TwoEighty CONSULTING

# Land at rear of 175 Briar Road

Energy and Sustainability Statement

March 2024

## Table of Contents



### Audit Sheet

| Revision | Issued for | Date | Author |
|---|---|---|---|
| 0 | Draft | 28/03/24 | OE |
| 1 | Submission | 05/04/24 | OE |

# Executive Summary

This Energy and Sustainability statement reports how the proposed scheme at Land at rear of 175 Briar Road, Watford, WD25 0HL has responded to local policy requirements regarding sustainability, energy and climate change.

This assessment is prepared to support the planning application for the construction of a one-bedroom bungalow at land at the rear of 175 Briar Road.

This assessment has been prepared in line with the requirements of Watford's local policy surrounding Energy and Climate Change. The scheme complies with all relevant to Energy and Sustainability contained in Watford's Local Plan (2021).

The proposed energy strategy is set out in this report and the scheme achieves an on-site **CO2 reduction of 59%**, surpassing the 19% CO2 reduction required by local policy.

With regards to sustainability, the scheme aspires to reduce its environmental impact by incorporating sustainable measures across the design. Additional sustainability measures that will be integrated are contained in the body of this report.

*Table 1: Regulated domestic carbon dioxide savings achieved on-site.*

| | Regulated domestic carbon dioxide emissions | |
|---|---|---|
| | Tonnes CO2 per annum | % Reduction |
| Baseline Part L (2021) Compliant Scheme | 0.6 | - |
| Watford Policy: 19% Reduction Requirement | 0.5 | 19% |
| Proposed Scheme at 175 Briar Road | 0.2 | 59% |
| **Total regulated carbon dioxide reduction** | **0.4** | **59%** |

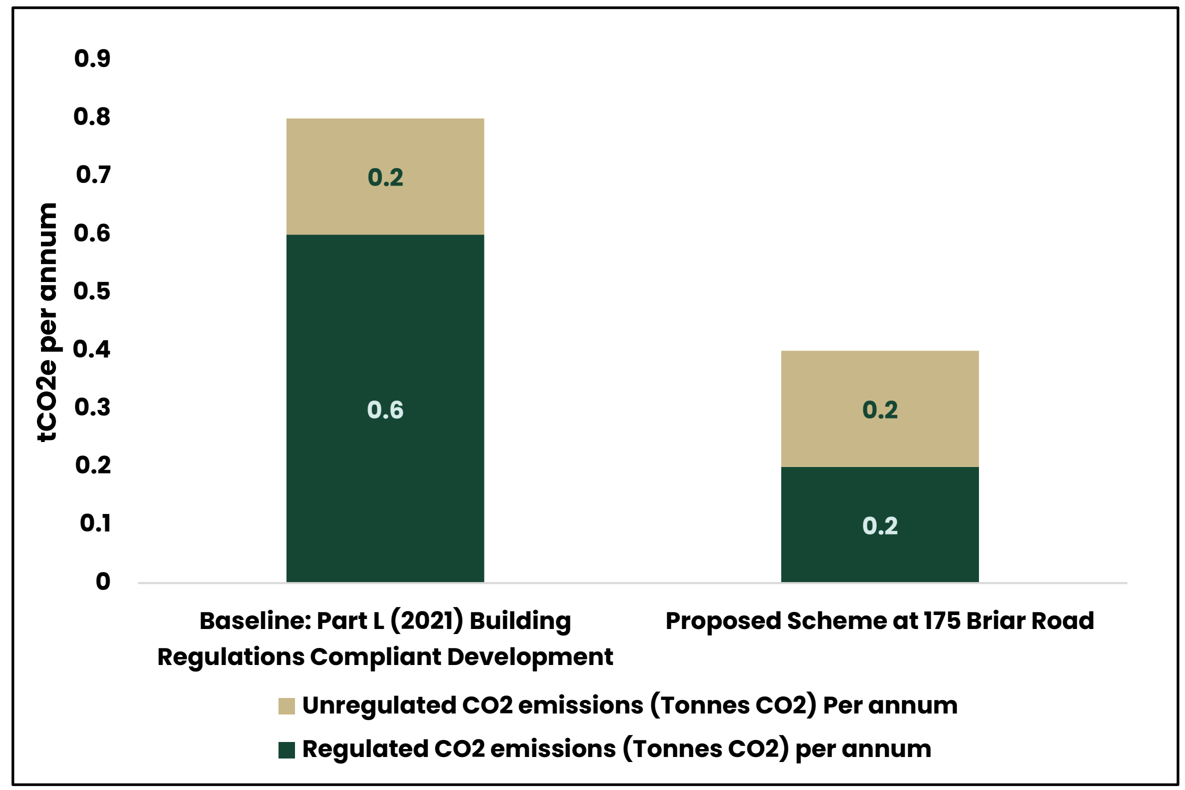



*Figure 1: Carbon dioxide emissions per annum at the proposed scheme.*

**SAP 10.2 Carbon Factors have been used to assess the scheme, with the following emission rates:*

- *Natural Gas:* *0.210kgCO2/kWh*
- *Grid Electricity:* *0.136 kgCO2/kWh*

# 1. Introduction

### 1.1 Site Overview

TwoEighty are appointed to prepare this Energy and Sustainability Statement for the proposed scheme at Land at rear of 175 Briar Road, Watford, WD25 0HL . The site plan is shown in Figure 2 to the right.

The proposed development is construction of a one-bedroom bungalow at land at the rear of 175 Briar Road.

The site is situated within the jurisdiction of Watford Borough Council. This assessment details how the proposed scheme adheres to regional and local policy requirements regarding energy and sustainability.


*Figure 2: Site location (green).*

# 2. Overview of Policies

### 2.1 National Policy

The National Planning Policy Framework (NPPF) (December 2023) establishes the Government's planning policies for England and denotes how these are expected to be applied. It provides a clear framework for which local authorities can use to develop their own distinctive local and neighbourhood plans. At the heart of the NPPF is a presumption in favour of sustainable development, which should be a core principle of plan making and decision taking. The core elements of the NPPF relating to sustainability focused decisions are listed below:

*Plans and decisions should apply a presumption in favour of sustainable development. For plan-making this means that:*

a) *all plans should promote a sustainable pattern of development that seeks to: meet the development needs of their area; align growth and infrastructure; improve the environment; mitigate climate change (including by making effective use of land in urban areas) and adapt to its effects;*
b) *strategic policies should, as a minimum, provide for objectively assessed needs for housing and other uses, as well as any needs that cannot be met within neighbouring areas6, unless: i. the application of policies in this Framework that protect areas or assets of particular importance provides a strong reason for restricting the overall scale, type or distribution of development in the plan area; or ii. any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in this Framework taken as a whole. For decision-taking this means:*
c) *approving development proposals that accord with an up-to-date development plan without delay; or*
d) *where there are no relevant development plan policies, or the policies which are most important for determining the application are out-of-date, granting permission unless:*
    i. *the application of policies in this Framework that protect areas or assets of particular importance provides a clear reason for refusing the development proposed7; or*
    ii. *any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in this Framework taken as a whole.*

The NPPF also acknowledges that the planning system should support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change. It should help to: shape places in ways that contribute to radical reductions in greenhouse gas emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure. To this extent, the policies relevant to procuring a low carbon future include:

*New development should be planned for in ways that:*

a) *avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and*
b) *can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards.*

*To help increase the use and supply of renewable and low carbon energy and heat, plans should:*

a) *provide a positive strategy for energy from these sources, that maximises the potential for suitable development, and their future re-powering and life extension, while ensuring that adverse impacts are addressed appropriately (including cumulative landscape and visual impacts);*
b) *consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and*
c) *identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for colocating potential heat customers and suppliers.*

# 2. Overview of Policies

### 2.2 Local Policy: Watford Local Plan (2021 – 2038)

Watford Borough Council adopted their new local plan on 17th October 2022. The Local Plan contains planning policies and site allocations to guide new development and inform planning decisions that help shape Watford's future.

Watford declared a climate emergency in 2019, setting a goal to be a carbon-neutral borough by 2030. This means that the borough is committed to reducing carbon dioxide emissions of new development.

The Local Plan enforces this requirement, with the following policies deemed relevant to this Energy and Sustainability Statement:

- **Policy CC8.1: Mitigating Climate Change and Reducing Carbon Emissions**
- **Policy CC8.3: Sustainable Construction and Resource Management**

The local plan places significant emphasis on reducing regulated carbon emissions of new development through use of energy efficient building fabric and use of low and zero carbon technologies.

Policy CC8.1 requires new development to employ sustainable construction methods, to be high quality and use on-site low carbon and renewable technologies. Policy CC8.3 then stipulates that new development must achieve a 19% improvement for carbon emission over the target emission rate as set out in Part L (2013) or any updated government standards. In lieu of these policies, the proposed scheme targeted to meet or exceed a 19% improvement for carbon emissions as set out in Part L (2021), which is the latest governmental standard and therefore represents best practice.

The proposed scheme has exceeded the 19% carbon reduction requirements stipulated in local policy, achieving an on-site regulated carbon reduction of 59%.

Other policy requirements relevant to residential development, include conserving water use, managing flood risk and improving biodiversity.

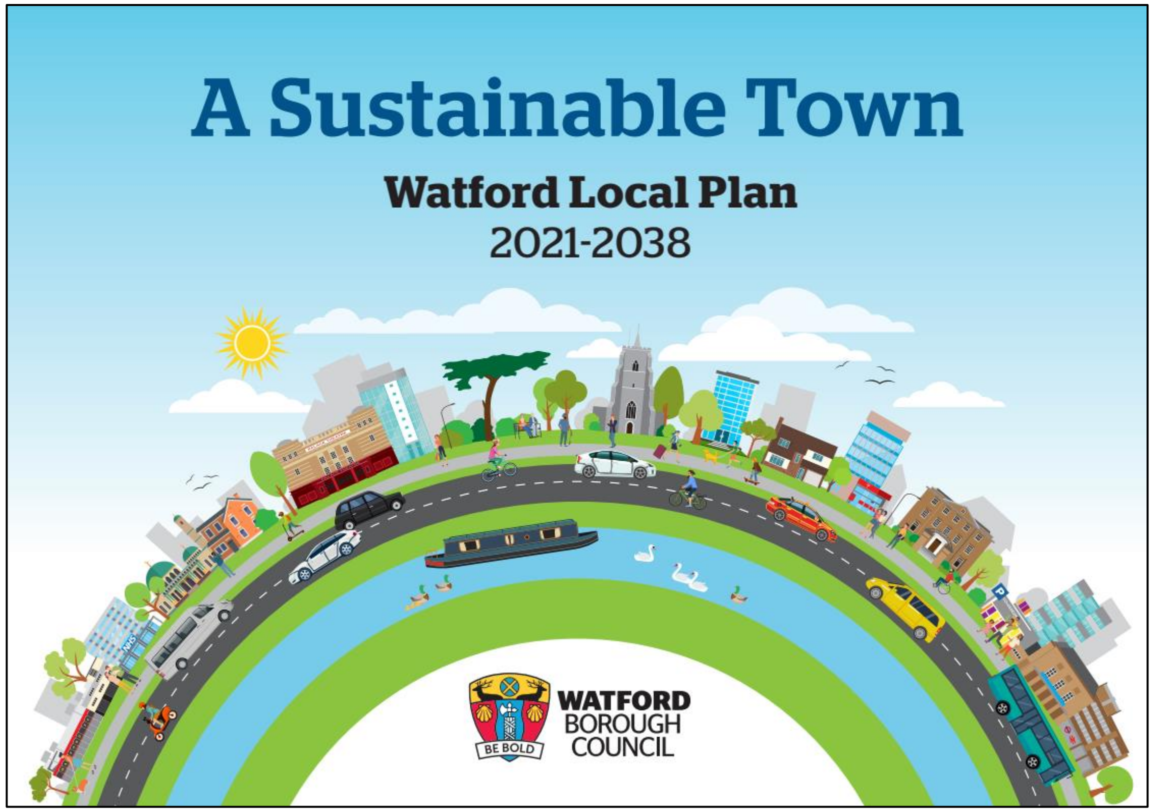


*Figure 3: Watford Borough Council's Local Plan (2021 – 2038).*

# 3. Methodology

### 3.1 Energy Hierarchy Application

In accordance with local policy, the proposed scheme has adopted the Energy Hierarchy, comprised of:

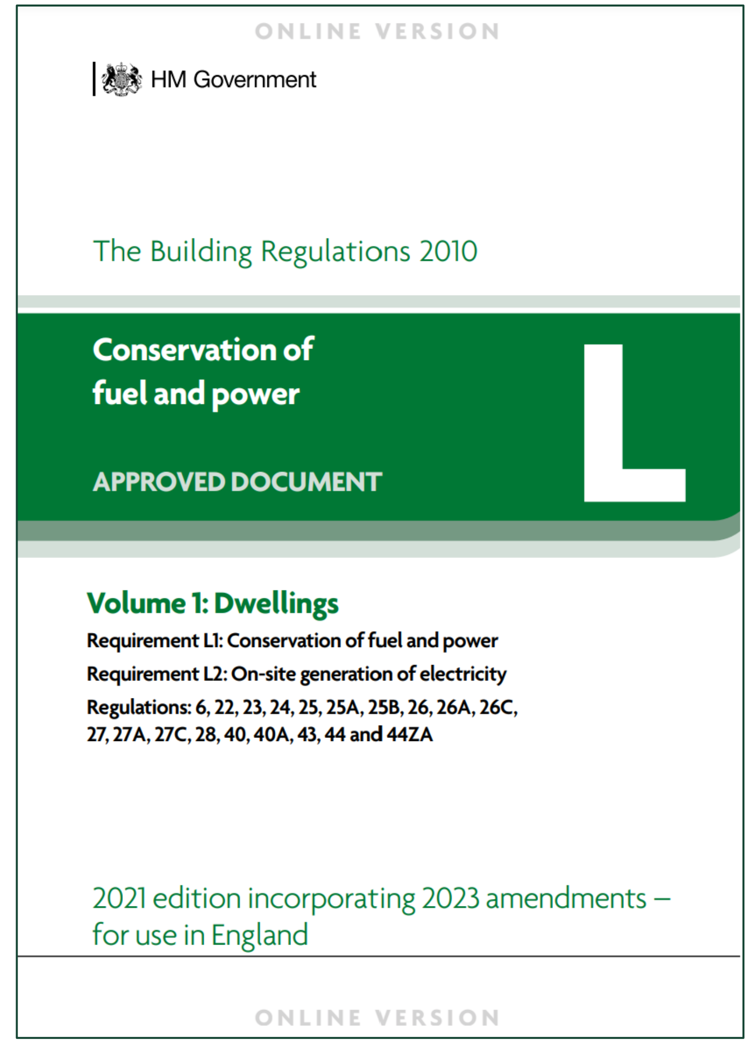
- Be Lean – use less energy; achieved through implementation of building envelope upgrades and passive design measures.
- Be Clean – supply energy efficiently; connecting to existing or future District Heating networks.
- Be Green – use renewable technology; achieved through the implementation of green measures, such as Air Source Heat Pumps.

### 3.2 Energy Modelling

The latest version (SAP 10.2) of SAP software has been used to model the proposed scheme and accordingly, SAP 10.2 carbon factors have also been used. For the purposes of this report, renewable technology includes the provision of low carbon technologies such as Heat Pump technologies.

For the purposes of 'Be Lean' energy modelling, space heating and domestic hot water is provided by gas boilers with 89.5% efficiency, to standardise a target for comparison of energy efficiency. The 'Be Green' stage of the energy modelling then utilises an energy strategy comprised of Air Source Heat Pumps (ASHPs) which is the proposed energy strategy for this scheme.

The scheme has been modelled utilising the latest drawing set received from RP Project Design on the 20th March 2024.


ONLINE VERSION

HM Government

The Building Regulations 2010

Conservation of fuel and power

APPROVED DOCUMENT

L

Volume 1: Dwellings

Requirement L1: Conservation of fuel and power

Requirement L2: On-site generation of electricity

Regulations: 6, 22, 23, 24, 25, 25A, 25B, 26, 26A, 26C, 27, 27A, 27C, 28, 40, 40A, 43, 44 and 44ZA

2021 edition incorporating 2023 amendments – for use in England

ONLINE VERSION

*Figure 6: Building Regulations Part L (2021).*

# 4. Energy: Be Lean

Be Lean refers to the passive design and energy efficient solutions to minimise energy demand on-site.

### 4.1 Passive Measures

The following passive design measures will be included in the design to reduce energy demand and subsequent CO2 emissions emanating from the proposed development. The proposed building fabric values represent an improvement in comparison to the Part L (2021) backstop values. The following typical envelope performance characteristics and passive design measures will be included (see Table 2).

*Table 2: Building fabric parameters included in the proposed scheme's energy model.*

| Parameter | Input | Unit |
|---|---|---|
| Floor U-Value | 0.13 | W/m2K |
| Roof U-Value | 0.13 | W/m2K |
| External Walls U-Value | 0.17 | W/m2K |
| Glazing U-Value | 1.2 | W/m2K |
| Glazing G-Value | 0.76 | - |
| Frame Factor | 0.7 (Default) | - |
| Thermal Mass Parameter | 250 (Medium) | kJ/m2K |
| Thermal Bridge Y-Value | <0.1 (Default) | - |
| Ventilation Method | Passive | - |
| Air Permeability | 3.0 @ 50Pa (m3/(h.m2)) | - |
| Wastewater Heat Recovery | Recoup: Pipe HEX | Efficiency 63.6% |

A number of Passive Measures will be included on site, comprised of:

- An improved building fabric by comparison to the Part L (2021) back stop values.
- High performance glazing.
- Low air permeability to minimise heat loss.
- An orientation that suits sunlight and daylight access.
- Wastewater Heat Recovery system provided to the bathroom to maximise domestic hot water efficiency.

### 4.2 Active Measures

The scheme will benefit from high efficiency LED lighting throughout with a minimum efficacy of 90 lumens/Watt.

### 4.3 Fabric Energy Efficiency

The proposed scheme also has a Dwelling Fabric Energy Efficiency (DFEE) score that exceeds the Target Fabric Energy Efficiency (TFEE) rating representing a fabric efficiency improvement against Building Regulations Part L (2021).

# 4. Energy: Be Lean

### 4.4 Passive Overheating Mitigation Measures

Whilst the Be Lean stage predominantly relates to Energy Reduction through design, passive measures to mitigate overheating risk have also been considered, and include:

- Minimising internal heat through fully insulated pipework.
- Reducing heat entering through the use of, ~200mm window reveals and internal shutters.
- Openable windows with large free area to maximise passive ventilation to habitable spaces.
- Careful design of internal spaces to facilitate natural and cross-ventilation as much as possible at the scheme.
- Active cooling has been avoided due to the increased energy consumption associated with its use.

It is envisioned that through the combination of the above measures, and by adopting principles included within Part O (2021) Building Regulations, the overheating risk of the scheme is reduced.

# 5. Energy: Be Clean

Be Clean refers to measures that serve to reduce the overall emissions of the development using either District Heating Networks or Combined Heat and Power (CHP) engines. This can be achieved through exploiting local energy resources in proximity to the site boundary, such as secondary heat. The Be Clean stage is reviewed after development has made all reasonable efforts to reduce energy demand at the Be Lean Stage.

### 5.1 Area Wide Energy Networks: Existing and Planned

The first stage in assessing feasibility of the Be Clean stage is to evaluate localised opportunities for connecting to District Heating Networks (DHN) that are either already existing or planned within the vicinity of the proposed development.

An investigation has been carried out to determine the presence of any area wide district heating networks in the area or if any are planned in the future. This investigation has been conducted utilising the Department for Energy Security and Net Zero's (DESNZ) Heat Network Planning Database.

The investigation concluded that there are no District Heat Networks, either in situ or proposed, in vicinity of the site, with the closest heat network more than 1 mile from the proposed scheme. In addition, as a development of only one residential unit, it is not envisioned that the on-site space heating and domestic hot water demand would be sufficiently large enough to warrant any form of on-site communal or district heating systems. Therefore, there are no carbon savings at this stage of the energy hierarchy.

# 6. Energy: Be Green

Once all Be Lean and Be Clean measures have been incorporated into the design, the scheme should then look to reduce the overall emissions of the development through the inclusion of renewable and low carbon technologies such as Air Source Heat Pumps or Solar Photovoltaic Panels (PV panels).

This section addresses policies contained within the IPPPS and the Carbon Offsetting SPD. Several renewable and low carbon technologies were assessed for their compatibility with the project.

### 6.1 Renewable and Low Carbon Technologies Appraisal

The following renewable and low carbon technologies were reviewed for their compatibility with the proposed scheme and discussed with the design team:

- **Solar Photovoltaic Panels (PV):** PV panels generate electricity on site through exposure to solar radiation.
- **Solar Thermal Panels:** Solar Thermal panels capture long-wave radiation and use it to heat fluid contained in vacuum sealed circuits.
- **Biomass Heating:** Biomass relies on the combustion of organic material such as woodchips to provide space heating and domestic hot water.
- **Air Source Ground Heat Pumps (ASHPs):** ASHPs work by capturing energy from the ambient outdoor air and use it to evaporate and compress refrigerant. This compression generates heat. ASHPs can be used for both space heating and/or domestic hot water supply.
- **Ground Source Heat Pumps (GSHPs):** GSHPs capture heat from the earth or sub-terrain aquifers and use this heat to evaporate and compress refrigerant; generating heat.

### 6.2 Site Constraints Review

A review of the potential low carbon technologies listed above illustrated that Air Source Heat Pumps were best suited to the proposed scheme, partially for their ability to provide both space heating and domestic hot water at very high efficiencies.

Biomass was ruled out as a Be Green measure, owing to its requirements for large storage areas for fuel, and equally because of the potential impact on local Air Quality. Any combustion process can emit oxides of nitrogen and particulate matter.

Ground Source Heat Pumps were assessed for their feasibility at the site, however  due to complications with both their requirement for borehole or slinky arrangements and subsequent potential for further environmental complications, they were ruled out.

Further information regarding the chosen technologies for the site can be found overleaf.

# 6. Energy: Be Green

### 6.3 Included Low Carbon Technologies: Air Source Heat Pump

The scheme has opted to utilise an individual Air Source Heat Pump (ASHP) solution to provide space heating and domestic hot water (DHW) for the proposed dwelling.

Heat Pumps work by extracting energy from the ambient air temperature outside, and using it to evaporate and compress refrigerant, which in turn, generates hot water. They capture the energy from ambient air via an external condenser unit (Figure 8), which connects to an internal heat pump unit. It is currently proposed that the condensers will be discreetly situated at the scheme, away from any local sensitive noise receptors.

The water generated by the Heat Pump system will be stored in a well-insulated hot water cylinder. The space will be heated using an underfloor heating system to maximise efficiency.

The Heat Pump will seek to comply with the minimum performance standards as set out in the Enhanced Capital Allowances (ECA) criteria and the Microgeneration Certification Scheme for Heat Pump Certification.

*Table 3: Summary of Space Heating and Domestic Hot Water Strategy at the Be Green Stage.*

| Space Heating and DHW Strategy | Type | Details |
|---|---|---|
| Space Heating System | ASHP | 170% default efficiency. (MCS) |
| Heating Emitter | Underfloor Heating | - |
| Domestic Hot Water System | ASHP | 170% default efficiency. (MCS) |
| DHW Storage | Yes | ~200 litres, 150 mm foam insulation |
| Low / Zero Carbon Technologies Used | ASHP | 170% default efficiency. |

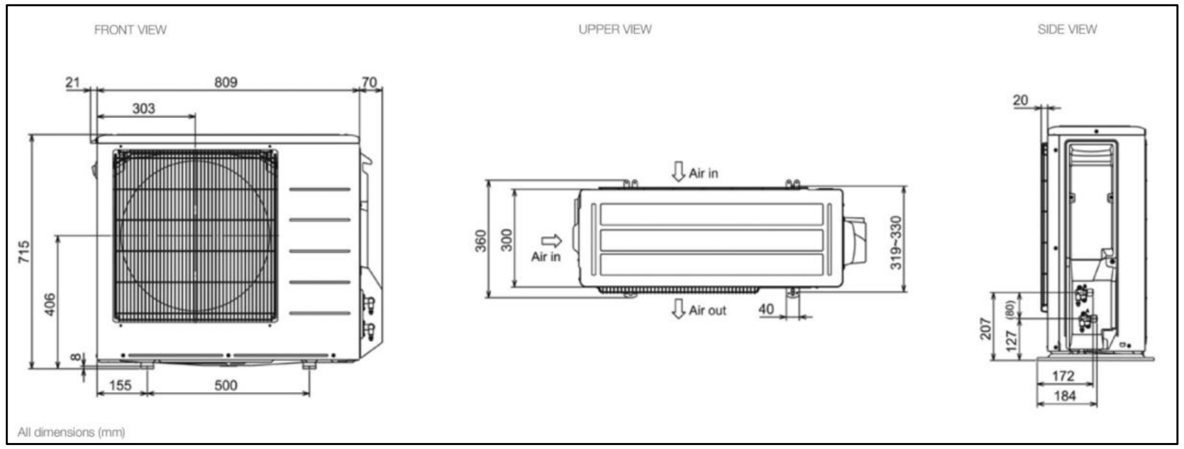



*Figure 8: Dimensions of a Mitsubishi external condenser unit.*

*Figure 9: Indicative example of Daikin Altherma External Condenser (Source: Daikin).*

# 7. Site Wide Carbon Reduction Summary

The scheme has adopted the Energy Hierarchy, with Be Lean measures comprising a building envelope that exceeds Part L (2021) requirements combined with the inclusion of Wastewater Heat Recovery (WWHRS) systems. Be Green measures include a low carbon space heating and domestic hot water strategy utilising Air Source Heat pump technology.

The scheme achieves an overall **on-site regulated CO2 reduction of 59%**, surpassing the 19% requirement set out in local policy.

*Table 5: Summary of carbon dioxide emissions from the baseline scheme.*

| | Carbon dioxide emissions (tonnes CO2 per annum) | |
|---|---|---|
| | Regulated | Unregulated |
| Baseline Scheme Compliant with Part L (2021) Building Regulations | 0.6 | 0.2 |
| Watford Local Plan Target Requirements | 0.6 | 0.2 |
| **After application of Energy Hierarchy at 175 Briar Road.** | **4.0** | **5.3** |

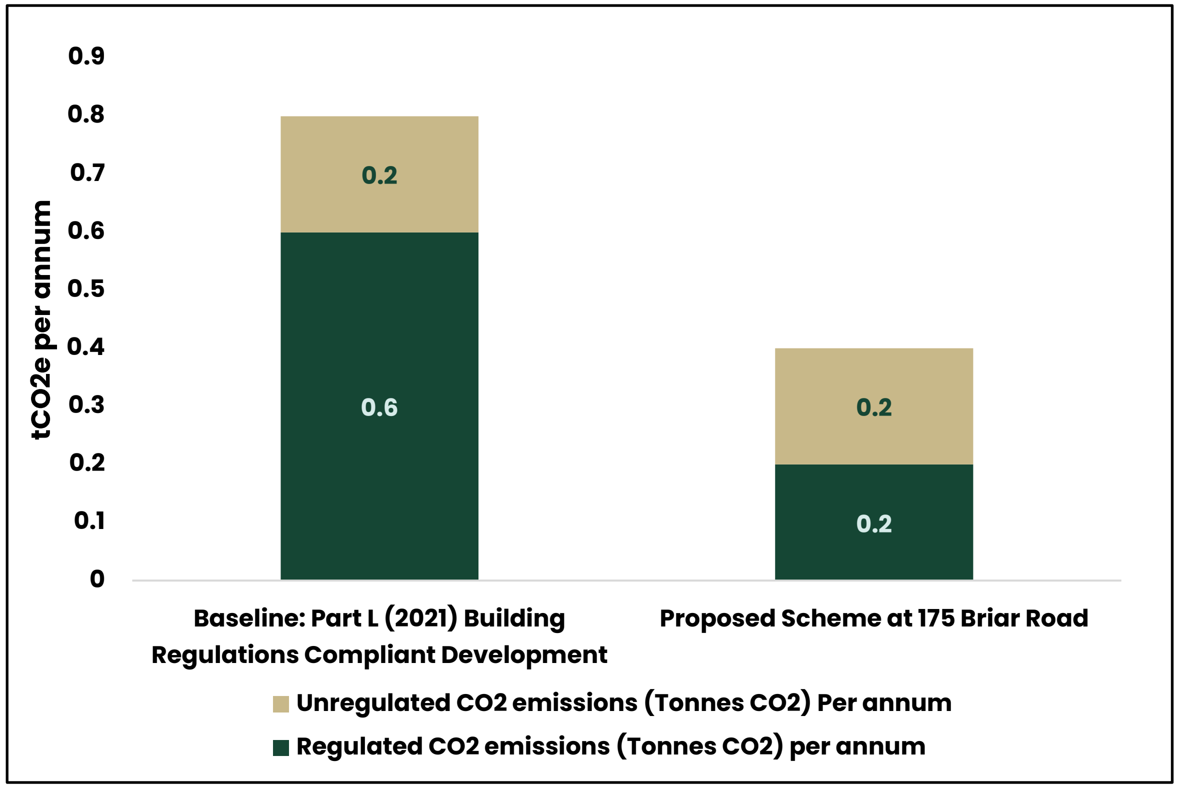



*Figure 11: Carbon emissions summary of the proposed scheme at 175 Briar Road.*

# 8. Sustainability

### 8.1 Sustainability Summary

Sustainability is a core focal point of the design which constitutes the construction of an energy efficient dwelling. The dwelling's target is to meet or exceed the required carbon reduction target, and compliance at the design stage has been demonstrated in the body of this report.

Additional sustainability measures that will be incorporated and adhered to are detailed below, to assist with compliance with both local and regional policies regarding Energy and Sustainability.

### 8.2 Management

To ensure that the construction site is managed in a way that is not detrimental to the environment or neighbours, the contractor will be selected with consideration of their ability to comply with the principles of the Considerate Constructors Scheme. The principal contractors and subcontractors will be encouraged to monitor their energy and water consumption on-site to promote conservation use and all timber used will be legally harvested and FSC certified.

To ensure that the proposed building services and energy strategy are sufficiently installed, the scheme will look to achieve MCS certification for the Air Source Heat Pump.

Post completion, a building user guide will be provided to occupants to ensure that the occupants are familiar with the building systems and to answer any questions that might impact on the use of the space. This will ensure that the proposed scheme is used in an efficient manner.

### 8.3 Health and Wellbeing

The development is designed to encourage a healthy and safe internal and external environment. All habitable spaces will look to meet daylight targets set by the Building Research Establishment's publication on *Site Layout: Planning for Daylight and Sunlight – A guide to good practice* (2022)

Building materials will be specified to improve both the thermal efficiency of the unit, and to improve sound insulation between dwellings and external noise sources.

The unit will be capable of using passive ventilation methods to ensure a constant and fresh flow of air. Cross ventilation has been maximised in accordance with best practice to reduce overheating risk in hotter periods.

### 8.4 Energy

The proposed scheme demonstrates a carbon reduction that surpasses regulated $CO_2$ reduction targets set in Local and Regional Policy and equates to an 0.4 tonne $CO_2$ reduction beyond Building Regulations Part L (2021).

To further support with energy conservation, the scheme will benefit from the ability to display energy consumption data and record energy use, which will enable residents to reduce their unregulated energy use.

Where white goods are provided to the unit, the scheme will look to procure A-rated energy efficient appliances where feasible. This will reduce both energy consumption and carbon emissions from appliance use within the unit.

All external lighting will use energy efficient bulbs and operate on either a timer or passive infrared (PIR) sensor to minimise use when the spaces aren't in use.

### 8.5 Transport

To promote the use of public transport, occupants will be provided with details of the local public transport connections in the vicinity of the site. This includes the Briar Road bus stop approximately 150 metres to the north west of the site, providing accessibility to bus route 319. This routes provide frequent trips to Watford, Woodside and Kingswood. The site is also situated within a 2 mile walk of North Watford Train Station.

# 8. Sustainability

### 8.5 Transport Continued

The site is situated in proximity to local amenities which could be reached via walking or cycling. There is a local grocery store and pharmacy within 500m of the site.

To promote the adoption of cycling by residents and reduce need for short vehicle trips, a bike storage facility will be provided on site for occupants use. In accordance with Part S of Building Regulations electric Vehicle charging infrastructure will also be incorporated as part of the scheme. This will encourage electric vehicle trips and reduce the use of Internal Combustion Engine (ICE) vehicles, benefitting local air quality.

### 8.6 Water

Reducing the consumption of potable water will be a significant consideration for the scheme. The water consumption criteria for occupants will be in line with the 110 litres per person per day, as required by Building Regulations Part G.

Water use will be reduced as much as possible, primarily through the specification of efficient sanitary ware and water efficient fittings. External water use will be reduced through providing space for the provision of a water butt in the private amenity space at the rear of the scheme.

### 8.7 Flood Risk

The scheme is situated within flood Zone 1, meaning the site has a low risk of fluvial flooding.

*[https://flood-map-for-planning.](https://flood-map-for-planning.service.gov.uk/location) service.gov.uk/location*

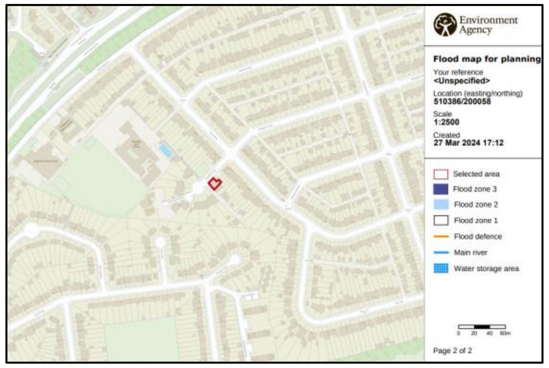



*Figure 12: Flood risk map for planning. Site (red).*

### 8.8 Materials and Embodied Carbon

Materials with a low environmental impact and low embodied carbon footprint will be implemented where feasible. Recycled, sustainable and locally sourced materials will be prioritised. Where possible, building materials should achieve a rating of A+ to D in the BRE's Green Guide on Materials.

Circular economy principles will be adopted and any waste arising from the demolition of existing structures on site will be assessed for practicability of reusing the waste in the new scheme.

### 8.9 Waste

Where possible, closed loop recycling will be practiced on site, and where this isn't possible, open loop recycling will be undertaken to minimise the amount of waste generated. Additionally, a construction site waste management strategy will be implemented to set out targets to minimise waste and procedures for handling any hazardous materials that may arise as a result of the proposed works.

Municipal waste will be minimised through the installation of on-site recycling space and storage. Residents will be requested to separate and recycle their waste in dedicated recycling containers provided.

# 8. Sustainability

### 8.10 Pollution

To reduce both the carbon dioxide and nitrogen oxide (NOX) emissions associated with the proposed site, there will be no combustion boilers provided.

All external lighting provided will be designed with the consideration of reducing nighttime pollution.

### 8.11 Land Use and Ecology

To promote an improvement in ecological value, the site will look to protect existing ecological features during the construction stage. The scheme will also benefit from new planting of shrubs and other native species in the garden area to the rear of the site.

### 8.12 Sustainability Conclusion

The measures identified and detailed in this section promote a holistically sustainable scheme that demonstrates a significant improvement in comparison to the existing dwelling on site. The proposed scheme will benefit from:

- Reduced regulated carbon dioxide emissions.
- No nitrogen oxide emissions from the energy strategy.
- Low flow water appliances.
- Promotion of public transport and active travel, supported by proximity of local transport links and amenities.
- Planting of new shrubs and native species to garden.
- Minimising waste arising from construction and occupation through adoption of circular economy principles.

# 9. Conclusion

An Energy and Sustainability Statement has been undertaken to demonstrate how the proposed scheme at Land at rear of 175 Briar Road, Watford, WD25 0HL has responded to local policy requirements regarding sustainability, energy and climate change.

This assessment is prepared to support the planning application for the construction of a one-bedroom bungalow at land at the rear of 175 Briar Road.

The proposed energy strategy complies with all local policies relevant to Climate Change and Energy and exceeds the CO2 reduction requirement set out in Watford's Local Plan.

The scheme will benefit from passive design and energy efficiency improvements, including an improved building fabric, beyond requirements of Part L (2021), a Wastewater Heat Recovery System and low energy lighting. The energy strategy is comprised of an Air Source Heat Pump solution providing space heating and domestic hot water, offering a low carbon solution.

The energy strategy follows the energy hierarchy; Be Lean, Be Clean, Be Green to maximise the carbon reduction. The proposed energy strategy is set out in this report and the scheme achieves an on-site regulated **CO2 reduction of 59%** beyond Building Regulations Part L (2021).

The scheme has incorporated the core principles of sustainability in its design and will continue to integrate the sustainability requirements set out in local and regional policy throughout the next stages of the development.

*Table 7: Percentage of carbon dioxide reductions achieved at scheme.*

| | Regulated domestic carbon dioxide emissions | |
|---|---|---|
| | Tonnes CO2 per annum | % Reduction |
| Baseline Part L (2021) Compliant Scheme | 0.6 | - |
| Watford Policy: 19% Reduction Requirement | 0.5 | 19% |
| Proposed Scheme at 175 Briar Road | 0.2 | 59% |
| **Total regulated carbon dioxide reduction** | **0.4** | **59%** |

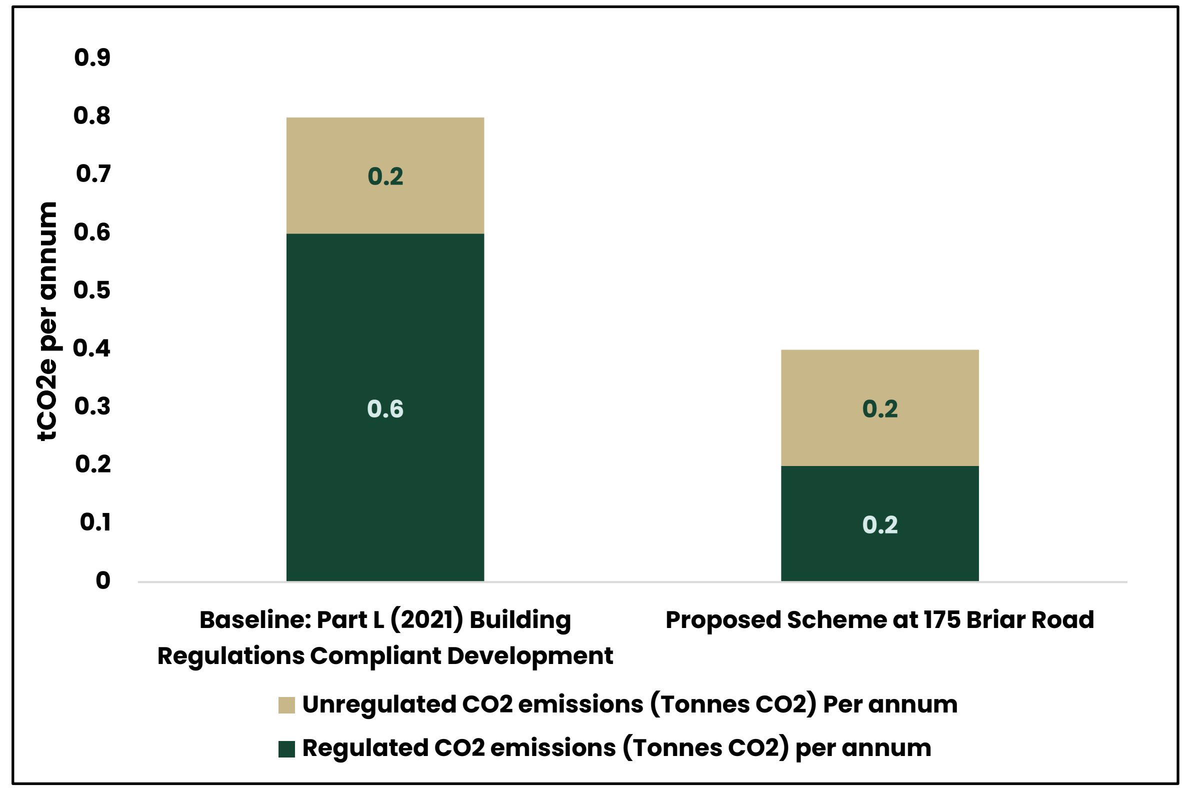



*Figure 13 Carbon dioxide emissions per annum at the proposed scheme.*

**SAP 10.2 Carbon Factors have been used to assess the scheme, with the following emission rates:*

- *Natural Gas:* 0.210kgCO2/kWh
- *Grid Electricity:* 0.136 kgCO2/kWh

# 10. Appendices

# 10.1 Appendix A – SAP Worksheets

# Full SAP Calculation Printout

elmhurst energy

| | | | |
|---|---|---|---|
| Property Reference | Rear of 175 Briar Road | Issued on Date | 05/04/2024 |
| Assessment Reference | Be Green | Prop Type Ref | |
| Property | Rear of 175 Briar Road, Watford, WD25 0HL | | |

| | | | | | |
|---|---|---|---|---|---|
| SAP Rating | 81 B | DER | 6.57 | TER | 15.36 |
| Environmental | 96 A | % DER < TER | | | 57.23 |
| $CO_2$ Emissions (t/year) | 0.23 | DFEE | 49.61 | TFEE | 50.01 |
| Compliance Check | See BREL | % DFEE < TFEE | | | 0.80 |
| % DPER < TPER | 15.56 | DPER | 69.27 | TPER | 82.04 |

| | | | |
|---|---|---|---|
| Assessor Details | Mr. Oliver Eggenton | Assessor ID | AQ01-0001 |
| Client | | | |

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SAP 10 WORKSHEET FOR New Build (As Designed)   (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE
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1. Overall dwelling characteristics
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                                                                                      Area          Storey height               Volume
                                                                                      (m2)               (m)                     (m3)
Ground floor                                                                       37.7400 (1b)     x      2.4000 (2b)    =     90.5760 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)               37.7400                                                          (4)
Dwelling volume                                                            (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =     90.5760 (5)


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2. Ventilation rate
-----------------------------------------------------------------------------------------------------
                                                                                                                         m3 per hour

Number of open chimneys                                                                                      0 * 80 =      0.0000 (6a)
Number of open flues                                                                                         0 * 20 =      0.0000 (6b)
Number of chimneys / flues attached to closed fire                                                           0 * 10 =      0.0000 (6c)
Number of flues attached to solid fuel boiler                                                                0 * 20 =      0.0000 (6d)
Number of flues attached to other heater                                                                     0 * 35 =      0.0000 (6e)
Number of blocked chimneys                                                                                   0 * 20 =      0.0000 (6f)
Number of intermittent extract fans                                                                          1 * 10 =     10.0000 (7a)
Number of passive vents                                                                                      0 * 10 =      0.0000 (7b)
Number of flueless gas fires                                                                                 0 * 40 =      0.0000 (7c)

                                                                                                             Air changes per hour
Infiltration due to chimneys, flues and fans   = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =         10.0000 / (5) =      0.1104 (8)
Pressure test                                                                                                                  Yes
Pressure Test Method                                                                                                   Blower Door
Measured/design AP50                                                                                                        3.0000 (17)
Infiltration rate                                                                                                           0.2604 (18)
Number of sides sheltered                                                                                                        0 (19)

Shelter factor                                                                  (20) = 1 - [0.075 x (19)] =      1.0000 (20)
Infiltration rate adjusted to include shelter factor                                     (21) = (18) x (20)  =      0.2604 (21)


                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Wind speed      5.1000     5.0000     4.9000     4.4000     4.3000     3.8000     3.8000     3.7000     4.0000     4.3000     4.5000     4.7000 (22)
Wind factor     1.2750     1.2500     1.2250     1.1000     1.0750     0.9500     0.9500     0.9250     1.0000     1.0750     1.1250     1.1750 (22a)
Adj infilt rate
                0.3320     0.3255     0.3190     0.2864     0.2799     0.2474     0.2474     0.2409     0.2604     0.2799     0.2930     0.3060 (22b)
Effective ac    0.5551     0.5530     0.5509     0.5410     0.5392     0.5306     0.5306     0.5290     0.5339     0.5392     0.5429     0.5468 (25)


-----------------------------------------------------------------------------------------------------
3. Heat losses and heat loss parameter
-----------------------------------------------------------------------------------------------------
Element                                          Gross      Openings         NetArea      U-value          A x U      K-value           A x K
                                                    m2            m2              m2       W/m2K            W/K       kJ/m2K            kJ/K
Window (Uw = 1.20)                                                             8.0000      1.1450         9.1603                                  (27)
Door                                                                           1.3000      1.0000         1.3000                                  (26)
Heatloss Floor 1                                                              37.7400      0.1300         4.9062     110.0000       4151.4000 (28a)
External Wall 1                                65.0000        9.3000          55.7000      0.1700         9.4690      60.0000       3342.0000 (29a)
External Roof 1                                37.7400                        37.7400      0.1300         4.9062       9.0000        339.6600 (30)
Total net area of external elements Aum(A, m2)                               140.4800                                                          (31)
Fabric heat loss, W/K = Sum (A x U)                                    (26)...(30) + (32) =    29.7417                                         (33)

Heat capacity Cm = Sum(A x k)                                                    (28)...(30) + (32) + (32a)...(32e) =    7833.0600 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                         207.5533 (35)
Thermal bridges (User defined value 0.050 * total exposed area)                                                             7.0240 (36)
Point Thermal bridges                                                                                        (36a) =      0.0000
Total fabric heat loss                                                                        (33) + (36) + (36a) =      36.7657 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)
                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(38)m          16.5925    16.5285    16.4658    16.1713    16.1162    15.8597    15.8597    15.8122    15.9585    16.1162    16.2277    16.3442 (38)
Heat transfer coeff
               53.3582    53.2942    53.2315    52.9370    52.8819    52.6254    52.6254    52.5779    52.7242    52.8819    52.9934    53.1099 (39)
Average = Sum(39)m / 12 =                                                                                                            52.9367
```

```
                 Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
HLP              1.4138    1.4121    1.4105    1.4027    1.4012    1.3944    1.3944    1.3932    1.3970    1.4012    1.4042    1.4073 (40)
HLP (average)                                                                                                                1.4027
Days in mont        31        28        31        30        31        30        31        31        30        31        30        31
```

```
-------------------------------------------------------------------------------------------------------
4. Water heating energy requirements (kWh/year)
-------------------------------------------------------------------------------------------------------
Assumed occupancy                                                                                                            1.3477 (42)
Hot water usage for mixer showers
                62.7444   61.7838   60.3681   58.1903   56.2390   53.5092   51.3502   53.8743   55.1438   57.8475   60.6632   62.6878 (42a)
Hot water usage for baths
                19.8037   19.5048   19.0795   18.4426   17.8686   17.0784   16.4790   17.2120   17.5967   18.3796   19.1936   19.7880 (42b)
Hot water usage for other uses
                28.4313   27.3974   26.3636   25.3297   24.2958   23.2620   23.2620   24.2958   25.3297   26.3636   27.3974   28.4313 (42c)
Average daily hot water use (litres/day)                                                                                   102.0548 (43)

                 Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
Daily hot water use
               110.9794  108.6859  105.8111  101.9625   98.4034   93.8496   91.0911   95.3821   98.0702  102.5907  107.2543  110.9071 (44)
Energy conte   163.3808  143.8135  151.2019  133.1886  126.8028  108.5340  100.6583  112.2665  113.7565  132.1985  144.9577  162.8752 (45)
Energy content (annual)                                                                          Total = Sum(45)m =       1593.6341
Distribution loss  (46)m = 0.15 x (45)m
                24.5071   21.5720   22.6803   19.9783   19.0204   16.2801   15.0987   16.8400   17.0635   19.8298   21.7437   24.4313 (46)
Water storage loss:
Store volume                                                                                                               150.0000 (47)
  b) If manufacturer declared loss factor is not known :
  Hot water storage loss factor from Table 2 (kWh/litre/day)                                                                 0.0158 (51)
  Volume factor from Table 2a                                                                                                0.9283 (52)
  Temperature factor from Table 2b                                                                                           0.5400 (53)
Enter (49) or (54) in (55)                                                                                                   1.1889 (55)
Total storage loss
                36.8551   33.2885   36.8551   35.6662   36.8551   35.6662   36.8551   36.8551   35.6662   36.8551   35.6662   36.8551 (56)
If cylinder contains dedicated solar storage
                36.8551   33.2885   36.8551   35.6662   36.8551   35.6662   36.8551   36.8551   35.6662   36.8551   35.6662   36.8551 (57)
Primary loss    23.2624   21.0112   23.2624   22.5120   23.2624   22.5120   23.2624   23.2624   22.5120   23.2624   22.5120   23.2624 (59)
Combi loss       0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (61)
Total heat required for water heating calculated for each month
               223.4983  198.1131  211.3194  191.3668  186.9203  166.7122  160.7758  172.3840  171.9347  192.3160  203.1359  222.9927 (62)
WWHRS          -45.6440  -40.3289  -42.1794  -36.3503  -33.9614  -27.9156  -24.3946  -28.3614  -28.9029  -34.9327  -39.7454  -45.4530 (63a)
PV diverter      0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (63b)
Solar input      0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (63c)
FGHRS            0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (63d)
Output from w/h
               177.8543  157.7843  169.1400  155.0165  152.9589  138.7966  136.3812  144.0225  143.0318  157.3832  163.3905  177.5396 (64)
                                                                           Total per year (kWh/year) = Sum(64)m =     1873.2994 (64)
12Total per year (kWh/year)                                                                                                  1873 (64)
Electric shower(s)
                 0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (64a)
                                            Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =   0.0000 (64a)
Heat gains from water heating, kWh/month
               102.4181   91.2577   98.3686   90.8278   90.2559   82.6301   81.5629   85.4226   84.3666   92.0500   94.7410  102.2500 (65)
```

```
-------------------------------------------------------------------------------------------------------
5. Internal gains (see Table 5 and 5a)
-------------------------------------------------------------------------------------------------------
Metabolic gains (Table 5), Watts
                 Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
(66)m           67.3825   67.3825   67.3825   67.3825   67.3825   67.3825   67.3825   67.3825   67.3825   67.3825   67.3825   67.3825 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
                58.5792   64.8556   58.5792   60.5319   58.5792   60.5319   58.5792   58.5792   60.5319   58.5792   60.5319   58.5792 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
               115.8944  117.0970  114.0665  107.6148   99.4706   91.8163   86.7027   85.5001   88.5307   94.9824  103.1265  110.7809 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
                29.7383   29.7383   29.7383   29.7383   29.7383   29.7383   29.7383   29.7383   29.7383   29.7383   29.7383   29.7383 (69)
Pumps, fans      3.0000    3.0000    3.0000    3.0000    3.0000    0.0000    0.0000    0.0000    0.0000    3.0000    3.0000    3.0000 (70)
Losses e.g. evaporation (negative values) (Table 5)
               -53.9060  -53.9060  -53.9060  -53.9060  -53.9060  -53.9060  -53.9060  -53.9060  -53.9060  -53.9060  -53.9060  -53.9060 (71)
Water heating gains (Table 5)
               137.6587  135.8002  132.2159  126.1497  121.3117  114.7641  109.6275  114.8153  117.1758  123.7231  131.5847  137.4328 (72)
Total internal gains
               358.3471  363.9675  351.0764  340.5111  325.5763  310.3270  298.1242  302.1094  309.4531  323.4995  341.4579  353.0076 (73)
```

```
-------------------------------------------------------------------------------------------------------
6. Solar gains
-------------------------------------------------------------------------------------------------------
[Jan]                                          Area       Solar flux             g             FF            Access           Gains
                                                 m2         Table 6a    Specific data   Specific data       factor               W
                                                                W/m2      or Table 6b     or Table 6c     Table 6d
-------------------------------------------------------------------------------------------------------
Northeast                                      5.5000        11.2829          0.7600          0.7000         0.7700         22.8786 (75)
Southeast                                      1.8000        36.7938          0.7600          0.7000         0.7700         24.4170 (77)
Southwest                                      0.7000        36.7938          0.7600          0.7000         0.7700          9.4955 (79)
-------------------------------------------------------------------------------------------------------

Solar gains     56.7911  104.3356  162.9418  235.7264  294.9149  306.3661  289.7166  243.4826  187.8197  120.7556   69.4066   47.7059 (83)
Total gains    415.1383  468.3032  514.0182  576.2375  620.4912  616.6930  587.8408  545.5920  497.2728  444.2551  410.8645  400.7135 (84)
```

```
-------------------------------------------------------------------------------------------------------
7. Mean internal temperature (heating season)
-------------------------------------------------------------------------------------------------------
Temperature during heating periods in the living area from Table 9, Th1 (C)                                                 21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)
                 Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
tau             40.7782   40.8271   40.8752   41.1026   41.1455   41.3460   41.3460   41.3834   41.2685   41.1455   41.0589   40.9688
alpha            3.7185    3.7218    3.7250    3.7402    3.7430    3.7564    3.7564    3.7589    3.7512    3.7430    3.7373    3.7313
util living area
                 0.9679    0.9494    0.9139    0.8286    0.6895    0.5191    0.3866    0.4315    0.6530    0.8642    0.9467    0.9716 (86)

MIT             19.7765   19.9530   20.2125   20.5366   20.7681   20.8788   20.9079   20.9028   20.8264   20.5296   20.1055   19.7434 (87)
Th 2            19.7527   19.7540   19.7553   19.7613   19.7624   19.7676   19.7676   19.7686   19.7656   19.7624   19.7601   19.7578 (88)
```

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| util rest of house | | | | | | | | | | | | | |
| | 0.9597 | 0.9368 | 0.8925 | 0.7882 | 0.6236 | 0.4294 | 0.2818 | 0.3214 | 0.5618 | 0.8220 | 0.9313 | 0.9642 | (89) |
| MIT 2 | 18.3717 | 18.5917 | 18.9102 | 19.2933 | 19.5385 | 19.6407 | 19.6591 | 19.6580 | 19.6020 | 19.2987 | 18.7902 | 18.3341 | (90) |
| Living area fraction | | | | | | | | | fLA = Living area / (4) = | | | 0.3590 | (91) |
| MIT | 18.8761 | 19.0804 | 19.3778 | 19.7397 | 19.9800 | 20.0853 | 20.1074 | 20.1050 | 20.0416 | 19.7406 | 19.2625 | 18.8401 | (92) |
| Temperature adjustment | | | | | | | | | | | | 0.0000 | |
| adjusted MIT | 18.8761 | 19.0804 | 19.3778 | 19.7397 | 19.9800 | 20.0853 | 20.1074 | 20.1050 | 20.0416 | 19.7406 | 19.2625 | 18.8401 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation | 0.9524 | 0.9285 | 0.8849 | 0.7874 | 0.6360 | 0.4533 | 0.3112 | 0.3522 | 0.5836 | 0.8211 | 0.9236 | 0.9573 | (94) |
| Useful gains | 395.3689 | 434.8054 | 454.8324 | 453.7160 | 394.6363 | 279.5491 | 182.9419 | 192.1703 | 290.2204 | 364.7826 | 379.4581 | 383.5990 | (95) |
| Ext temp. | 4.3000 | 4.9000 | 6.5000 | 8.9000 | 11.7000 | 14.6000 | 16.6000 | 16.4000 | 14.1000 | 10.6000 | 7.1000 | 4.2000 | (96) |
| Heat loss rate W | | | | | | | | | | | | | |
| | 777.7528 | 755.7360 | 685.5049 | 573.8216 | 437.8620 | 288.6638 | 184.5807 | 194.7989 | 313.2666 | 483.3743 | 644.5305 | 777.5347 | (97) |
| Space heating kWh | | | | | | | | | | | | | |
| | 284.4937 | 215.6654 | 171.6203 | 86.4761 | 32.1599 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 88.2322 | 190.8521 | 293.0882 | (98a) |
| Space heating requirement - total per year (kWh/year) | | | | | | | | | | | | 1362.5880 | |
| Solar heating kWh | | | | | | | | | | | | | |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (98b) |
| Solar heating contribution - total per year (kWh/year) | | | | | | | | | | | | 0.0000 | |
| Space heating kWh | | | | | | | | | | | | | |
| | 284.4937 | 215.6654 | 171.6203 | 86.4761 | 32.1599 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 88.2322 | 190.8521 | 293.0882 | (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) | | | | | | | | | | | | 1362.5880 | |
| Space heating per m2 | | | | | | | | | | | (98c) / (4) = | 36.1046 | (99) |

## 9a. Energy requirements - Individual heating systems, including micro-CHP

| | | |
|---|---|---|
| Fraction of space heat from secondary/supplementary system (Table 11) | 0.0000 | (201) |
| Fraction of space heat from main system(s) | 1.0000 | (202) |
| Efficiency of main space heating system 1 (in %) | 219.3000 | (206) |
| Efficiency of main space heating system 2 (in %) | 0.0000 | (207) |
| Efficiency of secondary/supplementary heating system, % | 0.0000 | (208) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Space heating requirement | | | | | | | | | | | | | |
| | 284.4937 | 215.6654 | 171.6203 | 86.4761 | 32.1599 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 88.2322 | 190.8521 | 293.0882 | (98) |
| Space heating efficiency (main heating system 1) | | | | | | | | | | | | | |
| | 219.3000 | 219.3000 | 219.3000 | 219.3000 | 219.3000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 219.3000 | 219.3000 | 219.3000 | (210) |
| Space heating fuel (main heating system) | | | | | | | | | | | | | |
| | 129.7281 | 98.3426 | 78.2583 | 39.4328 | 14.6648 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 40.2336 | 87.0279 | 133.6472 | (211) |
| Space heating efficiency (main heating system 2) | | | | | | | | | | | | | |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (212) |
| Space heating fuel (main heating system 2) | | | | | | | | | | | | | |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (213) |
| Space heating fuel (secondary) | | | | | | | | | | | | | |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (215) |
| Water heating | | | | | | | | | | | | | |
| Water heating requirement | | | | | | | | | | | | | |
| | 177.8543 | 157.7843 | 169.1400 | 155.0165 | 152.9589 | 138.7966 | 136.3812 | 144.0225 | 143.0318 | 157.3832 | 163.3905 | 177.5396 | (64) |
| Efficiency of water heater | | | | | | | | | | | | 190.4000 | (216) |
| (217)m | 190.4000 | 190.4000 | 190.4000 | 190.4000 | 190.4000 | 190.4000 | 190.4000 | 190.4000 | 190.4000 | 190.4000 | 190.4000 | 190.4000 | (217) |
| Fuel for water heating, kWh/month | | | | | | | | | | | | | |
| | 93.4109 | 82.8699 | 88.8340 | 81.4162 | 80.3355 | 72.8974 | 71.6288 | 75.6421 | 75.1217 | 82.6593 | 85.8143 | 93.2456 | (219) |
| Space cooling fuel requirement | | | | | | | | | | | | | |
| (221)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (221) |
| Pumps and Fa | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (231) |
| Lighting | 11.3257 | 9.0859 | 8.1809 | 5.9937 | 4.6297 | 3.7825 | 4.2233 | 5.4897 | 7.1305 | 9.3556 | 10.5672 | 11.6405 | (232) |
| Electricity generated by PVs (Appendix M) (negative quantity) | | | | | | | | | | | | | |
| (233a)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (233a) |
| Electricity generated by wind turbines (Appendix M) (negative quantity) | | | | | | | | | | | | | |
| (234a)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (234a) |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) | | | | | | | | | | | | | |
| (235a)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (235a) |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) | | | | | | | | | | | | | |
| (235c)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (235c) |
| Electricity generated by PVs (Appendix M) (negative quantity) | | | | | | | | | | | | | |
| (233b)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (233b) |
| Electricity generated by wind turbines (Appendix M) (negative quantity) | | | | | | | | | | | | | |
| (234b)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (234b) |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) | | | | | | | | | | | | | |
| (235b)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (235b) |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) | | | | | | | | | | | | | |
| (235d)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (235d) |

| | | |
|---|---|---|
| Annual totals kWh/year | | |
| Space heating fuel - main system 1 | 621.3351 | (211) |
| Space heating fuel - main system 2 | 0.0000 | (213) |
| Space heating fuel - secondary | 0.0000 | (215) |
| Efficiency of water heater | 190.4000 | |
| Water heating fuel used | 983.8757 | (219) |
| Space cooling fuel | 0.0000 | (221) |
| Electricity for pumps and fans: | | |
| Total electricity for the above, kWh/year | 0.0000 | (231) |
| Electricity for lighting (calculated in Appendix L) | 91.4053 | (232) |
| Energy saving/generation technologies (Appendices M ,N and Q) | | |
| PV generation | 0.0000 | (233) |
| Wind generation | 0.0000 | (234) |
| Hydro-electric generation (Appendix N) | 0.0000 | (235a) |
| Electricity generated - Micro CHP (Appendix N) | 0.0000 | (235) |
| Appendix Q - special features | | |
| Energy saved or generated | -0.0000 | (236) |
| Energy used | 0.0000 | (237) |
| Total delivered energy for all uses | 1696.6161 | (238) |

## 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

| | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Space heating - main system 1 | 621.3351 | 0.1558 | 96.8261 | (261) |
| Total CO2 associated with community systems | | | 0.0000 | (373) |
| Water heating (other fuel) | 983.8757 | 0.1403 | 138.0575 | (264) |
| Space and water heating | | | 234.8836 | (265) |
| Pumps, fans and electric keep-hot | 0.0000 | 0.0000 | 0.0000 | (267) |
| Energy for lighting | 91.4053 | 0.1443 | 13.1926 | (268) |
| Total CO2, kg/year | | | 248.0762 | (272) |
| EPC Dwelling Carbon Dioxide Emission Rate (DER) | | | 6.5700 | (273) |

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

| | Energy kWh/year | Primary energy factor kg CO2/kWh | Primary energy kWh/year | |
|---|---|---|---|---|
| Space heating - main system 1 | 621.3351 | 1.5769 | 979.8026 | (275) |
| Total CO2 associated with community systems | | | 0.0000 | (473) |
| Water heating (other fuel) | 983.8757 | 1.5188 | 1494.3330 | (278) |
| Space and water heating | | | 2474.1356 | (279) |
| Pumps, fans and electric keep-hot | 0.0000 | 0.0000 | 0.0000 | (281) |
| Energy for lighting | 91.4053 | 1.5338 | 140.2005 | (282) |
| Total Primary energy kWh/year | | | 2614.3361 | (286) |
| Dwelling Primary energy Rate (DPER) | | | 69.2700 | (287) |

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF TARGET EMISSIONS

1. Overall dwelling characteristics

| | | Area (m2) | | Storey height (m) | | Volume (m3) | |
|---|---|---|---|---|---|---|---|
| Ground floor | | 37.7400 (1b) | x | 2.4000 (2b) | = | 90.5760 | (1b) - (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 37.7400 | | | | | | (4) |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = | 90.5760 | (5) |

2. Ventilation rate

| | | m3 per hour | |
|---|---|---|---|
| Number of open chimneys | 0 * 80 = | 0.0000 | (6a) |
| Number of open flues | 0 * 20 = | 0.0000 | (6b) |
| Number of chimneys / flues attached to closed fire | 0 * 10 = | 0.0000 | (6c) |
| Number of flues attached to solid fuel boiler | 0 * 20 = | 0.0000 | (6d) |
| Number of flues attached to other heater | 0 * 35 = | 0.0000 | (6e) |
| Number of blocked chimneys | 0 * 20 = | 0.0000 | (6f) |
| Number of intermittent extract fans | 2 * 10 = | 20.0000 | (7a) |
| Number of passive vents | 0 * 10 = | 0.0000 | (7b) |
| Number of flueless gas fires | 0 * 40 = | 0.0000 | (7c) |

| | | Air changes per hour | |
|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = | 20.0000 / (5) = | 0.2208 | (8) |
| Pressure test | | Yes | |
| Pressure Test Method | | Blower Door | |
| Measured/design AP50 | | 5.0000 | (17) |
| Infiltration rate | | 0.4708 | (18) |
| Number of sides sheltered | | 0 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 1.0000 | (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) = | 0.4708 | (21) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wind speed | 5.1000 | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 | (22) |
| Wind factor | 1.2750 | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 | (22a) |
| Adj infilt rate | 0.6003 | 0.5885 | 0.5767 | 0.5179 | 0.5061 | 0.4473 | 0.4473 | 0.4355 | 0.4708 | 0.5061 | 0.5297 | 0.5532 | (22b) |
| Effective ac | 0.6802 | 0.6732 | 0.6663 | 0.6341 | 0.6281 | 0.6000 | 0.6000 | 0.5948 | 0.6108 | 0.6281 | 0.6403 | 0.6530 | (25) |

3. Heat losses and heat loss parameter

| Element | Gross m2 | Openings m2 | NetArea m2 | U-value W/m2K | A x U W/K | K-value kJ/m2K | A x K kJ/K | |
|---|---|---|---|---|---|---|---|---|
| TER Opaque door | | | 1.3000 | 1.0000 | 1.3000 | | | (26) |
| TER Opening Type (Uw = 1.20) | | | 8.0000 | 1.1450 | 9.1603 | | | (27) |
| Heatloss Floor 1 | | | 37.7400 | 0.1300 | 4.9062 | | | (28a) |
| External Wall 1 | 65.0000 | 9.3000 | 55.7000 | 0.1800 | 10.0260 | | | (29a) |
| External Roof 1 | 37.7400 | | 37.7400 | 0.1100 | 4.1514 | | | (30) |
| Total net area of external elements Aum(A, m2) | | | 140.4800 | | | | | (31) |
| Fabric heat loss, W/K = Sum (A x U) | | | | (26)...(30) + (32) = | 29.5439 | | | (33) |

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 207.5533 (35)

List of Thermal Bridges

| K1 Element | Length | Psi-value | Total |
|---|---|---|---|
| E5 Ground floor (normal) | 25.0000 | 0.1600 | 4.0000 |
| E16 Corner (normal) | 9.6000 | 0.0900 | 0.8640 |

| | | | |
|---|---|---|---|
| Thermal bridges (Sum(L x Psi) calculated using Appendix K) | | 4.8640 | (36) |
| Point Thermal bridges | (36a) = | 0.0000 | |
| Total fabric heat loss | (33) + (36) + (36a) = | 34.4079 | (37) |

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m | 20.3303 | 20.1212 | 19.9162 | 18.9534 | 18.7733 | 17.9348 | 17.9348 | 17.7795 | 18.2578 | 18.7733 | 19.1377 | 19.5187 | (38) |
| Heat transfer coeff | | | | | | | | | | | | | |
| | 54.7382 | 54.5291 | 54.3241 | 53.3614 | 53.1812 | 52.3427 | 52.3427 | 52.1874 | 52.6657 | 53.1812 | 53.5456 | 53.9266 | (39) |
| Average = Sum(39)m / 12 = | | | | | | | | | | | | 53.3605 | |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HLP | 1.4504 | 1.4449 | 1.4394 | 1.4139 | 1.4091 | 1.3869 | 1.3869 | 1.3828 | 1.3955 | 1.4091 | 1.4188 | 1.4289 | (40) |
| HLP (average) | | | | | | | | | | | | 1.4139 | |
| Days in mont | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |

## 4. Water heating energy requirements (kWh/year)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Assumed occupancy | | | | | | | | | | | | 1.3477 | (42) |
| Hot water usage for mixer showers | | | | | | | | | | | | | |
| | 46.8150 | 46.1115 | 45.0863 | 43.1248 | 41.6772 | 40.0629 | 39.1454 | 40.1628 | 41.2781 | 43.0114 | 45.0150 | 46.6357 | (42a) |
| Hot water usage for baths | | | | | | | | | | | | | |
| | 20.2552 | 19.9544 | 19.5308 | 18.7497 | 18.1649 | 17.5164 | 17.1661 | 17.5867 | 18.0447 | 18.7387 | 19.5358 | 20.1868 | (42b) |
| Hot water usage for other uses | | | | | | | | | | | | | |
| | 28.4313 | 27.3974 | 26.3636 | 25.3297 | 24.2958 | 23.2620 | 23.2620 | 24.2958 | 25.3297 | 26.3636 | 27.3974 | 28.4313 | (42c) |
| Average daily hot water use (litres/day) | | | | | | | | | | | | 87.7883 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily hot water use | | | | | | | | | | | | | |
| | 95.5016 | 93.4633 | 90.9807 | 87.2042 | 84.1379 | 80.8413 | 79.5734 | 82.0453 | 84.6525 | 88.1136 | 91.9483 | 95.2537 | (44) |
| Energy conte | 151.2511 | 133.0906 | 139.8339 | 119.3782 | 113.2658 | 99.4038 | 96.2371 | 101.5893 | 104.3850 | 119.5693 | 130.9972 | 149.1443 | (45) |
| Energy content (annual) | | | | | | | | | | Total = Sum(45)m = | | 1458.1456 | |
| Distribution loss (46)m = 0.15 x (45)m | | | | | | | | | | | | | |
| | 22.6877 | 19.9636 | 20.9751 | 17.9067 | 16.9899 | 14.9106 | 14.4356 | 15.2384 | 15.6578 | 17.9354 | 19.6496 | 22.3716 | (46) |
| Water storage loss: | | | | | | | | | | | | | |
| Store volume | | | | | | | | | | | | 150.0000 | (47) |
| a) If manufacturer declared loss factor is known (kWh/day): | | | | | | | | | | | | 1.3938 | (48) |
| Temperature factor from Table 2b | | | | | | | | | | | | 0.5400 | (49) |
| Enter (49) or (54) in (55) | | | | | | | | | | | | 0.7527 | (55) |
| Total storage loss | | | | | | | | | | | | | |
| | 23.3325 | 21.0745 | 23.3325 | 22.5798 | 23.3325 | 22.5798 | 23.3325 | 23.3325 | 22.5798 | 23.3325 | 22.5798 | 23.3325 | (56) |
| If cylinder contains dedicated solar storage | | | | | | | | | | | | | |
| | 23.3325 | 21.0745 | 23.3325 | 22.5798 | 23.3325 | 22.5798 | 23.3325 | 23.3325 | 22.5798 | 23.3325 | 22.5798 | 23.3325 | (57) |
| Primary loss | 23.2624 | 21.0112 | 23.2624 | 22.5120 | 23.2624 | 22.5120 | 23.2624 | 23.2624 | 22.5120 | 23.2624 | 22.5120 | 23.2624 | (59) |
| Combi loss | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (61) |
| Total heat required for water heating calculated for each month | | | | | | | | | | | | | |
| | 197.8460 | 175.1763 | 186.4288 | 164.4700 | 159.8607 | 144.4956 | 142.8320 | 148.1842 | 149.4769 | 166.1642 | 176.0890 | 195.7392 | (62) |
| WWHRS | -21.4019 | -18.9280 | -19.8203 | -16.4120 | -15.2954 | -13.0884 | -12.2683 | -13.0461 | -13.5417 | -15.9642 | -18.0855 | -21.0056 | (63a) |
| PV diverter | -0.0000 | -0.0000 | -0.0000 | -0.0000 | -0.0000 | -0.0000 | -0.0000 | -0.0000 | -0.0000 | -0.0000 | -0.0000 | -0.0000 | (63b) |
| Solar input | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (63c) |
| FGHRS | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (63d) |
| Output from w/h | | | | | | | | | | | | | |
| | 176.4442 | 156.2483 | 166.6085 | 148.0580 | 144.5653 | 131.4072 | 130.5638 | 135.1381 | 135.9351 | 150.2000 | 158.0035 | 174.7337 | (64) |
| | | | | | | | | Total per year (kWh/year) = Sum(64)m = | | | | 1807.9056 | (64) |
| 12Total per year (kWh/year) | | | | | | | | | | | | 1808 | (64) |
| Electric shower(s) | | | | | | | | | | | | | |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (64a) |
| | | | | | Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = | | | | | | | 0.0000 | (64a) |
| Heat gains from water heating, kWh/month | | | | | | | | | | | | | |
| | 87.5669 | 77.9212 | 83.7707 | 75.7667 | 74.9368 | 69.1252 | 69.2748 | 71.0544 | 70.7815 | 77.0327 | 79.6300 | 86.8664 | (65) |

## 5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m | 67.3825 | 67.3825 | 67.3825 | 67.3825 | 67.3825 | 67.3825 | 67.3825 | 67.3825 | 67.3825 | 67.3825 | 67.3825 | 67.3825 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 58.5792 | 64.8556 | 58.5792 | 60.5319 | 58.5792 | 60.5319 | 58.5792 | 58.5792 | 60.5319 | 58.5792 | 60.5319 | 58.5792 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 115.8944 | 117.0970 | 114.0665 | 107.6148 | 99.4706 | 91.8163 | 86.7027 | 85.5001 | 88.5307 | 94.9824 | 103.1265 | 110.7809 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 29.7383 | 29.7383 | 29.7383 | 29.7383 | 29.7383 | 29.7383 | 29.7383 | 29.7383 | 29.7383 | 29.7383 | 29.7383 | 29.7383 | (69) |
| Pumps, fans | 3.0000 | 3.0000 | 3.0000 | 3.0000 | 3.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 3.0000 | 3.0000 | 3.0000 | (70) |
| Losses e.g. evaporation (negative values) (Table 5) | | | | | | | | | | | | | |
| | -53.9060 | -53.9060 | -53.9060 | -53.9060 | -53.9060 | -53.9060 | -53.9060 | -53.9060 | -53.9060 | -53.9060 | -53.9060 | -53.9060 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 117.6975 | 115.9541 | 112.5950 | 105.2316 | 100.7215 | 96.0073 | 93.1112 | 95.5032 | 98.3076 | 103.5386 | 110.5973 | 116.7559 | (72) |
| Total internal gains | | | | | | | | | | | | | |
| | 338.3859 | 344.1215 | 331.4555 | 319.5929 | 304.9861 | 291.5702 | 281.6079 | 282.7972 | 290.5849 | 303.3150 | 320.4704 | 332.3308 | (73) |

## 6. Solar gains

| [Jan] | Area m2 | Solar flux Table 6a W/m2 | g Specific data or Table 6b | FF Specific data or Table 6c | Access factor Table 6d | Gains W | |
|---|---|---|---|---|---|---|---|
| Northeast | 5.5000 | 11.2829 | 0.6300 | 0.7000 | 0.7700 | 18.9652 | (75) |
| Southeast | 1.8000 | 36.7938 | 0.6300 | 0.7000 | 0.7700 | 20.2404 | (77) |
| Southwest | 0.7000 | 36.7938 | 0.6300 | 0.7000 | 0.7700 | 7.8713 | (79) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains | 47.0769 | 86.4888 | 135.0702 | 195.4048 | 244.4689 | 253.9613 | 240.1598 | 201.8343 | 155.6926 | 100.1000 | 57.5344 | 39.5457 | (83) |
| Total gains | 385.4627 | 430.6103 | 466.5257 | 514.9977 | 549.4551 | 545.5315 | 521.7678 | 484.6315 | 446.2775 | 403.4150 | 378.0048 | 371.8764 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tau | 39.7501 | 39.9026 | 40.0531 | 40.7758 | 40.9139 | 41.5693 | 41.5693 | 41.6930 | 41.3144 | 40.9139 | 40.6354 | 40.3484 | |
| alpha | 3.6500 | 3.6602 | 3.6702 | 3.7184 | 3.7276 | 3.7713 | 3.7713 | 3.7795 | 3.7543 | 3.7276 | 3.7090 | 3.6899 | |
| util living area | | | | | | | | | | | | | |
| | 0.9748 | 0.9610 | 0.9347 | 0.8669 | 0.7452 | 0.5723 | 0.4299 | 0.4771 | 0.7021 | 0.8923 | 0.9584 | 0.9776 | (86) |

```
MIT            19.3387    19.5664    19.9126    20.3808    20.7351    20.9288    20.9812    20.9724    20.8439    20.3992    19.8138    19.3191 (87)
Th 2           19.7249    19.7291    19.7332    19.7527    19.7563    19.7734    19.7734    19.7765    19.7668    19.7563    19.7489    19.7412 (88)
util rest of house
                0.9681     0.9508     0.9172     0.8317     0.6815     0.4779     0.3154     0.3585     0.6114     0.8556     0.9457     0.9716 (89)
MIT 2          17.8593    18.1468    18.5785    19.1512    19.5408    19.7330    19.7673    19.7666    19.6643    19.1904    18.4747    17.8454 (90)
Living area fraction                                                                                fLA = Living area / (4) =      0.3590 (91)
MIT            18.3905    18.6564    19.0575    19.5927    19.9696    20.1623    20.2031    20.1995    20.0878    19.6244    18.9555    18.3745 (92)
Temperature adjustment                                                                                                             0.0000
adjusted MIT   18.3905    18.6564    19.0575    19.5927    19.9696    20.1623    20.2031    20.1995    20.0878    19.6244    18.9555    18.3745 (93)


----------------------------------------------------------------------------------------------------
8. Space heating requirement
----------------------------------------------------------------------------------------------------

                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation     0.9586     0.9396     0.9056     0.8264     0.6934     0.5092     0.3564     0.4008     0.6370     0.8510     0.9352     0.9628 (94)
Useful gains  369.4942   404.5999   422.4946   425.6196   380.9809   277.7629   185.9828   194.2333   284.2663   343.3041   353.5176   358.0286 (95)
Ext temp.       4.3000     4.9000     6.5000     8.9000    11.7000    14.6000    16.6000    16.4000    14.1000    10.6000     7.1000     4.2000 (96)
Heat loss rate W
              771.2862   750.1266   682.1760   570.5751   439.7874   291.1472   188.5975   198.2882   315.3510   479.9275   634.8083   764.3825 (97)
Space heating kWh
              298.9332   232.1939   193.2030   104.3680    43.7520     0.0000     0.0000     0.0000     0.0000   101.6478   202.5294   302.3273 (98a)
Space heating requirement - total per year (kWh/year)                                                                          1478.9545
Solar heating kWh
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (98b)
Solar heating contribution - total per year (kWh/year)                                                                            0.0000
Space heating kWh
              298.9332   232.1939   193.2030   104.3680    43.7520     0.0000     0.0000     0.0000     0.0000   101.6478   202.5294   302.3273 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)                                                 1478.9545
Space heating per m2                                                                                          (98c) / (4) =     39.1880 (99)


----------------------------------------------------------------------------------------------------
9a. Energy requirements - Individual heating systems, including micro-CHP
----------------------------------------------------------------------------------------------------
Fraction of space heat from secondary/supplementary system (Table 11)                                                             0.0000 (201)
Fraction of space heat from main system(s)                                                                                        1.0000 (202)
Efficiency of main space heating system 1 (in %)                                                                                 92.3000 (206)
Efficiency of main space heating system 2 (in %)                                                                                  0.0000 (207)
Efficiency of secondary/supplementary heating system, %                                                                           0.0000 (208)

                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Space heating requirement
              298.9332   232.1939   193.2030   104.3680    43.7520     0.0000     0.0000     0.0000     0.0000   101.6478   202.5294   302.3273 (98)
Space heating efficiency (main heating system 1)
               92.3000    92.3000    92.3000    92.3000    92.3000     0.0000     0.0000     0.0000     0.0000    92.3000    92.3000    92.3000 (210)
Space heating fuel (main heating system)
              323.8713   251.5644   209.3206   113.0747    47.4020     0.0000     0.0000     0.0000     0.0000   110.1276   219.4251   327.5485 (211)
Space heating efficiency (main heating system 2)
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (212)
Space heating fuel (main heating system 2)
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (213)
Space heating fuel (secondary)
                0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (215)

Water heating
Water heating requirement
              176.4442   156.2483   166.6085   148.0580   144.5653   131.4072   130.5638   135.1381   135.9351   150.2000   158.0035   174.7337 (64)
Efficiency of water heater                                                                                                       79.8000 (216)
(217)m         85.2321    84.9463    84.3928    83.2903    81.7244    79.8000    79.8000    79.8000    79.8000    83.2035    84.6176    85.2773 (217)
Fuel for water heating, kWh/month
              207.0161   183.9376   197.4204   177.7615   176.8938   164.6707   163.6137   169.3460   170.3448   180.5211   186.7264   204.9006 (219)
Space cooling fuel requirement
(221)m          0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (221)
Pumps and Fa    7.3041     6.5973     7.3041     7.0685     7.3041     7.0685     7.3041     7.3041     7.0685     7.3041     7.0685     7.3041 (231)
Lighting       12.1716     9.7645     8.7919     6.4413     4.9754     4.0650     4.5388     5.8997     7.6631    10.0544    11.3564    12.5099 (232)
Electricity generated by PVs (Appendix M) (negative quantity)
(233a)m       -30.6063   -40.9582   -55.9883   -59.8755   -62.2341   -57.4316   -56.8437   -54.8369   -50.8958   -45.4669   -32.9192   -26.7399 (233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(234a)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(235a)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)
(235c)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235c)
Electricity generated by PVs (Appendix M) (negative quantity)
(233b)m       -24.6525   -50.7894   -98.9869  -145.8841  -190.2218  -190.0422  -187.6695  -159.9709  -118.8053   -71.4771   -32.5354   -19.5625 (233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)
(234b)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)
(235b)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)
(235d)m         0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (235d)
Annual totals kWh/year
Space heating fuel - main system 1                                                                                             1602.3343 (211)
Space heating fuel - main system 2                                                                                                0.0000 (213)
Space heating fuel - secondary                                                                                                    0.0000 (215)
Efficiency of water heater                                                                                                       79.8000
Water heating fuel used                                                                                                        2183.1527 (219)
Space cooling fuel                                                                                                                0.0000 (221)

Electricity for pumps and fans:
Total electricity for the above, kWh/year                                                                                        86.0000 (231)
Electricity for lighting (calculated in Appendix L)                                                                              98.2318 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation                                                                                                                 -1865.3941 (233)
Wind generation                                                                                                                   0.0000 (234)
Hydro-electric generation (Appendix N)                                                                                            0.0000 (235a)
Electricity generated - Micro CHP (Appendix N)                                                                                    0.0000 (235)
Appendix Q - special features
Energy saved or generated                                                                                                        -0.0000 (236)
Energy used                                                                                                                       0.0000 (237)
Total delivered energy for all uses                                                                                            2104.3247 (238)


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12a. Carbon dioxide emissions - Individual heating systems including micro-CHP
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| | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year | |
|---|---|---|---|---|
| Space heating - main system 1 | 1602.3343 | 0.2100 | 336.4902 | (261) |
| Total CO2 associated with community systems | | | 0.0000 | (373) |
| Water heating (other fuel) | 2183.1527 | 0.2100 | 458.4621 | (264) |
| Space and water heating | | | 794.9523 | (265) |
| Pumps, fans and electric keep-hot | 86.0000 | 0.1387 | 11.9293 | (267) |
| Energy for lighting | 98.2318 | 0.1443 | 14.1779 | (268) |
| Energy saving/generation technologies | | | | |
| PV Unit electricity used in dwelling | -574.7964 | 0.1356 | -77.9508 | |
| PV Unit electricity exported | -1290.5977 | 0.1265 | -163.2356 | |
| Total | | | -241.1864 | (269) |
| Total CO2, kg/year | | | 579.8730 | (272) |
| EPC Target Carbon Dioxide Emission Rate (TER) | | | 15.3600 | (273) |

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

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| | Energy kWh/year | Primary energy factor kg CO2/kWh | Primary energy kWh/year | |
|---|---|---|---|---|
| Space heating - main system 1 | 1602.3343 | 1.1300 | 1810.6377 | (275) |
| Total CO2 associated with community systems | | | 0.0000 | (473) |
| Water heating (other fuel) | 2183.1527 | 1.1300 | 2466.9625 | (278) |
| Space and water heating | | | 4277.6002 | (279) |
| Pumps, fans and electric keep-hot | 86.0000 | 1.5128 | 130.1008 | (281) |
| Energy for lighting | 98.2318 | 1.5338 | 150.6713 | (282) |
| Energy saving/generation technologies | | | | |
| PV Unit electricity used in dwelling | -574.7964 | 1.5013 | -862.9212 | |
| PV Unit electricity exported | -1290.5977 | 0.4643 | -599.2226 | |
| Total | | | -1462.1438 | (283) |
| Total Primary energy kWh/year | | | 3096.2286 | (286) |
| Target Primary Energy Rate (TPER) | | | 82.0400 | (287) |