard & meet the RHI eligibility criteria.
- **Reductions in Energy Achievable:** - Reduce energy demand by less per m^2 than solar thermal panels.
- **Reductions in CO_2 Achievable: -** Provide greater %age reductions in CO_2 than energy. Comparable to solar thermal (esp. in SAP).
- **Advantages:** - Large reductions in Energy. Currently receives benefit from SAP of an electrical baseline rather than gas.
- **Disadvantages: -**
  - Small reduction in CO_2. CoP limited in SAP. Only small cost savings.
  - GSHPs are not entirely a 'renewable' technology as they require electricity to drive their pumps or compressors.
- **Application: -** Best suited for small to medium developments ~1-100

8. AIR SOURCE HEAT PUMPS (ASHPS)

- Air Source Heat Pumps work in much the same way as a refrigerator, converting low grade heat from a large 'reservoir' into higher temperature heat for input into a smaller space. Electricity drives the pump which extracts heat from the air as it flows over the coils in the heat pump unit. A compressor in the heat pump upgrades the temperature of the extracted energy which can then be used for space heating and hot water.

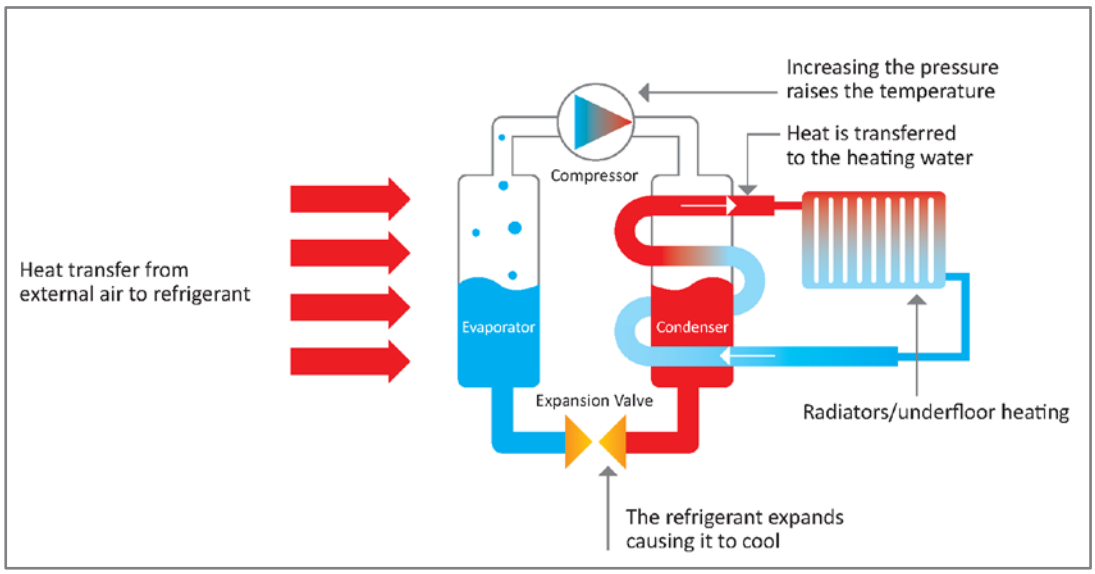

Diagram 4 – Air Source Heat Pump

- Generally ASHPs are air-to-water devices but can also be air-to-air.
- **Performance and Calculation Methodology: -**
  - System requires electricity to drive the pump. Therefore displaces gas heating with electric, which has higher carbon intensity (gas: 0.216; electricity: 0.519).
  - Performance defined by the Coefficient of Performance (CoP) which is a measure of electricity input to heat output. However, the concept of a CoP must be treated with caution as it is an instantaneous measurement and does not take account of varying external conditions throughout the year.
  - As they are upgrading heat energy from the air, ASHPs operate at 'efficiencies' in excess of 250%. This is limited in SAP unless an Appendix Q rated model is used.
  - British winter conditions (low temperatures and high humidity) lead to freezing of external unit. Reverse cycling defrosts the ASHP, but can substantially reduce performance when it is most needed. Performance under these conditions varies considerably between models. Vital that ASHP that has been proven in British winter conditions is installed.
  - Due to the lower temperature of the output of ASHPs compared to traditional gas boilers, ASHPs work best in well insulated buildings and with underfloor heating. They can, however, also be installed with oversized radiators, albeit with a consequent reduction in performance.
- **Capital Cost: -** ~£2,000 per house.
- **Running Costs/Savings: -**
  - Electricity more expensive than gas, thus fuel costs not reduced as much as energy is reduced.
  - Payback period of ~10 years per dwelling.
- **Land Use Issues and Space Required: -**
  - No need for external ground works, only a heat pump unit for the air to pass through.
  - Minimal external visual evidence.
- **Operational Impacts/Issues: -**
  - Work best in well insulated houses.
  - Unit must be sized correctly for each dwelling.
  - Vital that ASHP model selected has been proven to maintain performance at the low temperature and high humidity conditions of the British winter.

- May need immersion backup for hot water.
- Highly reliable and require virtually no maintenance.
- Noise from ASHPs must be below 42 dB at a position one metre external to the centre point of any door or window in a habitable room. According to planning standards MCS020.

- **Embodied Energy:** - Low. Carbon payback longer than for GSHPs as the CoP is lower.
- **Funding Opportunities:** - Renewable Heat Incentive (RHI) provides incentive funds to developers of small or medium installations with a reasonable heat load that meet a minimum energy efficiency standard & meet the RHI eligibility criteria.
- **Reductions in Energy Achievable: -** Large reductions in energy demand. Less so than GSHPs.
- **Reductions in CO_2 Achievable:** - Provide smaller percentage reductions in CO_2 than energy. Less than GSHPs.
- **Advantages:** - Large reductions in Energy. Currently receives benefit from SAP of an electrical fuel factor rather than a gas baseline.
- **Disadvantages: -**
  - Small reduction in CO_2 CoP limited in SAP. Only small cost savings.
  - ASHPs are not entirely a 'renewable' technology as they require electricity to drive their pumps or compressors.
- **Application: -** Best suited for small to medium developments ~1-100

9. WIND POWER

- Wind energy installations can range from small domestic turbines (1kW) to large commercial turbines (140m tall, 2MW). There are also different designs and styles (horizontal or vertical axis; 1 blade to multiple blades) to suit the location. They generate clean electricity that can be provided for use on-site, or sold directly to the local electricity network
- **Performance and Calculation Methodology: -**
  - Power generated is proportional to the cube of the wind speed. Therefore, wind speed is critical.
  - Horizontal axis turbines require >~6m/s to operate effectively and vertical axis turbines require >~4.5m/s. The rated power of a turbine is often for wind speeds double these figures.
  - Wind speeds for area from BERR's Wind Speed Database.
  - Electricity produced displaces grid electricity which has a carbon intensity of 0.568 kg/kWh.

- **Capital Cost: -**
  - ~£1,000 per kW. Smaller models are more expensive per kW.
  - Vertical axis turbines more expensive than horizontal.
- **Running Costs/Savings: -**
  - Reduce reliance on grid electricity and therefore reduce costs.
  - Payback period of ~15-20 years per dwelling.
  - Feed-in tariff and ROC payments required for maximum financial benefit.
- **Land Use Issues and Space Required: -**
  - Smaller models (<6kW) can be roof mounted.
  - Must be higher than surrounding structures/trees.
  - Planning permission required.
- **Operational Impacts/Issues: -**
  - Urban environments generally have low wind speeds and high turbulence which reduce the effectiveness of turbines.
  - Vertical axis turbines have a lower performance than horizontal axis turbines but work better in urban environments.
  - Annual services required.
  - Turbines rated in excess of 5kW may require the network to be strengthened and arrangements to be made with the local Distribution Network Operator and electricity supplier.
  - Noise.
- **Embodied Energy: -** Carbon payback is ~1 year for most turbines.
- **Funding Opportunities:** - Financier utilising Feed-in-Tariffs.
- **Reductions in Energy Achievable:** - Significant reduction in reliance on grid electricity.
- **Reductions in CO_2 Achievable: -** Good. Greater reduction in CO_2 than PV for same investment.
- **Advantages: -** Virtually free fuel; reductions in CO_2.
- **Disadvantages: -**
  - Expensive, although cheaper than PV for same return.
  - Lack of suitable sites.

- Maintenance costs.
- Often not building integrated.

> **Application:** Best suited for small to large developments in rural open areas

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10. HYDRO POWER

> Hydro power harnesses the energy of falling water, converting the potential or kinetic energy of water into electricity through use of a hydro turbine. Micro hydro schemes (<100kW) tend to be 'run-of-river' developments, taking the flow of the river that is available at any given time and not relying on a reservoir of stored water. They generate clean electricity that can be provided for use on-site, or sold directly to the local electricity network.

> **Performance and Calculation Methodology: -**

- Flow rates at particular sites from National River Flow Archive held by Centre for Ecology and Hydrology.
- Electricity produced displaces grid electricity which has a carbon intensity of 0.568 kg/kWh.

> **Capital Cost: -**

- £3,000 - £5,000 per kW.
- Particularly cost effective on sites of old water mills where much of the infrastructure is in place.

> **Running Costs/Savings: -**

- Reduce reliance on grid electricity and therefore reduce costs.
- Payback period of ~10-15 years per dwelling
- Feed-in tariff and ROC payments required for maximum financial benefit.

> **Land Use Issues and Space Required: -**

- Require suitable water resource.
- Visual intrusion of scheme.
- Special requirements where river populated by migrating species of fish.
- Planning permission will require various consents and licences including an Environmental Statement and Abstraction Licence.

> **Operational Impacts/Issues: -**

- Routine inspections and annual service required.
- Automatic cleaners should be installed to prevent intake of rubbish.

> **Embodied Energy: -** Carbon payback for small schemes of ~1 year.

- **Funding Opportunities: -** Financier utilising Feed-in-Tariffs.
- **Reductions in Energy Achievable:** - significant reduction in reliance on grid electricity.
- **Reductions in CO_2 Achievable:** - High.
- **Advantages:** - Virtually free fuel, reductions in CO_2.
- **Disadvantages: -**
    - Expensive, but good payback period.
    - Lack of suitable sites.
    - Planning obstructions.
- **Application: -** Best suited to medium to larger developments in rural places ~ 100+ units