TEMPLAR HOUSE

ENERGY STRATEGY

JULY 2015

NORTHWOOD INVESTORS

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Templar House

Site Wide Energy Statement

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		Name	David Mason	Harry Thurman	
		Signature			
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		Name	David Mason	Harry Thurman	
		Signature			
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Contents

Executive Summary

Templar House aims to be as energy efficient as practicable and generate its own energy where this is feasible. The location and nature of the buildings will naturally lead to certain energy requirements which cannot be avoided such as lighting, heating and cooling.

The residential, commercial and retail areas were modelled using Government-approved software and the notional building Target Emission Rates (TER) were calculated. Energy efficiency measures were introduced for each building, and all renewable energy technologies were considered.

For the residential building, a combination of photovoltaic modules and air source heat pumps are considered to be the most feasible technologies for the development. In addition to this a water to water heat pump allows heat recovery from the commercial building's chilled water loop. This provides additional heat to the residential building that would normally be rejected to atmosphere.

For the commercial building, an air cooled chilled water system, incorporating highly efficient screw compressors was found to meet the office cooling demand most effectively. The office building's energy performance is bolstered by an optimised facade, efficient air handling plant, LED lighting with daylight control and photovoltaic modules. These are considered the best mix of technologies for the development.

CHP was deemed not feasible, although capped pipework to the site boundary would be in place such that a future connection to a low carbon district heating network can be facilitated when it becomes available.

Templar House includes retail spaces at ground level. Services to these areas will be installed as part of the future tenant fit out works. As a result, only the baseline Part L 2013 carbon dioxide emissions have been calculated for the retail areas as part of this energy statement. Future tenancy fit-outs will need to comply with this benchmark as a minimum.

The following tables summarise the site wide percentage improvements on Part L 2013 carbon emissions that are achieved by the current energy strategy. This shows significant improvements in carbon emissions given the constraints of the site and its location.

Commercial and Residential Combined CO_2 Emissions		
	Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	449.6	423.7
Passive Design	394.6	423.7
Efficient Technology	386.9	423.7
Energy Generation	368.2	423.7
Regulated Carbon dioxide savings		
	Tonnes CO_2 per annum	% improvement
Savings from demand reduction	55.0	12.2%
Savings from efficient technology	7.7	1.9%
Savings from renewable energy	18.7	4.8%
Total Cumulative Savings	81.4	18.1%

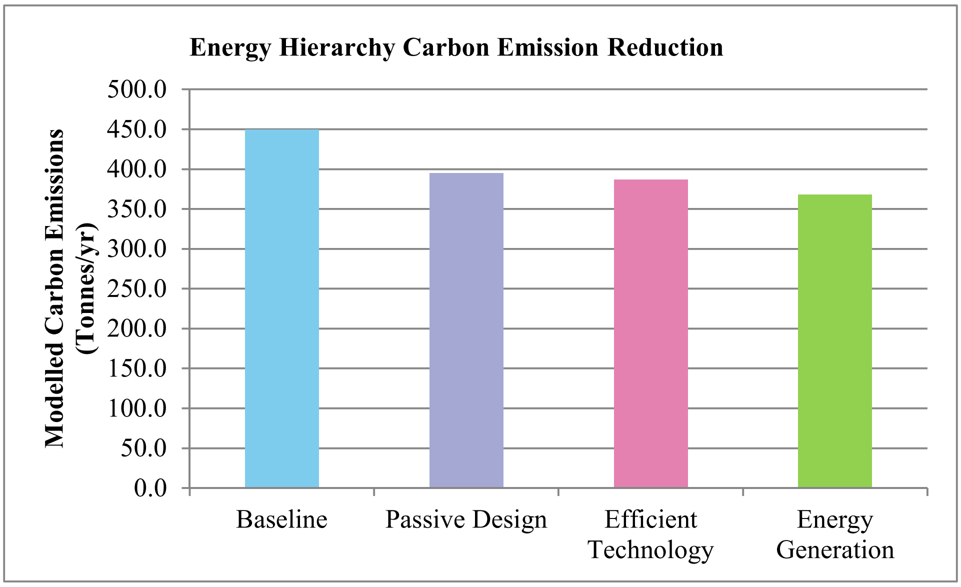


Figure 1 Reduction in Carbon Emissions

The following table indicates the baseline 2013 Part L carbon emissions target for the retail areas.

Retail CO_2 Emissions		
	Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	24.8	6.1

The graph below demonstrates the percentage of baseline carbon emissions attributed to each of the site uses at Templar House. It can be seen that retail accounts approximately 5% of the development's regulated base line emissions.

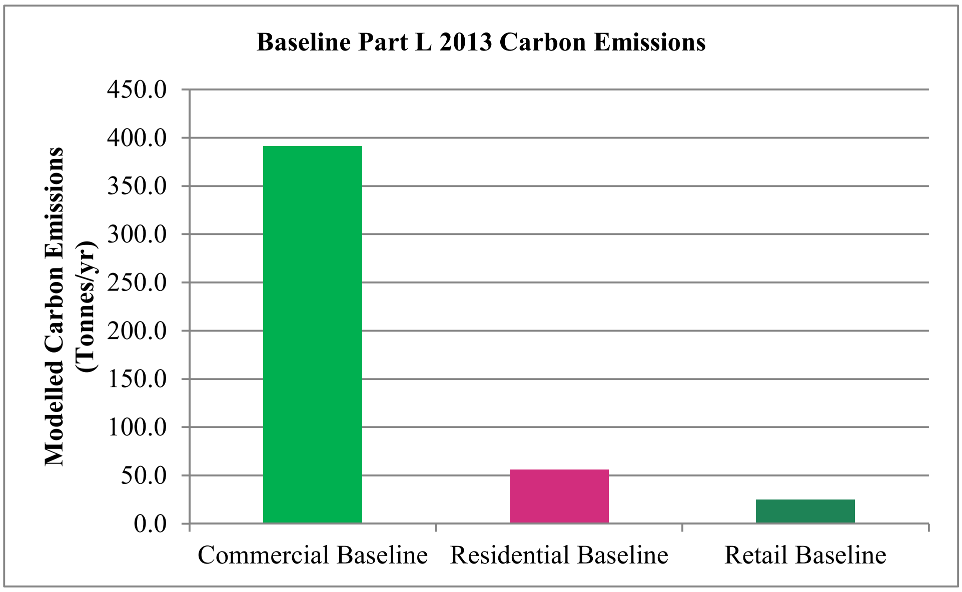


Figure 3 Part L 2013 baseline carbon emissions

The following table summarises the total improvement upon the baseline 2013 Part L carbon emissions that is achieved by the proposed energy strategy for the entire Templar House development (commercial, residential and retail).

Site-wide CO_2 Emissions		
	Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	474.4	429.8
Clean energy strategy	393.0	429.8
Regulated Carbon dioxide savings		
	Tonnes CO_2 per annum	% improvement
Total Target Saving	166.0	35
Annual Shortfall	84.6	
25 year cumulative shortfall	2115.9	

1 Introduction

This report outlines the energy strategy that has been developed for Templar House to address the planning requirements of the Mayor of London's "London Plan" and the policies of the London Borough of Camden.

The project involves the demolition of an existing building and erection of two new buildings to provide a mix of uses comprising office, up to 48 residential units and retail together with, landscaping works, public realm improvements, plant, car and cycle parking and other ancillary works. The development is referred to in this report as 'Templar House'.

The existing Templar House building was constructed in 1959 and stretches from Eagle Street to the north to High Holborn to the south. The existing building is largely relying on ageing plant, equipment and out-dated building fabric.

The new buildings will incorporate efficient plant and equipment, well insulated building fabric to minimise heat loss/gains, and high performing glazing to maximise daylight whilst minimising building energy consumption.

The vision for Templar House is to be as low energy dependent as practicable. This report outlines how this will be achieved.

1.1 Planning Context

The London Plan, with revised early minor alterations and the Draft Further Alterations (2015), is the Spatial Development Strategy for London published by the Greater London Authority (GLA) and covers all 32 London Boroughs and includes the City of London Corporation. The Plan contains a number of policies which are relevant to Energy:

Policy 5.2: Minimising carbon dioxide emissions

"The Mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.

Residential buildings: Year Improvement on 2010 Building Regulations
2010 – 2013 25 per cent (Code for Sustainable Homes level 4)*
*2013 – 2016 40 per cent***
2016 – 2031 Zero carbon

Non-domestic buildings: Year Improvement on 2010 Building Regulations
2010 – 2013 25 per cent
*2013 – 2016 40 per cent***
2016 – 2019 As per building regulations requirements
2019 – 2031 Zero carbon"

Also highlighted in this Policy is:

"The carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere."

*Following the conclusion of the governments technical housing standards review on the 27th March 2015, the government has withdrawn the Code for Sustainable Homes. While the CfSH energy targets can no longer be mandated by planning, the scheme will still target carbon dioxide emissions equivalent to a CfSH level 4 development.

**Since 6 April 2014 the 2013 changes to Part L of the Building Regulations have come into effect. As outlined in the Sustainable, Design and Construction SPG, from 6 April 2014 the Mayor will apply a 35 per cent carbon reduction target beyond Part L 2013 of the Building Regulations - this is deemed to be broadly equivalent to the 40 per cent target beyond Part L 2010 of the Building Regulations, as specified in Policy 5.2 of the London Plan for 2013-2016.

The 35% reduction target against 2013 Part L carbon emissions is used for comparison in this report.

Policy 5.3: Sustainable design and construction

"Development proposals should demonstrate that sustainable design standards are integral to the proposal, including its construction and operation, and ensure that they are considered at the beginning of the design process."

Policy 5.6: Decentralised energy in development proposals

"Development proposals should evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine opportunities to extend the system beyond the site boundary to adjacent sites."

"Major development proposals should select energy systems in accordance with the following hierarchy:

- Connection to existing heating or cooling networks
- Site wide CHP network
- Communal heating and cooling."

Policy 5.7: Renewable energy

"Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible."

1.2 The London Borough of Camden

Camden's 'Core Strategy' sets out the key elements of the Council's planning vision and strategy for the borough. 'Camden Development Policies', (adopted on 8th November 2010) sets out the detailed planning policies that the Council will use when determining applications for planning permission in the borough to achieve the vision and objectives of the Core Strategy.

Policy DP22 Promoting Sustainable Design and Construction

The Council will require development to incorporate sustainable design and construction measures. Schemes must:

- *a) demonstrate how sustainable development principles, including the relevant measures set out in paragraph 22.5 below, have been incorporated into the design and proposed implementation; and*
- *b) incorporate green or brown roofs and green walls wherever suitable.*

The Council will promote and measure sustainable design and construction by:

- *c) expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 and Code Level 4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016;**
- *d) expecting developments (except new build) of 500 sq m of residential floorspace or above or 5 or more dwellings to achieve "very good" in EcoHomes assessments prior to 2013 and encouraging "excellent" from 2013;*
- *e) expecting non-domestic developments of 500sqm of floorspace or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019.*

The Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as:

- *f) summer shading and planting;*
- *g) limiting run-off;*
- *h) reducing water consumption;*
- *i) reducing air pollution; and*
- *j) not locating vulnerable uses in basements in flood-prone areas*

*As discussed, Code for Sustainable Homes has been withdrawn however the scheme will target carbon emissions equivalent to a CfSH level 4.

National and regional planning documentation

The National Planning Policy Framework (NPPF) was published in March 2012 and sets out the Government's planning policies for England and how these are expected to be applied. There are three dimensions to sustainable development: economic, social and environmental. These dimensions give rise to the need for the planning system to perform a number of roles, one of which is the environmental role – contributing to protecting and enhancing our natural, built and historic environment and mitigating and adapting to climate change including moving to a low carbon economy. At the heart of the National Planning Policy Framework is a presumption in favour of sustainable development.

Supporting the NPPF are guidance document which provide further clarification of how the NPPF can be interpreted. Air quality, pollution and Climate Change are of specific relevance to the energy report.

As the proposed development is being carried out in London, the 2014 Supplementary Planning Guidance (SPG): Sustainable Design and Construction is also to be considered within this report; namely those instances relating to sustainable design, a low carbon future and designed for future climate change.

2 Notional Building Energy Demand and Carbon Dioxide Emissions

In order to establish the Part L compliant notional carbon dioxide emissions at Templar House (known as the Target Emission Rate), Government-approved software was used to model the commercial and residential buildings.

A commercial building energy model was realised using IES software and massing geometry received from the architect to establish the 2013 Part L Target Emissions Rate (TER). The TER sets a minimum carbon emissions baseline which the commercial building must improve upon in order to comply with Part L 2013. IES software was also used to produce notional building carbon estimates for the retail areas.

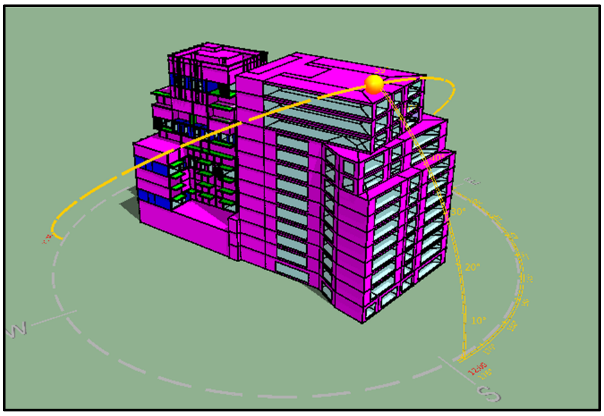


Figure 4 Image of development (surrounding buildings not shown)

The Residential building 2013 Part L TER was formulated using NHER Plan Assessor software. Version 6.0.1.1 provided the 2013 Part L carbon emissions baseline.

Assumptions regarding the types of plant and fabric performance that were inputted into the notional building models were established by SAP 2012 (residential developments) and NCM 2013 (commercial developments). The section below outlines these as well as the assumptions-used by the software to calculate the TER for the residential, commercial and retail areas.

Notional building software assumptions: Residential Building

- Treated Area (m^2): 3369
- Opening Areas: 25% of total floor area
- Roof U-Values: 0.13 $W/m^2.K$
- External Wall U-Values: 0.18 $W/m^2.K$
- Floor U-Values: 0.13 $W/m^2.K$
- Glazing U-values: 1.4 $W/m^2.K$
- g-values: 0.63
- Thermal Mass: Medium (TMP = 250kJ/m^2K)
- Shading and orientation: All glazing orientated E/W with average overshading
- Living Area: Same as actual dwelling
- Number of sheltered sides: Same as actual dwelling
- Allowance for thermal bridging: y = 0.05 W/m^2K

- Ventilation System: Natural Ventilation with intermittent extract fans
- Air permeability: 5 m3/h per m2 of envelope area at 50Pa
- Extract Fans: 2 extract fans for total floor area up to 70m^2, 3 for total floor area > 70m^2 and up to 100m^2, 4 for total floor area > 100m^2
- Main heating fuel (space and water): Mains gas
- Boiler efficiency: 89.5%
- Heating system controls: Time and temperature zone control, boiler interlock and weather compensation.
- Hot water system: Heated by boiler. Separate time control for space and water heating.
- Hot water cylinder: 150 litre cylinder. Heat loss factor 1.39kWh/day
- Primary water heating losses: Fully insulated primary pipework. Cylinder temperature controlled by thermostat. Cylinder in heated space
- Water use limited to 125 litres per person per day: Yes
- Secondary space heating: None
- Low energy light fittings: 100% of fixed outlets.
- Air conditioning: None

Notional building software assumptions: Commercial Building

- Treated Area (m^2): 16585 m²
- Boiler Efficiency: 0.81 (SCoP)
- Specific Fan Power: 1.6 W/l/s
- Roof U-Values: 0.18 W/m².K
- Wall U-Values: 0.26 W/m².K
- Glazing U-values: 1.6 W/m².K
- g-values: 0.4
- Main Heating System: Gas fired boiler
- Main Cooling system: Water cooled chillers and FCU
- Cooling Efficiency: 4.5 (SEER)
- Domestic hot water: Same as main heating system
- Heat recovery: 70%
- Lighting efficacy: 60 lumens/W
- Lighting control: Daylight dimming, manual-on-auto-off
- Air Permeability: 3 m^3/h per m^2 of envelope area at 50Pa

Notional building software assumptions: Retail Spaces

- Treated Area (m^2): 578 m²
- Boiler Efficiency: 0.86 (SCoP)
- Specific Fan Power: 1.8 W/l/s
- Roof U-Values: 0.18 W/m².K
- Wall U-Values: 0.26 W/m².K
- Glazing U-values: 1.8 W/m².K
- g-values: 0.4
- Main Heating System: Air Source Heat Pumps (electric)
- Main Cooling system: Split/multi-split system
- Cooling Efficiency: 2.84 (SEER)
- Domestic hot water: Same as main heating system
- Heat recovery: 70%
- Lighting efficacy: 60 lumens/W
- Display lamp efficacy: 22 lumens/W (efficient lamps)
- Lighting control: manual-on-auto-off

Carbon Dioxide Emissions of Notional Buildings
Based on the notional building assumptions above, the 2013 Part L baseline carbon dioxide emissions are as follows:

Site	Tonnes CO_2/yr
Notional Residential Demise	56.5
Notional Commercial Demise	393.1
Residential/Commercial Subtotal	**449.6**
Notional Retail Demise	24.8
Development Total	**474.4**

The total baseline emissions for the residential and commercial areas are 449.6 tonnes of CO2 per annum. The total site baseline emissions (including commercial, residential and retail accommodation) are 474.4 tonnes of CO_2 per annum

The following section outlines how Templar House improves upon the notional 2013 Part L compliant building assumptions.

The retail units will be offered on a shell and core basis and the fit-out will be the responsibility of the tenants. All units will be subject to the building control regulations at the time of fit out. As such, no further energy improvement can be taken over and above compliance with the current building regulations Part L 2013.

3 Reducing Carbon Dioxide Emissions

It is proposed to follow the Mayor's hierarchy for reducing carbon emissions. This involves:

- Reducing energy consumption though architectural passive design (Be Lean);
- Using low energy technologies and efficient building systems (Be Green);
- Generating energy where feasible on site from renewable energy technologies (Be Clean).

3.1 Passive Design (Be Lean)

The starting point for the Templar House energy strategy is to “design out” energy consumption as much as possible. Passive design is the most effective means, both in carbon dioxide and financial terms, to ensure Templar House is inherently low in energy usage.

There are a range of energy-efficiency measures that have been applied to Templar House as an integral part of the design process:

- Enhanced thermal envelope performance. This reduces the heating and cooling load for the development.
- The building form has been considered to ensure that glazed areas have been optimised for daylight while limiting heat gains and heat losses.

- External shading on a number of apartments reduces the direct solar gains they receive. The office building also provides self-shading to the residential building, reducing the solar gain and therefore reducing the cooling requirements throughout the year. It should be noted that the National Calculation Methodology does not allow this self-shading benefit to be considered in the models. The office south-facing Portland stone façade incorporates recessed windows for additional shading benefit. The depth of the window recess increases up the building so that the higher solar exposure at upper levels is matched with deeper shade protection.
- Glazed areas of facade incorporate high efficiency glazing throughout. The glazing performance serves to reduce the heat gain and heat loss at the building perimeter, which reduces the heating energy consumption.
- Envelope air tightness has been enhanced by approximately 50% over standard facades, leading to savings in heating and cooling energy consumption throughout the year, and optimising the potential for heat recovery.
- Passive Solar Gain allows solar gain to offset the perimeter heat loss in winter. The active building controls will automatically adjust the amount of heating in each zone, thereby reducing the energy demand of the heating system.
- LED lighting has been introduced to reduce both lighting input power and internal cooling loads.
- Overheating analysis has been conducted and this has led to the following features being incorporated to the lean building design:
    - High performance solar control on the facades that require it
    - Beneficial self-shading on the south facade from external terraces during peak summer conditions
    - Window recesses on the south-facing office façade as described above.

Note: The commercial and residential elements of Templar House comply with Part L Criterion 3. The BRUKL and a sample of the SAP calculations have been included in Appendix A. Further to this, overheating analysis has been performed over and above the requirements of Part L: Criterion 3. This analysis has informed the façade design in order to minimise Templar House cooling loads.

The following improvements to the notional building fabric and lighting parameters were modelled to optimise passive design and minimise energy consumption.

Lean Building: Residential Building

- Treated Area (m^2): 3369 m²
- Opening Areas: 25% of total floor area
- Roof U-Values: 0.13 W/m².K
- External Wall U-Values: 0.18 W/m².K
- Floor U-Values: 0.13 W/m².K

- Glazing U-values: 1.1 W/m².K
- g-values: 0.4
- Thermal Mass: Medium (TMP = 250kJ/m^{2}K)
- Shading and orientation: Apartment specific
- Living Area: Apartment specific
- Number of sheltered sides: Apartment specific
- Allowance for thermal bridging: y = 0.15 W/m^{2}K
- Low energy light fittings: 100% of fixed outlets.

Lean Building: Commercial Building

- Area (m^2): 16585 m²
- Boiler Efficiency: 0.91
- Specific Fan Power: 1.6 W/l/s
- Roof U-Values: 0.18 W/m².K
- Wall U-Values: 0.2 W/m².K
- Glazing U-values: 1.49 W/m².K
- g-values (levels 1-9): 0.17
- g-values (levels 10-13): 0.15 total façade g-value including interstitial blinds
- Lighting efficacy: 70 lumens/W (LED lighting throughout)
- Lighting control: Daylight dimming, manual-on-auto-off

Lean Site-wide Results

The following tables summarise the percentage improvements on 2013 Part L carbon emissions that are achieved by the lean building strategy described above. The results indicate that passive design features introduced to the residential building: like triple glazing and efficient lighting, provide a marginal reduction (6.4%) in carbon dioxide emissions. This is likely due to the fact that the notional building fabric performances specified by the Standard Assessment Procedure (SAP) are relatively efficient by current industry standards. Only moderate building fabric improvements are achievable against the notional building benchmark.

A greater reduction in carbon emissions (13.1%) is achieved by the commercial building, largely due to the introduction of LED lighting in the lean building model. LED lighting has been incorporated into the passive building design as it contributes to a twofold reduction in energy demand: both by limiting lighting power draw and internal heat gains.

Residential CO2 Emissions		
	Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	56.5	60.7
Passive design	52.9	60.7
Regulated Carbon dioxide savings		
	Tonnes CO_2 per annum	% improvement
Savings from demand reduction	3.6	6.4%

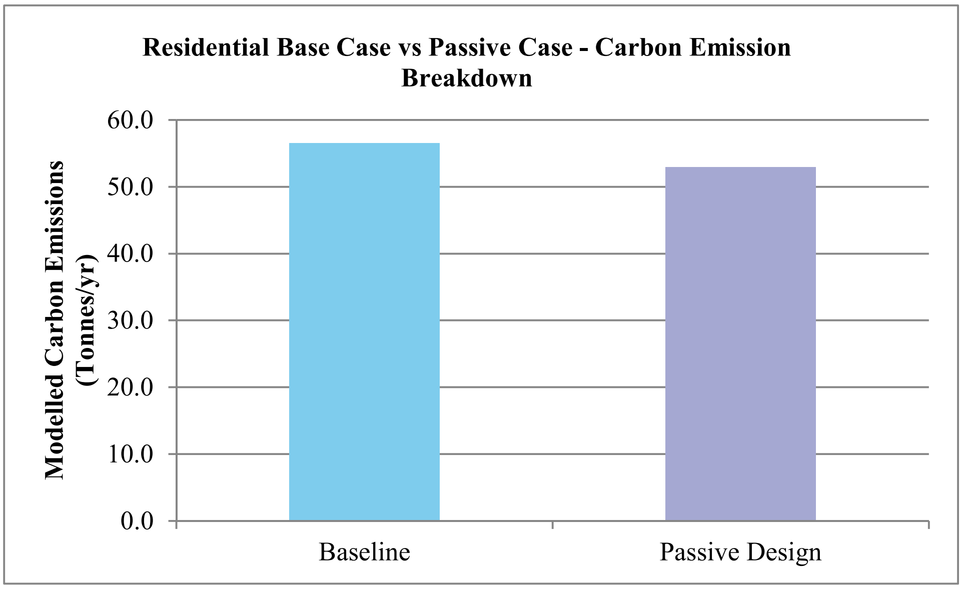


Figure 5 Residential reduction in carbon emissions

Commercial Building		
	Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	393.1	363.1
Passive design	341.7	363.1
Regulated Carbon dioxide savings		
	Tonnes CO_2 per annum	% improvement
Savings from demand reduction	51.4	13.1%

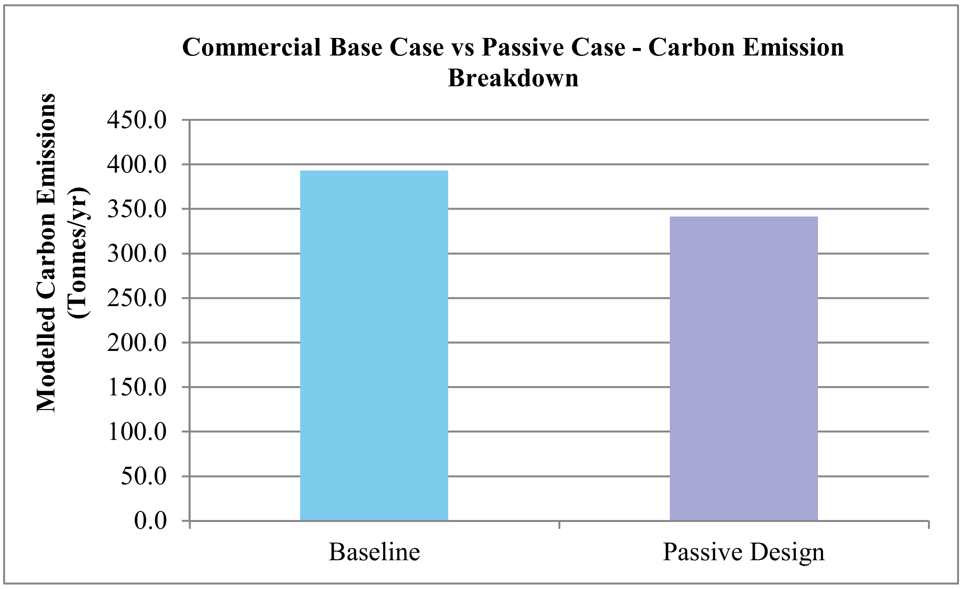


Figure 6 Commercial building reductions in carbon emissions

3.2 Energy Efficient Building Systems (Be Green)

The previous section indicates that passive design elements can achieve a valuable reduction in site wide carbon emissions at Templar House. To reduce carbon emissions further, the following improvements to internal fittings and plant performance were introduced:

- High efficiency air-cooled chillers have been specified to meet the commercial building's cooling requirements.
- High efficiency air handling plant with efficient thermal wheels have been specified for the commercial building.
- Daylight dimming has been incorporated in the commercial building's design.
- Low-flow sanitary fittings have been specified, to reduce the commercial and residential buildings' domestic hot water demand.
- A water-water heat pump system has been specified to recover waste heat from the commercial building to preheat domestic hot water in the residential building.

These measures will be implemented in the holistic approach to the design and will be used whenever appropriate. The following improvements to plant and equipment efficiencies were modelled in combination with the passive design features mentioned previously, to simulate the 'green' building's energy performance.

Green Building: Residential

- Ventilation System: Balanced mechanical ventilation with heat recovery. MVHR SFP 0.72 W/l/s. Heat recovery efficiency 86%
- Air permeability: 2.5 m3/h per m2 of envelope area at 50Pa
- Extract Fans: local mechanical ventilation heat recovery unit.
- Main heating fuel (space and water): Air source heat pumps (ASHP)
- Heating system controls: Charging system linked to use, programmer and TRVs
- Hot water system*: Air source heat pumps and gas fired boilers
- Space heating WWHP efficiency*: 17% demand SCOP = 4
- Water heating WWHP efficiency*: 22% demand SCoP = 4
- Water heating boiler efficiency: 93%
- Hot water cylinder: No storage within apartment
- Primary water heating losses: Fully insulated primary pipework.
- Water use limited to 125 litres per person per day: Yes
- Secondary space heating: None
- Low energy light fittings: 100% of fixed outlets.
- Cooling Efficiency: 4.86 (SEER)

**WWHP technology was simulated in NHER by ASHPs to approximate carbon offset benefits of the site-wide heat recovery system*

Green Building: Commercial

- Main Heating System: Gas fired boiler
- Main Cooling system: Air cooled chillers. Semi-hermetic, single screw compressor.

- Cooling Efficiency: 5.1 (SEER)
- Domestic hot water: Same as main heating system
- Heat recovery Efficiency: 0.8

Lean and Green Site-wide Results

The following tables summarise the percentage improvement on 2013 Part L carbon dioxide emissions that are generated by the lean and green building strategies described above.

Further to the carbon emission reductions achieved by passive design (detailed above), the introduction of efficient condensing gas fired boilers and the site wide heat recovery system are estimated to reduce the residential building carbon emissions by 8.2%.

The heat recovery system proposed for Templar House is especially suited because it capitalises on the complimentary heating and cooling profiles of the residential and commercial buildings. The high domestic hot water demand of the residential building provides a suitable heat sink to deliver waste heat that is rejected by the commercial building's cooling plant. A water-water heat pump will recover this waste energy to preheat domestic hot water and reduce the load on residential boilers. Buffer vessels at basement level store the recovered heat ready for use.

Energy simulations estimate the commercial building's carbon emissions to reduce by 1% due to the introduction of highly efficient air cooled chiller plant. This is a conservative figure and in practice, the carbon savings generated by efficient technology are expected to be greater, on account of the site-wide energy recovery system. The water-water heat pump technology which supplies waste heat from the office to preheat residential domestic hot water will have a residual benefit for the office cooling plant by reducing the chiller's heat rejection load. The lower chilled water return temperatures that are a residual benefit of the water-water heat recovery system improves the efficiency of chiller plant by reducing input power to the compressor and allowing the chiller to operate at more efficient part-load performance.

Since chilled water return temperatures fluctuate and dependent on the residential domestic hot water demand, a conservative modelling approach was adopted that did not simulate this residual efficiency uplift.

Energy efficient technologies, in combination with passive building design have enabled the 'lean and green' Templar House design to improve upon the Part L 2013 baseline by 14.1% for the residential building and 13.9% for the commercial building.

Residential Building		
	Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	56.5	60.7
Passive design	52.9	60.7
Efficient technology	48.6	60.7
Regulated Carbon dioxide savings		

	Tonnes CO_2 per annum	% improvement
Savings from demand reduction	3.6	6.4%
Savings from efficient technology	4.4	8.2%
Total Cumulative Savings	8	14.1%

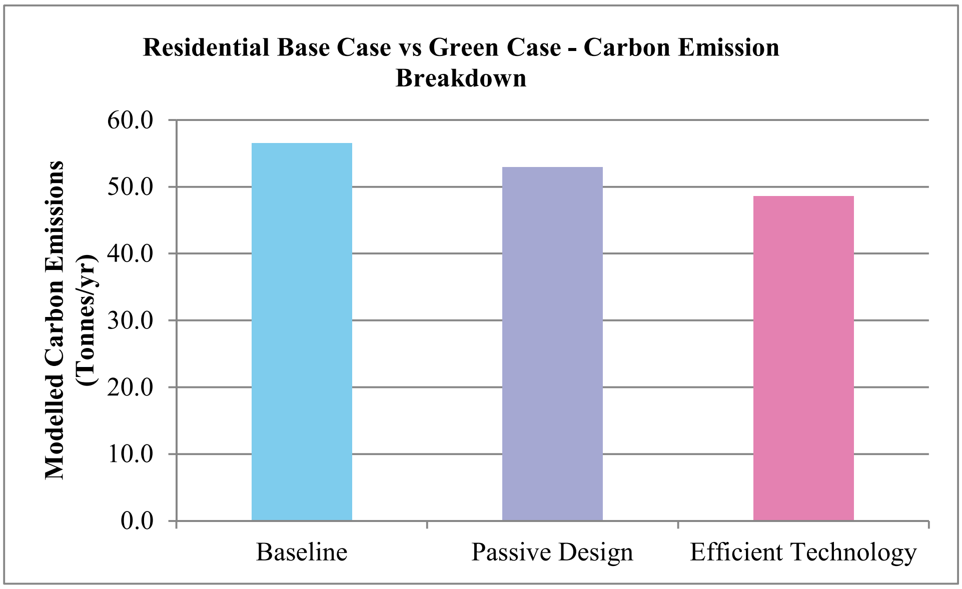


Figure 7 Residential building reduction in carbon emissions achieved through passive design and efficient technologies

Commercial Building		
	Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	393.1	363.1
Passive design	341.7	363.1
Efficient technology	338.3	363.1
Regulated Carbon dioxide savings		
	Tonnes CO_2 per annum	% improvement
Savings from demand reduction	51.4	13.1%
Savings from efficient technology	3.3	1.0%
Total Cumulative Savings	54.7	13.9%

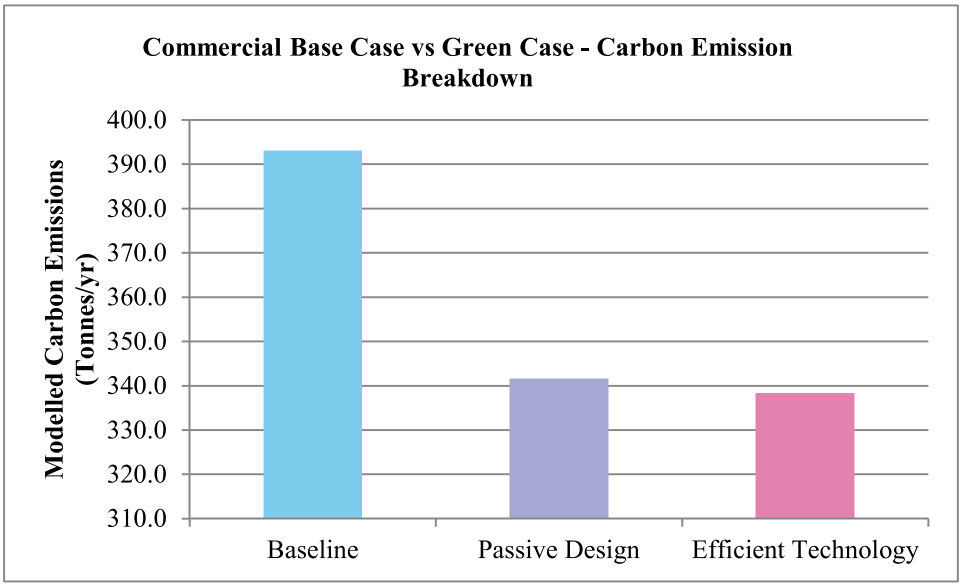


Figure 8 Commercial building reduction in carbon emissions achieved through passive design and efficient technology

3.2.1 Combined Heat and Power (CHP)

Combined heat and power generates electricity with the by-product of useful heat. Whenever the unit operates, grid-electricity is displaced while the heat-generated can be used either directly, stored for use later or converted into cooling through absorption chillers. The low carbon nature of the CHP plant is attributed to the generation of electricity on site (so incurring no transmission losses) and the use of heat which would ordinarily be lost to atmosphere.

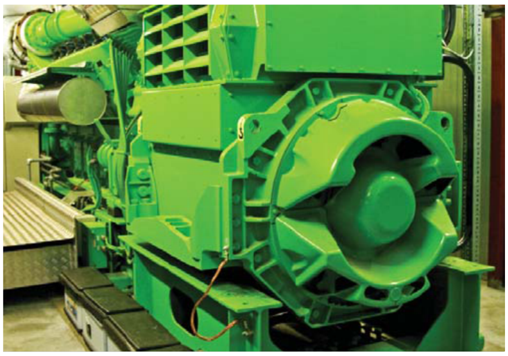


Figure 9: Example CHP engine

The improvements to the buildings highlighted in the preceding section have led to a reduction in the requirements for both space heating and domestic hot water. The strategy for providing the heat required in the development follows the following hierarchy.

- Reduce the heating and domestic hot water requirements
- Utilisation of waste heat from the commercial building

- Provision of heat via high efficiency air source heat pumps
- Finally, provide high temperature hot water via efficient gas fire boilers.

It should be borne in mind, therefore, that in any consideration of CHP, the hourly loads which may be expected would directly conflict with the 'waste' heat being provided by the commercial office. In turn this would drastically reduce the number of run hours of the CHP Unit.

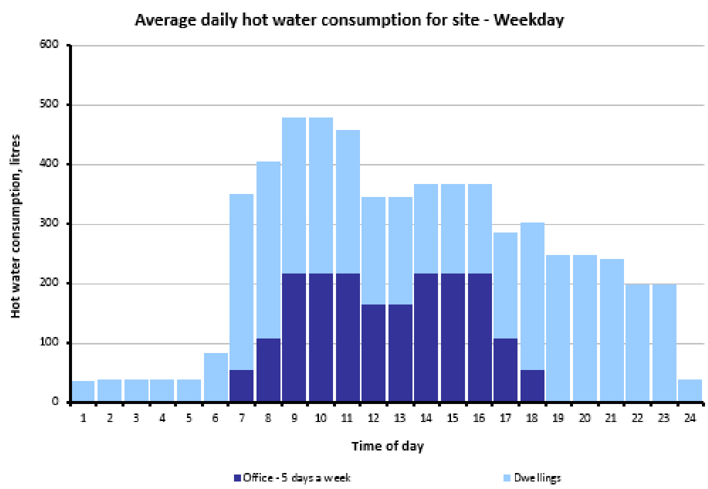
Section 10.25 of the GLA guidance on preparing energy assessments (April 2015), states *'there may be particular circumstances where CHP is justified in smaller mixed developments (e.g 350 units) where there is a more substantial non-domestic building space'.* There are 48 apartments proposed for the Templar House residential demise and any CHP system designed to meet domestic hot water demand is expected to be very small. In spite of this, the scheme is mixed use with 16585m^2 of office to provide a consistent on-site energy demand which could be supplied by CHP if it were proven viable. As a result, the following feasibility assessment for a site-wide CHP energy centre at Templar House was conducted:

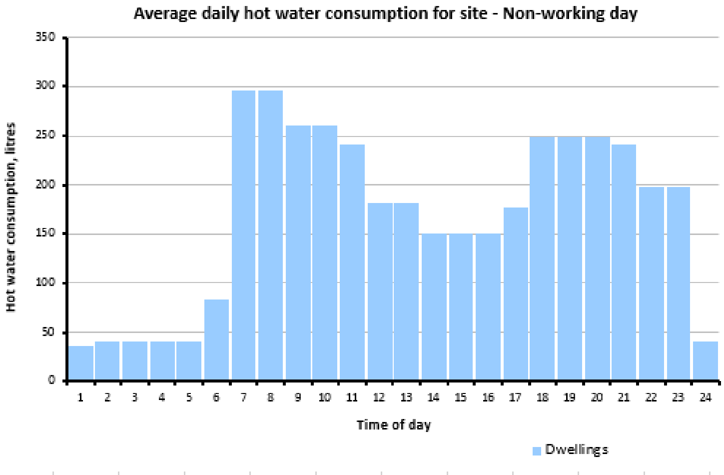
It is widely accepted that CHP should run for at least 4500 hours per year to be economically feasible. This means that the CHP system would need to running during the summer and therefore it is usual to size the system on the domestic hot water consumption. The daily profile of water use is not flat and therefore periods would occur when the CHP system is operating and there is more heat than required; the excess can be put in a thermal store for later use.

The number of days a typical office is occupied per annum is circa 253, with 104 days accounted as weekends and 8 days as bank holidays. Any consideration of CHP should therefore consider that for over 30% of the year, there is no heat requirement attributed to commercial premises.

For the Templar House site, an estimate of the likely hot water demand was made. The estimate of the residential domestic hot water requirement and its variation over 24-hours and weekends and weekdays was derived from *Becker, B.R. and K.E. Stogsdill, 1990. "Development of Hot Water Use Data Base." ASHRAE Transactions, Vol.96, Part 2, pp. 422-427.Americal Society of Heating, Refrigerating*. The office hot water requirement was derived from the Part L profiles assumed for offices.

The following graphics were then generated:





An analysis of the suitable thermal capacity for the CHP unit was undertaken. Assuming that a CHP unit should operate for the longest time possible (for financial viability as cited earlier), a weekday running time of 17 hours was modelled. This led to a thermal capacity of the CHP to be 361 kWh/day divided by 17 leading to 21 kW_{th}. To meet the demand on a non-working day, the 21 kW_{th} unit would operate for a little under 10 hours per day. The total operating hours would be 5730 per annum.

The thermal capacity of circa 21 kW is incredibly small and would be based on a reciprocating engine. According to DECC's annually published data in the annual Digest of UK energy statistics (DUKES), Table 7D, the average electrical efficiency of reciprocating CHP is 25% and thermally 49%. If these values are used to calculate the primary energy savings and the associated carbon dioxide emissions with CHP, there is a net increase in CO_2 emissions for the use of such a small CHP unit and there are no primary energy savings. In line with the EU Directive on CHP, the employment of CHP for the Templar House Site would not meet the requirements of a 10% reduction in CO_2 and a positive primary energy saving.

It is therefore considered that CHP is not feasible for this development.

3.2.2 District Heating networks

At the time of compiling this report, there is currently no district heating network to which the proposed development could connect immediately.

Inquiries have been made to the operators of the Citigen district heating network, which was initially regarded as a feasible energy source due to its proximity to the Templar House site. The team have subsequently been advised that connection to the Citigen network would not be a feasible solution due to the size of the scheme and technical complexities in extending the network further west beyond Farringdon Road. This correspondence has been provided in Appendix B.

In order to future proof the scheme, capped pipe work would be installed to the boundary of the site to facilitate connection to any future, low carbon district heating source. Therefore, if the Citigen network were ever extended or an alternative network became available within close proximity to the site, we would commit to connecting to it.

The entire basement of the site is occupied by plant and this will also constitute the location of the centralised site-wide energy system. The diagram below indicates potential locations for any future district heating connections.

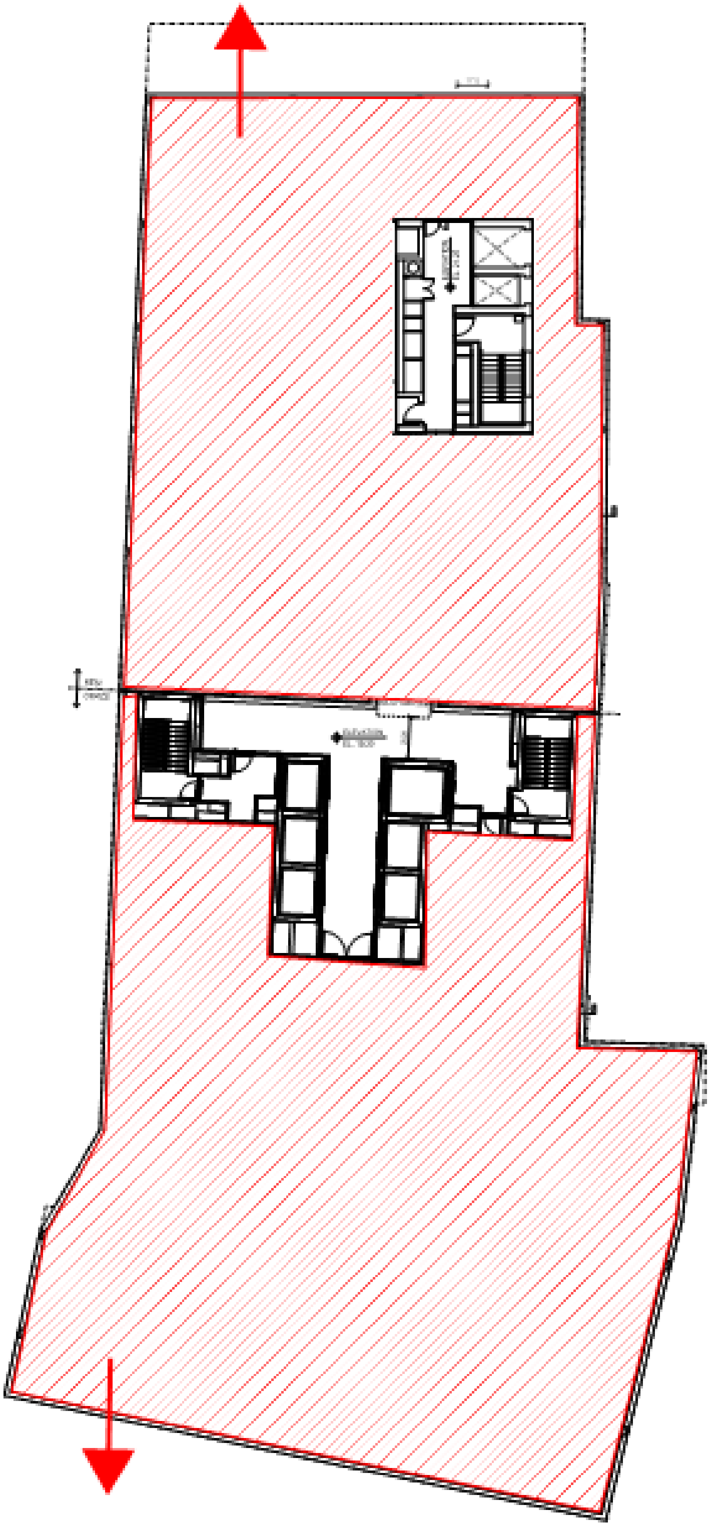


Figure 10 Site-wide energy centre with future connection to district heating scheme

3.3 Renewable energy technologies (Be Clean)

There are many technologies which generate energy from renewable resources. Here follows a list of commercially viable, proven technologies in the UK:

- Large scale wind (greater than 100 kW) turbines
- Small scale wind turbines
- Hydro electric
- Photovoltaics
- Solar thermal for hot water
- Biomass heating
- Ground source heating and cooling
- Air source heating and cooling

Some of the above can be discounted immediately, such as hydro-electric as there are no rivers on the site.

The technologies that have been considered are as follows:

Wind Turbines

Wind turbines harness the kinetic energy in the wind and convert this to electrical energy through a mechanical turbine. The efficacy of wind turbines depends heavily on the (i) wind speed and (ii) the swept area of the turbine's blades.

In the urban environment, wind is generally very turbulent owing to the buildings obstructing its path; this leads to low, 'gusty' wind speeds. Large scale wind turbines need a considerable wind speed to even start operating, while smaller machines can cope with lower 'start up' speeds.

The physical constraints of the site preclude the use of large-scale wind turbines as these should be mounted on the ground; in addition, the wind speed is not suitable for such machines.

Small-scale wind turbines have been employed in the urban environment in recent years. Studies have indicated however that their performance is very poor unless they are sited well above the surrounding buildings. In the case of the proposed building, the roof-space is constrained and the area that is available to renewable energy infrastructure is considered more suited to PV installations; additionally, wind turbines would not enhance the building visually and contribute virtually no energy to the development.

It is therefore deemed that wind turbines are not feasible for this project.

Photovoltaics (PV)

Photovoltaics are semiconductors which convert incident sunlight into electricity. They are an excellent technology in the urban-context; there are many roofs in London which are ideal for PV.

Key to the efficacy of PV is shading. If shading occurs on an individual module, the electrical output of the whole array is reduced. This tends to mean that the optimum siting of modules should be completely un-shaded. Where this is unavoidable, bespoke electrical wiring can be made to arrays to ensure that the maximum output can be achieved even when particular modules are shaded.

The majority of plant and equipment at Templar House is housed at basement level, which has made space at roof level available for photovoltaic installations. The roof areas are generally not shaded by the surrounding buildings.

It is therefore deemed that photovoltaics are feasible for this project.

Solar thermal for hot water

Solar panels can be used to good effect to raise the temperature of water when the sun shines. Both flat plate and evacuated tubes are available in the UK and there are many installation examples.

Flat panels should be orientated towards the sun and inclined at a suitable angle which is driven by the hot water requirement of a building. Evacuated tubes can be rotated to optimise the efficiency and therefore are able to be mounted at almost any angle.

While there could be space at roof level made available for a solar thermal array, it is believed that PV installations would provide a greater carbon offset benefit for the site. Low-grade heat is already generated by air-source heat pumps and the site-wide heat recovery system. A third heating system would add further complication to system controls with little returns in energy savings.

It is therefore suggested that solar thermal is not feasible for this project.

Biomass Heating

Biomass heating tends to use woodchip or wood pellets as a fuel source. These are then combusted at high efficiency to generate heat.

The heat loads for the proposed development are not expected to be large enough to make biomass heating a feasible option. In addition to this, combustion of biomass in a location such as Templar House will inevitably lead to a degradation in air quality – indeed, recent publications from the Mayor of London’s office advise that biomass installations below 500 kW thermal capacity should not be considered. Added to this would be the delivery of biomass to the site and the storage thereof; both of which are not favourable for Templar House.

It is deemed therefore that biomass heating is not feasible for the project.

Ground source heating and cooling

There is much debate as to whether this technology should really be considered “renewable” as electricity is still required to operate the components constituting a heat pump. That said, the technology does indeed utilise temperature differentials owing directly to the sun.

There a number of ways in which the ground can be used: horizontal pipes in the ground; vertical boreholes, and; putting the pipe work in piles. In all cases, the system is closed and the working fluid is pumped around. Open loop systems tend to use an aquifer deep underground to act as a heat sink; this technology is not widely used in the UK and various trial installations in London are not performing as designed.

In London, the ground make-up is such that clay is found in the tens of metres under the surface; unfortunately clay does not allow for the dissipation of heat effectively as it does not allow the free movement of water. If heat cannot be effectively moved, the use of heat pumps should be such that the net heat which is extracted and re-introduced to the ground over a year is equal i.e. the amount of heating and cooling supplied by the technology should be equal.

Templar House does have complimentary heating and cooling demands that could suit heat pump technology, although an air-source option is considered more appropriate due to the constraints of the site.

Air-source heating

The Greater London Authority recognises air source heat pumps as a renewable energy source, as these systems operate by receiving and rejecting heat from the surrounding air.

A gas supply will not be provided to the residential building due to site restrictions. This, as well as the need for individual metering of tenant utilities, has led to the provision of heat pumps to undertake heating and cooling within the residential building.

Air source heat pump technologies are deemed feasible for Templar House.

3.3.1 Photovoltaic system sizing

Roof areas above both the residential and commercial buildings that are not occupied by mechanical plant or BMU equipment have been designated for PV. These PV areas are favourably orientated, not shaded significantly by surrounding buildings and do not detract from the architectural vision for the development as they will not interrupt townscape views. The area proposed is 150 m^2 of active PV area. This equates to approximately 250m2 of total PV area, including access and spacing to prevent self-shading.

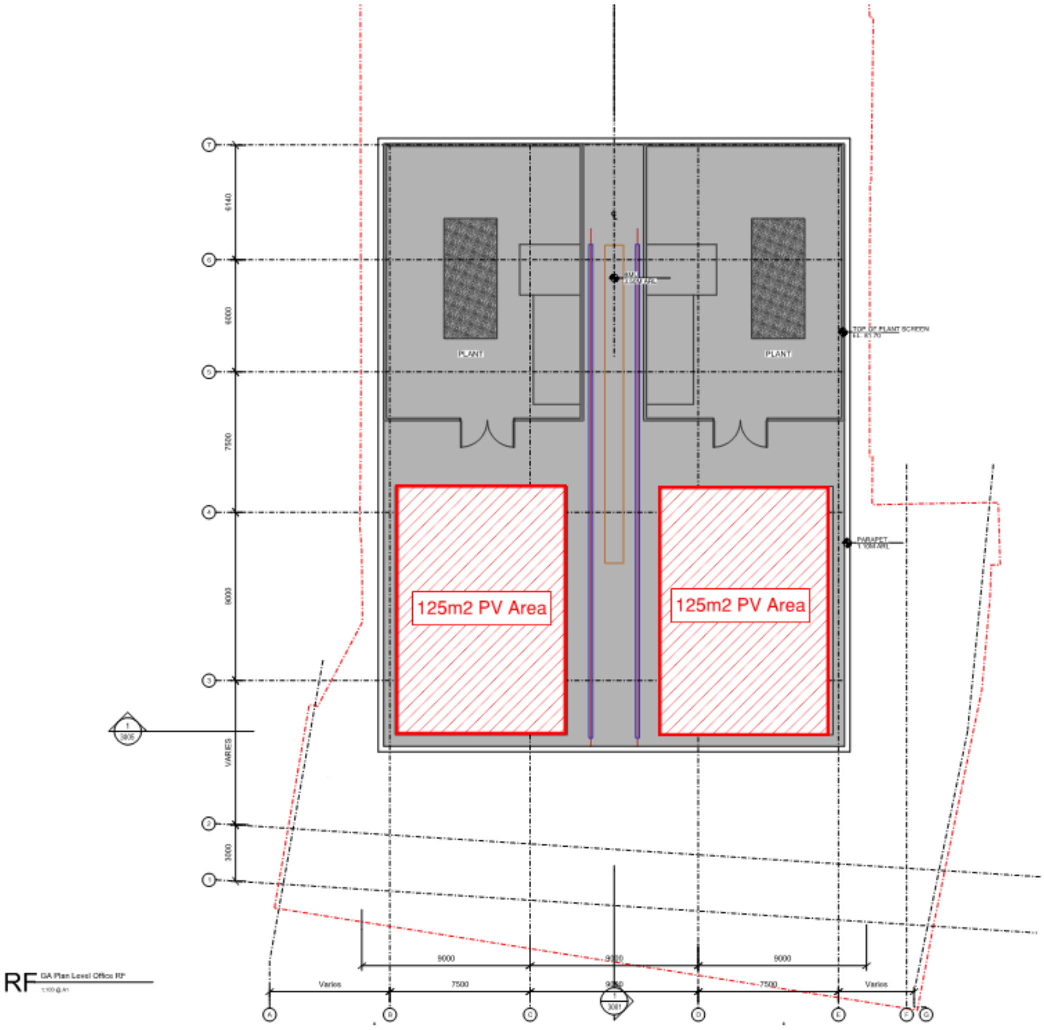


Figure 10 Roof plan showing location of photovoltaics

At Templar House, a suitable area has been designated for PV which (i) maintains the architectural vision and (ii) is un-shaded all year round. Based on the indicative PV areas outlined above, the likely carbon dioxide savings for the site would be approximately 8.3 tonnes per annum. The precise value will depend on the technology-selected and the balance of system components.

The following tables summarise the percentage improvement on 2013 Part L carbon dioxide emissions that are generated by the lean, green and clean building strategies described above.

Residential Building		
	Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	56.5	60.7
Passive design	52.9	60.7
Efficient technology	48.6	60.7
Renewable Energy	38.2	60.7
Regulated Carbon dioxide savings		
	Tonnes CO_2 per annum	% improvement

Savings from demand reduction	3.6	6.4%
Savings efficient technology	4.4	8.2%
Savings from renewable energy	10.4	21.5%
Total Cumulative Savings	18.4	32.5%

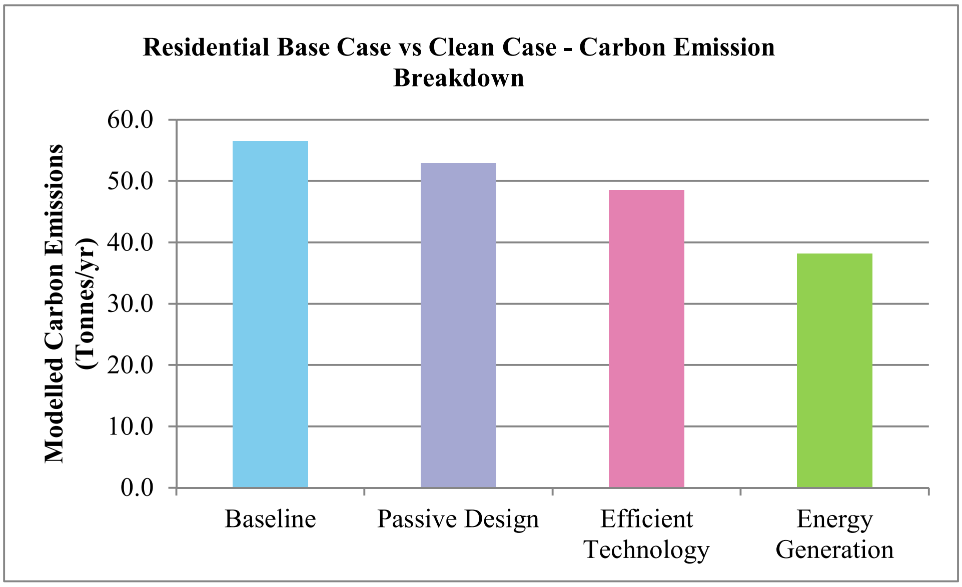


Figure 11 Residential building reduction in carbon emissions achieved through passive design, efficient technologies and on-site energy generation

Commercial Building		
	Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	393.1	363.1
Passive design	341.7	363.1
Efficient technology	338.3	363.1
Renewable Energy	330.0	363.1
Regulated Carbon dioxide savings		
	Tonnes CO_2 per annum	% improvement
Savings from demand reduction	51.4	13.1%
Savings from efficient technology	3.3	1.0%
Savings from renewable energy	8.3	2.5%
Total Cumulative Savings	63.0	16.0%

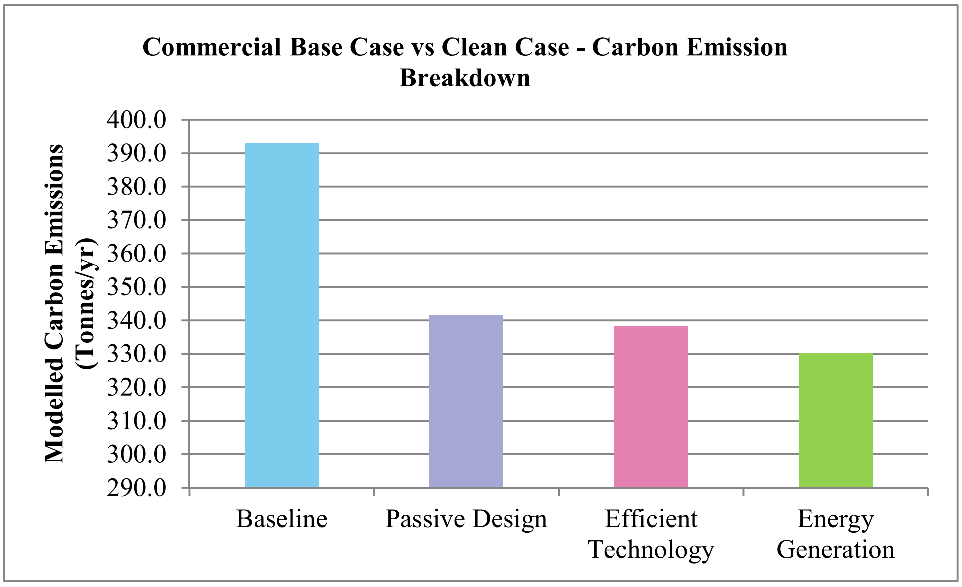


Figure 12 Commercial building reductions in carbon emissions achieved through passive design, efficient technologies and onsite energy generation

3.3.2 Clean Conclusion

Of the renewable technologies available, photovoltaics for the commercial building and a combination of photovoltaics and air source heat pumps for the residential building are considered the most practical and feasible. In addition to this, a site wide energy system which uses water-water heat pumps to recover energy rejected from the commercial building's cooling plant to preheat residential domestic hot water is proposed. It is estimated that approximately 18.7 tonnes of CO_2 could be abated on-site by the renewable technologies and 7.7 tonnes of CO_2 by the introduction of efficient technologies like air cooled chillers. In total, the energy efficient strategy is able to achieve an 18.1% reduction in carbon emissions against the Part L 2013 baseline.

Commercial and Residential CO2 Emissions		
	Carbon dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	449.6	423.7
Passive Design	394.6	423.7
Efficient Technology	386.9	423.7
Energy Generation	368.2	423.7
Regulated Carbon dioxide savings		
	Tonnes CO_2 per annum	% improvement
Savings from demand reduction	55.0	12.2%
Savings from air cooled chillers and site-wide heat recovery	7.7	1.9%

Savings from renewable energy	18.7	4.8%
Total Cumulative Savings	81.4	18.1%

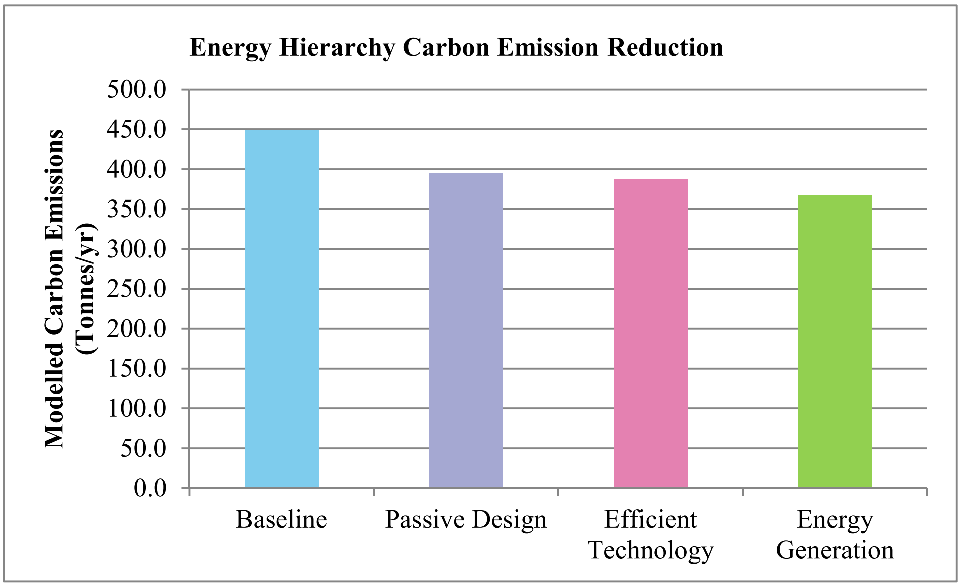


Figure 13 Commercial and residential reduction in carbon emissions achieved through passive design, efficient technologies and onsite energy generation

4 Conclusion

Templar House aims to be as energy efficient as practicable and generate its own energy where this is feasible. The location and nature of the development will naturally lead to certain energy requirements which cannot be avoided such as lighting, heating and cooling.

Templar House was modelled using Government-approved software and the notional building Target Emission Rates were calculated for each building. Energy efficiency measures were employed for each building, and all available renewable energy technologies were considered.

Photovoltaic modules across the site and air source heat pumps serving the residential building space heating and domestic hot water were found to be the most feasible renewable technologies. In addition to this a water to water heat pump system that recovers waste heat from the commercial building's cooling system to preheat residential domestic hot water is the preferred site-wide energy strategy. CHP and CCHP were deemed to be unfeasible, although capped pipework to the site boundary would be in place such that a future connection to the district heating and cooling could be facilitated.

The energy efficiency measures and renewable energy technologies lead to a combined 18.1% improvement in regulated carbon dioxide emissions for the commercial and residential areas, above Part L 2013 requirements. This equates to a 17.1% improvement across the Templar House site including baseline retail emissions. This is considered the maximum feasible and viable reduction within the constraints of the site and its location.

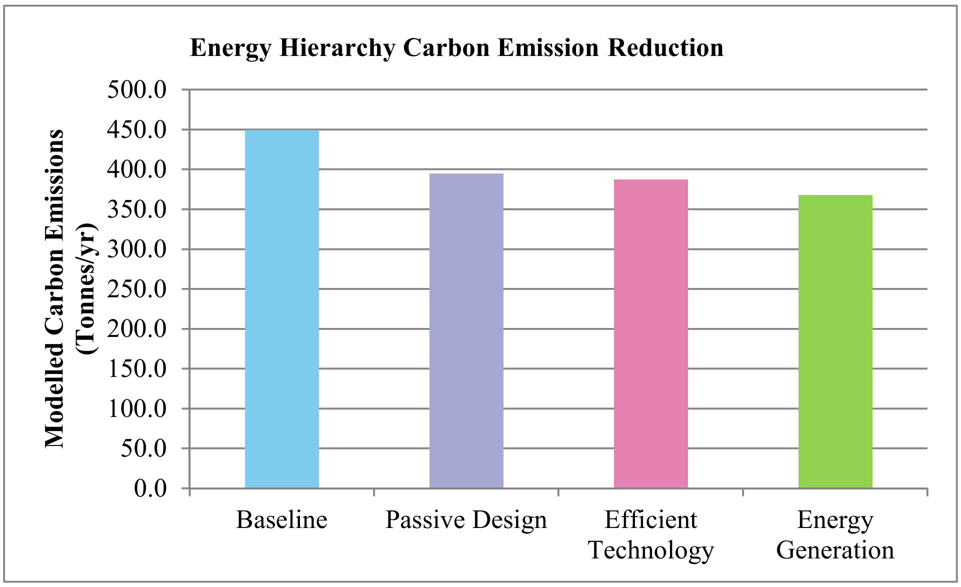


Figure 14 Templar House reduction in carbon emissions

5 Appendices

5.1 Appendix A – BRUKL Report and Sample SAP

BRUKL Output Document

Compliance with England Building Regulations Part L 2013

HM Government

Project name

Templar House

As designed

Date: Tue Jul 14 17:29:00 2015

Administrative information

Building Details

Address: High Holborn, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

BRUKL compliance check version: v5.2.b.1

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	23.7
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	23.7
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	20.6
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.2	0.2	LV000000:Surf[1]
Floor	0.25	0.2	0.2	LV000000:Surf[0]
Roof	0.25	0.18	0.18	LV000001:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.36	1.49	LV00000C:Surf[0]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = 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	3

2.b 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- Main system

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	2.7	0	1.6	0.65
Standard value	0.91*	2.7	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

"No HWS in project, or hot water is provided by HVAC system"

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
G Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P7	-	-	-	0.4	-	-	-	1.6	-	-	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
L2 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 Core	-	-	-	0.4	-	-	-	1.6	-	-	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
L7 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
podium level 1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 P2	-	-	-	0.4	-	-	-	1.6	-	-	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**
L12 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
G Office Lobby Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
G Office Lobby P1	-	-	-	0.4	-	-	-	1.6	-	-	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	
G Core	70	-	-	2211
L1 Core	70	-	-	2185
L1 P1	70	-	-	902
L1 P2	70	-	-	773
L1 P3	70	-	-	378
L1 P4	70	-	-	437
L1 P5	70	-	-	410
L1 P6	70	-	-	1477
L1 P7	70	-	-	242
L1 P8	70	-	-	423
L1 Central	70	-	-	3210
L2 P1	70	-	-	902
L2 P2	70	-	-	773
L2 P3	70	-	-	378
L2 P4	70	-	-	437
L2 P5	70	-	-	410
L2 P6	70	-	-	1477
L2 P7	70	-	-	242
L2 P8	70	-	-	423
L2 Central	70	-	-	3210
L3 P1	70	-	-	902
L3 P2	70	-	-	773
L3 P3	70	-	-	378
L3 P4	70	-	-	437
L3 P5	70	-	-	410
L3 P6	70	-	-	1477
L3 P7	70	-	-	242
L3 P8	70	-	-	423

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L3 Central	70	-	-	3210
L4 P1	70	-	-	902
L4 P2	70	-	-	773
L4 P3	70	-	-	378
L4 P4	70	-	-	437
L4 P5	70	-	-	410
L4 P6	70	-	-	1477
L4 P7	70	-	-	242
L4 P8	70	-	-	423
L4 Central	70	-	-	3210
L5 P1	70	-	-	902
L5 P2	70	-	-	773
L5 P3	70	-	-	378
L5 P4	70	-	-	437
L5 P5	70	-	-	410
L5 P6	70	-	-	1477
L5 P7	70	-	-	242
L5 P8	70	-	-	423
L5 Central	70	-	-	3210
L6 P1	70	-	-	902
L6 P2	70	-	-	773
L6 P3	70	-	-	378
L6 P4	70	-	-	437
L6 P5	70	-	-	410
L6 P6	70	-	-	1477
L6 P7	70	-	-	242
L6 P8	70	-	-	423
L6 Central	70	-	-	3210
L6 Core	70	-	-	2161
L5 Core	70	-	-	2161
L4 Core	70	-	-	2161
L3 Core	70	-	-	2161
L2 Core	70	-	-	2161
L7 Core	70	-	-	2161
L7 P1	70	-	-	902
L7 P2	70	-	-	771
L7 P3	70	-	-	195
L7 P4	70	-	-	731
L7 P5	70	-	-	423
L7 P6	70	-	-	231
L7 Central	70	-	-	2789
L7 P7	70	-	-	1412
L8 Core	70	-	-	2161

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L8 P1	70	-	-	902
L8 P2	70	-	-	771
L8 P3	70	-	-	195
L8 P4	70	-	-	731
L8 P5	70	-	-	423
L8 P6	70	-	-	231
L8 Central	70	-	-	2789
L8 P7	70	-	-	1412
L9 Core	70	-	-	2161
L9 P1	70	-	-	902
L9 P2	70	-	-	771
L9 P3	70	-	-	195
L9 P4	70	-	-	731
L9 P5	70	-	-	423
L9 P6	70	-	-	231
L9 Central	70	-	-	2789
L9 P7	70	-	-	1412
L10 Core	70	-	-	1802
L10 P1	70	-	-	1130
L10 P2	70	-	-	979
L10 Central	70	-	-	1577
L10 P3	70	-	-	174
L10 P4	70	-	-	1338
podium level 1	70	-	-	1736
L11 Core	70	-	-	1802
L11 P1	70	-	-	1130
L11 P2	70	-	-	979
L11 Central	70	-	-	1577
L11 P3	70	-	-	174
L11 P4	70	-	-	1338
L12 Core	70	-	-	1802
L12 P1	70	-	-	1130
L12 P2	70	-	-	979
L12 Central	70	-	-	1577
L12 P3	70	-	-	174
L12 P4	70	-	-	1338
L13 Core	70	-	-	1802
L13 P1	70	-	-	1130
L13 P2	70	-	-	979
L13 Central	70	-	-	1577
L13 P3	70	-	-	174
L13 P4	70	-	-	1338
G Office Lobby Central	70	-	-	1528

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
G Office Lobby P1	70	-	-	476

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?
G Core	N/A	N/A
L1 Core	N/A	N/A
L1 P1	NO (-89.6%)	NO
L1 P2	NO (-88.5%)	NO
L1 P3	NO (-98.3%)	NO
L1 P4	NO (-99.1%)	NO
L1 P5	NO (-97.2%)	NO
L1 P6	NO (-81.2%)	NO
L1 P7	NO (-96.1%)	NO
L1 P8	NO (-97.5%)	NO
L1 Central	NO (-97.3%)	NO
L2 P1	NO (-89.4%)	NO
L2 P2	NO (-87.9%)	NO
L2 P3	NO (-98.3%)	NO
L2 P4	NO (-99.1%)	NO
L2 P5	NO (-97.7%)	NO
L2 P6	NO (-81.5%)	NO
L2 P7	NO (-96.7%)	NO
L2 P8	NO (-97.6%)	NO
L2 Central	NO (-97.4%)	NO
L3 P1	NO (-89.2%)	NO
L3 P2	NO (-86%)	NO
L3 P3	NO (-98.1%)	NO
L3 P4	NO (-99%)	NO
L3 P5	NO (-97.3%)	NO
L3 P6	NO (-77.9%)	NO
L3 P7	NO (-96.2%)	NO
L3 P8	NO (-97.4%)	NO
L3 Central	NO (-97.1%)	NO
L4 P1	NO (-88.4%)	NO
L4 P2	NO (-82.1%)	NO
L4 P3	NO (-97.7%)	NO
L4 P4	NO (-98.8%)	NO
L4 P5	NO (-96.9%)	NO
L4 P6	NO (-73.6%)	NO
L4 P7	NO (-95.3%)	NO
L4 P8	NO (-97.1%)	NO
L4 Central	NO (-96.6%)	NO
L5 P1	NO (-87.5%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L5 P2	NO (-75.6%)	NO
L5 P3	NO (-97.2%)	NO
L5 P4	NO (-98.7%)	NO
L5 P5	NO (-96.6%)	NO
L5 P6	NO (-71.5%)	NO
L5 P7	NO (-94.9%)	NO
L5 P8	NO (-96.8%)	NO
L5 Central	NO (-96.1%)	NO
L6 P1	NO (-85.8%)	NO
L6 P2	NO (-65.3%)	NO
L6 P3	NO (-96.4%)	NO
L6 P4	NO (-98.4%)	NO
L6 P5	NO (-96.2%)	NO
L6 P6	NO (-69.3%)	NO
L6 P7	NO (-94.1%)	NO
L6 P8	NO (-96.4%)	NO
L6 Central	NO (-95.1%)	NO
L6 Core	N/A	N/A
L5 Core	N/A	N/A
L4 Core	N/A	N/A
L3 Core	N/A	N/A
L2 Core	N/A	N/A
L7 Core	N/A	N/A
L7 P1	NO (-81.2%)	NO
L7 P2	NO (-59.7%)	NO
L7 P3	NO (-80.7%)	NO
L7 P4	NO (-66.2%)	NO
L7 P5	NO (-94.7%)	NO
L7 P6	NO (-91.9%)	NO
L7 Central	NO (-91.5%)	NO
L7 P7	NO (-65.3%)	NO
L8 Core	N/A	N/A
L8 P1	NO (-73.5%)	NO
L8 P2	NO (-59%)	NO
L8 P3	NO (-80.2%)	NO
L8 P4	NO (-65.8%)	NO
L8 P5	NO (-93.9%)	NO
L8 P6	NO (-91.2%)	NO
L8 Central	NO (-90.9%)	NO
L8 P7	NO (-63.7%)	NO
L9 Core	NO (-100%)	NO
L9 P1	NO (-64.4%)	NO
L9 P2	NO (-56.8%)	NO
L9 P3	NO (-79.7%)	NO
L9 P4	NO (-65.9%)	NO
L9 P5	NO (-93.1%)	NO
L9 P6	NO (-90.6%)	NO
L9 Central	NO (-90.1%)	NO
L9 P7	NO (-62.1%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L10 Core	N/A	N/A
L10 P1	NO (-58.4%)	NO
L10 P2	NO (-57.1%)	NO
L10 Central	NO (-83.3%)	NO
L10 P3	NO (-80.8%)	NO
L10 P4	NO (-70%)	NO
podium level 1	NO (-94.8%)	NO
L11 Core	N/A	N/A
L11 P1	NO (-69.1%)	NO
L11 P2	NO (-56.8%)	NO
L11 Central	NO (-84.6%)	NO
L11 P3	NO (-79.7%)	NO
L11 P4	NO (-67.6%)	NO
L12 Core	N/A	N/A
L12 P1	NO (-56.4%)	NO
L12 P2	NO (-66%)	NO
L12 Central	NO (-83.3%)	NO
L12 P3	NO (-78.8%)	NO
L12 P4	NO (-65.3%)	NO
L13 Core	N/A	N/A
L13 P1	NO (-69.8%)	NO
L13 P2	NO (-69.2%)	NO
L13 Central	NO (-86.3%)	NO
L13 P3	NO (-79.5%)	NO
L13 P4	NO (-66.7%)	NO
G Office Lobby Central	NO (-96.1%)	NO
G Office Lobby P1	NO (-49.5%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the 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?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	14730.5	14730.5
External area [m²]	8624.8	8624.8
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	4730.57	5927.76
Average U-value [W/m²K]	0.55	0.69
Alpha value* [%]	10	10

* 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
100	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: 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	4.2	5.69
Cooling	6.84	6.46
Auxiliary	13.03	15.05
Lighting	17.69	21.46
Hot water	3.34	3.17
Equipment*	42.18	42.18
TOTAL**	**45.1**	**51.83**

* 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]	106.36	105.78
Primary energy* [kWh/m²]	121.64	139.43
Total emissions [kg/m²]	20.6	23.7

* 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] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	13	93.4	4.2	6.8	13	0.86	3.79	0.91	5.01
	Notional	17.7	88.1	5.7	6.5	15.1	0.86	3.79	----	----

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 BCO can give particular attention to items with specifications that 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	0.2	LV000000:Surf[1]
Floor	0.2	0.2	LV000000:Surf[0]
Roof	0.15	0.18	LV000001:Surf[0]
Windows, roof windows, and rooflights	1.5	1.1	L100002A:Surf[0]
Personnel doors	1.5	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = 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
$m^3/(h.m^2)$ at 50 Pa	5	3

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Templar House

As designed

Date: Mon Jul 13 16:02:11 2015

Administrative information

Building Details

Address: High Holborn, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

BRUKL compliance check version: v5.2.b.1

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	23.7
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	23.7
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	19.9
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.2	0.2	LV000000:Surf[1]
Floor	0.25	0.2	0.2	LV000000:Surf[0]
Roof	0.25	0.18	0.18	LV000001:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.36	1.49	LV00000C:Surf[0]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = 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	3

2.b 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- Main system

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	3.11	0	1.6	0.8
Standard value	0.91*	2.7	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

"No HWS in project, or hot water is provided by HVAC system"

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
G Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P7	-	-	-	0.4	-	-	-	1.6	-	-	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
L2 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 Core	-	-	-	0.4	-	-	-	1.6	-	-	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
L7 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
podium level 1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 P2	-	-	-	0.4	-	-	-	1.6	-	-	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**
L12 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
G Office Lobby Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
G Office Lobby P1	-	-	-	0.4	-	-	-	1.6	-	-	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	
G Core	70	-	-	2211
L1 Core	70	-	-	2185
L1 P1	70	-	-	902
L1 P2	70	-	-	773
L1 P3	70	-	-	378
L1 P4	70	-	-	437
L1 P5	70	-	-	410
L1 P6	70	-	-	1477
L1 P7	70	-	-	242
L1 P8	70	-	-	423
L1 Central	70	-	-	3210
L2 P1	70	-	-	902
L2 P2	70	-	-	773
L2 P3	70	-	-	378
L2 P4	70	-	-	437
L2 P5	70	-	-	410
L2 P6	70	-	-	1477
L2 P7	70	-	-	242
L2 P8	70	-	-	423
L2 Central	70	-	-	3210
L3 P1	70	-	-	902
L3 P2	70	-	-	773
L3 P3	70	-	-	378
L3 P4	70	-	-	437
L3 P5	70	-	-	410
L3 P6	70	-	-	1477
L3 P7	70	-	-	242
L3 P8	70	-	-	423

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
L3 Central	70	-	-	3210
L4 P1	70	-	-	902
L4 P2	70	-	-	773
L4 P3	70	-	-	378
L4 P4	70	-	-	437
L4 P5	70	-	-	410
L4 P6	70	-	-	1477
L4 P7	70	-	-	242
L4 P8	70	-	-	423
L4 Central	70	-	-	3210
L5 P1	70	-	-	902
L5 P2	70	-	-	773
L5 P3	70	-	-	378
L5 P4	70	-	-	437
L5 P5	70	-	-	410
L5 P6	70	-	-	1477
L5 P7	70	-	-	242
L5 P8	70	-	-	423
L5 Central	70	-	-	3210
L6 P1	70	-	-	902
L6 P2	70	-	-	773
L6 P3	70	-	-	378
L6 P4	70	-	-	437
L6 P5	70	-	-	410
L6 P6	70	-	-	1477
L6 P7	70	-	-	242
L6 P8	70	-	-	423
L6 Central	70	-	-	3210
L6 Core	70	-	-	2161
L5 Core	70	-	-	2161
L4 Core	70	-	-	2161
L3 Core	70	-	-	2161
L2 Core	70	-	-	2161
L7 Core	70	-	-	2161
L7 P1	70	-	-	902
L7 P2	70	-	-	771
L7 P3	70	-	-	195
L7 P4	70	-	-	731
L7 P5	70	-	-	423
L7 P6	70	-	-	231
L7 Central	70	-	-	2789
L7 P7	70	-	-	1412
L8 Core	70	-	-	2161

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L8 P1	70	-	-	902
L8 P2	70	-	-	771
L8 P3	70	-	-	195
L8 P4	70	-	-	731
L8 P5	70	-	-	423
L8 P6	70	-	-	231
L8 Central	70	-	-	2789
L8 P7	70	-	-	1412
L9 Core	70	-	-	2161
L9 P1	70	-	-	902
L9 P2	70	-	-	771
L9 P3	70	-	-	195
L9 P4	70	-	-	731
L9 P5	70	-	-	423
L9 P6	70	-	-	231
L9 Central	70	-	-	2789
L9 P7	70	-	-	1412
L10 Core	70	-	-	1802
L10 P1	70	-	-	1130
L10 P2	70	-	-	979
L10 Central	70	-	-	1577
L10 P3	70	-	-	174
L10 P4	70	-	-	1338
podium level 1	70	-	-	1736
L11 Core	70	-	-	1802
L11 P1	70	-	-	1130
L11 P2	70	-	-	979
L11 Central	70	-	-	1577
L11 P3	70	-	-	174
L11 P4	70	-	-	1338
L12 Core	70	-	-	1802
L12 P1	70	-	-	1130
L12 P2	70	-	-	979
L12 Central	70	-	-	1577
L12 P3	70	-	-	174
L12 P4	70	-	-	1338
L13 Core	70	-	-	1802
L13 P1	70	-	-	1130
L13 P2	70	-	-	979
L13 Central	70	-	-	1577
L13 P3	70	-	-	174
L13 P4	70	-	-	1338
G Office Lobby Central	70	-	-	1528

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
G Office Lobby P1	70	-	-	476

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?
G Core	N/A	N/A
L1 Core	N/A	N/A
L1 P1	NO (-89.6%)	NO
L1 P2	NO (-88.5%)	NO
L1 P3	NO (-98.3%)	NO
L1 P4	NO (-99.1%)	NO
L1 P5	NO (-97.2%)	NO
L1 P6	NO (-81.2%)	NO
L1 P7	NO (-96.1%)	NO
L1 P8	NO (-97.5%)	NO
L1 Central	NO (-97.3%)	NO
L2 P1	NO (-89.4%)	NO
L2 P2	NO (-87.9%)	NO
L2 P3	NO (-98.3%)	NO
L2 P4	NO (-99.1%)	NO
L2 P5	NO (-97.7%)	NO
L2 P6	NO (-81.5%)	NO
L2 P7	NO (-96.7%)	NO
L2 P8	NO (-97.6%)	NO
L2 Central	NO (-97.4%)	NO
L3 P1	NO (-89.2%)	NO
L3 P2	NO (-86%)	NO
L3 P3	NO (-98.1%)	NO
L3 P4	NO (-99%)	NO
L3 P5	NO (-97.3%)	NO
L3 P6	NO (-77.9%)	NO
L3 P7	NO (-96.2%)	NO
L3 P8	NO (-97.4%)	NO
L3 Central	NO (-97.1%)	NO
L4 P1	NO (-88.4%)	NO
L4 P2	NO (-82.1%)	NO
L4 P3	NO (-97.7%)	NO
L4 P4	NO (-98.8%)	NO
L4 P5	NO (-96.9%)	NO
L4 P6	NO (-73.6%)	NO
L4 P7	NO (-95.3%)	NO
L4 P8	NO (-97.1%)	NO
L4 Central	NO (-96.6%)	NO
L5 P1	NO (-87.5%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L5 P2	NO (-75.6%)	NO
L5 P3	NO (-97.2%)	NO
L5 P4	NO (-98.7%)	NO
L5 P5	NO (-96.6%)	NO
L5 P6	NO (-71.5%)	NO
L5 P7	NO (-94.9%)	NO
L5 P8	NO (-96.8%)	NO
L5 Central	NO (-96.1%)	NO
L6 P1	NO (-85.8%)	NO
L6 P2	NO (-65.3%)	NO
L6 P3	NO (-96.4%)	NO
L6 P4	NO (-98.4%)	NO
L6 P5	NO (-96.2%)	NO
L6 P6	NO (-69.3%)	NO
L6 P7	NO (-94.1%)	NO
L6 P8	NO (-96.4%)	NO
L6 Central	NO (-95.1%)	NO
L6 Core	N/A	N/A
L5 Core	N/A	N/A
L4 Core	N/A	N/A
L3 Core	N/A	N/A
L2 Core	N/A	N/A
L7 Core	N/A	N/A
L7 P1	NO (-81.2%)	NO
L7 P2	NO (-59.7%)	NO
L7 P3	NO (-80.7%)	NO
L7 P4	NO (-66.2%)	NO
L7 P5	NO (-94.7%)	NO
L7 P6	NO (-91.9%)	NO
L7 Central	NO (-91.5%)	NO
L7 P7	NO (-65.3%)	NO
L8 Core	N/A	N/A
L8 P1	NO (-73.5%)	NO
L8 P2	NO (-59%)	NO
L8 P3	NO (-80.2%)	NO
L8 P4	NO (-65.8%)	NO
L8 P5	NO (-93.9%)	NO
L8 P6	NO (-91.2%)	NO
L8 Central	NO (-90.9%)	NO
L8 P7	NO (-63.7%)	NO
L9 Core	NO (-100%)	NO
L9 P1	NO (-64.4%)	NO
L9 P2	NO (-56.8%)	NO
L9 P3	NO (-79.7%)	NO
L9 P4	NO (-65.9%)	NO
L9 P5	NO (-93.1%)	NO
L9 P6	NO (-90.6%)	NO
L9 Central	NO (-90.1%)	NO
L9 P7	NO (-62.1%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L10 Core	N/A	N/A
L10 P1	NO (-58.4%)	NO
L10 P2	NO (-57.1%)	NO
L10 Central	NO (-83.3%)	NO
L10 P3	NO (-80.8%)	NO
L10 P4	NO (-70%)	NO
podium level 1	NO (-94.8%)	NO
L11 Core	N/A	N/A
L11 P1	NO (-69.1%)	NO
L11 P2	NO (-56.8%)	NO
L11 Central	NO (-84.6%)	NO
L11 P3	NO (-79.7%)	NO
L11 P4	NO (-67.6%)	NO
L12 Core	N/A	N/A
L12 P1	NO (-56.4%)	NO
L12 P2	NO (-66%)	NO
L12 Central	NO (-83.3%)	NO
L12 P3	NO (-78.8%)	NO
L12 P4	NO (-65.3%)	NO
L13 Core	N/A	N/A
L13 P1	NO (-69.8%)	NO
L13 P2	NO (-69.2%)	NO
L13 Central	NO (-86.3%)	NO
L13 P3	NO (-79.5%)	NO
L13 P4	NO (-66.7%)	NO
G Office Lobby Central	NO (-96.1%)	NO
G Office Lobby P1	NO (-49.5%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the 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?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	14730.5	14730.5
External area [m^2]	8624.8	8624.8
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	4730.57	5927.76
Average U-value [W/m^{2}K]	0.55	0.69
Alpha value* [%]	10	10

* 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
100	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: 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/m^2]

	Actual	Notional
Heating	3.75	5.69
Cooling	6.72	6.46
Auxiliary	13.03	15.05
Lighting	17.69	21.46
Hot water	3.2	3.17
Equipment*	42.18	42.18
TOTAL**	**44.39**	**51.83**

* 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/m^2]

	Actual	Notional
Photovoltaic systems	1.12	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/m^2]	105.47	105.78
Primary energy* [kWh/m^2]	120.56	139.43
Total emissions [kg/m^2]	19.9	23.7

* 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] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	12.1	93.4	3.7	6.7	13	0.9	3.86	0.95	5.1
	Notional	17.7	88.1	5.7	6.5	15.1	0.86	3.79	----	----

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 BCO can give particular attention to items with specifications that 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	0.2	LV000000:Surf[1]
Floor	0.2	0.2	LV000000:Surf[0]
Roof	0.15	0.18	LV000001:Surf[0]
Windows, roof windows, and rooflights	1.5	1.1	L100002A:Surf[0]
Personnel doors	1.5	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = 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
$m^3/(h.m^2)$ at 50 Pa	5	3

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Templar House

As designed

Date: Tue Jul 14 17:02:43 2015

Administrative information

Building Details

Address: High Holborn, London,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

BRUKL compliance check version: v5.2.b.1

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	23.7
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	23.7
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	20.4
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a Building fabric

Element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	Surface where the maximum value occurs*
Wall**	0.35	0.2	0.2	LV000000:Surf[1]
Floor	0.25	0.2	0.2	LV000000:Surf[0]
Roof	0.25	0.18	0.18	LV000001:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.36	1.49	LV00000C:Surf[0]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]

U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]

U_{i-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	3

2.b 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- Main system

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.95	3.11	0	1.6	0.8
Standard value	0.91*	2.7	N/A	1.6	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

"No HWS in project, or hot water is provided by HVAC system"

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
G Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L1 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 P7	-	-	-	0.4	-	-	-	1.6	-	-	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
L2 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 P8	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L6 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L5 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L4 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L3 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L2 Core	-	-	-	0.4	-	-	-	1.6	-	-	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
L7 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L7 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L8 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P5	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P6	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L9 P7	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L10 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
podium level 1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L11 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 P2	-	-	-	0.4	-	-	-	1.6	-	-	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
L12 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L12 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 Core	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 P1	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 P2	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 P3	-	-	-	0.4	-	-	-	1.6	-	-	N/A
L13 P4	-	-	-	0.4	-	-	-	1.6	-	-	N/A
G Office Lobby Central	-	-	-	0.4	-	-	-	1.6	-	-	N/A
G Office Lobby P1	-	-	-	0.4	-	-	-	1.6	-	-	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	
G Core	70	-	-	2211
L1 Core	70	-	-	2185
L1 P1	70	-	-	902
L1 P2	70	-	-	773
L1 P3	70	-	-	378
L1 P4	70	-	-	437
L1 P5	70	-	-	410
L1 P6	70	-	-	1477
L1 P7	70	-	-	242
L1 P8	70	-	-	423
L1 Central	70	-	-	3210
L2 P1	70	-	-	902
L2 P2	70	-	-	773
L2 P3	70	-	-	378
L2 P4	70	-	-	437
L2 P5	70	-	-	410
L2 P6	70	-	-	1477
L2 P7	70	-	-	242
L2 P8	70	-	-	423
L2 Central	70	-	-	3210
L3 P1	70	-	-	902
L3 P2	70	-	-	773
L3 P3	70	-	-	378
L3 P4	70	-	-	437
L3 P5	70	-	-	410
L3 P6	70	-	-	1477
L3 P7	70	-	-	242
L3 P8	70	-	-	423

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L3 Central	70	-	-	3210
L4 P1	70	-	-	902
L4 P2	70	-	-	773
L4 P3	70	-	-	378
L4 P4	70	-	-	437
L4 P5	70	-	-	410
L4 P6	70	-	-	1477
L4 P7	70	-	-	242
L4 P8	70	-	-	423
L4 Central	70	-	-	3210
L5 P1	70	-	-	902
L5 P2	70	-	-	773
L5 P3	70	-	-	378
L5 P4	70	-	-	437
L5 P5	70	-	-	410
L5 P6	70	-	-	1477
L5 P7	70	-	-	242
L5 P8	70	-	-	423
L5 Central	70	-	-	3210
L6 P1	70	-	-	902
L6 P2	70	-	-	773
L6 P3	70	-	-	378
L6 P4	70	-	-	437
L6 P5	70	-	-	410
L6 P6	70	-	-	1477
L6 P7	70	-	-	242
L6 P8	70	-	-	423
L6 Central	70	-	-	3210
L6 Core	70	-	-	2161
L5 Core	70	-	-	2161
L4 Core	70	-	-	2161
L3 Core	70	-	-	2161
L2 Core	70	-	-	2161
L7 Core	70	-	-	2161
L7 P1	70	-	-	902
L7 P2	70	-	-	771
L7 P3	70	-	-	195
L7 P4	70	-	-	731
L7 P5	70	-	-	423
L7 P6	70	-	-	231
L7 Central	70	-	-	2789
L7 P7	70	-	-	1412
L8 Core	70	-	-	2161

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
L8 P1	70	-	-	902
L8 P2	70	-	-	771
L8 P3	70	-	-	195
L8 P4	70	-	-	731
L8 P5	70	-	-	423
L8 P6	70	-	-	231
L8 Central	70	-	-	2789
L8 P7	70	-	-	1412
L9 Core	70	-	-	2161
L9 P1	70	-	-	902
L9 P2	70	-	-	771
L9 P3	70	-	-	195
L9 P4	70	-	-	731
L9 P5	70	-	-	423
L9 P6	70	-	-	231
L9 Central	70	-	-	2789
L9 P7	70	-	-	1412
L10 Core	70	-	-	1802
L10 P1	70	-	-	1130
L10 P2	70	-	-	979
L10 Central	70	-	-	1577
L10 P3	70	-	-	174
L10 P4	70	-	-	1338
podium level 1	70	-	-	1736
L11 Core	70	-	-	1802
L11 P1	70	-	-	1130
L11 P2	70	-	-	979
L11 Central	70	-	-	1577
L11 P3	70	-	-	174
L11 P4	70	-	-	1338
L12 Core	70	-	-	1802
L12 P1	70	-	-	1130
L12 P2	70	-	-	979
L12 Central	70	-	-	1577
L12 P3	70	-	-	174
L12 P4	70	-	-	1338
L13 Core	70	-	-	1802
L13 P1	70	-	-	1130
L13 P2	70	-	-	979
L13 Central	70	-	-	1577
L13 P3	70	-	-	174
L13 P4	70	-	-	1338
G Office Lobby Central	70	-	-	1528

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
G Office Lobby P1	70	-	-	476

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?
G Core	N/A	N/A
L1 Core	N/A	N/A
L1 P1	NO (-89.6%)	NO
L1 P2	NO (-88.5%)	NO
L1 P3	NO (-98.3%)	NO
L1 P4	NO (-99.1%)	NO
L1 P5	NO (-97.2%)	NO
L1 P6	NO (-81.2%)	NO
L1 P7	NO (-96.1%)	NO
L1 P8	NO (-97.5%)	NO
L1 Central	NO (-97.3%)	NO
L2 P1	NO (-89.4%)	NO
L2 P2	NO (-87.9%)	NO
L2 P3	NO (-98.3%)	NO
L2 P4	NO (-99.1%)	NO
L2 P5	NO (-97.7%)	NO
L2 P6	NO (-81.5%)	NO
L2 P7	NO (-96.7%)	NO
L2 P8	NO (-97.6%)	NO
L2 Central	NO (-97.4%)	NO
L3 P1	NO (-89.2%)	NO
L3 P2	NO (-86%)	NO
L3 P3	NO (-98.1%)	NO
L3 P4	NO (-99%)	NO
L3 P5	NO (-97.3%)	NO
L3 P6	NO (-77.9%)	NO
L3 P7	NO (-96.2%)	NO
L3 P8	NO (-97.4%)	NO
L3 Central	NO (-97.1%)	NO
L4 P1	NO (-88.4%)	NO
L4 P2	NO (-82.1%)	NO
L4 P3	NO (-97.7%)	NO
L4 P4	NO (-98.8%)	NO
L4 P5	NO (-96.9%)	NO
L4 P6	NO (-73.6%)	NO
L4 P7	NO (-95.3%)	NO
L4 P8	NO (-97.1%)	NO
L4 Central	NO (-96.6%)	NO
L5 P1	NO (-87.5%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L5 P2	NO (-75.6%)	NO
L5 P3	NO (-97.2%)	NO
L5 P4	NO (-98.7%)	NO
L5 P5	NO (-96.6%)	NO
L5 P6	NO (-71.5%)	NO
L5 P7	NO (-94.9%)	NO
L5 P8	NO (-96.8%)	NO
L5 Central	NO (-96.1%)	NO
L6 P1	NO (-85.8%)	NO
L6 P2	NO (-65.3%)	NO
L6 P3	NO (-96.4%)	NO
L6 P4	NO (-98.4%)	NO
L6 P5	NO (-96.2%)	NO
L6 P6	NO (-69.3%)	NO
L6 P7	NO (-94.1%)	NO
L6 P8	NO (-96.4%)	NO
L6 Central	NO (-95.1%)	NO
L6 Core	N/A	N/A
L5 Core	N/A	N/A
L4 Core	N/A	N/A
L3 Core	N/A	N/A
L2 Core	N/A	N/A
L7 Core	N/A	N/A
L7 P1	NO (-81.2%)	NO
L7 P2	NO (-59.7%)	NO
L7 P3	NO (-80.7%)	NO
L7 P4	NO (-66.2%)	NO
L7 P5	NO (-94.7%)	NO
L7 P6	NO (-91.9%)	NO
L7 Central	NO (-91.5%)	NO
L7 P7	NO (-65.3%)	NO
L8 Core	N/A	N/A
L8 P1	NO (-73.5%)	NO
L8 P2	NO (-59%)	NO
L8 P3	NO (-80.2%)	NO
L8 P4	NO (-65.8%)	NO
L8 P5	NO (-93.9%)	NO
L8 P6	NO (-91.2%)	NO
L8 Central	NO (-90.9%)	NO
L8 P7	NO (-63.7%)	NO
L9 Core	NO (-100%)	NO
L9 P1	NO (-64.4%)	NO
L9 P2	NO (-56.8%)	NO
L9 P3	NO (-79.7%)	NO
L9 P4	NO (-65.9%)	NO
L9 P5	NO (-93.1%)	NO
L9 P6	NO (-90.6%)	NO
L9 Central	NO (-90.1%)	NO
L9 P7	NO (-62.1%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L10 Core	N/A	N/A
L10 P1	NO (-58.4%)	NO
L10 P2	NO (-57.1%)	NO
L10 Central	NO (-83.3%)	NO
L10 P3	NO (-80.8%)	NO
L10 P4	NO (-70%)	NO
podium level 1	NO (-94.8%)	NO
L11 Core	N/A	N/A
L11 P1	NO (-69.1%)	NO
L11 P2	NO (-56.8%)	NO
L11 Central	NO (-84.6%)	NO
L11 P3	NO (-79.7%)	NO
L11 P4	NO (-67.6%)	NO
L12 Core	N/A	N/A
L12 P1	NO (-56.4%)	NO
L12 P2	NO (-66%)	NO
L12 Central	NO (-83.3%)	NO
L12 P3	NO (-78.8%)	NO
L12 P4	NO (-65.3%)	NO
L13 Core	N/A	N/A
L13 P1	NO (-69.8%)	NO
L13 P2	NO (-69.2%)	NO
L13 Central	NO (-86.3%)	NO
L13 P3	NO (-79.5%)	NO
L13 P4	NO (-66.7%)	NO
G Office Lobby Central	NO (-96.1%)	NO
G Office Lobby P1	NO (-49.5%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the 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?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	14730.5	14730.5
External area [m^2]	8624.8	8624.8
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	4730.57	5927.76
Average U-value [W/m^2K]	0.55	0.69
Alpha value* [%]	10	10

* 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
100	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: 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/m^2]

	Actual	Notional
Heating	3.75	5.69
Cooling	6.72	6.46
Auxiliary	13.03	15.05
Lighting	17.69	21.46
Hot water	3.2	3.17
Equipment*	42.18	42.18
TOTAL**	**44.39**	**51.83**

* 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/m^2]

	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/m^2]	105.47	105.78
Primary energy* [kWh/m^2]	120.56	139.43
Total emissions [kg/m^2]	20.4	23.7

* 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] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	12.1	93.4	3.7	6.7	13	0.9	3.86	0.95	5.1
	Notional	17.7	88.1	5.7	6.5	15.1	0.86	3.79	----	----

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 BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	U_{i-Typ}	U_{i-Min}	Surface where the minimum value occurs*
Wall	0.23	0.2	LV000000:Surf[1]
Floor	0.2	0.2	LV000000:Surf[0]
Roof	0.15	0.18	LV000001:Surf[0]
Windows, roof windows, and rooflights	1.5	1.1	L100002A:Surf[0]
Personnel doors	1.5	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

U_{i-Typ} = Typical individual element U-values [W/(m²K)] U_{i-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
$m^3/(h.m^2)$ at 50 Pa	5	3

SAP Worksheet
Design - 'Lean' Energy Strategy

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	David Mason	Assessor number	12345
Client	Northwood Investors	Last modified	30/06/2015
Address	High Holborn, London		

1. Overall dwelling dimensions

	Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied	55.70	(1a)	x	2.90	(2a)	=	161.53	(3a)
Total floor area (1a) + (1b) + (1c) + (1d)...(1n) =	55.70	(4)						
Dwelling volume						(3a) + (3b) + (3c) + (3d)...(3n) =	161.53	(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		2.50	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.13	(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) =	0.10	(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	0.12	0.12	0.12	0.11	0.10	0.09	0.09	0.09	0.10	0.10	0.11	0.11	(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	73.10	(23c)

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

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			13.92	x	1.33	=	18.45			(27)
Party wall			70.47	x	0.00	=	0.00			(32)
External wall			12.76	x	0.18	=	2.30			(29a)
Total area of external elements ∑A, m²			26.68							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	20.75	(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		4.00	(36)
Total fabric heat loss	(33) + (36) =	24.75	(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)	13.75	13.62	13.50	12.85	12.72	12.08	12.08	11.95	12.33	12.72	12.98	13.24	(38)
Heat transfer coefficient, W/K (37)m + (38)m	38.51	38.38	38.25	37.60	37.47	36.83	36.83	36.70	37.09	37.47	37.73	37.99	
Average = ∑(39)1...12/12 =												37.57	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.69	0.69	0.69	0.68	0.67	0.66	0.66	0.66	0.67	0.67	0.68	0.68	
Average = ∑(40)1...12/12 =												0.67	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.86	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	78.32	(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)	86.16	83.02	79.89	76.76	73.62	70.49	70.49	73.62	76.76	79.89	83.02	86.16	
∑(44)1...12 =												939.88	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	127.77	111.75	115.31	100.53	96.46	83.24	77.13	88.51	89.57	104.38	113.94	123.74	
∑(45)1...12 =												1232.34	(45)
Distribution loss 0.15 x (45)m	19.17	16.76	17.30	15.08	14.47	12.49	11.57	13.28	13.44	15.66	17.09	18.56	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	110.00	(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	1.03	(52)
Temperature factor from Table 2b	0.60	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	1.03	(54)
Enter (50) or (54) in (55)	1.03	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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

183.04	161.67	170.59	154.03	151.74	136.73	132.41	143.79	143.06	159.66	167.44	179.01	(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

183.04	161.67	170.59	154.03	151.74	136.73	132.41	143.79	143.06	159.66	167.44	179.01	
										∑(64)1...12 =	1883.18	(64)

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

86.70	77.10	82.56	76.22	76.30	70.47	69.87	73.65	72.58	78.93	80.68	85.36	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	36.91	32.79	26.66	20.19	15.09	12.74	13.77	17.89	24.02	30.49	35.59	37.94	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	241.77	244.28	237.96	224.50	207.51	191.54	180.87	178.37	184.69	198.15	215.14	231.10	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	(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)	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	(71)
Water heating gains (Table 5)	116.54	114.73	110.97	105.86	102.55	97.88	93.91	98.99	100.80	106.09	112.06	114.74	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	480.39	476.96	460.76	435.71	410.31	387.32	373.71	380.41	394.67	419.89	447.95	468.94	(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	0.30	x	11.52	x	10.63	x 0.9 x	0.63	x	0.95	=	19.79	(74)
East	0.30	x	2.40	x	19.64	x 0.9 x	0.63	x	0.95	=	7.62	(76)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains in watts ∑(74)m...(82)m	27.41	52.73	88.82	139.04	182.95	193.80	181.76	147.01	105.83	62.71	33.92	22.77	(83)
Total gains - internal and solar (73)m + (83)m	507.80	529.69	549.58	574.75	593.26	581.12	555.47	527.42	500.49	482.60	481.86	491.71	(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)	0.96	0.94	0.89	0.76	0.58	0.41	0.29	0.32	0.51	0.77	0.92	0.97	(86)

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

20.71	20.78	20.88	20.97	21.00	21.00	21.00	21.00	21.00	20.97	20.85	20.70	(87)

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

20.35	20.35	20.35	20.36	20.36	20.38	20.38	20.38	20.37	20.36	20.36	20.36	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.95	0.93	0.87	0.73	0.55	0.37	0.25	0.28	0.46	0.74	0.90	0.96	(89)

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

19.99	20.08	20.21	20.33	20.36	20.38	20.38	20.38	20.37	20.34	20.18	19.97	(90)

Living area fraction — Living area ÷ (4) = 0.46 (91)

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

20.32	20.40	20.52	20.63	20.66	20.67	20.67	20.67	20.66	20.63	20.49	20.31	(92)

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

20.32	20.40	20.52	20.63	20.66	20.67	20.67	20.67	20.66	20.63	20.49	20.31	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.95	0.93	0.87	0.74	0.56	0.38	0.27	0.30	0.49	0.75	0.91	0.96	(94)
Useful gains, ηmGm, W (94)m x (84)m	483.22	492.51	480.60	426.81	333.99	223.32	149.73	156.58	242.98	362.87	436.94	471.13	(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]	617.06	595.03	536.31	440.96	335.64	223.39	149.74	156.59	243.39	375.88	505.39	612.05	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	99.58	68.90	41.45	10.19	1.23	0.00	0.00	0.00	0.00	9.68	49.29	104.84	

∑(98)1...5, 10...12 = 385.14 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 6.91 (99)

8c. Space cooling requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm	0.00	0.00	0.00	0.00	0.00	346.19	272.53	278.92	0.00	0.00	0.00	0.00	(100)
Utilisation factor for loss ηm	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	(101)
Useful loss ηmLm (watts) (100)m x (101)m	0.00	0.00	0.00	0.00	0.00	345.62	272.42	278.68	0.00	0.00	0.00	0.00	(102)
Gains	0.00	0.00	0.00	0.00	0.00	710.32	676.65	625.43	0.00	0.00	0.00	0.00	(103)
Space cooling requirement, whole dwelling, continuous (kWh) 0.024 x [(103)m - (102)m] x (41)m	0.00	0.00	0.00	0.00	0.00	262.58	300.75	257.98	0.00	0.00	0.00	0.00	

∑(104)6...8 = 821.31 (104)

Cooled fraction — cooled area ÷ (4) = 0.72 (105)

Intermittency factor (Table 10)

0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.25	0.00	0.00	0.00	0.00

∑(106)6...8 = 0.75 (106)

Space cooling requirement (104)m x (105) x (106)m

0.00	0.00	0.00	0.00	0.00	47.38	54.26	46.55	0.00	0.00	0.00	0.00

	∑(107)6...8 =	148.19	(107)
Space cooling requirement kWh/m²/year	(107) ÷ (4) =	2.66	(108)

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	385.14			(98)
Space heat from boilers		(98) x (304a) x (305) x (306) =	404.40	(307a)

Water heating

Annual water heating requirement	1883.18			(64)
Water heat from boilers		(64) x (303a) x (305a) x (306) =	1977.33	(310a)
Electricity used for heat distribution		0.01 × [(307a)...(307e) + (310a)...(310e)] =	23.81	(313)
Cooling System Energy Efficiency Ratio			0	(314)
Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside	177.36			(330a)
Total electricity for the above, kWh/year			177.36	(331)
Electricity for lighting (Appendix L)			260.77	(332)
Total delivered energy for all uses		(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	2850.36	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from boilers	404.40	x	4.24	x 0.01 =	17.15	(340a)
Water heating from boilers	1977.33	x	4.24	x 0.01 =	83.84	(342a)
Space cooling	-1.00	x	13.19	x 0.01 =	4.02	(348)
Pumps and fans	177.36	x	13.19	x 0.01 =	23.39	(349)
Electricity for lighting	260.77	x	13.19	x 0.01 =	34.40	(350)
Additional standing charges					120.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354) =	282.80	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.18	(357)
SAP value	83.55	
SAP rating (section 13)	84	(358)
SAP band	B	

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor	Emissions (kg/year)	
Emissions from other sources (space heating)				
Efficiency of boilers	89.50			(367a)

[(307a)+(310a)] x 100 ÷ (367a) =

CO2 emissions from boilers		451.84	x	0.216	=	97.60 (367)
Emissions from other sources (water heating)						
Efficiency of boilers		89.50				(367a)
CO2 emissions from boilers	[(307a)+(310a)] x 100 ÷ (367a) =	2208.20	x	0.216	=	477.21 (367)
Electrical energy for community heat distribution		23.81	x	0.52	=	12.36 (372)
Total CO2 associated with community systems						587.17 (373)
Total CO2 associated with space and water heating						587.17 (376)
Space cooling		-1.00	x	0.52	=	15.83 (377)
Pumps and fans		177.36	x	0.52	=	92.05 (378)
Electricity for lighting		260.77	x	0.52	=	135.34 (379)
Total CO_2, kg/year					(376)..(382) =	830.38 (383)
Dwelling CO_2 emission rate					(383) ÷ (4) =	14.91 (384)
EI value						88.95
EI rating (section 14)						89 (385)
EI band						B

13b. Primary energy - Community heating scheme

		Energy kWh/year		Primary factor		Primary energy (kWh/year)
Primary energy from other sources (space heating)						
Efficiency of boilers		89.50				(367a)
Primary energy from boilers	[(307a)+(310a)] x 100 ÷ (367a) =	451.84	x	1.22	=	551.25 (367)
Primary energy from other sources (water heating)						
Efficiency of boilers		89.50				(367a)
Primary energy from boilers	[(307a)+(310a)] x 100 ÷ (367a) =	2208.20	x	1.22	=	2695.36 (367)
Electrical energy for community heat distribution		23.81	x	3.07	=	73.09 (372)
Total primary energy associated with community systems						3319.70 (373)
Total primary energy associated with space and water heating						3319.70 (376)
Space cooling		-1.00	x	3.07	=	3.07 (377)
Pumps and fans		177.36	x	3.07	=	544.50 (378)
Electricity for lighting		260.77	x	3.07	=	800.57 (379)
Primary energy kWh/year						4758.37 (383)
Dwelling primary energy rate kWh/m2/year						85.43 (384)

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	David Mason	Assessor number	12345
Client	Northwood Investors	Last modified	30/06/2015
Address	High Holborn, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		55.70	(1a)	x	2.90	(2a)	=	161.53	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	55.70	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			161.53	(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		2.50	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.13	(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) =	0.10	(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	0.12	0.12	0.12	0.11	0.10	0.09	0.09	0.09	0.10	0.10	0.11	0.11	(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	73.10	(23c)

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

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			13.92	x	1.05	=	14.67			(27)
Party wall			70.47	x	0.00	=	0.00			(32)
External wall			12.76	x	0.18	=	2.30			(29a)
Total area of external elements ∑A, m²			26.68							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	16.96	(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		4.00	(36)
Total fabric heat loss	(33) + (36) =	20.97	(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)	13.75	13.62	13.50	12.85	12.72	12.08	12.08	11.95	12.33	12.72	12.98	13.24	(38)
Heat transfer coefficient, W/K (37)m + (38)m	34.72	34.59	34.46	33.82	33.69	33.04	33.04	32.91	33.30	33.69	33.94	34.20	
Average = ∑(39)1...12/12 =												33.78	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.62	0.62	0.62	0.61	0.60	0.59	0.59	0.59	0.60	0.60	0.61	0.61	
Average = ∑(40)1...12/12 =												0.61	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.86	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	78.32	(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)	86.16	83.02	79.89	76.76	73.62	70.49	70.49	73.62	76.76	79.89	83.02	86.16	
∑(44)1...12 =												939.88	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	127.77	111.75	115.31	100.53	96.46	83.24	77.13	88.51	89.57	104.38	113.94	123.74	
∑(45)1...12 =												1232.34	(45)
Distribution loss 0.15 x (45)m	19.17	16.76	17.30	15.08	14.47	12.49	11.57	13.28	13.44	15.66	17.09	18.56	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	110.00	(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	1.03	(52)
Temperature factor from Table 2b	0.60	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	1.03	(54)
Enter (50) or (54) in (55)	1.03	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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

183.04	161.67	170.59	154.03	151.74	136.73	132.41	143.79	143.06	159.66	167.44	179.01	(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

183.04	161.67	170.59	154.03	151.74	136.73	132.41	143.79	143.06	159.66	167.44	179.01

∑(64)1...12 = 1883.18 (64)

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

86.70	77.10	82.56	76.22	76.30	70.47	69.87	73.65	72.58	78.93	80.68	85.36	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	36.91	32.79	26.66	20.19	15.09	12.74	13.77	17.89	24.02	30.49	35.59	37.94	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	241.77	244.28	237.96	224.50	207.51	191.54	180.87	178.37	184.69	198.15	215.14	231.10	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	(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)	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	(71)
Water heating gains (Table 5)	116.54	114.73	110.97	105.86	102.55	97.88	93.91	98.99	100.80	106.09	112.06	114.74	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	480.39	476.96	460.76	435.71	410.31	387.32	373.71	380.41	394.67	419.89	447.95	468.94	(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	0.30	x	11.52	x	10.63	x 0.9 x	0.40	x	0.95	=	12.57	(74)
East	0.30	x	2.40	x	19.64	x 0.9 x	0.40	x	0.95	=	4.84	(76)

Solar gains in watts ∑(74)m...(82)m

17.40	33.48	56.39	88.28	116.16	123.05	115.40	93.34	67.19	39.82	21.53	14.45	(83)

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

497.79	510.44	517.15	523.99	526.47	510.37	489.12	473.75	461.86	459.71	469.48	483.40	(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)	0.95	0.93	0.88	0.76	0.59	0.41	0.30	0.32	0.50	0.74	0.90	0.96	(86)

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

20.80	20.85	20.92	20.98	21.00	21.00	21.00	21.00	21.00	20.98	20.91	20.79	(87)

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

20.41	20.41	20.41	20.42	20.43	20.44	20.44	20.44	20.43	20.43	20.42	20.42	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.94	0.92	0.86	0.73	0.56	0.38	0.26	0.28	0.46	0.71	0.88	0.95	(89)

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

20.16	20.22	20.32	20.40	20.42	20.44	20.44	20.44	20.43	20.41	20.31	20.15	(90)

Living area fraction — Living area ÷ (4) = 0.46 (91)

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

20.46	20.51	20.59	20.67	20.69	20.70	20.70	20.70	20.70	20.68	20.59	20.45	(92)

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

20.46	20.51	20.59	20.67	20.69	20.70	20.70	20.70	20.70	20.68	20.59	20.45	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.94	0.92	0.86	0.74	0.57	0.39	0.28	0.30	0.48	0.72	0.88	0.95	(94)
Useful gains, ηmGm, W (94)m x (84)m	467.47	468.38	447.01	388.38	301.77	201.46	135.41	141.50	219.46	332.66	415.12	457.39	(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]	560.91	540.00	485.70	397.98	302.85	201.49	135.41	141.50	219.63	339.46	457.85	555.70	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	69.52	48.13	28.78	6.91	0.80	0.00	0.00	0.00	0.00	5.06	30.77	73.14	

∑(98)1...5, 10...12 = 263.12 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 4.72 (99)

8c. Space cooling requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm	0.00	0.00	0.00	0.00	0.00	310.58	244.50	250.13	0.00	0.00	0.00	0.00	(100)
Utilisation factor for loss ηm	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	(101)
Useful loss ηmLm (watts) (100)m x (101)m	0.00	0.00	0.00	0.00	0.00	310.08	244.42	249.97	0.00	0.00	0.00	0.00	(102)
Gains	0.00	0.00	0.00	0.00	0.00	592.40	566.05	535.98	0.00	0.00	0.00	0.00	(103)
Space cooling requirement, whole dwelling, continuous (kWh) 0.024 x [(103)m - (102)m] x (41)m	0.00	0.00	0.00	0.00	0.00	203.27	239.30	212.79	0.00	0.00	0.00	0.00	

∑(104)6...8 = 655.36 (104)

Cooled fraction — cooled area ÷ (4) = 0.72 (105)

Intermittency factor (Table 10)

0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.25	0.00	0.00	0.00	0.00

∑(106)6...8 = 0.75 (106)

Space cooling requirement (104)m x (105) x (106)m

0.00	0.00	0.00	0.00	0.00	36.68	43.18	38.39	0.00	0.00	0.00	0.00

	∑(107)6...8 =	118.25	(107)
Space cooling requirement kWh/m²/year	(107) ÷ (4) =	2.12	(108)

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 heat pump			1.00	(303a)
Fraction of total space heat from community heat pump		(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	263.12			(98)
Space heat from heat pump		(98) x (304a) x (305) x (306) =	276.27	(307a)
Water heating				
Annual water heating requirement	1883.18			(64)
Water heat from boilers		(64) x (303a) x (305a) x (306) =	790.93	(310a)
Water heat from heat pump		(64) x (303b) x (305a) x (306) =	751.39	(310b)
Water heat from heat pump		(64) x (303c) x (305a) x (306) =	435.01	(310c)
Electricity used for heat distribution		0.01 × [(307a)...(307e) + (310a)...(310e)] =	22.51	(313)
Cooling System Energy Efficiency Ratio			0	(314)
Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside	177.36			(330a)
Total electricity for the above, kWh/year			177.36	(331)
Electricity for lighting (Appendix L)			260.77	(332)
Energy saving/generation technologies				
electricity generated by PV (Appendix M)			-204.09	(333)
Total delivered energy for all uses		(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	2511.98	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from heat pump	276.27	x	4.24	x 0.01 =	11.71	(340a)
Water heating from boilers	790.93	x	4.24	x 0.01 =	33.54	(342a)
Water heating from heat pump	751.39	x	4.24	x 0.01 =	31.86	(342b)
Water heating from heat pump	435.01	x	4.24	x 0.01 =	18.44	(342c)
Space cooling	-1.00	x	13.19	x 0.01 =	3.21	(348)
Pumps and fans	177.36	x	13.19	x 0.01 =	23.39	(349)
Electricity for lighting	260.77	x	13.19	x 0.01 =	34.40	(350)
Additional standing charges					120.00	(351)
Energy saving/generation technologies						
pv savings	-204.09	x	13.19	x 0.01 =	0.00	(352)
Total energy cost				(340a)...(342e) + (345)...(354) =	276.55	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.15	(357)

SAP value					83.91	
SAP rating (section 13)					84	(358)
SAP band					B	

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of heat pump	300.00					(367a)
CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) =	92.09	x	0.519	=	47.80	(367)
Emissions from other sources (water heating)						
Efficiency of boilers	93.00					(367a)
CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) =	849.39	x	0.216	=	183.70	(367)
Efficiency of heat pump	300.00					(367b)
CO2 emissions from heat pump [(307b)+(310b)] x 100 ÷ (367b) =	250.13	x	0.519	=	129.99	(368)
Efficiency of heat pump	400.00					(367c)
CO2 emissions from heat pump [(307c)+(310c)] x 100 ÷ (367c) =	108.50	x	0.519	=	56.44	(369)
Electrical energy for community heat distribution	22.51	x	0.52	=	11.68	(372)
Total CO2 associated with community systems					429.61	(373)
Total CO2 associated with space and water heating					429.61	(376)
Space cooling	-1.00	x	0.52	=	12.63	(377)
Pumps and fans	177.36	x	0.52	=	92.05	(378)
Electricity for lighting	260.77	x	0.52	=	135.34	(379)
Energy saving/generation technologies						
pv savings	-204.09	x	0.52	=	-105.92	(380)
Total CO_2, kg/year				(376)..(382) =	563.71	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	10.12	(384)
EI value					92.50	
EI rating (section 14)					92	(385)
EI band					A	

13b. Primary energy - Community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary energy from other sources (space heating)						
Efficiency of heat pump	300.00					(367a)
Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) =	92.09	x	3.07	=	282.72	(367)
Primary energy from other sources (water heating)						
Efficiency of boilers	93.00					(367a)
Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) =	849.39	x	1.22	=	1037.57	(367)
Efficiency of heat pump	300.00					(367b)
Primary energy from heat pump [(307b)+(310b)] x 100 ÷ (367b) =	250.13	x	3.07	=	768.92	(368)
Efficiency of heat pump	400.00					(367c)
Primary energy from heat pump [(307c)+(310c)] x 100 ÷ (367c) =	108.50	x	3.07	=	333.87	(369)
Electrical energy for community heat distribution	22.51	x	3.07	=	69.09	(372)
Total primary energy associated with community systems					2492.17	(373)
Total primary energy associated with space and water heating					2492.17	(376)
Space cooling	-1.00	x	3.07	=	3.07	(377)
Pumps and fans	177.36	x	3.07	=	544.50	(378)

Electricity for lighting	260.77	x	3.07	=	800.57	(379)
Energy saving/generation technologies						
Electricity generated - PVs	-204.09	x	3.07	=	-626.54	(380)
Primary energy kWh/year					3285.39	(383)
Dwelling primary energy rate kWh/m2/year					58.98	(384)

SAP Worksheet
Design - 'Green' Energy Strategy

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	David Mason	Assessor number	12345
Client	Northwood Investors	Last modified	30/06/2015
Address	High Holborn, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		55.70	(1a)	x	2.90	(2a)	=	161.53	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	55.70	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			161.53	(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		2.50	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.13	(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) =	0.10	(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	0.12	0.12	0.12	0.11	0.10	0.09	0.09	0.09	0.10	0.10	0.11	0.11	(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	73.10	(23c)

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

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			13.92	x	1.05	=	14.67			(27)
Party wall			70.47	x	0.00	=	0.00			(32)
External wall			12.76	x	0.18	=	2.30			(29a)
Total area of external elements ∑A, m²			26.68							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	16.96	(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		4.00	(36)
Total fabric heat loss	(33) + (36) =	20.97	(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)	13.75	13.62	13.50	12.85	12.72	12.08	12.08	11.95	12.33	12.72	12.98	13.24	(38)
Heat transfer coefficient, W/K (37)m + (38)m	34.72	34.59	34.46	33.82	33.69	33.04	33.04	32.91	33.30	33.69	33.94	34.20	
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.62	0.62	0.62	0.61	0.60	0.59	0.59	0.59	0.60	0.60	0.61	0.61	
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)

Heat transfer coefficient: Average = ∑(39)1...12/12 = 33.78 (39)

Heat loss parameter: Average = ∑(40)1...12/12 = 0.61 (40)

4. Water heating energy requirement

Assumed occupancy, N	1.86	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	78.32	(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)	86.16	83.02	79.89	76.76	73.62	70.49	70.49	73.62	76.76	79.89	83.02	86.16	
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	127.77	111.75	115.31	100.53	96.46	83.24	77.13	88.51	89.57	104.38	113.94	123.74	
Distribution loss 0.15 x (45)m	19.17	16.76	17.30	15.08	14.47	12.49	11.57	13.28	13.44	15.66	17.09	18.56	(46)

Hot water usage: ∑(44)1...12 = 939.88 (44)

Energy content: ∑(45)1...12 = 1232.34 (45)

Storage volume (litres) including any solar or WWHRS storage within same vessel	110.00	(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	1.03	(52)
Temperature factor from Table 2b	0.60	(53)
Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)	1.03	(54)
Enter (50) or (54) in (55)	1.03	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	32.01	28.92	32.01	30.98	32.01	30.98	32.01	32.01	30.98	32.01	30.98	32.01	(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

183.04	161.67	170.59	154.03	151.74	136.73	132.41	143.79	143.06	159.66	167.44	179.01	(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

183.04	161.67	170.59	154.03	151.74	136.73	132.41	143.79	143.06	159.66	167.44	179.01	

∑(64)1...12 = 1883.18 (64)

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

86.70	77.10	82.56	76.22	76.30	70.47	69.87	73.65	72.58	78.93	80.68	85.36	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)													
	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	111.47	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	36.91	32.79	26.66	20.19	15.09	12.74	13.77	17.89	24.02	30.49	35.59	37.94	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	241.77	244.28	237.96	224.50	207.51	191.54	180.87	178.37	184.69	198.15	215.14	231.10	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	(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)													
	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	-74.31	(71)
Water heating gains (Table 5)													
	116.54	114.73	110.97	105.86	102.55	97.88	93.91	98.99	100.80	106.09	112.06	114.74	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
	480.39	476.96	460.76	435.71	410.31	387.32	373.71	380.41	394.67	419.89	447.95	468.94	(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	0.30	x	11.52	x	10.63	x 0.9 x	0.40	x	0.95	=	12.57	(74)
East	0.30	x	2.40	x	19.64	x 0.9 x	0.40	x	0.95	=	4.84	(76)

Solar gains in watts ∑(74)m...(82)m

17.40	33.48	56.39	88.28	116.16	123.05	115.40	93.34	67.19	39.82	21.53	14.45	(83)

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

497.79	510.44	517.15	523.99	526.47	510.37	489.12	473.75	461.86	459.71	469.48	483.40	(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)												
0.95	0.93	0.88	0.76	0.59	0.41	0.30	0.32	0.50	0.74	0.90	0.96	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	20.80	20.85	20.92	20.98	21.00	21.00	21.00	21.00	21.00	20.98	20.91	20.79	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	20.41	20.41	20.41	20.42	20.43	20.44	20.44	20.44	20.43	20.43	20.42	20.42	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.94	0.92	0.86	0.73	0.56	0.38	0.26	0.28	0.46	0.71	0.88	0.95	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	20.16	20.22	20.32	20.40	20.42	20.44	20.44	20.44	20.43	20.41	20.31	20.15	(90)

Living area fraction — Living area ÷ (4) = 0.46 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	20.46	20.51	20.59	20.67	20.69	20.70	20.70	20.70	20.70	20.68	20.59	20.45	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate	20.46	20.51	20.59	20.67	20.69	20.70	20.70	20.70	20.70	20.68	20.59	20.45	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.94	0.92	0.86	0.74	0.57	0.39	0.28	0.30	0.48	0.72	0.88	0.95	(94)
Useful gains, ηmGm, W (94)m x (84)m	467.47	468.38	447.01	388.38	301.77	201.46	135.41	141.50	219.46	332.66	415.12	457.39	(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]	560.91	540.00	485.70	397.98	302.85	201.49	135.41	141.50	219.63	339.46	457.85	555.70	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	69.52	48.13	28.78	6.91	0.80	0.00	0.00	0.00	0.00	5.06	30.77	73.14	

∑(98)1...5, 10...12 = 263.12 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 4.72 (99)

8c. Space cooling requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm	0.00	0.00	0.00	0.00	0.00	310.58	244.50	250.13	0.00	0.00	0.00	0.00	(100)
Utilisation factor for loss ηm	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	(101)
Useful loss ηmLm (watts) (100)m x (101)m	0.00	0.00	0.00	0.00	0.00	310.08	244.42	249.97	0.00	0.00	0.00	0.00	(102)
Gains	0.00	0.00	0.00	0.00	0.00	592.40	566.05	535.98	0.00	0.00	0.00	0.00	(103)
Space cooling requirement, whole dwelling, continuous (kWh) 0.024 x [(103)m - (102)m] x (41)m	0.00	0.00	0.00	0.00	0.00	203.27	239.30	212.79	0.00	0.00	0.00	0.00	

∑(104)6...8 = 655.36 (104)

Cooled fraction — cooled area ÷ (4) = 0.72 (105)

Intermittency factor (Table 10)	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.25	0.00	0.00	0.00	0.00	

∑(106)6...8 = 0.75 (106)

Space cooling requirement (104)m x (105) x (106)m	0.00	0.00	0.00	0.00	0.00	36.68	43.18	38.39	0.00	0.00	0.00	0.00

	∑(107)6...8 =	118.25	(107)
Space cooling requirement kWh/m²/year	(107) ÷ (4) =	2.12	(108)

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	263.12			(98)
Space heat from boilers		(98) x (304a) x (305) x (306) =	276.27	(307a)

Water heating

Annual water heating requirement	1883.18			(64)
Water heat from boilers		(64) x (303a) x (305a) x (306) =	1542.32	(310a)
Water heat from heat pump		(64) x (303b) x (305a) x (306) =	435.01	(310b)
Electricity used for heat distribution		0.01 × [(307a)...(307e) + (310a)...(310e)] =	22.52	(313)
Cooling System Energy Efficiency Ratio			0	(314)
Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside	177.36			(330a)
Total electricity for the above, kWh/year			177.36	(331)
Electricity for lighting (Appendix L)			260.77	(332)
Total delivered energy for all uses		(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	2716.07	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from boilers	276.27	x	4.24	x 0.01 =	11.71	(340a)
Water heating from boilers	1542.32	x	4.24	x 0.01 =	65.39	(342a)
Water heating from heat pump	435.01	x	4.24	x 0.01 =	18.44	(342b)
Space cooling	-1.00	x	13.19	x 0.01 =	3.21	(348)
Pumps and fans	177.36	x	13.19	x 0.01 =	23.39	(349)
Electricity for lighting	260.77	x	13.19	x 0.01 =	34.40	(350)
Additional standing charges					120.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354) =	276.55	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.15	(357)
SAP value	83.91	
SAP rating (section 13)	84	(358)
SAP band	B	

12b. Carbon dioxide emissions - Community heating scheme

	Energy kWh/year	Emission factor	Emissions (kg/year)

Emissions from other sources (space heating)						
Efficiency of boilers		93.00				(367a)
CO2 emissions from boilers	[(307a)+(310a)] x 100 ÷ (367a) =	297.07	x	0.216	= 64.17	(367)
Emissions from other sources (water heating)						
Efficiency of boilers		93.00				(367a)
CO2 emissions from boilers	[(307a)+(310a)] x 100 ÷ (367a) =	1657.33	x	0.216	= 358.22	(367)
Efficiency of heat pump		400.00				(367b)
CO2 emissions from heat pump	[(307b)+(310b)] x 100 ÷ (367b) =	108.50	x	0.519	= 56.44	(368)
Electrical energy for community heat distribution		22.52	x	0.52	= 11.69	(372)
Total CO2 associated with community systems					490.51	(373)
Total CO2 associated with space and water heating					490.51	(376)
Space cooling		-1.00	x	0.52	= 12.63	(377)
Pumps and fans		177.36	x	0.52	= 92.05	(378)
Electricity for lighting		260.77	x	0.52	= 135.34	(379)
Total CO_2, kg/year				(376)..(382) =	730.53	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	13.12	(384)
EI value					90.28	
EI rating (section 14)					90	(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		93.00				(367a)
Primary energy from boilers	[(307a)+(310a)] x 100 ÷ (367a) =	297.07	x	1.22	= 362.42	(367)
Primary energy from other sources (water heating)						
Efficiency of boilers		93.00				(367a)
Primary energy from boilers	[(307a)+(310a)] x 100 ÷ (367a) =	1657.33	x	1.22	= 2023.26	(367)
Efficiency of heat pump		400.00				(367b)
Primary energy from heat pump	[(307b)+(310b)] x 100 ÷ (367b) =	108.50	x	3.07	= 333.87	(368)
Electrical energy for community heat distribution		22.52	x	3.07	= 69.12	(372)
Total primary energy associated with community systems					2788.68	(373)
Total primary energy associated with space and water heating					2788.68	(376)
Space cooling		-1.00	x	3.07	= 3.07	(377)
Pumps and fans		177.36	x	3.07	= 544.50	(378)
Electricity for lighting		260.77	x	3.07	= 800.57	(379)
Primary energy kWh/year					4208.44	(383)
Dwelling primary energy rate kWh/m2/year					75.56	(384)

5.2 Appendix B – Citigen Correspondence

David Mason

From:	White, Andrew <andrew.white@eonenergy.com>
Sent:	03 March 2015 10:04
To:	Harry Thurman
Subject:	RE: Templar House - Connection to CitiGen.

Morning Harry,

I can confirm that the below email is an accurate summary of our conversation. Of course, should we extend the network west towards High Holborn there may be an opportunity in the future to connect to the building to our network.

Kind regards,

Andrew

Andrew White
Community Energy
E.ON Energy Solutions Limited
M: +44 (0) 7805 753 088
andrew.white@eonenergy.com

E.ON Energy Solutions Limited, Community Energy
Citigen
47-53 Charterhouse Street
EC1M 6PB
eonenergy.com/sustainable
www.twitter.com/talkingenergy

Proud to have been awarded BITC's Community Mark

From: Harry Thurman [mailto:Harry.Thurman@arup.com]
Sent: 03 March 2015 10:02
To: White, Andrew
Subject: RE: Templar House - Connection to CitiGen.

Morning Andrew,

Thank you for taking the time to discuss the potential for connecting our scheme (Templar House) to the Citigen district heating network.

We understand that based on the size of our scheme that it would not be feasible to extend the Citigen network to our site. We also understand that there are additional technical difficulties in extending the network further west beyond Farringdon Road. Therefore we will be unable to connect to the Citigen network at present and we should consider other means of providing heat to the site.

We will be designing scheme to be connect to any future district heating scheme that may become available.

I would be grateful if you could confirm that this is an accurate summary of our conversation.

Kind Regards,

Harry

From: White, Andrew [mailto:andrew.white@eonenergy.com]
Sent: 20 February 2015 16:23
To: Harry Thurman
Subject: FW: Templar House - Connection to CitiGen.

Harry,

I have been forwarded your email below regarding a possible connection to our Citigen district heating network. I will give you a call on Monday to discuss if that's OK?

Kind regards,

Andrew

Andrew White
Community Energy
E.ON Energy Solutions Limited
M: +44 (0) 7805 753 088
andrew.white@eonenergy.com

E.ON Energy Solutions Limited, Community Energy
Citigen
47-53 Charterhouse Street
EC1M 6PB
eonenergy.com/sustainable
www.twitter.com/talkingenergy

From: Harry Thurman [mailto:Harry.Thurman@arup.com]
Sent: 13 February 2015 14:45
To: CHP Commercial Team
Subject: Templar House - Connection to CitiGen.

Dear Whom It may Concern,

We are looking to develop a new scheme commercial office and residential in Holborn and wanted to enquire into the possibility of connecting to the CitiGen District Heating network that is approximately 950m away from our site?

The address is:

Templar House
81-87 High Holborn
LONDON
WC1V 6NU

I would be grateful if you could let me know if this is a possibility and the available capacity.

Regards,

Harry

Harry Thurman
Senior Engineer | Mechanical

13 Fitzroy Street London W1T 4BQ United Kingdom
t +44 20 7755 2712 **d** +44 20 7755 2712
f +44 20 7755 9012
www.arup.com