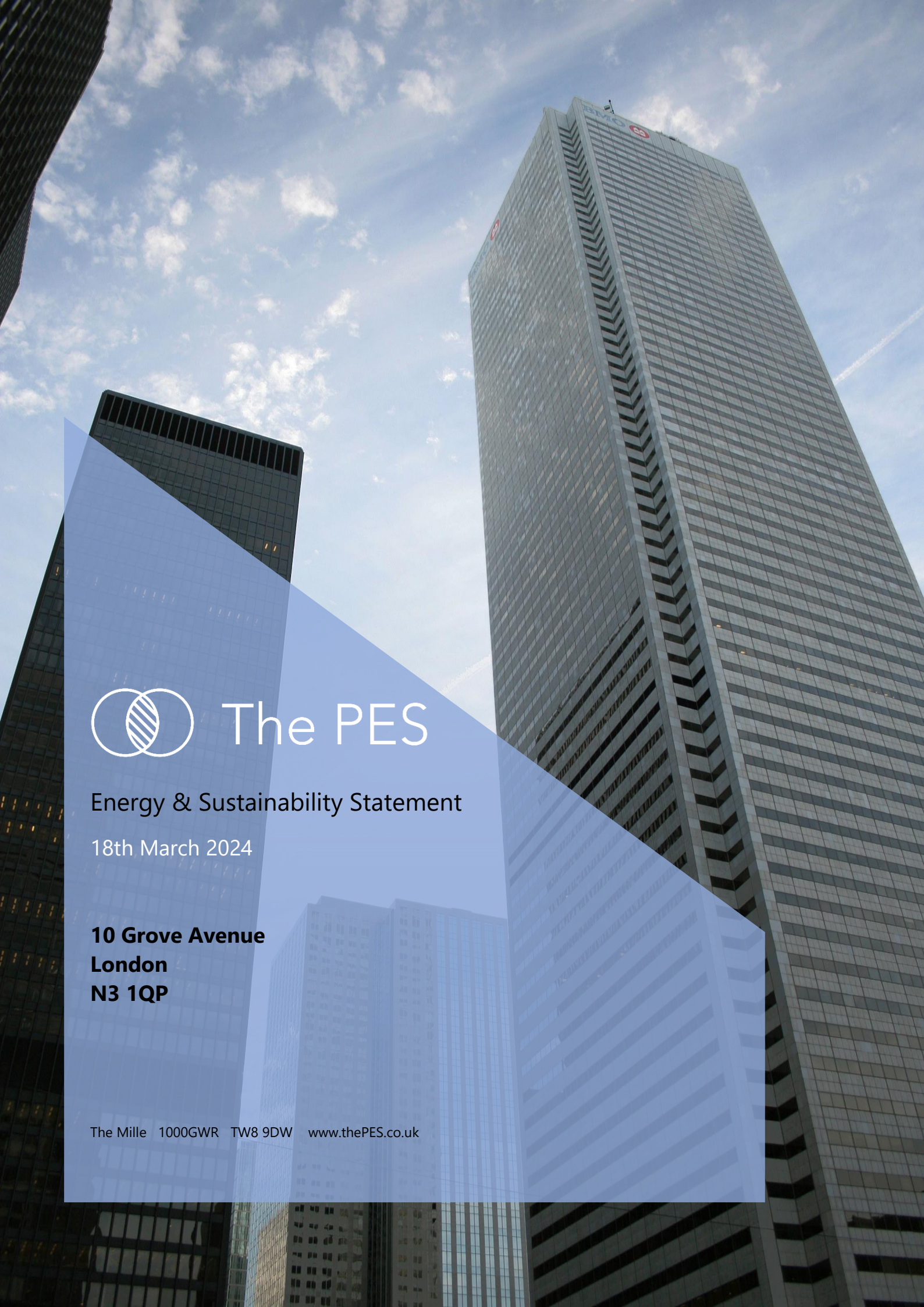

The PES

# Energy & Sustainability Statement

18th March 2024

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**London**
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## 1.0 Executive Summary

The proposed development project at Grove Avenue, Barnet involves the development of a new single dwelling residential development.

It has been designed to achieve the highest of environmental performance standards following the Energy Hierarchy as set down by the London Plan and the London Borough of Barnet's local plan policies.

The report takes on board the latest GLA guidance on writing energy statements (June 2022) as well as taking into account matters raised with the recently adopted London Plan.

The PES Ltd have been appointed to develop a strategy and advise how the proposed development of new build apartments will comply with these requirements.

A 'Lean, Clean, Green' has been adopted and the development achieves an overall improvement (DER/TER) in regulated emissions at over **70%** above Part L 2021 standard, through the adoption of passive design standards, high standards of insulation with heating and hot water to be provided via heat pump technology.

## 2.0 The Site & Proposal

The proposal site is located to the rear of 10 Grove Avenue, and fronts on to Falkland Avenue

The proposals for the site include the demolition of the existing garage building and redevelopment of the site as a two storey studio dwelling.

### 2.1 Local Planning Context

The project sits within the London Borough of Barnet (Barnet).

Barnet's Local Plan (Core Strategy) Development Plan Document was adopted in September 2012; Policy CS13 states:-

We will seek to minimise Barnet's contribution to climate change and ensure that through the efficient use of natural resources the borough develops in a way which respects environmental limits and improves quality of life.

- We will promote the highest environmental standards for development and through our SPDs on Sustainable Design and Construction and Green Infrastructure we will continue working to deliver exemplary levels of sustainability throughout Barnet in order to mitigate and adapt to the effects of a changing climate.
- We will expect all development to be energy efficient and seek to minimise any wasted heat or power.
- In line with London Plan Policy 5.2 – Minimising Carbon Dioxide Emissions we will expect major development in accordance with the Mayor's energy hierarchy to reduce carbon dioxide emissions beyond the 2010 Building Regulations.
- We will maximise opportunities for implementing new district-wide networks supplied by decentralised energy (including renewable generation) in partnership with key stakeholders in areas of major mixed use growth including town centres. Where feasible we will expect all development to contribute to new and existing frameworks.
- We will support solutions that minimise or avoid harm to a heritage asset's significance while delivering improved energy performance or generation.
- We will make Barnet a water efficient borough and minimise the potential for fluvial and surface flooding by ensuring development does not cause harm to the water environment, water quality and drainage systems. Development should utilise Sustainable Urban Drainage Systems (SUDS) in order to reduce surface water run-off and ensure such run-off is managed as close to its source as possible subject to local geology and ground water levels.

- We will improve air and noise quality by requiring Air Quality Assessments and Noise Impact Assessments from development in line with Barnet's SPD on Sustainable Design and Construction.

Barnet's Development Management Policies – also adopted in 2012 – Policy DM04 states:

a. All major development will be required to demonstrate through an Energy Statement compliance with the Mayor's targets for reductions in carbon dioxide emissions within the framework of the Mayor's energy hierarchy.

b. Where Decentralised Energy (DE) is feasible or planned, major development will either provide:

i. suitable connection

ii. the ability to connect in future

iii. a feasibility study

iv. a financial contribution to a proposed feasibility study.

c. i. Where there is a localised source of air pollution, buildings should be designed and sited to reduce exposure to air pollutants.

ii. Development proposals will ensure that development is not contributing to poor air quality and provide air quality assessments where appropriate.

g. Development should demonstrate compliance with the London Plan water hierarchy for run off especially in areas identified as prone to flooding from surface water run off. All new development in areas at risk from fluvial flooding must demonstrate application of the sequential approach set out in the NPPF (paras 100 to 104) and provide information on the known flood risk potential of the application site.

h. Development proposals will wherever possible be expected to naturalise a water course, ensure an adequate buffer zone is created and enable public accessibility. Where appropriate, contributions towards river restoration

Following an initial dialogue with Barnet; a pre-application document and response is in place, and confirms:-

*Sustainability*

Barnet's Sustainable Design and Construction SPD (2016) states:-

If the proposal is a 'major' development* then the London Plan Policy 5.2 requires that major developments meet the required 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. Greater policy details are set out in London Plan Policy 5.2 for the applicant to review.

Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy.

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.

**2.2 The London Plan**

Chapter 9 deals with Sustainable Infrastructure:-

Policy SI2 - Minimising greenhouse gas emissions

Major development should be net zero-carbon.151 This means reducing greenhouse gas emissions in operation and minimising both annual and peak energy demand in accordance with the following energy hierarchy:
1) be lean: use less energy and manage demand during operation
2) be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly
3) be green: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site
4) be seen: monitor, verify and report on energy performance.

B Major development should include a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy and will be expected to monitor and report on energy performance.

C In meeting the zero-carbon target a minimum on-site reduction of at least 35 per cent beyond Building Regulations is expected. Residential development should aim to achieve 10 per cent, and non-residential development should aim to achieve 15 per cent through energy efficiency measures. Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided:

1) through a cash in lieu contribution to the relevant borough's carbon offset fund, and/or
2) off-site provided that an alternative proposal is identified and delivery is certain.

Policy SI3 - Energy infrastructure

A Boroughs and developers should engage at an early stage with relevant energy companies and bodies to establish the future energy and infrastructure requirements arising from large-scale development proposals such as Opportunity Areas, Town Centres, other growth areas or clusters of significant new development.
B Energy masterplans should be developed for large-scale development locations (such as those outlined in Part A and other opportunities) which establish the most effective energy supply options. Energy masterplans should identify:

1) major heat loads (including anchor heat loads, with particular reference to sites such as universities, hospitals and social housing)
2) heat loads from existing buildings that can be connected to future phases of a heat network
3) major heat supply plant including opportunities to utilise heat from energy from waste plants
4) secondary heat sources, including both environmental and waste heat
5) opportunities for low and ambient temperature heat networks
6) possible land for energy centres and/or energy storage
7) possible heating and cooling network routes
8) opportunities for futureproofing utility infrastructure networks to minimise the impact from road works
9) infrastructure and land requirements for electricity and gas supplies
10) implementation options for delivering feasible projects, considering issues of procurement, funding and risk, and the role of the public sector
11) opportunities to maximise renewable electricity generation and incorporate demand-side response measures.

D Major development proposals within Heat Network Priority Areas should have a communal low-temperature heating system:

1) the heat source for the communal heating system should be selected in accordance with the following heating hierarchy:
a) connect to local existing or planned heat networks
b) use zero-emission or local secondary heat sources (in conjunction with heat pump, if required)
c) use low-emission combined heat and power (CHP) (only where there is a case for CHP to enable the delivery of an area-wide heat network, meet the development's electricity demand and provide demand response to the local electricity network)
d) use ultra-low NOx gas boilers

2) CHP and ultra-low NOx gas boiler communal or district heating systems should be designed to ensure that they meet the requirements in Part B of Policy SI 1 Improving air quality
3) where a heat network is planned but not yet in existence the development should be designed to allow for the cost-effective connection at a later date.

Policy SI4 - Managing heat risk

A Development proposals should minimise adverse impacts on the urban heat island through design, layout, orientation, materials and the incorporation of green infrastructure.

B Major development proposals should demonstrate through an energy strategy how they will reduce the potential for internal overheating and reliance on air conditioning systems in accordance with the following cooling hierarchy:

1) reduce the amount of heat entering a building through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure

2) minimise internal heat generation through energy efficient design

3) manage the heat within the building through exposed internal thermal mass and high ceilings

4) provide passive ventilation

5) provide mechanical ventilation

6) provide active cooling systems.

Policy SI5 Water infrastructure

C Development proposals should:

1) through the use of Planning Conditions minimise the use of mains water in line with the Optional Requirement of the Building Regulations (residential development), achieving mains water consumption of 105 litres or less per head per day (excluding allowance of up to five litres for external water consumption)

2) achieve at least the BREEAM excellent standard for the 'Wat 01' water category160 or equivalent (commercial development)

3) incorporate measures such as smart metering, water saving and recycling measures, including retrofitting, to help to achieve lower water consumption rates and to maximise future-proofing.

Policy SI12 - Flood risk management

C Development proposals should ensure that flood risk is minimised and mitigated, and that residual risk is addressed. This should include, where possible, making space for water and aiming for development to be set back from the banks of watercourses.

E Development proposals for utility services should be designed to remain operational under flood conditions and buildings should be designed for quick recovery following a flood.

F Development proposals adjacent to flood defences will be required to protect the integrity of flood defences and allow access for future maintenance and upgrading.

Unless exceptional circumstances are demonstrated for not doing so, development proposals should be set back from flood defences to allow for any foreseeable future maintenance and upgrades in a sustainable and cost-effective way.

G Natural flood management methods should be employed in development proposals due to their multiple benefits including increasing flood storage and creating recreational areas and habitat.

Policy SI13 - Sustainable drainage

A Lead Local Flood Authorities should identify – through their Local Flood Risk Management Strategies and Surface Water Management Plans – areas where there are particular surface water management issues and aim to reduce these risks. Increases in surface water run-off outside these areas also need to be identified and addressed.

B Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features, in line with the following drainage hierarchy:

1) rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation)

2) rainwater infiltration to ground at or close to source

3) rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens) It is noted that the proposed non-domestic development is greater than 1,000m$^2$ and would be considered major development.

4) rainwater discharge direct to a watercourse (unless not appropriate)

5) controlled rainwater discharge to a surface water sewer or drain

6) controlled rainwater discharge to a combined sewer.

C Development proposals for impermeable surfacing should normally be resisted unless they can be shown to be unavoidable, including on small surfaces such as front gardens and driveways.

D Drainage should be designed and implemented in ways that promote multiple benefits including increased water use efficiency, improved water quality, and enhanced biodiversity, urban greening, amenity and recreation.

It is noted that the single dwelling development at the Grove Avenue would be considered a non-major full planning application and this report is informed accordingly based upon SAP10.2 calculation methodology.

In order to populate the Tables within this report, the GLA Part L reporting spreadsheet is attached at **Appendix D.**

## 3.0 Baseline energy results

The first stage of the Mayor's Energy Hierarchy is to consider the baseline energy model.

The following section details the baseline energy requirements for the development – the starting point when considering the energy hierarchy.

### 3.1 New Build Dwellings

The baseline emission levels – the Target Emission Rate (TER) - is obtained by applying the design to a reference 'notional' building the characteristics of which are set by regulations – SAP10.2; The new Part L Building Regulations 2021 came into force in June 2022 and introduced a completely new notional dwelling as detailed below:-

**Table 1.1 Summary of notional dwelling specification for new dwelling[1]**

| Element or system | Reference value for target setting |
|---|---|
| Opening areas (windows, roof windows, rooflights and doors) | Same as for actual dwelling not exceeding a total area of openings of 25% of total floor area[2] |
| External walls including semi-exposed walls | U = 0.18 W/(m²·K) |
| Party walls | U = 0 |
| Floors | U = 0.13 W/(m²·K) |
| Roofs | U = 0.11 W/(m²·K) |
| Opaque door (less than 30% glazed area) | U = 1.0 W/(m²·K) |
| Semi-glazed door (30–60% glazed area) | U = 1.0 W/(m²·K) |
| Windows and glazed doors with greater than 60% glazed area | U = 1.2 W/(m²·K)<br>Frame factor = 0.7 |
| Roof windows | U = 1.2 W/(m²·K), when in vertical position (for correction due to angle, see specification in SAP 10 Appendix R) |
| Rooflights | U = 1.7 W/(m²·K), when in horizontal position (for correction due to angle, see specification in SAP 10 Appendix R) |
| Ventilation system | Natural ventilation with intermittent extract fans |
| Air permeability | 5 m³/(h·m²) at 50 Pa |
| Main heating fuel (space and water) | Mains gas |
| Heating system | Boiler and radiators<br>Central heating pump 2013 or later, in heated space<br>Design flow temperature = 55 °C |
| Boiler | Efficiency, SEDBUK 2009 = 89.5% |
| Heating system controls | Boiler interlock, ErP Class V<br>Either:<br>– single storey dwelling in which the living area is greater than 70% of the total floor area: programmer and room thermostat<br>– any other dwelling: time and temperature zone control, thermostatic radiator valves |
| Hot water system | Heated by boiler (regular or combi as above)<br>Separate time control for space and water heating |
| Wastewater heat recovery (WWHR) | All showers connected to WWHR, including showers over baths<br>Instantaneous WWHR with 36% recovery efficiency utilisation of 0.98 |
| Hot water cylinder | If cylinder, declared loss factor = 0.85 x (0.2 + 0.051 $V^{2/3}$) kWh/day<br>where V is the volume of the cylinder in litres |
| Lighting | Fixed lighting capacity (lm) = 185 x total floor area<br>Efficacy of all fixed lighting = 80 lm/W |
| Air conditioning | None |
| Photovoltaic (PV) system | For houses: kWp = 40% of ground floor area, including unheated spaces / 6.5<br>For flats: kWp = 40% of dwelling floor area / (6.5 x number of storeys in block)<br>System facing south-east or south-west |

**NOTE:**
1. For a dwelling connected to an existing district heat network, an alternative notional building is used. See paragraph 1.8 and SAP 10.
2. See SAP 10 for details.

SAP first creates the notional reference building, based upon the same shape and form as the proposed dwelling and applies the above the characteristics as defined in SAP10.2, prior to applying the actual construction and HVAC solution of the proposed dwellings to generate the Dwelling Emission Rate (DER).

### 3.2 Unregulated Energy Use

The baseline un-regulated energy use for cooking & appliances in the residential units have been calculated using the SAP Section 16 methodology; the same calculation used for Code for Sustainable Homes (CfSH) Ene 7.

Appliances = $E_A$ = 207.8 X (TFA X N)$^{0.4714}$

Cooking = (138 + 28N)/TFA

N = no of occupant SAP table 1B

TFA – Total Floor Areas

The unregulated energy use per sqm is summarised in Table 1 below and amended to reflect SAP10.2 emission values.

The GLA reporting spreadsheet of all calculations for the project is attached at **Appendix D.**

Table 1 – Unregulated Energy Use

| Unit | Unregulated Energy Use SAP10.2<br><br>Kg/annum |
|---|---|
| Grove Avenue | 197 |

The un-regulated emission rates are added to the baseline regulated emission rates (as calculated under 3.1 above) in order to set the total baseline emission rates before then applying the energy hierarchy in line with London Plan and Barnet policies.

### 3.3 Baseline Results

The baseline building results have been calculated and are presented in Table 2 below.

The Baseline SAP outputs (which summarise the key data) are attached at **Appendix A**. The GLA reporting spreadsheet is attached at **Appendix D.**

Table 2 – Baseline energy consumption and CO2 emissions

| Unit | Target Emission Rate (regulated energy use) Kg/annum | Unregulated Energy Use<br><br>Kg/annum | Total baseline emissions<br><br>Kg |
|---|---|---|---|
| | | | |
| Grove Avenue | 879 | 197 | 1,076 |
| | | | |
| **Scheme Total** | **879** | **197** | **1,076** |

## 4.0 Design for energy efficiency

The first step in the Mayor's 'Energy Hierarchy' as laid out in Chapter 9 of the New London Plan, requests that buildings be designed to use improved energy efficiency measures – Be Lean. This will reduce demand for heating, cooling, and lighting, and therefore reduce operational costs while also minimizing associated carbon dioxide emissions.

This section sets out the measures included within the design of the development, to reduce the demand for energy, both gas and electricity (not including energy from renewable sources). The table at the end of this section details the amount of energy used and $CO_2$ produced by the building after the energy efficiency measures have been included. From these figures the overall reduction in $CO_2$ emissions, as a result of passive design measures, can be calculated. To achieve reductions in energy demand the following measures have been included within the design and specification of the building:

### 4.1 Passive Design

The National Planning Policy Framework emphasises the need to take account of climate change over the longer term and plan new developments to avoid increased vulnerability to the range of impacts arising from climate change. The UK Climate Impacts Programme 2009 projections suggest that by the 2080's the UK is likely to experience summer temperatures that are up to 4.2°C higher than they are today.

Accordingly, designers are to ensure buildings are designed and constructed to be comfortable in higher temperatures, without resorting to energy intensive air conditioning.

In line with current GLA Guidance, the project at the Grove Avenue has been designed to ensure the building is not vulnerable to overheating; to instigate consideration of the risk of overheating with the proposed development, the design team have followed the guidance within the London Plan, Chapter 9, which consider the control of overheating using the Cooling Hierarchy.

1. **minimise internal heat generation through energy efficient design**

The project will be designed to best practice thermal insulation levels as noted, full details of which are noted under 4.3 below.

Not only does good insulation assist in reducing heat losses in the winter, it has a significant impact on preventing heat travelling through the build fabric during the summer.

LED lighting and low energy electrical goods will further reduce internal gains and the potential for overheating issues.

2. **reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and wall**

The development is design with the main living area to the south westerly aspect

As such, the living areas harvest useful excessive solar gains whilst introducing plenty of natural daylight.

The secondary spaces to the rear do not have glazed area, aside from a single rooflight, thus reducing heat losses.

The glazing specification will utilise an element of solar control to further protect the internal spaces from risk of overheating.

3. **manage the heat within the building through exposed internal thermal mass and high ceilings**

The house is designed with floor to ceiling heights at circa 2.5m.

The new build structure is expected to be a of a traditional brick and block construction with solid floors offering significant thermal mass able to absorb heat during the summer months, which can then be ventilated during the evening or overnight.

4. **passive ventilation**

The main glazed areas also have opening areas to introduce high levels of natural "purge" ventilation to maximise the natural cooling impact.

5. **mechanical ventilation**

The passive ventilation and cooling strategy as out lined above; it is considered acceptable for occupants to be able to open glazing for background and purge ventilation, reducing any overheating risk.

### 4.2 Heating System

The "notional" heating system considered under the "be lean – use less energy" section of the Energy Hierarchy, will consist of high efficiency condensing gas boilers providing under floor heating and domestic hot water.

- A Rated boiler systems – (92.3%+ SEDBUK efficiency) & load compensation.
- Insulated primary pipework

To increase the efficiency in the use of the heating system, the following controls will be used to eliminate needless firing of the boilers.

- Boilers fitted with weather compensation systems

### 4.3 Fabric heat loss

Insulation measures will be utilised to ensure the calculated U-values exceed the Building Regulations minima, with specific guidance taken from the design team: -

- New wall constructions will be of a highly insulated cavity wall system using full-fill PIR insulation and will target a U-Value of 0.15W/$m^2$k or better.
- Lower ground floors walls will be of a solid construction targeting 0.12W/$m^2$k.
- New flat and pitched roof constructions are yet to be specified, but constructions achieving a U-Value of 0.10W/$m^2$k will be targeted.

Glazing

- The new glazing for windows and doors will be triple glazed with an area weighted average U-Value of 1.0W/$m^2$K or better.

Air Tightness

- The new house will be tested to 4$m^3$/hr/$m^2$ in line with best practice for naturally ventilated buildings.

Construction Details

- Heat loss via non-repeating thermal bridging within the new build elements will be minimised by the use of Accredited Construction Details for these new build units. An overall Y-Value <0.07 is targeted.

### 4.4 Ventilation

As noted above, the house is to utilise a low energy natural ventilation strategy, with trickle (background) ventilators, opening windows for additional purge ventilation and wet room extracts; AD Part F System 1.

### 4.5 Lighting and appliances

The house will incorporate high efficiency light fittings utilising LED lamps and any external lighting will utilise photocell controls to ensure lighting is not left on during the day.

### 4.6 Waste Water Heat Recovery

The showers are to be fitted with waster water heat recovery systems working at some 45% effieincy

### 4.7 Energy efficiency results

The above data has been used to update the SAP models; the Dwelling Emission Rate outputs of which are attached at **Appendix B**, with the GLA spreadsheet at **Appendix D**.

The following Table 3 shows the unit emission levels, as well as the overall emissions from the building.

Table 3 – Energy Efficient emission levels

| Unit | Target Emission Rate (regulated energy use) Kg/annum | Unregulated Energy Use Kg/annum | Total emissions Kg |
|---|---|---|---|
| | | | |
| Grove Avenue | 749 | 197 | 946 |
| | | | |
| **Scheme Total** | **749** | **197** | **946** |

The results show that the energy efficiency measures introduced have resulted in the reduction in $CO_2$ emissions from the development of **12.1%.**

Regulated emissions have been reduced by **14.8%.**

The total Part L Fabric Energy Efficiency Standard (FEES) for the development – set out in Table 4 below:-

Table 4 – Residential FEES

| | Target Fabric Energy Efficiency (MWh/year) | Design Fabric Energy Efficiency (MWh/year) | Improvement (percent) |
|---|---|---|---|
| Development Total | 43.07 | 39.18 | 9% |

## 5.0 Supplying Energy Efficiently

The second stage in the Mayor's 'Energy Hierarchy' is to ensure efficient and low carbon energy supply – Be Clean. In particular, this concerns provision of decentralised energy where practical and appropriate.

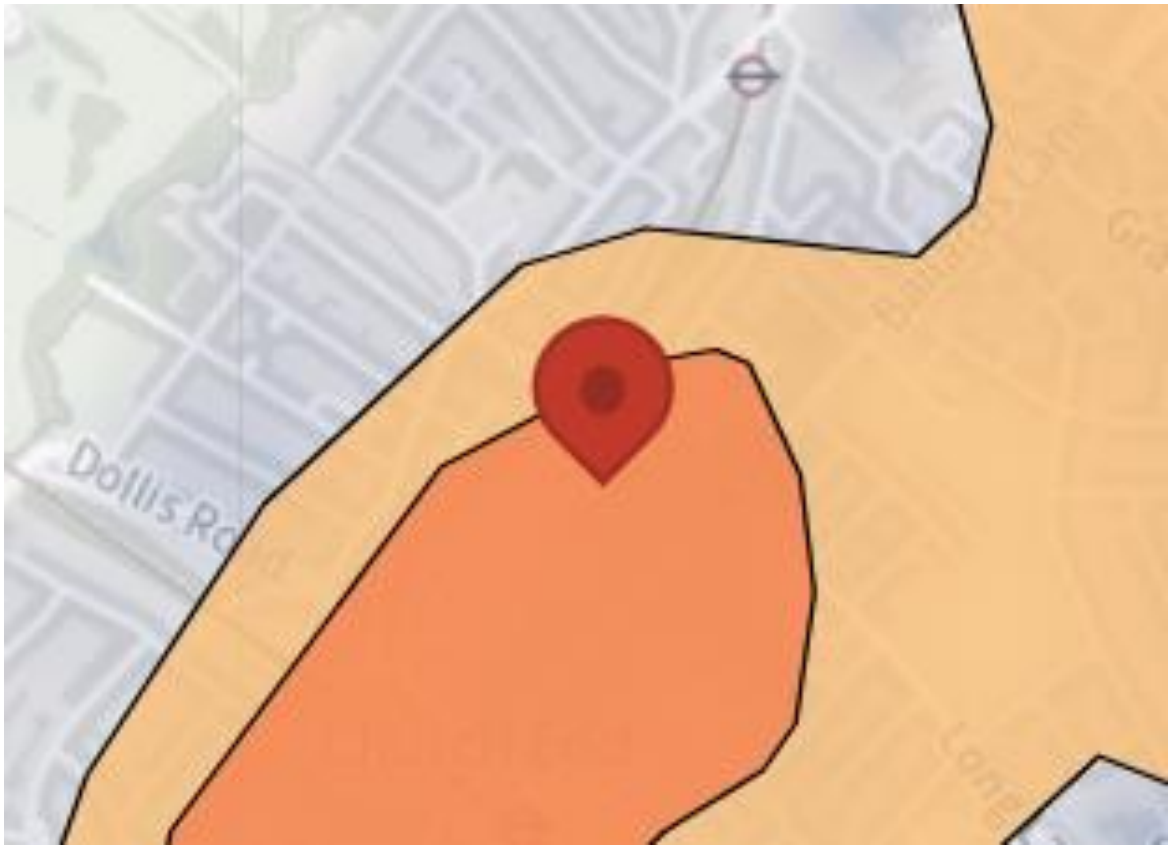
The London Plan requires that:-

"Major development proposals within Heat Network Priority Areas should have a communal heating system

1) the heat source for the communal heating system should be selected in accordance with the following heating hierarchy:

a) connect to local existing or planned heat networks"

The extract from the London Heat Map (reproduced below) identifies that the site is not in reach of a proposed heat network, but is within a high heat network priority area.




Extract from London Heat Map

Clearly, as non major scheme, this matter of DEN connections need not be considered further, however, the proposed LTHW heating system would be compatible with a DEN connection should one become available.

## 6.0 Renewable Energy Options

The final element of the Mayor's 'Energy Hierarchy' requires development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible – Be Green.

Renewable energy can be defined as energy taken from naturally occurring or renewable sources, such as sunlight, wind, wave's tides, geothermal etc. Harnessing these energy sources can involve a direct use of natural energy, such as solar water heating panels, or it can be a more indirect process, such as the use of Biofuels produced from plants, which have harnessed and embodied the suns energy through photosynthesis.

The energy efficiency measures and the sourcing the energy efficiently outlined above have the most significant impact on the heating and hot water energy requirements for the development, and the associated reduction in energy consumption.

This section then sets out the feasibility of implementing different energy technologies in consideration of: -

- Potential for Carbon savings
- Capital costs
- Running costs
- Payback period as a result of energy saved/Government incentives
- Maturity/availability of technology
- Reliability of the technology and need for back up or alternative systems.

### 6.1 Government incentives

#### 6.1.1 Smart Export Guarantee (SEG)

Introduced in 2020, the SEG will enable solar photovoltaic (PV), wind, hydro and anaerobic digestion (AD) installations up to 5MW and micro-combined heat and power (micro-CHP) up to 50kW will be able to receive an export tariff under the policy.

The SEG is a market-led initiative, requiring electricity supply licensees to offer export tariffs to eligible generators. Suppliers are free to set their own SEG compliant tariff price (provided it is above zero pence at all times) and decide how their tariffs work.

Installation owners are able to shop around and select the Licensee of their choice based upon an offer of the most appropriate tariff.

Payment are made against metered exports only.

#### 6.1.2 Renewable Heat Incentive

The Renewable Heat Incentive (RHI) was formally closed to applications in March 2022.

### 6.2 Wind turbines

Wind turbines come in two main types'- horizontal axis and vertical axis. The more traditional horizontal axis systems rotate around the central pivot to face into the wind, whilst vertical axis systems work with wind from all directions.

The potential application of wind energy technologies at a particular site is dependent upon a variety of factors. But mainly these are: -

- Wind speed
- Wind turbulence
- Visual impact
- Noise impact
- Impact upon ecology

The availability and consistency of wind in urban environments is largely dependent upon the proximity, scale and orientation of surrounding obstructions. The site is flanked by other low – medium rise properties to all directions. To overcome these obstructions and to receive practical amounts of non-turbulent wind, the blades of a wind turbine would need to be placed significantly above the roof level of these buildings and the proposed project at the Grove Avenue itself.

It is inconceivable that any wind turbines of this size would be considered acceptable in this location.

### 6.3 Solar Energy

The proposed development has areas of flat roof that could accommodate solar panels orientated to the south east.

In general, the roofs will have an unrestricted aspect, so there is scope therefore to site solar photovoltaic (PV) or water heating equipment at roof level.

#### 6.3.1 Solar water heating

Solar water heating panels come in two main types; flat plate collectors and evacuated tubes. Flat plate collectors feed water, or other types of fluid used specifically to carry heat, through a roof mounted collector and into a hot water storage tank. Evacuated tube collectors are slightly more advanced as they employ sealed vacuum tubes, which capture and harness the heat more effectively.

Both collector types can capture heat whether the sky is overcast or clear. Depending on location, approximately 900–1100 kWh of solar energy falls on each $m^2$ of unshaded UK roof surface annually. The usable energy output per $m^2$ of solar panel as a result of this amount of insolation ranges from between 380 – 550 kWh/yr.

Solar hot water systems are of course, displacing gas for DHW provision (as noted above), and due to the low cost of gas as a source of energy, solar thermal systems tend

to have a very poor pay back model unless there is a reliable and consultant demand for hot water; a medium size residential scheme simply does not provide this

Accordingly, given the limited roof space available and the strategy to off-set the electrical use, solar PV may be a stronger candidate (see below) and offer a greater return on investment.

Accordingly, solar thermal would not be the optimum solution for the proposed development.

### 6.3.2 Photovoltaics (PV)

A 1kWp (1 kilowatt peak) system in the UK could be expected to produce between 790-800kWh of electricity per year based upon a south east orientation according to SAP2005 methodology used by the Microgeneration Certification Scheme (MCS).

The figure given in the London Renewables Toolkit is 783 kWh per year for a development in London.

Despite the withdrawal of the Feed in Tariff, the returns on PV installations can still achieve returns in excess in 4-5% due to the electricity cost savings.

However, the PV installation would be highly limited, would be overlooked by neighbours and would also have a very negative impact on building aesthetics – so the design team are to pursue alternative renewable technologies.

### 6.4 Biomass heating

Biomass is a term given to fuel derived directly from biological sources for example rapeseed oil, wood chip/pellets or gas from anaerobic digestion. It can only be considered as a renewable energy source if the carbon dioxide emitted from burning the fuel is later recaptured in reproducing the fuel source (i.e. trees that are grown to become wood fuel, capture carbon as they grow).

Biomass heating systems require space to site a boiler and fuel hopper along with a supply of fuel – which can be very bulky items. There also needs to be a local source of biomass fuel that can be delivered on a regular basis. There are also issues with fuel storage and delivery which mitigate against this technology.

Additionally, a boiler of this type would replace the need for a conventional gas boiler and therefore offset all the gas energy typically used for space and water heating. However, biomass releases high levels of $NO_x$ emissions and particulate matters, as well as other pollutants and would therefore have to be considered carefully against the high standard of air quality requirements within the London boroughs. Accordingly, the use of biomass is not considered appropriate for this project.

### 6.5 Ground source heat pump

Ground source heating or cooling requires a source of consistent ground temperature, which could be a vertical borehole or a spread of pipework loops and a 'heat pump'. The system uses a loop of fluid to collect the more constant temperature in the ground and transport it to a heat pump. In a cooling system this principle works in reverse and the heat is distributed into the ground.

The heat pump then generates increased temperatures by 'condensing' the heat taken from the ground, producing hot water temperatures in the region of 45°C. This water can then be used as pre-heated water for a conventional boiler or to provide space heating with an under floor heating system.

The use of a ground source heating/cooling system will therefore require:

- Vertical borehole or ground loop
- Use of under floor heating
- Space for heat pump unit

Clearly, there is sufficient land area to install low level collector loops to enable a ground source heating solution.

However, with the advance of air source heat pump technology, and taking into account the high capital cost, it consider that air source heating could offer a more practical solution.

### 6.6 Air source heat pump

Air source heating or cooling also employs the principle of a heat pump. This time either, upgrading the ambient external air temperature to provide higher temperatures for water and space heating, or taking warmth from within the building and dissipating it to the outdoor air.

It must be remembered that heat pumps utilise grid based electricity, so calculations base the benefits on SAP10.2 emissions data

Assuming a seasonal system efficiency of 320% (Coefficient of Performance of 3.2) and that the air source heat pump will replace 100% of the space heating/hot water demand, then the system would reduce the overall $CO_2$ emissions by approximately 60%. The table below demonstrates, on the assumption of a demand of 10,000kWh/year for heating and hot water.

Table 5 – Air Source Heat Pump Performance

| Type of Array | Energy Consumption (kWh/yr.) | Emission factor ($kgCO_2/h$) | Total $CO_2$ emissions (kg/annum) |
|---|---|---|---|
| 90% efficient gas boiler | 11111 | 0.210 | 2333 |
| 320% efficient ASHP | 2813 | 0.136 | 383 |
| 100% efficient immersion (back-up) | 1000 | 0.136 | 136 |

A theoretical carbon saving of 77%

Overall system efficiency is conservatively expected to be around 330% based on the delivery of DHW at higher temperatures. Accordingly, the design team are proposing the use of an individual heat pump systems to service the heating & DHW requirements for the new dwelling.

The use of these highly efficient electrically driven HVAC systems also offer the benefit of having a zero contribution to local environment's nitrous oxide and particulate levels; this is considered to be a significant advantage.

### 6.7 Final Emissions Calculation

Given the outcome of the feasibility study above, the developer is proposing the use of the above noted air source heat pump system for the heating and DHW requirements for the dwelling.

The final table – Table 6 – summarises the final outputs from the SAP models; attached at **Appendix C.**

Table 6 – "Be Green" emission levels

| Unit | Target Emission Rate (regulated energy use) Kg/annum | Unregulated Energy Use Kg/annum | Total baseline emissions Kg |
|---|---|---|---|
| | | | |
| Grove Avenue | 263 | 197 | 460 |
| | | | |
| **Scheme Total** | **263** | **197** | **460** |

The data at Table 6 confirms that overall emissions – including unregulated energy use - have been reduced by **57.3%** over and above the baseline model, with a **45%** reduction in emissions directly from the use of energy generating and renewable technologies, i.e. over and above the energy efficient model.

Excluding the un-regulated use, i.e. considering emissions controlled under AD Part L, then the final reduction in DER/TER equates to **70.1%.**

## 7.0 Sustainable Design & Construction

### 7.1 Domestic Accommodation

The Code for Sustainable Homes (the Code) was the national standard for the sustainable design and construction of new homes.

This was formally withdrawn by DCLG, and planning authorities are no longer able to require developments to meet the technical guidance within the Code for Sustainable Homes

However, the applicants do acknowledge some requirements of the Code, and intend to incorporate the following measures in order to underline the suitability credentials of the proposed development

- Water use - Ensuring that internal wholesome water use will be limited to 105 litres/person/day. A sample Part G internal water use calculation is attached at **Appendix E**.
- SuDs – the existing site is a mix of buildings, hard standing and soft landscaping; with the introduction of new SuDs strategies, surface water run-off will be reduced. A SuDs strategy and report will accompany the application under separate cover.
- Waste and recycling – appropriate internal and external storage space will be provided to ensure that residents can sort, store and dispose of waste and recyclable materials.
- The principle contractor will be required to produce a site waste management plan and sustainable procurement plan, to ensure the use of responsibly sourced materials and to ensure that construction waste sent to landfill is kept to a minimum.
- The contractor will also produce a construction management plan highlighting best practice construction site standards to avoid the potential for air (dust) pollution, ground water pollution or indeed, noise pollution.
- An energy display devices will be provided for the house. These would monitor the electrical consumption and heating fuel to enable enhanced management of utility costs.
- Only appliances with a high EU energy rating to be installed - typically these would be a washer/dryer, a fridge/freezer and a dishwasher.

## 8.0 Conclusions

This report has detailed the baseline energy requirements for the proposed new dwelling at Grove Avenue, the reduction in energy demand as a result of energy efficiency measures and the potential to achieve further $CO_2$ reductions using renewable energy technologies.

The baseline results have shown that if the development was built to a standard to meet only the minimum requirements of current building regulations, the total amount of $CO_2$ emissions would be **1,076Kg/year**.

Following the introduction of passive energy efficiency measures into the development, as detailed in section 4, the total amount of $CO_2$ emissions would be reduced to **946Kg/year**

There is also a requirement to reduce $CO_2$ emissions across the development using renewable or low-carbon energy sources. Therefore, the report has considered the feasibility of the following technologies:

- Wind turbines
- Solar hot water
- Photovoltaic systems
- Biomass heating
- CHP (Combined heat and power)
- Ground & Air source heating

The results of the assessment of suitable technologies relative to the nature, locations and type of development suggest that the most suitable solution to meeting reduction in $CO_2$ emissions would be via the use of heat pump technology for the generation of heating & hot water.

This has been used in the SAP models (reproduced at **Appendix C**) for the development which have also been detailed above in Table 6, which show a final gross emission level of **460Kg/year**, representing a total reduction in emission over the baseline model, taking into account unregulated energy, of **57.3%.**

**In addition, the final SAP outputs at Appendix C demonstrate that the development achieves an overall improvement over the Building Regulations Part L2021 standards for regulated emissions of minimum of 70.1%.**

Tables 7 & 8 Demonstrate how the Grove Avenue project complies with the London Plan requirements and the GLA guidance relating to zero carbon development.

Table 7 – Carbon Emission Reductions – Domestic Buildings

| Key | Tonnes/annum |
|---|---|
| Baseline $CO_2$ emissions (Part L 2021 of the Building Regulations Compliant Development) | 0.9 |
| CO2 emissions after energy demand reduction (be lean) | 0.7 |
| CO2 emissions after energy demand reduction (be lean) AND heat network (be clean) | 0.7 |
| CO2 emissions after energy demand reduction (be lean) AND heat network (be clean) AND renewable energy (be green) | 0.3 |

Table 8 – Regulated Emissions Savings – Domestic Buildings

| | Regulated Carbon Dioxide Savings | |
|---|---|---|
| | (Tonnes CO2 per annum) | % |
| Savings from energy demand reduction | 0.1 | 15 |
| Savings from heat network | 0.0 | 0 |
| Savings from renewable energy | 0.5 | 55 |
| Total Cumulative Savings | **0.6** | **70** |
| | (Tonnes $CO_2$) | |
| Carbon Shortfall | 0.3 | |
| Cumulative savings for off-set payment | 8 | |
| Cash-in-lieu Contribution | **N/A** | |

# Appendix A

**Baseline/Un-regulated Energy Use:-**

**SAP Outputs & Target Emission Rates**

| | | | | | |
|---|---|---|---|---|---|
| **Property Reference** | 1 LEAN Grove Avenue | | | **Issued on Date** | 14/03/2024 |
| **Assessment Reference** | Grove Avenue | | **Prop Type Ref** | | |
| **Property** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **SAP Rating** | 85 B | **DER** | 15.16 | **TER** | 12.91 |
| **Environmental** | 88 B | **% DER < TER** | | | -17.43 |
| **CO₂ Emissions (t/year)** | 0.91 | **DFEE** | 39.18 | **TFEE** | 43.07 |
| **Compliance Check** | See BREL | **% DFEE < TFEE** | | | 9.02 |
| **% DPER < TPER** | -23.50 | **DPER** | 83.67 | **TPER** | 67.75 |
| **Assessor Details** | Mr. Neil Ingham | | | **Assessor ID** | AV35-0001 |
| **Client** | | | | | |

Full SAP Calculation Printout
energy efficiency

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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 (m2) | | Storey height (m) | | Volume (m3) | |
|---|---|---|---|---|---|---|
| Basement floor | 44.3400 (1a) | x | 2.5000 (2a) | = | 110.8500 | (1a) - (3a) |
| Ground floor | 23.7400 (1b) | x | 3.1000 (2b) | = | 73.5940 | (1b) - (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 68.0800 | | | | | (4) |
| Dwelling volume | | | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = | 184.4440 | (5) |

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## 2. Ventilation rate

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| | | 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) = | 0.1084 | (8) |
| Pressure test | | Yes | |
| Pressure Test Method | | Blower Door | |
| Measured/design AP50 | | 4.0000 | (17) |
| Infiltration rate | | 0.3084 | (18) |
| Number of sides sheltered | | 2 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.8500 | (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) = | 0.2622 | (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 | 0.3343 | 0.3277 | 0.3212 | 0.2884 | 0.2818 | 0.2491 | 0.2491 | 0.2425 | 0.2622 | 0.2818 | 0.2949 | 0.3080 | (22b) |
| Effective ac | 0.5559 | 0.5537 | 0.5516 | 0.5416 | 0.5397 | 0.5310 | 0.5310 | 0.5294 | 0.5344 | 0.5397 | 0.5435 | 0.5474 | (25) |

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## 3. Heat losses and heat loss parameter

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| 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 | |
|---|---|---|---|---|---|---|---|---|
| G (Uw = 0.90) | | | 17.4300 | 0.8687 | 15.1419 | | | (27) |
| DOOR | | | 2.0000 | 1.0000 | 2.0000 | | | (26) |
| Opening | | | 2.6600 | 0.8687 | 2.3108 | | | (27a) |
| GF | | | 37.5000 | 0.1200 | 4.5000 | 110.0000 | 4125.0000 | (28a) |
| EW | 150.5700 | 19.4300 | 131.1400 | 0.1300 | 17.0482 | 140.0000 | 18359.6000 | (29a) |
| External Roof 1 | 44.3400 | 2.6600 | 41.6800 | 0.1000 | 4.1680 | 9.0000 | 375.1200 | (30) |
| Total net area of external elements Aum(A, m2) | | | 232.4100 | | | | | (31) |
| Fabric heat loss, W/K = Sum (A x U) | | | (26)...(30) + (32) = | | 45.1689 | | | (33) |
| IS | | | 94.8000 | | | 9.0000 | 853.2000 | (32c) |
| IF | | | 23.7400 | | | 18.0000 | 427.3200 | (32d) |
| IC | | | 23.7400 | | | 9.0000 | 213.6600 | (32e) |

| | | |
|---|---|---|
| Heat capacity Cm = Sum(A x k) | (28)...(30) + (32) + (32a)...(32e) = 24353.9000 | (34) |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K | 357.7247 | (35) |
| Thermal bridges (User defined value 0.050 * total exposed area) | 11.6205 | (36) |
| Point Thermal bridges | (36a) = 0.0000 | |
| Total fabric heat loss | (33) + (36) + (36a) = 56.7894 | (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 | 33.8337 | 33.7016 | 33.5722 | 32.9643 | 32.8505 | 32.3211 | 32.3211 | 32.2230 | 32.5250 | 32.8505 | 33.0806 | 33.3212 | (38) |
| Heat transfer coeff | | | | | | | | | | | | | |
| | 90.6231 | 90.4910 | 90.3616 | 89.7537 | 89.6399 | 89.1105 | 89.1105 | 89.0124 | 89.3144 | 89.6399 | 89.8700 | 90.1106 | (39) |
| Average = Sum(39)m / 12 = | | | | | | | | | | | | 89.7531 | |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HLP | 1.3311 | 1.3292 | 1.3273 | 1.3184 | 1.3167 | 1.3089 | 1.3089 | 1.3075 | 1.3119 | 1.3167 | 1.3201 | 1.3236 | (40) |
| HLP (average) | | | | | | | | | | | | 1.3183 | |
| Days in mont | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |

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4. Water heating energy requirements (kWh/year)

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Full SAP Calculation Printout

Assumed occupancy 2.1986 (42)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage for mixer showers | | | | | | | | | | | | | |
| | 61.0833 | 60.1654 | 58.8277 | 56.2683 | 54.3796 | 52.2733 | 51.0761 | 52.4036 | 53.8588 | 56.1204 | 58.7347 | 60.8493 | (42a) |
| Hot water usage for baths | | | | | | | | | | | | | |
| | 26.3911 | 25.9991 | 25.4472 | 24.4295 | 23.6675 | 22.8225 | 22.3661 | 22.9142 | 23.5109 | 24.4151 | 25.4537 | 26.3018 | (42b) |
| Hot water usage for other uses | | | | | | | | | | | | | |
| | 37.1461 | 35.7953 | 34.4446 | 33.0938 | 31.7430 | 30.3923 | 30.3923 | 31.7430 | 33.0938 | 34.4446 | 35.7953 | 37.1461 | (42c) |
| Average daily hot water use (litres/day) | | | | | | | | | | | | 114.5546 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily hot water use | | | | | | | | | | | | | |
| | 124.6205 | 121.9598 | 118.7194 | 113.7916 | 109.7901 | 105.4881 | 103.8344 | 107.0608 | 110.4636 | 114.9800 | 119.9837 | 124.2972 | (44) |
| Energy conte | 197.3684 | 173.6691 | 182.4674 | 155.7751 | 147.7986 | 129.7099 | 125.5788 | 132.5637 | 136.2126 | 156.0268 | 170.9388 | 194.6194 | (45) |
| Energy content (annual) | | | | | | | | | | Total = Sum(45)m = | | 1902.7285 | |
| Distribution loss (46)m = 0.15 x (45)m | | | | | | | | | | | | | |
| | 29.6053 | 26.0504 | 27.3701 | 23.3663 | 22.1698 | 19.4565 | 18.8368 | 19.8845 | 20.4319 | 23.4040 | 25.6408 | 29.1929 | (46) |
| Water storage loss: | | | | | | | | | | | | | |
| Total storage 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 | (56) |
| If cylinder contains dedicated solar storage | | | | | | | | | | | | | |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (57) |
| Primary 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 | (59) |
| Combi loss | 50.9589 | 46.0274 | 50.9589 | 49.3151 | 50.9589 | 49.3151 | 50.9589 | 50.9589 | 49.3151 | 50.9589 | 49.3151 | 50.9589 | (61) |
| Total heat required for water heating calculated for each month | | | | | | | | | | | | | |
| | 248.3273 | 219.6965 | 233.4263 | 205.0901 | 198.7575 | 179.0250 | 176.5377 | 183.5226 | 185.5277 | 206.9857 | 220.2539 | 245.5783 | (62) |
| WWHRS | -47.1589 | -41.7078 | -43.6740 | -36.1638 | -33.7033 | -28.8402 | -27.0331 | -28.7470 | -29.8392 | -35.1771 | -39.8514 | -46.2856 | (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 | | | | | | | | | | | | | |
| | 201.1683 | 177.9888 | 189.7523 | 168.9264 | 165.0542 | 150.1848 | 149.5046 | 154.7756 | 155.6885 | 171.8086 | 180.4025 | 199.2927 | (64) |
| | | | | | | | | | | Total per year (kWh/year) = Sum(64)m = | | 2064.5473 | (64) |
| 12Total per year (kWh/year) | | | | | | | | | | | | 2065 | (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 | | | | | | | | | | | | | |
| | 78.3647 | 69.2518 | 73.4101 | 64.1240 | 61.8828 | 55.4573 | 54.4947 | 56.8171 | 57.6195 | 64.6186 | 69.1659 | 77.4507 | (65) |

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

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Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 97.2329 | 107.6507 | 97.2329 | 100.4740 | 97.2329 | 100.4740 | 97.2329 | 97.2329 | 100.4740 | 97.2329 | 100.4740 | 97.2329 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 192.7750 | 194.7755 | 189.7345 | 179.0029 | 165.4562 | 152.7242 | 144.2185 | 142.2181 | 147.2590 | 157.9906 | 171.5373 | 184.2693 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | (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) | | | | | | | | | | | | | |
| | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 105.3289 | 103.0533 | 98.6695 | 89.0611 | 83.1757 | 77.0240 | 73.2455 | 76.3671 | 80.0270 | 86.8530 | 96.0638 | 104.1004 | (72) |
| Total internal gains | | | | | | | | | | | | | |
| | 454.3162 | 464.4588 | 444.6163 | 427.5173 | 404.8442 | 386.2016 | 370.6762 | 371.7974 | 383.7394 | 401.0559 | 427.0544 | 444.5819 | (73) |

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6. Solar gains

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| [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 | |
|---|---|---|---|---|---|---|---|
| Southeast | 4.0500 | 36.7938 | 0.6300 | 0.6300 | 0.7700 | 40.9868 | (77) |
| Southwest | 13.3800 | 36.7938 | 0.6300 | 0.6300 | 0.7700 | 135.4084 | (79) |
| North | 2.6600 | 26.0000 | 0.5700 | 0.7000 | 1.0000 | 24.8354 | (82) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains | 201.2305 | 352.0474 | 502.8108 | 652.6674 | 753.9549 | 757.4706 | 726.6323 | 650.4311 | 554.9950 | 395.1228 | 242.8026 | 171.0169 | (83) |
| Total gains | 655.5467 | 816.5062 | 947.4271 | 1080.1848 | 1158.7991 | 1143.6722 | 1097.3086 | 1022.2285 | 938.7344 | 796.1787 | 669.8570 | 615.5988 | (84) |

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7. Mean internal temperature (heating season)

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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 | 74.6496 | 74.7585 | 74.8656 | 75.3726 | 75.4683 | 75.9167 | 75.9167 | 76.0003 | 75.7433 | 75.4683 | 75.2751 | 75.0741 | |
| alpha | 5.9766 | 5.9839 | 5.9910 | 6.0248 | 6.0312 | 6.0611 | 6.0611 | 6.0667 | 6.0496 | 6.0312 | 6.0183 | 6.0049 | |
| util living area | | | | | | | | | | | | | |
| | 0.9962 | 0.9860 | 0.9557 | 0.8599 | 0.6887 | 0.4950 | 0.3569 | 0.3996 | 0.6379 | 0.9159 | 0.9890 | 0.9973 | (86) |
| MIT | 20.2084 | 20.3876 | 20.6000 | 20.8132 | 20.9179 | 20.9451 | 20.9484 | 20.9480 | 20.9336 | 20.7736 | 20.4433 | 20.1739 | (87) |
| Th 2 | 19.8165 | 19.8180 | 19.8195 | 19.8265 | 19.8278 | 19.8339 | 19.8339 | 19.8350 | 19.8315 | 19.8278 | 19.8251 | 19.8224 | (88) |
| util rest of house | | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.9944 | 0.9799 | 0.9375 | 0.8131 | 0.6140 | 0.4067 | 0.2626 | 0.2990 | 0.5389 | 0.8736 | 0.9830 | 0.9961 | (89) |
| MIT 2 | 18.9178 | 19.1447 | 19.4050 | 19.6472 | 19.7428 | 19.7668 | 19.7681 | 19.7692 | 19.7590 | 19.6163 | 19.2230 | 18.8786 | (90) |
| Living area fraction | | | | | | | | | | fLA = Living area / (4) = | | 0.3183 | (91) |
| MIT | 19.3286 | 19.5403 | 19.7854 | 20.0183 | 20.1168 | 20.1419 | 20.1437 | 20.1444 | 20.1329 | 19.9847 | 19.6114 | 19.2909 | (92) |
| Temperature adjustment | | | | | | | | | | | | -0.1500 | |
| adjusted MIT | 19.1786 | 19.3903 | 19.6354 | 19.8683 | 19.9668 | 19.9919 | 19.9937 | 19.9944 | 19.9829 | 19.8347 | 19.4614 | 19.1409 | (93) |

---

8. Space heating requirement

---

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation | 0.9931 | 0.9770 | 0.9341 | 0.8150 | 0.6232 | 0.4188 | 0.2755 | 0.3128 | 0.5522 | 0.8739 | 0.9805 | 0.9950 | (94) |
| Useful gains | 650.9928 | 797.7216 | 884.9543 | 880.3045 | 722.2083 | 479.0152 | 302.3299 | 319.7539 | 518.3971 | 695.7975 | 656.8188 | 612.5445 | (95) |
| [illegible] | [illegible] | [illegible]000 | 6.5000 | 8.9000 | 11.7000 | 14.6000 | 16.6000 | 16.4000 | 14.1000 | 10.6000 | 7.1000 | 4.2000 | (96) |
| | 1348.3428 | 1311.2453 | 1186.9329 | 984.4476 | 741.0378 | 480.4712 | 302.4186 | 319.9451 | 525.4260 | 827.7942 | 1110.9206 | 1346.3345 | (97) |
| Space heating kWh | 518.8284 | 345.0879 | 224.6721 | 74.9830 | 14.0091 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 98.2055 | 326.9533 | 545.9397 | (98a) |
| Space heating requirement - total per year (kWh/year) | | | | | | | | | | | | 2148.6792 | |
| 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 | 518.8284 | 345.0879 | 224.6721 | 74.9830 | 14.0091 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 98.2055 | 326.9533 | 545.9397 | (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) | | | | | | | | | | | | 2148.6792 | |
| Space heating per m2 | | | | | | | | | | | (98c) / (4) = | 31.5611 | (99) |

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

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| | | |
|---|---|---|
| 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 | 518.8284 | 345.0879 | 224.6721 | 74.9830 | 14.0091 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 98.2055 | 326.9533 | 545.9397 | (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) | 562.1110 | 373.8764 | 243.4151 | 81.2384 | 15.1778 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 106.3982 | 354.2289 | 591.4840 | (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 | 201.1683 | 177.9888 | 189.7523 | 168.9264 | 165.0542 | 150.1848 | 149.5046 | 154.7756 | 155.6885 | 171.8086 | 180.4025 | 199.2927 | (64) |
| Efficiency of water heater | | | | | | | | | | | | 79.8000 | (216) |
| (217)m | 88.4298 | 87.6293 | 86.1231 | 83.2667 | 80.6546 | 79.8000 | 79.8000 | 79.8000 | 79.8000 | 83.9343 | 87.4303 | 88.5890 | (217) |
| Fuel for water heating, kWh/month | 227.4893 | 203.1156 | 220.3268 | 202.8739 | 204.6433 | 188.2015 | 187.3491 | 193.9544 | 195.0984 | 204.6943 | 206.3386 | 224.9632 | (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 | 3.4822 | 3.1452 | 3.4822 | 3.3699 | 3.4822 | 3.3699 | 3.4822 | 3.4822 | 3.3699 | 3.4822 | 3.3699 | 3.4822 | (231) |
| Lighting | 18.1825 | 14.5867 | 13.1337 | 9.6223 | 7.4326 | 6.0725 | 6.7802 | 8.8132 | 11.4475 | 15.0197 | 16.9647 | 18.6879 | (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 | 2327.9298 | (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 | 2459.0484 | (219) |
| Space cooling fuel | 0.0000 | (221) |
| Electricity for pumps and fans: | | |
| central heating pump | 41.0000 | (230c) |
| Total electricity for the above, kWh/year | 41.0000 | (231) |
| Electricity for lighting (calculated in Appendix L) | 146.7435 | (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 | 4974.7217 | (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 |
|---|---|---|---|

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| | | | | |
|---|---|---|---|---|
| Space heating - main system 1 | 2327.9298 | 0.2100 | 488.8652 | (261) |
| Total CO2 associated with community systems | | | 0.0000 | (373) |
| Water heating (other fuel) | 2459.0484 | 0.2100 | 516.4002 | (264) |
| Space and water heating | | | 1005.2654 | (265) |
| Pumps, fans and electric keep-hot | 41.0000 | 0.1387 | 5.6872 | (267) |
| Energy for lighting | 146.7435 | 0.1443 | 21.1796 | (268) |
| Total CO2, kg/year | | | 1032.1322 | (272) |
| EPC Dwelling Carbon Dioxide Emission Rate (DER) | | | 15.1600 | (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 | |
|---|---|---|---|---|
| | 2327.9298 | 1.1300 | 2630.5606 | (275) |
| Total CO2 associated with community systems | | | 0.0000 | (473) |
| Water heating (other fuel) | 2459.0484 | 1.1300 | 2778.7247 | (278) |
| Space and water heating | | | 5409.2854 | (279) |
| Pumps, fans and electric keep-hot | 41.0000 | 1.5128 | 62.0248 | (281) |
| Energy for lighting | 146.7435 | 1.5338 | 225.0801 | (282) |
| Total Primary energy kWh/year | | | 5696.3902 | (286) |
| Dwelling Primary energy Rate (DPER) | | | 83.6700 | (287) |

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

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1. Overall dwelling characteristics

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| | Area (m2) | | Storey height (m) | | Volume (m3) | |
|---|---|---|---|---|---|---|
| Basement floor | 44.3400 | (1a) x | 2.5000 | (2a) = | 110.8500 | (1a) - (3a) |
| Ground floor | 23.7400 | (1b) x | 3.1000 | (2b) = | 73.5940 | (1b) - (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 68.0800 | | | | | (4) |
| Dwelling volume | | | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = | | 184.4440 | (5) |

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2. Ventilation rate

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| | | 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) = | 0.1084 | (8) |
| Pressure test | | Yes | |
| Pressure Test Method | | Blower Door | |
| Measured/design AP50 | | 5.0000 | (17) |
| Infiltration rate | | 0.3584 | (18) |
| Number of sides sheltered | | 2 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.8500 | (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) = | 0.3047 | (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 | 0.3885 | 0.3808 | 0.3732 | 0.3351 | 0.3275 | 0.2894 | 0.2894 | 0.2818 | 0.3047 | 0.3275 | 0.3428 | 0.3580 | (22b) |
| Effective ac | 0.5754 | 0.5725 | 0.5696 | 0.5562 | 0.5536 | 0.5419 | 0.5419 | 0.5397 | 0.5464 | 0.5536 | 0.5587 | 0.5641 | (25) |

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3. Heat losses and heat loss parameter

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| 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 | | | 2.0000 | 1.0000 | 2.0000 | | | (26) |
| TER Opening Type (Uw = 1.20) | | | 13.0300 | 1.1450 | 14.9198 | | | (27) |
| Opening | | | 1.9900 | 2.0221 | 4.0239 | | | (27a) |
| GF | | | 37.5000 | 0.1300 | 4.8750 | | | (28a) |
| EW | 150.5700 | 15.0300 | 135.5400 | 0.1800 | 24.3972 | | | (29a) |
| External Roof 1 | 44.3400 | 1.9900 | 42.3500 | 0.1100 | 4.6585 | | | (30) |
| Total net area of external elements Aum(A, m2) | | | 232.4100 | | | | | (31) |
| Fabric heat loss, W/K = Sum (A x U) | | | (26)...(30) + (32) = | | 54.8744 | | | (33) |

| | | | |
|---|---|---|---|
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K | | 357.7247 | (35) |
| List of Thermal Bridges | | | |
| K1 Element | Length 60.0000 | Psi-value 0.0500 | Total 3.0000 |
| E1 Steel lintel with perforated steel base plate | | | |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K) | | 3.0000 | (36) |
| Point Thermal bridges | (36a) = | 0.0000 | |
| Total fabric heat loss | (33) + (36) + (36a) = | 57.8744 | (37) |

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

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Elmhurst Energy

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m | 35.0255 | 34.8472 | 34.6724 | 33.8514 | 33.6978 | 32.9827 | 32.9827 | 32.8503 | 33.2582 | 33.6978 | 34.0085 | 34.3334 | (38) |
| Heat transfer coeff | | | | | | | | | | | | | |
| | 92.8999 | 92.7216 | 92.5468 | 91.7258 | 91.5722 | 90.8572 | 90.8572 | 90.7248 | 91.1326 | 91.5722 | 91.8830 | 92.2078 | (39) |
| Average = Sum(39)m / 12 = | | | | | | | | | | | | 91.7251 | |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HLP | 1.3646 | 1.3620 | 1.3594 | 1.3473 | 1.3451 | 1.3346 | 1.3346 | 1.3326 | 1.3386 | 1.3451 | 1.3496 | 1.3544 | (40) |
| HLP (average) | | | | | | | | | | | | 1.3473 | |
| Days in mont | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |

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4. Water heating energy requirements (kWh/year)

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Assumed occupancy | | | | | | | | | | | | 2.1986 | (42) |
| Hot water usage for mixer showers | | | | | | | | | | | | | |
| | 61.0833 | 60.1654 | 58.8277 | 56.2683 | 54.3796 | 52.2733 | 51.0761 | 52.4036 | 53.8588 | 56.1204 | 58.7347 | 60.8493 | (42a) |
| Hot water usage for baths | | | | | | | | | | | | | |
| | 26.3911 | 25.9991 | 25.4472 | 24.4295 | 23.6675 | 22.8225 | 22.3661 | 22.9142 | 23.5109 | 24.4151 | 25.4537 | 26.3018 | (42b) |
| Hot water usage for other uses | | | | | | | | | | | | | |
| | 37.1461 | 35.7953 | 34.4446 | 33.0938 | 31.7430 | 30.3923 | 30.3923 | 31.7430 | 33.0938 | 34.4446 | 35.7953 | 37.1461 | (42c) |
| Average daily hot water use (litres/day) | | | | | | | | | | | | 114.5546 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily hot water use | | | | | | | | | | | | | |
| | 124.6205 | 121.9598 | 118.7194 | 113.7916 | 109.7901 | 105.4881 | 103.8344 | 107.0608 | 110.4636 | 114.9800 | 119.9837 | 124.2972 | (44) |
| Energy conte | 197.3684 | 173.6691 | 182.4674 | 155.7751 | 147.7986 | 129.7099 | 125.5788 | 132.5637 | 136.2126 | 156.0268 | 170.9388 | 194.6194 | (45) |
| Energy content (annual) | | | | | | | | | | Total = Sum(45)m = | | 1902.7285 | |
| Distribution loss (46)m = 0.15 x (45)m | | | | | | | | | | | | | |
| | 29.6053 | 26.0504 | 27.3701 | 23.3663 | 22.1698 | 19.4565 | 18.8368 | 19.8845 | 20.4319 | 23.4040 | 25.6408 | 29.1929 | (46) |
| Water storage loss: | | | | | | | | | | | | | |
| Total storage 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 | (56) |
| If cylinder contains dedicated solar storage | | | | | | | | | | | | | |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (57) |
| Primary 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 | (59) |
| Combi loss | 50.9589 | 46.0274 | 50.9589 | 49.3151 | 50.9589 | 49.3151 | 50.9589 | 50.9589 | 49.3151 | 50.9589 | 49.3151 | 50.9589 | (61) |
| Total heat required for water heating calculated for each month | | | | | | | | | | | | | |
| | 248.3273 | 219.6965 | 233.4263 | 205.0901 | 198.7575 | 179.0250 | 176.5377 | 183.5226 | 185.5277 | 206.9857 | 220.2539 | 245.5783 | (62) |
| WWHRS | -27.9247 | -24.6969 | -25.8611 | -21.4140 | -19.9571 | -17.0775 | -16.0074 | -17.0223 | -17.6690 | -20.8298 | -23.5976 | -27.4076 | (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 | | | | | | | | | | | | | |
| | 220.4025 | 194.9997 | 207.5651 | 183.6761 | 178.8004 | 161.9475 | 160.5303 | 166.5003 | 167.8587 | 186.1559 | 196.6563 | 218.1707 | (64) |
| | | | | | | | | | | Total per year (kWh/year) = Sum(64)m = | | 2243.2634 | (64) |
| 12Total per year (kWh/year) | | | | | | | | | | | | 2243 | (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 | | | | | | | | | | | | | |
| | 78.3647 | 69.2518 | 73.4101 | 64.1240 | 61.8828 | 55.4573 | 54.4947 | 56.8171 | 57.6195 | 64.6186 | 69.1659 | 77.4507 | (65) |

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

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Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 97.2138 | 107.6296 | 97.2138 | 100.4543 | 97.2138 | 100.4543 | 97.2138 | 97.2138 | 100.4543 | 97.2138 | 100.4543 | 97.2138 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 192.7750 | 194.7755 | 189.7345 | 179.0029 | 165.4562 | 152.7242 | 144.2185 | 142.2181 | 147.2590 | 157.9906 | 171.5373 | 184.2693 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | (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) | | | | | | | | | | | | | |
| | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 105.3289 | 103.0533 | 98.6695 | 89.0611 | 83.1757 | 77.0240 | 73.2455 | 76.3671 | 80.0270 | 86.8530 | 96.0638 | 104.1004 | (72) |
| Total internal gains | | | | | | | | | | | | | |
| | 454.2971 | 464.4377 | 444.5972 | 427.4976 | 404.8251 | 386.1819 | 370.6572 | 371.7784 | 383.7197 | 401.0368 | 427.0347 | 444.5628 | (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 | |
|---|---|---|---|---|---|---|---|
| Southeast | 3.0300 | 36.7938 | 0.6300 | 0.7000 | 0.7700 | 34.0714 | (77) |
| Southwest | 10.0000 | 36.7938 | 0.6300 | 0.7000 | 0.7700 | 112.4467 | (79) |
| North | 1.9900 | 26.0000 | 0.6300 | 0.7000 | 1.0000 | 20.5356 | (82) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains | 167.0537 | 292.2254 | 417.3025 | 541.5834 | 625.5646 | 628.4561 | 602.8805 | 539.7007 | 460.5798 | 327.9619 | 201.5593 | 141.9754 | (83) |
| Total gains | 621.3508 | 756.6631 | 861.8997 | 969.0810 | 1030.3897 | 1014.6380 | 973.5377 | 911.4791 | 844.2995 | 728.9986 | 628.5941 | 586.5382 | (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 | 72.8200 | 72.9600 | 73.0978 | 73.7521 | 73.8758 | 74.4572 | 74.4572 | 74.5659 | 74.2322 | 73.8758 | 73.6260 | 73.3666 | |
| alpha | 5.8547 | 5.8640 | 5.8732 | 5.9168 | 5.9251 | 5.9638 | 5.9638 | 5.9711 | 5.9488 | 5.9251 | 5.9084 | 5.8911 | |
| util living area | | | | | | | | | | | | | |
| | 0.9972 | 0.9907 | 0.9721 | 0.9066 | 0.7632 | 0.5641 | 0.4094 | 0.4555 | 0.7070 | 0.9429 | 0.9922 | 0.9980 | (86) |
| MIT | 19.9366 | 20.1516 | 20.4243 | 20.7354 | 20.9254 | 20.9895 | 20.9987 | 20.9975 | 20.9634 | 20.6968 | 20.2528 | 19.8987 | (87) |
| Th 2 | 19.7906 | 19.7926 | 19.7946 | 19.8039 | 19.8057 | 19.8139 | 19.8139 | 19.8154 | 19.8107 | 19.8057 | 19.8022 | 19.7985 | (88) |
| util rest of house | | | | | | | | | | | | | |

Full SAP Calculation Printout
Elmhurst Energy

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.9958 | 0.9865 | 0.9595 | 0.8686 | 0.6882 | 0.4642 | 0.2998 | 0.3396 | 0.6026 | 0.9099 | 0.9879 | 0.9970 | (89) |
| MIT 2 | 18.5893 | 18.8633 | 19.2034 | 19.5714 | 19.7570 | 19.8099 | 19.8136 | 19.8149 | 19.7936 | 19.5419 | 19.0008 | 18.5469 | (90) |
| Living area fraction | | | | | | | | | fLA = Living area / (4) = | | | 0.3183 | (91) |
| MIT | 19.0182 | 19.2733 | 19.5921 | 19.9419 | 20.1289 | 20.1854 | 20.1908 | 20.1913 | 20.1660 | 19.9095 | 19.3993 | 18.9772 | (92) |
| Temperature adjustment | | | | | | | | | | | | 0.0000 | |
| adjusted MIT | 19.0182 | 19.2733 | 19.5921 | 19.9419 | 20.1289 | 20.1854 | 20.1908 | 20.1913 | 20.1660 | 19.9095 | 19.3993 | 18.9772 | (93) |

---

8. Space heating requirement

---

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation | 0.9946 | 0.9840 | 0.9568 | 0.8736 | 0.7098 | 0.4961 | 0.3348 | 0.3767 | 0.6355 | 0.9134 | 0.9859 | 0.9960 | (94) |
| Useful gains | 617.9878 | 744.5833 | 824.6565 | 846.5983 | 731.4193 | 503.3657 | 325.9326 | 343.3308 | 536.5864 | 665.8512 | 619.7225 | 584.2015 | (95) |
| [illegible] | [illegible] | [illegible] | 6.5000 | 8.9000 | 11.7000 | 14.6000 | 16.6000 | 16.4000 | 14.1000 | 10.6000 | 7.1000 | 4.2000 | (96) |
| [illegible] | 1367.3157 | 1332.7193 | 1211.6290 | 1012.8275 | 771.8558 | 507.4699 | 326.2524 | 343.9677 | 552.8086 | 852.4913 | 1130.1000 | 1362.5695 | (97) |
| Space heating kWh | 557.5000 | 395.2274 | 287.9075 | 119.6850 | 30.0848 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 138.8603 | 367.4718 | 579.1058 | (98a) |
| Space heating requirement - total per year (kWh/year) | | | | | | | | | | | | 2475.8426 | |
| 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 | 557.5000 | 395.2274 | 287.9075 | 119.6850 | 30.0848 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 138.8603 | 367.4718 | 579.1058 | (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) | | | | | | | | | | | | 2475.8426 | |
| Space heating per m2 | | | | | | | | | | | (98c) / (4) = | 36.3667 | (99) |

---

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

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 %) | | | | | | | | | | | | 92.4000 | (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 | 557.5000 | 395.2274 | 287.9075 | 119.6850 | 30.0848 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 138.8603 | 367.4718 | 579.1058 | (98) |
| Space heating efficiency (main heating system 1) | 92.4000 | 92.4000 | 92.4000 | 92.4000 | 92.4000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 92.4000 | 92.4000 | 92.4000 | (210) |
| Space heating fuel (main heating system) | 603.3550 | 427.7353 | 311.5882 | 129.5292 | 32.5593 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 150.2817 | 397.6968 | 626.7379 | (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 | 220.4025 | 194.9997 | 207.5651 | 183.6761 | 178.8004 | 161.9475 | 160.5303 | 166.5003 | 167.8587 | 186.1559 | 196.6563 | 218.1707 | (64) |
| Efficiency of water heater | | | | | | | | | | | | 80.3000 | (216) |
| (217)m | 86.2819 | 85.8619 | 85.0827 | 83.4863 | 81.4346 | 80.3000 | 80.3000 | 80.3000 | 80.3000 | 83.7619 | 85.7004 | 86.3688 | (217) |
| Fuel for water heating, kWh/month | 255.4448 | 227.1084 | 243.9570 | 220.0074 | 219.5631 | 201.6781 | 199.9132 | 207.3478 | 209.0395 | 222.2441 | 229.4695 | 252.6036 | (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 | 20.1991 | 16.2045 | 14.5903 | 10.6895 | 8.2569 | 6.7459 | 7.5322 | 9.7906 | 12.7171 | 16.6855 | 18.8462 | 20.7605 | (232) |
| Electricity generated by PVs (Appendix M) (negative quantity) | | | | | | | | | | | | | |
| (233a)m | -39.1032 | -53.9554 | -75.9473 | -83.5948 | -88.6950 | -82.3092 | -81.3024 | -77.4481 | -70.4400 | -60.8509 | -42.5754 | -33.9478 | (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 | -25.8193 | -53.8371 | -106.1301 | -158.1482 | -207.9106 | -208.4429 | -205.9715 | -174.9255 | -128.9386 | -76.5445 | -34.3259 | -20.4520 | (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 | | | | | | | | | | | | 2679.4833 | (211) |
| Space heating fuel - main system 2 | | | | | | | | | | | | 0.0000 | (213) |
| Space heating fuel - secondary | | | | | | | | | | | | 0.0000 | (215) |
| Efficiency of water heater | | | | | | | | | | | | 80.3000 | |
| Water heating fuel used | | | | | | | | | | | | 2688.3765 | (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) | | | | | | | | | | | | 163.0184 | (232) |
| Energy saving/generation technologies (Appendices M ,N and Q) | | | | | | | | | | | | | |
| PV generation | | | | | | | | | | | | -2191.6156 | (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 | | | | | | | | | | | | 3425.2626 | (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 | 2679.4833 | 0.2100 | 562.6915 | (261) |

| | | | | |
|---|---|---|---|---|
| Total CO2 associated with community systems | | | 0.0000 | (373) |
| Water heating (other fuel) | 2688.3765 | 0.2100 | 564.5591 | (264) |
| Space and water heating | | | 1127.2506 | (265) |
| Pumps, fans and electric keep-hot | 86.0000 | 0.1387 | 11.9293 | (267) |
| Energy for lighting | 163.0184 | 0.1443 | 23.5286 | (268) |
| | | | | |
| Energy saving/generation technologies | | | | |
| PV Unit electricity used in dwelling | -790.1695 | 0.1350 | -106.6961 | |
| PV Unit electricity exported | -1401.4461 | 0.1261 | -176.7684 | |
| Total | | | -283.4645 | (269) |
| Total CO2, kg/year | | | 879.2439 | (272) |
| EPC Target Carbon Dioxide Emission Rate (TER) | | | 12.9100 | (273) |

Full SAP Calculation Printout energyhelpline

1 heating systems including micro-CHP

| | Energy kWh/year | Primary energy factor kg CO2/kWh | Primary energy kWh/year | |
|---|---|---|---|---|
| Space heating - main system 1 | 2679.4833 | 1.1300 | 3027.8162 | (275) |
| Total CO2 associated with community systems | | | 0.0000 | (473) |
| Water heating (other fuel) | 2688.3765 | 1.1300 | 3037.8654 | (278) |
| Space and water heating | | | 6065.6816 | (279) |
| Pumps, fans and electric keep-hot | 86.0000 | 1.5128 | 130.1008 | (281) |
| Energy for lighting | 163.0184 | 1.5338 | 250.0430 | (282) |
| | | | | |
| Energy saving/generation technologies | | | | |
| PV Unit electricity used in dwelling | -790.1695 | 1.4991 | -1184.5193 | |
| PV Unit electricity exported | -1401.4461 | 0.4630 | -648.8773 | |
| Total | | | -1833.3966 | (283) |
| Total Primary energy kWh/year | | | 4612.4287 | (286) |
| Target Primary Energy Rate (TPER) | | | 67.7500 | (287) |

# Appendix B

**Energy Efficient Design:-**

**SAP Outputs & Dwelling Emission Rates**

# Full SAP Calculation Printout

| | | | |
|---|---|---|---|
| **Property Reference** | 1 LEAN Grove Avenue | **Issued on Date** | 14/03/2024 |
| **Assessment Reference** | Grove Avenue | **Prop Type Ref** | |
| **Property** | | | |

| | | | | | |
|---|---|---|---|---|---|
| **SAP Rating** | 85 B | **DER** | 15.16 | **TER** | 12.91 |
| **Environmental** | 88 B | **% DER < TER** | | | -17.43 |
| **$CO_2$ Emissions (t/year)** | 0.91 | **DFEE** | 39.18 | **TFEE** | 43.07 |
| **Compliance Check** | See BREL | **% DFEE < TFEE** | | | 9.02 |
| **% DPER < TPER** | -23.50 | **DPER** | 83.67 | **TPER** | 67.75 |

| | | | |
|---|---|---|---|
| **Assessor Details** | Mr. Neil Ingham | **Assessor ID** | AV35-0001 |
| **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 (m2) | | Storey height (m) | | Volume (m3) | |
|---|---|---|---|---|---|---|
| Basement floor | 44.3400 | (1a) | x 2.5000 | (2a) = | 110.8500 | (1a) - (3a) |
| Ground floor | 23.7400 | (1b) | x 3.1000 | (2b) = | 73.5940 | (1b) - (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 68.0800 | | | | | (4) |
| Dwelling volume | | | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = | | 184.4440 | (5) |

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2. Ventilation rate

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| | 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) = | 0.1084 (8) |
| Pressure test | | Yes |
| Pressure Test Method | | Blower Door |
| Measured/design AP50 | | 4.0000 (17) |
| Infiltration rate | | 0.3084 (18) |
| Number of sides sheltered | | 2 (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.8500 (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) = | 0.2622 (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 | 0.3343 | 0.3277 | 0.3212 | 0.2884 | 0.2818 | 0.2491 | 0.2491 | 0.2425 | 0.2622 | 0.2818 | 0.2949 | 0.3080 | (22b) |
| Effective ac | 0.5559 | 0.5537 | 0.5516 | 0.5416 | 0.5397 | 0.5310 | 0.5310 | 0.5294 | 0.5344 | 0.5397 | 0.5435 | 0.5474 | (25) |

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3. Heat losses and heat loss parameter

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| 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 | |
|---|---|---|---|---|---|---|---|---|
| G (Uw = 0.90) | | | 17.4300 | 0.8687 | 15.1419 | | | (27) |
| DOOR | | | 2.0000 | 1.0000 | 2.0000 | | | (26) |
| Opening | | | 2.6600 | 0.8687 | 2.3108 | | | (27a) |
| GF | | | 37.5000 | 0.1200 | 4.5000 | 110.0000 | 4125.0000 | (28a) |
| EW | 150.5700 | 19.4300 | 131.1400 | 0.1300 | 17.0482 | 140.0000 | 18359.6000 | (29a) |
| External Roof 1 | 44.3400 | 2.6600 | 41.6800 | 0.1000 | 4.1680 | 9.0000 | 375.1200 | (30) |
| Total net area of external elements Aum(A, m2) | | | 232.4100 | | | | | (31) |
| Fabric heat loss, W/K = Sum (A x U) | | | (26)...(30) + (32) = | | 45.1689 | | | (33) |
| IS | | | 94.8000 | | | 9.0000 | 853.2000 | (32c) |
| IF | | | 23.7400 | | | 18.0000 | 427.3200 | (32d) |
| IC | | | 23.7400 | | | 9.0000 | 213.6600 | (32e) |

| | | |
|---|---|---|
| Heat capacity Cm = Sum(A x k) | (28)...(30) + (32) + (32a)...(32e) = | 24353.9000 (34) |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K | | 357.7247 (35) |
| Thermal bridges (User defined value 0.050 * total exposed area) | | 11.6205 (36) |
| Point Thermal bridges | (36a) = | 0.0000 |
| Total fabric heat loss | (33) + (36) + (36a) = | 56.7894 (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 | 33.8337 | 33.7016 | 33.5722 | 32.9643 | 32.8505 | 32.3211 | 32.3211 | 32.2230 | 32.5250 | 32.8505 | 33.0806 | 33.3212 | (38) |
| Heat transfer coeff | | | | | | | | | | | | | |
| | 90.6231 | 90.4910 | 90.3616 | 89.7537 | 89.6399 | 89.1105 | 89.1105 | 89.0124 | 89.3144 | 89.6399 | 89.8700 | 90.1106 | (39) |
| Average = Sum(39)m / 12 = | | | | | | | | | | | | 89.7531 | |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HLP | 1.3311 | 1.3292 | 1.3273 | 1.3184 | 1.3167 | 1.3089 | 1.3089 | 1.3075 | 1.3119 | 1.3167 | 1.3201 | 1.3236 | (40) |
| HLP (average) | | | | | | | | | | | | 1.3183 | |
| Days in mont | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |

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4. Water heating energy requirements (kWh/year)

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Full SAP Calculation Printout

Assumed occupancy 2.1986 (42)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage for mixer showers | | | | | | | | | | | | | |
| | 61.0833 | 60.1654 | 58.8277 | 56.2683 | 54.3796 | 52.2733 | 51.0761 | 52.4036 | 53.8588 | 56.1204 | 58.7347 | 60.8493 | (42a) |
| Hot water usage for baths | | | | | | | | | | | | | |
| | 26.3911 | 25.9991 | 25.4472 | 24.4295 | 23.6675 | 22.8225 | 22.3661 | 22.9142 | 23.5109 | 24.4151 | 25.4537 | 26.3018 | (42b) |
| Hot water usage for other uses | | | | | | | | | | | | | |
| | 37.1461 | 35.7953 | 34.4446 | 33.0938 | 31.7430 | 30.3923 | 30.3923 | 31.7430 | 33.0938 | 34.4446 | 35.7953 | 37.1461 | (42c) |
| Average daily hot water use (litres/day) | | | | | | | | | | | | 114.5546 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily hot water use | | | | | | | | | | | | | |
| | 124.6205 | 121.9598 | 118.7194 | 113.7916 | 109.7901 | 105.4881 | 103.8344 | 107.0608 | 110.4636 | 114.9800 | 119.9837 | 124.2972 | (44) |
| Energy conte | 197.3684 | 173.6691 | 182.4674 | 155.7751 | 147.7986 | 129.7099 | 125.5788 | 132.5637 | 136.2126 | 156.0268 | 170.9388 | 194.6194 | (45) |
| Energy content (annual) | | | | | | | | | | Total = Sum(45)m = | | 1902.7285 | |
| Distribution loss (46)m = 0.15 x (45)m | | | | | | | | | | | | | |
| | 29.6053 | 26.0504 | 27.3701 | 23.3663 | 22.1698 | 19.4565 | 18.8368 | 19.8845 | 20.4319 | 23.4040 | 25.6408 | 29.1929 | (46) |
| Water storage loss: | | | | | | | | | | | | | |
| Total storage 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 | (56) |
| If cylinder contains dedicated solar storage | | | | | | | | | | | | | |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (57) |
| Primary 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 | (59) |
| Combi loss | 50.9589 | 46.0274 | 50.9589 | 49.3151 | 50.9589 | 49.3151 | 50.9589 | 50.9589 | 49.3151 | 50.9589 | 49.3151 | 50.9589 | (61) |
| Total heat required for water heating calculated for each month | | | | | | | | | | | | | |
| | 248.3273 | 219.6965 | 233.4263 | 205.0901 | 198.7575 | 179.0250 | 176.5377 | 183.5226 | 185.5277 | 206.9857 | 220.2539 | 245.5783 | (62) |
| WWHRS | -47.1589 | -41.7078 | -43.6740 | -36.1638 | -33.7033 | -28.8402 | -27.0331 | -28.7470 | -29.8392 | -35.1771 | -39.8514 | -46.2856 | (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 | | | | | | | | | | | | | |
| | 201.1683 | 177.9888 | 189.7523 | 168.9264 | 165.0542 | 150.1848 | 149.5046 | 154.7756 | 155.6885 | 171.8086 | 180.4025 | 199.2927 | (64) |
| | | | | | | | | | | Total per year (kWh/year) = Sum(64)m = | | 2064.5473 | (64) |
| 12Total per year (kWh/year) | | | | | | | | | | | | 2065 | (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 | | | | | | | | | | | | | |
| | 78.3647 | 69.2518 | 73.4101 | 64.1240 | 61.8828 | 55.4573 | 54.4947 | 56.8171 | 57.6195 | 64.6186 | 69.1659 | 77.4507 | (65) |

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

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Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 97.2329 | 107.6507 | 97.2329 | 100.4740 | 97.2329 | 100.4740 | 97.2329 | 97.2329 | 100.4740 | 97.2329 | 100.4740 | 97.2329 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 192.7750 | 194.7755 | 189.7345 | 179.0029 | 165.4562 | 152.7242 | 144.2185 | 142.2181 | 147.2590 | 157.9906 | 171.5373 | 184.2693 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | (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) | | | | | | | | | | | | | |
| | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 105.3289 | 103.0533 | 98.6695 | 89.0611 | 83.1757 | 77.0240 | 73.2455 | 76.3671 | 80.0270 | 86.8530 | 96.0638 | 104.1004 | (72) |
| Total internal gains | | | | | | | | | | | | | |
| | 454.3162 | 464.4588 | 444.6163 | 427.5173 | 404.8442 | 386.2016 | 370.6762 | 371.7974 | 383.7394 | 401.0559 | 427.0544 | 444.5819 | (73) |

---

6. Solar gains

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| [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 | |
|---|---|---|---|---|---|---|---|
| Southeast | 4.0500 | 36.7938 | 0.6300 | 0.6300 | 0.7700 | 40.9868 | (77) |
| Southwest | 13.3800 | 36.7938 | 0.6300 | 0.6300 | 0.7700 | 135.4084 | (79) |
| North | 2.6600 | 26.0000 | 0.5700 | 0.7000 | 1.0000 | 24.8354 | (82) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains | 201.2305 | 352.0474 | 502.8108 | 652.6674 | 753.9549 | 757.4706 | 726.6323 | 650.4311 | 554.9950 | 395.1228 | 242.8026 | 171.0169 | (83) |
| Total gains | 655.5467 | 816.5062 | 947.4271 | 1080.1848 | 1158.7991 | 1143.6722 | 1097.3086 | 1022.2285 | 938.7344 | 796.1787 | 669.8570 | 615.5988 | (84) |

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7. Mean internal temperature (heating season)

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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 | 74.6496 | 74.7585 | 74.8656 | 75.3726 | 75.4683 | 75.9167 | 75.9167 | 76.0003 | 75.7433 | 75.4683 | 75.2751 | 75.0741 | |
| alpha | 5.9766 | 5.9839 | 5.9910 | 6.0248 | 6.0312 | 6.0611 | 6.0611 | 6.0667 | 6.0496 | 6.0312 | 6.0183 | 6.0049 | |
| util living area | | | | | | | | | | | | | |
| | 0.9962 | 0.9860 | 0.9557 | 0.8599 | 0.6887 | 0.4950 | 0.3569 | 0.3996 | 0.6379 | 0.9159 | 0.9890 | 0.9973 | (86) |
| MIT | 20.2084 | 20.3876 | 20.6000 | 20.8132 | 20.9179 | 20.9451 | 20.9484 | 20.9480 | 20.9336 | 20.7736 | 20.4433 | 20.1739 | (87) |
| Th 2 | 19.8165 | 19.8180 | 19.8195 | 19.8265 | 19.8278 | 19.8339 | 19.8339 | 19.8350 | 19.8315 | 19.8278 | 19.8251 | 19.8224 | (88) |
| util rest of house | | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.9944 | 0.9799 | 0.9375 | 0.8131 | 0.6140 | 0.4067 | 0.2626 | 0.2990 | 0.5389 | 0.8736 | 0.9830 | 0.9961 | (89) |
| MIT 2 | 18.9178 | 19.1447 | 19.4050 | 19.6472 | 19.7428 | 19.7668 | 19.7681 | 19.7692 | 19.7590 | 19.6163 | 19.2230 | 18.8786 | (90) |
| Living area fraction | | | | | | | | | | fLA = Living area / (4) = | | 0.3183 | (91) |
| MIT | 19.3286 | 19.5403 | 19.7854 | 20.0183 | 20.1168 | 20.1419 | 20.1437 | 20.1444 | 20.1329 | 19.9847 | 19.6114 | 19.2909 | (92) |
| Temperature adjustment | | | | | | | | | | | | -0.1500 | |
| adjusted MIT | 19.1786 | 19.3903 | 19.6354 | 19.8683 | 19.9668 | 19.9919 | 19.9937 | 19.9944 | 19.9829 | 19.8347 | 19.4614 | 19.1409 | (93) |

---

8. Space heating requirement

---

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation | 0.9931 | 0.9770 | 0.9341 | 0.8150 | 0.6232 | 0.4188 | 0.2755 | 0.3128 | 0.5522 | 0.8739 | 0.9805 | 0.9950 | (94) |
| Useful gains | 650.9928 | 797.7216 | 884.9543 | 880.3045 | 722.2083 | 479.0152 | 302.3299 | 319.7539 | 518.3971 | 695.7975 | 656.8188 | 612.5445 | (95) |
| [illegible] | [illegible] | [illegible]000 | 6.5000 | 8.9000 | 11.7000 | 14.6000 | 16.6000 | 16.4000 | 14.1000 | 10.6000 | 7.1000 | 4.2000 | (96) |
| | 1348.3428 | 1311.2453 | 1186.9329 | 984.4476 | 741.0378 | 480.4712 | 302.4186 | 319.9451 | 525.4260 | 827.7942 | 1110.9206 | 1346.3345 | (97) |
| Space heating kWh | 518.8284 | 345.0879 | 224.6721 | 74.9830 | 14.0091 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 98.2055 | 326.9533 | 545.9397 | (98a) |
| Space heating requirement - total per year (kWh/year) | | | | | | | | | | | | 2148.6792 | |
| 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 | 518.8284 | 345.0879 | 224.6721 | 74.9830 | 14.0091 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 98.2055 | 326.9533 | 545.9397 | (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) | | | | | | | | | | | | 2148.6792 | |
| Space heating per m2 | | | | | | | | | | | (98c) / (4) = | 31.5611 | (99) |

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

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| | | |
|---|---|---|
| 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 | 518.8284 | 345.0879 | 224.6721 | 74.9830 | 14.0091 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 98.2055 | 326.9533 | 545.9397 | (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) | 562.1110 | 373.8764 | 243.4151 | 81.2384 | 15.1778 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 106.3982 | 354.2289 | 591.4840 | (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 | 201.1683 | 177.9888 | 189.7523 | 168.9264 | 165.0542 | 150.1848 | 149.5046 | 154.7756 | 155.6885 | 171.8086 | 180.4025 | 199.2927 | (64) |
| Efficiency of water heater | | | | | | | | | | | | 79.8000 | (216) |
| (217)m | 88.4298 | 87.6293 | 86.1231 | 83.2667 | 80.6546 | 79.8000 | 79.8000 | 79.8000 | 79.8000 | 83.9343 | 87.4303 | 88.5890 | (217) |
| Fuel for water heating, kWh/month | 227.4893 | 203.1156 | 220.3268 | 202.8739 | 204.6433 | 188.2015 | 187.3491 | 193.9544 | 195.0984 | 204.6943 | 206.3386 | 224.9632 | (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 | 3.4822 | 3.1452 | 3.4822 | 3.3699 | 3.4822 | 3.3699 | 3.4822 | 3.4822 | 3.3699 | 3.4822 | 3.3699 | 3.4822 | (231) |
| Lighting | 18.1825 | 14.5867 | 13.1337 | 9.6223 | 7.4326 | 6.0725 | 6.7802 | 8.8132 | 11.4475 | 15.0197 | 16.9647 | 18.6879 | (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 | 2327.9298 | (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 | 2459.0484 | (219) |
| Space cooling fuel | 0.0000 | (221) |
| Electricity for pumps and fans: | | |
| central heating pump | 41.0000 | (230c) |
| Total electricity for the above, kWh/year | 41.0000 | (231) |
| Electricity for lighting (calculated in Appendix L) | 146.7435 | (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 | 4974.7217 | (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 |
|---|---|---|---|

Full SAP Calculation Printout
energyhelper

| | | | | |
|---|---|---|---|---|
| Space heating - main system 1 | 2327.9298 | 0.2100 | 488.8652 | (261) |
| Total CO2 associated with community systems | | | 0.0000 | (373) |
| Water heating (other fuel) | 2459.0484 | 0.2100 | 516.4002 | (264) |
| Space and water heating | | | 1005.2654 | (265) |
| Pumps, fans and electric keep-hot | 41.0000 | 0.1387 | 5.6872 | (267) |
| Energy for lighting | 146.7435 | 0.1443 | 21.1796 | (268) |
| Total CO2, kg/year | | | 1032.1322 | (272) |
| EPC Dwelling Carbon Dioxide Emission Rate (DER) | | | 15.1600 | (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 | |
|---|---|---|---|---|
| | 2327.9298 | 1.1300 | 2630.5606 | (275) |
| Total CO2 associated with community systems | | | 0.0000 | (473) |
| Water heating (other fuel) | 2459.0484 | 1.1300 | 2778.7247 | (278) |
| Space and water heating | | | 5409.2854 | (279) |
| Pumps, fans and electric keep-hot | 41.0000 | 1.5128 | 62.0248 | (281) |
| Energy for lighting | 146.7435 | 1.5338 | 225.0801 | (282) |
| Total Primary energy kWh/year | | | 5696.3902 | (286) |
| Dwelling Primary energy Rate (DPER) | | | 83.6700 | (287) |

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

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1. Overall dwelling characteristics

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| | Area (m2) | | Storey height (m) | | Volume (m3) | |
|---|---|---|---|---|---|---|
| Basement floor | 44.3400 | (1a) x | 2.5000 | (2a) = | 110.8500 | (1a) - (3a) |
| Ground floor | 23.7400 | (1b) x | 3.1000 | (2b) = | 73.5940 | (1b) - (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 68.0800 | | | | | (4) |
| Dwelling volume | | | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = | | 184.4440 | (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 | 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) = | 0.1084 | (8) |
| Pressure test | | Yes | |
| Pressure Test Method | | Blower Door | |
| Measured/design AP50 | | 5.0000 | (17) |
| Infiltration rate | | 0.3584 | (18) |
| Number of sides sheltered | | 2 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.8500 | (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) = | 0.3047 | (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 | 0.3885 | 0.3808 | 0.3732 | 0.3351 | 0.3275 | 0.2894 | 0.2894 | 0.2818 | 0.3047 | 0.3275 | 0.3428 | 0.3580 | (22b) |
| Effective ac | 0.5754 | 0.5725 | 0.5696 | 0.5562 | 0.5536 | 0.5419 | 0.5419 | 0.5397 | 0.5464 | 0.5536 | 0.5587 | 0.5641 | (25) |

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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 | | | 2.0000 | 1.0000 | 2.0000 | | | (26) |
| TER Opening Type (Uw = 1.20) | | | 13.0300 | 1.1450 | 14.9198 | | | (27) |
| Opening | | | 1.9900 | 2.0221 | 4.0239 | | | (27a) |
| GF | | | 37.5000 | 0.1300 | 4.8750 | | | (28a) |
| EW | 150.5700 | 15.0300 | 135.5400 | 0.1800 | 24.3972 | | | (29a) |
| External Roof 1 | 44.3400 | 1.9900 | 42.3500 | 0.1100 | 4.6585 | | | (30) |
| Total net area of external elements Aum(A, m2) | | | 232.4100 | | | | | (31) |
| Fabric heat loss, W/K = Sum (A x U) | | | (26)...(30) + (32) = | | 54.8744 | | | (33) |

| | | | |
|---|---|---|---|
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K | | 357.7247 | (35) |
| List of Thermal Bridges | | | |
| K1 Element | Length 60.0000 | Psi-value 0.0500 | Total 3.0000 |
| E1 Steel lintel with perforated steel base plate | | | |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K) | | 3.0000 | (36) |
| Point Thermal bridges | (36a) = | 0.0000 | |
| Total fabric heat loss | (33) + (36) + (36a) = | 57.8744 | (37) |

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

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| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m | 35.0255 | 34.8472 | 34.6724 | 33.8514 | 33.6978 | 32.9827 | 32.9827 | 32.8503 | 33.2582 | 33.6978 | 34.0085 | 34.3334 | (38) |
| Heat transfer coeff | | | | | | | | | | | | | |
| | 92.8999 | 92.7216 | 92.5468 | 91.7258 | 91.5722 | 90.8572 | 90.8572 | 90.7248 | 91.1326 | 91.5722 | 91.8830 | 92.2078 | (39) |
| Average = Sum(39)m / 12 = | | | | | | | | | | | | 91.7251 | |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HLP | 1.3646 | 1.3620 | 1.3594 | 1.3473 | 1.3451 | 1.3346 | 1.3346 | 1.3326 | 1.3386 | 1.3451 | 1.3496 | 1.3544 | (40) |
| HLP (average) | | | | | | | | | | | | 1.3473 | |
| Days in mont | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |

---

4. Water heating energy requirements (kWh/year)

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Assumed occupancy | | | | | | | | | | | | 2.1986 | (42) |
| Hot water usage for mixer showers | | | | | | | | | | | | | |
| | 61.0833 | 60.1654 | 58.8277 | 56.2683 | 54.3796 | 52.2733 | 51.0761 | 52.4036 | 53.8588 | 56.1204 | 58.7347 | 60.8493 | (42a) |
| Hot water usage for baths | | | | | | | | | | | | | |
| | 26.3911 | 25.9991 | 25.4472 | 24.4295 | 23.6675 | 22.8225 | 22.3661 | 22.9142 | 23.5109 | 24.4151 | 25.4537 | 26.3018 | (42b) |
| Hot water usage for other uses | | | | | | | | | | | | | |
| | 37.1461 | 35.7953 | 34.4446 | 33.0938 | 31.7430 | 30.3923 | 30.3923 | 31.7430 | 33.0938 | 34.4446 | 35.7953 | 37.1461 | (42c) |
| Average daily hot water use (litres/day) | | | | | | | | | | | | 114.5546 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily hot water use | | | | | | | | | | | | | |
| | 124.6205 | 121.9598 | 118.7194 | 113.7916 | 109.7901 | 105.4881 | 103.8344 | 107.0608 | 110.4636 | 114.9800 | 119.9837 | 124.2972 | (44) |
| Energy conte | 197.3684 | 173.6691 | 182.4674 | 155.7751 | 147.7986 | 129.7099 | 125.5788 | 132.5637 | 136.2126 | 156.0268 | 170.9388 | 194.6194 | (45) |
| Energy content (annual) | | | | | | | | | | Total = Sum(45)m = | | 1902.7285 | |
| Distribution loss (46)m = 0.15 x (45)m | | | | | | | | | | | | | |
| | 29.6053 | 26.0504 | 27.3701 | 23.3663 | 22.1698 | 19.4565 | 18.8368 | 19.8845 | 20.4319 | 23.4040 | 25.6408 | 29.1929 | (46) |
| Water storage loss: | | | | | | | | | | | | | |
| Total storage 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 | (56) |
| If cylinder contains dedicated solar storage | | | | | | | | | | | | | |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (57) |
| Primary 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 | (59) |
| Combi loss | 50.9589 | 46.0274 | 50.9589 | 49.3151 | 50.9589 | 49.3151 | 50.9589 | 50.9589 | 49.3151 | 50.9589 | 49.3151 | 50.9589 | (61) |
| Total heat required for water heating calculated for each month | | | | | | | | | | | | | |
| | 248.3273 | 219.6965 | 233.4263 | 205.0901 | 198.7575 | 179.0250 | 176.5377 | 183.5226 | 185.5277 | 206.9857 | 220.2539 | 245.5783 | (62) |
| WWHRS | -27.9247 | -24.6969 | -25.8611 | -21.4140 | -19.9571 | -17.0775 | -16.0074 | -17.0223 | -17.6690 | -20.8298 | -23.5976 | -27.4076 | (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 | | | | | | | | | | | | | |
| | 220.4025 | 194.9997 | 207.5651 | 183.6761 | 178.8004 | 161.9475 | 160.5303 | 166.5003 | 167.8587 | 186.1559 | 196.6563 | 218.1707 | (64) |
| | | | | | | | | | | Total per year (kWh/year) = Sum(64)m = | | 2243.2634 | (64) |
| 12Total per year (kWh/year) | | | | | | | | | | | | 2243 | (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 | | | | | | | | | | | | | |
| | 78.3647 | 69.2518 | 73.4101 | 64.1240 | 61.8828 | 55.4573 | 54.4947 | 56.8171 | 57.6195 | 64.6186 | 69.1659 | 77.4507 | (65) |

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

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Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 97.2138 | 107.6296 | 97.2138 | 100.4543 | 97.2138 | 100.4543 | 97.2138 | 97.2138 | 100.4543 | 97.2138 | 100.4543 | 97.2138 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 192.7750 | 194.7755 | 189.7345 | 179.0029 | 165.4562 | 152.7242 | 144.2185 | 142.2181 | 147.2590 | 157.9906 | 171.5373 | 184.2693 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | (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) | | | | | | | | | | | | | |
| | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 105.3289 | 103.0533 | 98.6695 | 89.0611 | 83.1757 | 77.0240 | 73.2455 | 76.3671 | 80.0270 | 86.8530 | 96.0638 | 104.1004 | (72) |
| Total internal gains | | | | | | | | | | | | | |
| | 454.2971 | 464.4377 | 444.5972 | 427.4976 | 404.8251 | 386.1819 | 370.6572 | 371.7784 | 383.7197 | 401.0368 | 427.0347 | 444.5628 | (73) |

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6. Solar gains

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| [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 | |
|---|---|---|---|---|---|---|---|
| Southeast | 3.0300 | 36.7938 | 0.6300 | 0.7000 | 0.7700 | 34.0714 | (77) |
| Southwest | 10.0000 | 36.7938 | 0.6300 | 0.7000 | 0.7700 | 112.4467 | (79) |
| North | 1.9900 | 26.0000 | 0.6300 | 0.7000 | 1.0000 | 20.5356 | (82) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains | 167.0537 | 292.2254 | 417.3025 | 541.5834 | 625.5646 | 628.4561 | 602.8805 | 539.7007 | 460.5798 | 327.9619 | 201.5593 | 141.9754 | (83) |
| Total gains | 621.3508 | 756.6631 | 861.8997 | 969.0810 | 1030.3897 | 1014.6380 | 973.5377 | 911.4791 | 844.2995 | 728.9986 | 628.5941 | 586.5382 | (84) |

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7. Mean internal temperature (heating season)

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 72.8200 | 72.9600 | 73.0978 | 73.7521 | 73.8758 | 74.4572 | 74.4572 | 74.5659 | 74.2322 | 73.8758 | 73.6260 | 73.3666 | |
| alpha | 5.8547 | 5.8640 | 5.8732 | 5.9168 | 5.9251 | 5.9638 | 5.9638 | 5.9711 | 5.9488 | 5.9251 | 5.9084 | 5.8911 | |
| util living area | | | | | | | | | | | | | |
| | 0.9972 | 0.9907 | 0.9721 | 0.9066 | 0.7632 | 0.5641 | 0.4094 | 0.4555 | 0.7070 | 0.9429 | 0.9922 | 0.9980 | (86) |
| MIT | 19.9366 | 20.1516 | 20.4243 | 20.7354 | 20.9254 | 20.9895 | 20.9987 | 20.9975 | 20.9634 | 20.6968 | 20.2528 | 19.8987 | (87) |
| Th 2 | 19.7906 | 19.7926 | 19.7946 | 19.8039 | 19.8057 | 19.8139 | 19.8139 | 19.8154 | 19.8107 | 19.8057 | 19.8022 | 19.7985 | (88) |
| util rest of house | | | | | | | | | | | | | |

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.9958 | 0.9865 | 0.9595 | 0.8686 | 0.6882 | 0.4642 | 0.2998 | 0.3396 | 0.6026 | 0.9099 | 0.9879 | 0.9970 | (89) |
| MIT 2 | 18.5893 | 18.8633 | 19.2034 | 19.5714 | 19.7570 | 19.8099 | 19.8136 | 19.8149 | 19.7936 | 19.5419 | 19.0008 | 18.5469 | (90) |
| Living area fraction | | | | | | | | | fLA = Living area / (4) = | | | 0.3183 | (91) |
| MIT | 19.0182 | 19.2733 | 19.5921 | 19.9419 | 20.1289 | 20.1854 | 20.1908 | 20.1913 | 20.1660 | 19.9095 | 19.3993 | 18.9772 | (92) |
| Temperature adjustment | | | | | | | | | | | | 0.0000 | |
| adjusted MIT | 19.0182 | 19.2733 | 19.5921 | 19.9419 | 20.1289 | 20.1854 | 20.1908 | 20.1913 | 20.1660 | 19.9095 | 19.3993 | 18.9772 | (93) |

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8. Space heating requirement

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| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation | 0.9946 | 0.9840 | 0.9568 | 0.8736 | 0.7098 | 0.4961 | 0.3348 | 0.3767 | 0.6355 | 0.9134 | 0.9859 | 0.9960 | (94) |
| Useful gains | 617.9878 | 744.5833 | 824.6565 | 846.5983 | 731.4193 | 503.3657 | 325.9326 | 343.3308 | 536.5864 | 665.8512 | 619.7225 | 584.2015 | (95) |
| [illegible] | [illegible] | [illegible] | 6.5000 | 8.9000 | 11.7000 | 14.6000 | 16.6000 | 16.4000 | 14.1000 | 10.6000 | 7.1000 | 4.2000 | (96) |
| [illegible] | 1367.3157 | 1332.7193 | 1211.6290 | 1012.8275 | 771.8558 | 507.4699 | 326.2524 | 343.9677 | 552.8086 | 852.4913 | 1130.1000 | 1362.5695 | (97) |
| Space heating kWh | 557.5000 | 395.2274 | 287.9075 | 119.6850 | 30.0848 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 138.8603 | 367.4718 | 579.1058 | (98a) |
| Space heating requirement - total per year (kWh/year) | | | | | | | | | | | | 2475.8426 | |
| 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 | 557.5000 | 395.2274 | 287.9075 | 119.6850 | 30.0848 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 138.8603 | 367.4718 | 579.1058 | (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) | | | | | | | | | | | | 2475.8426 | |
| Space heating per m2 | | | | | | | | | | | (98c) / (4) = | 36.3667 | (99) |

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

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 %) | | | | | | | | | | | | 92.4000 | (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 | 557.5000 | 395.2274 | 287.9075 | 119.6850 | 30.0848 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 138.8603 | 367.4718 | 579.1058 | (98) |
| Space heating efficiency (main heating system 1) | 92.4000 | 92.4000 | 92.4000 | 92.4000 | 92.4000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 92.4000 | 92.4000 | 92.4000 | (210) |
| Space heating fuel (main heating system) | 603.3550 | 427.7353 | 311.5882 | 129.5292 | 32.5593 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 150.2817 | 397.6968 | 626.7379 | (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 | 220.4025 | 194.9997 | 207.5651 | 183.6761 | 178.8004 | 161.9475 | 160.5303 | 166.5003 | 167.8587 | 186.1559 | 196.6563 | 218.1707 | (64) |
| Efficiency of water heater | | | | | | | | | | | | 80.3000 | (216) |
| (217)m | 86.2819 | 85.8619 | 85.0827 | 83.4863 | 81.4346 | 80.3000 | 80.3000 | 80.3000 | 80.3000 | 83.7619 | 85.7004 | 86.3688 | (217) |
| Fuel for water heating, kWh/month | 255.4448 | 227.1084 | 243.9570 | 220.0074 | 219.5631 | 201.6781 | 199.9132 | 207.3478 | 209.0395 | 222.2441 | 229.4695 | 252.6036 | (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 | 20.1991 | 16.2045 | 14.5903 | 10.6895 | 8.2569 | 6.7459 | 7.5322 | 9.7906 | 12.7171 | 16.6855 | 18.8462 | 20.7605 | (232) |
| Electricity generated by PVs (Appendix M) (negative quantity) | | | | | | | | | | | | | |
| (233a)m | -39.1032 | -53.9554 | -75.9473 | -83.5948 | -88.6950 | -82.3092 | -81.3024 | -77.4481 | -70.4400 | -60.8509 | -42.5754 | -33.9478 | (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 | -25.8193 | -53.8371 | -106.1301 | -158.1482 | -207.9106 | -208.4429 | -205.9715 | -174.9255 | -128.9386 | -76.5445 | -34.3259 | -20.4520 | (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 | | | | | | | | | | | | 2679.4833 | (211) |
| Space heating fuel - main system 2 | | | | | | | | | | | | 0.0000 | (213) |
| Space heating fuel - secondary | | | | | | | | | | | | 0.0000 | (215) |
| Efficiency of water heater | | | | | | | | | | | | 80.3000 | |
| Water heating fuel used | | | | | | | | | | | | 2688.3765 | (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) | | | | | | | | | | | | 163.0184 | (232) |
| Energy saving/generation technologies (Appendices M ,N and Q) | | | | | | | | | | | | | |
| PV generation | | | | | | | | | | | | -2191.6156 | (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 | | | | | | | | | | | | 3425.2626 | (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 | 2679.4833 | 0.2100 | 562.6915 | (261) |

| | | | | |
|---|---|---|---|---|
| Total CO2 associated with community systems | | | 0.0000 | (373) |
| Water heating (other fuel) | 2688.3765 | 0.2100 | 564.5591 | (264) |
| Space and water heating | | | 1127.2506 | (265) |
| Pumps, fans and electric keep-hot | 86.0000 | 0.1387 | 11.9293 | (267) |
| Energy for lighting | 163.0184 | 0.1443 | 23.5286 | (268) |
| | | | | |
| Energy saving/generation technologies | | | | |
| PV Unit electricity used in dwelling | -790.1695 | 0.1350 | -106.6961 | |
| PV Unit electricity exported | -1401.4461 | 0.1261 | -176.7684 | |
| Total | | | -283.4645 | (269) |
| Total CO2, kg/year | | | 879.2439 | (272) |
| EPC Target Carbon Dioxide Emission Rate (TER) | | | 12.9100 | (273) |

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1 heating systems including micro-CHP

| | Energy kWh/year | Primary energy factor kg CO2/kWh | Primary energy kWh/year | |
|---|---|---|---|---|
| Space heating - main system 1 | 2679.4833 | 1.1300 | 3027.8162 | (275) |
| Total CO2 associated with community systems | | | 0.0000 | (473) |
| Water heating (other fuel) | 2688.3765 | 1.1300 | 3037.8654 | (278) |
| Space and water heating | | | 6065.6816 | (279) |
| Pumps, fans and electric keep-hot | 86.0000 | 1.5128 | 130.1008 | (281) |
| Energy for lighting | 163.0184 | 1.5338 | 250.0430 | (282) |
| | | | | |
| Energy saving/generation technologies | | | | |
| PV Unit electricity used in dwelling | -790.1695 | 1.4991 | -1184.5193 | |
| PV Unit electricity exported | -1401.4461 | 0.4630 | -648.8773 | |
| Total | | | -1833.3966 | (283) |
| Total Primary energy kWh/year | | | 4612.4287 | (286) |
| Target Primary Energy Rate (TPER) | | | 67.7500 | (287) |

# Appendix C

**Generating energy on-site:-**

**SAP Outputs Dwelling Emission Rates**

| | | | | | |
|---|---|---|---|---|---|
| **Property Reference** | 2 GREEN Grove Avenue | | | **Issued on Date** | 14/03/2024 |
| **Assessment Reference** | Grove Avenue | | **Prop Type Ref** | | |
| **Property** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **SAP Rating** | 85 B | **DER** | 3.87 | **TER** | 12.37 |
| **Environmental** | 97 A | **% DER < TER** | | | 68.71 |
| **CO₂ Emissions (t/year)** | 0.23 | **DFEE** | 39.18 | **TFEE** | 43.07 |
| **Compliance Check** | See BREL | **% DFEE < TFEE** | | | 9.02 |
| **% DPER < TPER** | 37.80 | **DPER** | 40.32 | **TPER** | 64.82 |

| | | | |
|---|---|---|---|
| **Assessor Details** | Mr. Neil Ingham | **Assessor ID** | AV35-0001 |
| **Client** | | | |

Full SAP Calculation Print out
energy efficiency

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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 (m2) | | Storey height (m) | | Volume (m3) | |
|---|---|---|---|---|---|---|
| Basement floor | 44.3400 (1a) | x | 2.5000 (2a) | = | 110.8500 | (1a) - (3a) |
| Ground floor | 23.7400 (1b) | x | 3.1000 (2b) | = | 73.5940 | (1b) - (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 68.0800 | | | | | (4) |
| Dwelling volume | | | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = | 184.4440 | (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) = | 0.1084 | (8) |
| Pressure test | | Yes | |
| Pressure Test Method | | Blower Door | |
| Measured/design AP50 | | 4.0000 | (17) |
| Infiltration rate | | 0.3084 | (18) |
| Number of sides sheltered | | 2 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.8500 | (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) = | 0.2622 | (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 | 0.3343 | 0.3277 | 0.3212 | 0.2884 | 0.2818 | 0.2491 | 0.2491 | 0.2425 | 0.2622 | 0.2818 | 0.2949 | 0.3080 | (22b) |
| Effective ac | 0.5559 | 0.5537 | 0.5516 | 0.5416 | 0.5397 | 0.5310 | 0.5310 | 0.5294 | 0.5344 | 0.5397 | 0.5435 | 0.5474 | (25) |

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3. Heat losses and heat loss parameter

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| 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 | |
|---|---|---|---|---|---|---|---|---|
| G (Uw = 0.90) | | | 17.4300 | 0.8687 | 15.1419 | | | (27) |
| DOOR | | | 2.0000 | 1.0000 | 2.0000 | | | (26) |
| Opening | | | 2.6600 | 0.8687 | 2.3108 | | | (27a) |
| GF | | | 37.5000 | 0.1200 | 4.5000 | 110.0000 | 4125.0000 | (28a) |
| EW | 150.5700 | 19.4300 | 131.1400 | 0.1300 | 17.0482 | 140.0000 | 18359.6000 | (29a) |
| External Roof 1 | 44.3400 | 2.6600 | 41.6800 | 0.1000 | 4.1680 | 9.0000 | 375.1200 | (30) |
| Total net area of external elements Aum(A, m2) | | | 232.4100 | | | | | (31) |
| Fabric heat loss, W/K = Sum (A x U) | | | (26)...(30) + (32) = | | 45.1689 | | | (33) |
| IS | | | 94.8000 | | | 9.0000 | 853.2000 | (32c) |
| IF | | | 23.7400 | | | 18.0000 | 427.3200 | (32d) |
| IC | | | 23.7400 | | | 9.0000 | 213.6600 | (32e) |

| | | |
|---|---|---|
| Heat capacity Cm = Sum(A x k) | (28)...(30) + (32) + (32a)...(32e) = | 24353.9000 (34) |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K | | 357.7247 (35) |
| Thermal bridges (User defined value 0.050 * total exposed area) | | 11.6205 (36) |
| Point Thermal bridges | (36a) = | 0.0000 |
| Total fabric heat loss | (33) + (36) + (36a) = | 56.7894 (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 | 33.8337 | 33.7016 | 33.5722 | 32.9643 | 32.8505 | 32.3211 | 32.3211 | 32.2230 | 32.5250 | 32.8505 | 33.0806 | 33.3212 | (38) |
| Heat transfer coeff | | | | | | | | | | | | | |
| | 90.6231 | 90.4910 | 90.3616 | 89.7537 | 89.6399 | 89.1105 | 89.1105 | 89.0124 | 89.3144 | 89.6399 | 89.8700 | 90.1106 | (39) |
| Average = Sum(39)m / 12 = | | | | | | | | | | | | 89.7531 | |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HLP | 1.3311 | 1.3292 | 1.3273 | 1.3184 | 1.3167 | 1.3089 | 1.3089 | 1.3075 | 1.3119 | 1.3167 | 1.3201 | 1.3236 | (40) |
| HLP (average) | | | | | | | | | | | | 1.3183 | |
| Days in mont | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |

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4. Water heating energy requirements (kWh/year)

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Assumed occupancy 2.1986 (42)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage for mixer showers | | | | | | | | | | | | | |
| | 61.0833 | 60.1654 | 58.8277 | 56.2683 | 54.3796 | 52.2733 | 51.0761 | 52.4036 | 53.8588 | 56.1204 | 58.7347 | 60.8493 | (42a) |
| Hot water usage for baths | | | | | | | | | | | | | |
| | 26.3911 | 25.9991 | 25.4472 | 24.4295 | 23.6675 | 22.8225 | 22.3661 | 22.9142 | 23.5109 | 24.4151 | 25.4537 | 26.3018 | (42b) |
| Hot water usage for other uses | | | | | | | | | | | | | |
| | 37.1461 | 35.7953 | 34.4446 | 33.0938 | 31.7430 | 30.3923 | 30.3923 | 31.7430 | 33.0938 | 34.4446 | 35.7953 | 37.1461 | (42c) |
| Average daily hot water use (litres/day) | | | | | | | | | | | | 114.5546 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily hot water use | | | | | | | | | | | | | |
| | 124.6205 | 121.9598 | 118.7194 | 113.7916 | 109.7901 | 105.4881 | 103.8344 | 107.0608 | 110.4636 | 114.9800 | 119.9837 | 124.2972 | (44) |
| Energy conte | 197.3684 | 173.6691 | 182.4674 | 155.7751 | 147.7986 | 129.7099 | 125.5788 | 132.5637 | 136.2126 | 156.0268 | 170.9388 | 194.6194 | (45) |
| Energy content (annual) | | | | | | | | | | Total = Sum(45)m = | | 1902.7285 | |
| Distribution loss (46)m = 0.15 x (45)m | | | | | | | | | | | | | |
| | 29.6053 | 26.0504 | 27.3701 | 23.3663 | 22.1698 | 19.4565 | 18.8368 | 19.8845 | 20.4319 | 23.4040 | 25.6408 | 29.1929 | (46) |
| Water storage loss: | | | | | | | | | | | | | |
| Store volume | | | | | | | | | | | | 170.0000 | (47) |
| a) If manufacturer declared loss factor is known (kWh/day): | | | | | | | | | | | | 1.5600 | (48) |
| Temperature factor from Table 2b | | | | | | | | | | | | 0.5400 | (49) |
| Enter (49) or (54) in (55) | | | | | | | | | | | | 0.8424 | (55) |
| Total storage loss | | | | | | | | | | | | | |
| | 26.1144 | 23.5872 | 26.1144 | 25.2720 | 26.1144 | 25.2720 | 26.1144 | 26.1144 | 25.2720 | 26.1144 | 25.2720 | 26.1144 | (56) |
| If cylinder contains dedicated solar storage | | | | | | | | | | | | | |
| | 26.1144 | 23.5872 | 26.1144 | 25.2720 | 26.1144 | 25.2720 | 26.1144 | 26.1144 | 25.2720 | 26.1144 | 25.2720 | 26.1144 | (57) |
| Primary 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 | (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 | | | | | | | | | | | | | |
| | 223.4828 | 197.2563 | 208.5818 | 181.0471 | 173.9130 | 154.9819 | 151.6932 | 158.6781 | 161.4846 | 182.1412 | 196.2108 | 220.7338 | (62) |
| WWHRS | -47.1589 | -41.7078 | -43.6740 | -36.1638 | -33.7033 | -28.8402 | -27.0331 | -28.7470 | -29.8392 | -35.1771 | -39.8514 | -46.2856 | (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 | | | | | | | | | | | | | |
| | 176.3238 | 155.5486 | 164.9078 | 144.8833 | 140.2097 | 126.1417 | 124.6601 | 129.9311 | 131.6455 | 146.9641 | 156.3595 | 174.4482 | (64) |
| | | | | | | | | | | Total per year (kWh/year) = Sum(64)m = | | 1772.0233 | (64) |
| 12Total per year (kWh/year) | | | | | | | | | | | | 1772 | (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 | | | | | | | | | | | | | |
| | 65.6250 | 57.7450 | 60.6704 | 51.7952 | 49.1430 | 43.1285 | 41.7549 | 44.0774 | 45.2907 | 51.8789 | 56.8372 | 64.7110 | (65) |

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

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Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 97.2329 | 107.6507 | 97.2329 | 100.4740 | 97.2329 | 100.4740 | 97.2329 | 97.2329 | 100.4740 | 97.2329 | 100.4740 | 97.2329 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 192.7750 | 194.7755 | 189.7345 | 179.0029 | 165.4562 | 152.7242 | 144.2185 | 142.2181 | 147.2590 | 157.9906 | 171.5373 | 184.2693 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | (69) |
| Pumps, fans | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (70) |
| Losses e.g. evaporation (negative values) (Table 5) | | | | | | | | | | | | | |
| | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 88.2056 | 85.9300 | 81.5462 | 71.9378 | 66.0525 | 59.9007 | 56.1222 | 59.2438 | 62.9037 | 69.7297 | 78.9405 | 86.9771 | (72) |
| Total internal gains | | | | | | | | | | | | | |
| | 434.1929 | 444.3355 | 424.4930 | 407.3940 | 384.7209 | 369.0783 | 353.5530 | 354.6742 | 366.6161 | 380.9326 | 406.9311 | 424.4586 | (73) |

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6. Solar gains

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| [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 | |
|---|---|---|---|---|---|---|---|
| Southeast | 4.0500 | 36.7938 | 0.6300 | 0.6300 | 0.7700 | 40.9868 | (77) |
| Southwest | 13.3800 | 36.7938 | 0.6300 | 0.6300 | 0.7700 | 135.4084 | (79) |
| North | 2.6600 | 26.0000 | 0.5700 | 0.7000 | 1.0000 | 24.8354 | (82) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains | 201.2305 | 352.0474 | 502.8108 | 652.6674 | 753.9549 | 757.4706 | 726.6323 | 650.4311 | 554.9950 | 395.1228 | 242.8026 | 171.0169 | (83) |
| Total gains | 635.4235 | 796.3829 | 927.3038 | 1060.0615 | 1138.6758 | 1126.5489 | 1080.1853 | 1005.1052 | 921.6111 | 776.0554 | 649.7337 | 595.4755 | (84) |

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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 | 74.6496 | 74.7585 | 74.8656 | 75.3726 | 75.4683 | 75.9167 | 75.9167 | 76.0003 | 75.7433 | 75.4683 | 75.2751 | 75.0741 | |
| alpha | 5.9766 | 5.9839 | 5.9910 | 6.0248 | 6.0312 | 6.0611 | 6.0611 | 6.0667 | 6.0496 | 6.0312 | 6.0183 | 6.0049 | |
| util living area | | | | | | | | | | | | | |
| | 0.9967 | 0.9876 | 0.9595 | 0.8678 | 0.6985 | 0.5022 | 0.3625 | 0.4063 | 0.6481 | 0.9235 | 0.9905 | 0.9978 | (86) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Living | 20.1915 | 20.3716 | 20.5865 | 20.8054 | 20.9155 | 20.9448 | 20.9483 | 20.9479 | 20.9323 | 20.7628 | 20.4270 | 20.1568 | |
| Non living | 18.8963 | 19.1249 | 19.3894 | 19.6398 | 19.7412 | 19.7667 | 19.7681 | 19.7691 | 19.7584 | 19.6054 | 19.2028 | 18.8569 | |
| 24 / 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24 / 9 | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |
| 16 / 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| MIT | 21.0000 | 21.0000 | 21.0000 | 21.0000 | 21.0000 | 21.0000 | 21.0000 | 21.0000 | 21.0000 | 21.0000 | 21.0000 | 21.0000 | (87) |
| Th 2 | 19.8165 | 19.8180 | 19.8195 | 19.8265 | 19.8278 | 19.8339 | 19.8339 | 19.8350 | 19.8315 | 19.8278 | 19.8251 | 19.8224 | (88) |
| util rest of house | | | | | | | | | | | | | |
| | 0.9952 | 0.9821 | 0.9426 | 0.8222 | 0.6235 | 0.4128 | 0.2667 | 0.3040 | 0.5483 | 0.8836 | 0.9853 | 0.9967 | (89) |
| MIT 2 | 19.8165 | 19.8180 | 19.8195 | 19.8265 | 19.8278 | 19.8339 | 19.8339 | 19.8350 | 19.8315 | 19.8278 | 19.8251 | 19.8224 | (90) |
| Living area fraction | | | | | | | | | fLA = Living area / (4) = | | | 0.3183 | (91) |
| MIT | 20.1932 | 20.1943 | 20.1953 | 20.2000 | 20.2009 | 20.2050 | 20.2050 | 20.2058 | 20.2034 | 20.2009 | 20.1991 | 20.1972 | (92) |
| Temperature adjustment | | | | | | | | | | | | 0.0000 | |
| adjusted MIT | 20.1932 | 20.1943 | 20.1953 | 20.2000 | 20.2009 | 20.2050 | 20.2050 | 20.2058 | 20.2034 | 20.2009 | 20.1991 | 20.1972 | (93) |



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8. Space heating requirement

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| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation | 0.9958 | 0.9841 | 0.9487 | 0.8380 | 0.6483 | 0.4416 | 0.2973 | 0.3367 | 0.5812 | 0.8981 | 0.9873 | 0.9971 | (94) |
| Useful gains | 632.7458 | 783.7321 | 879.7219 | 888.3404 | 738.2498 | 497.4525 | 321.1023 | 338.4583 | 535.5993 | 696.9762 | 641.4661 | 593.7429 | (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 | | | | | | | | | | | | | |
| | 1440.2935 | 1383.9934 | 1237.5266 | 1014.2180 | 762.0206 | 499.4683 | 321.2473 | 338.7647 | 545.1261 | 860.6245 | 1177.2172 | 1441.5197 | (97) |
| Space heating kWh | | | | | | | | | | | | | |
| | 600.8155 | 403.3756 | 266.2067 | 90.6319 | 17.6854 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 121.7544 | 385.7408 | 630.7459 | (98a) |
| Space heating requirement - total per year (kWh/year) | | | | | | | | | | | | 2516.9563 | |
| 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 | | | | | | | | | | | | | |
| | 600.8155 | 403.3756 | 266.2067 | 90.6319 | 17.6854 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 121.7544 | 385.7408 | 630.7459 | (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) | | | | | | | | | | | | 2516.9563 | |
| Space heating per m2 | | | | | | | | | | | (98c) / (4) = | 36.9706 | (99) |

---

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

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| | | |
|---|---|---|
| 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 %) | 306.7628 | (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 | | | | | | | | | | | | | |
| | 600.8155 | 403.3756 | 266.2067 | 90.6319 | 17.6854 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 121.7544 | 385.7408 | 630.7459 | (98) |
| Space heating efficiency (main heating system 1) | | | | | | | | | | | | | |
| | 306.7628 | 306.7628 | 306.7628 | 306.7628 | 306.7628 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 306.7628 | 306.7628 | 306.7628 | (210) |
| Space heating fuel (main heating system) | | | | | | | | | | | | | |
| | 195.8567 | 131.4943 | 86.7793 | 29.5446 | 5.7652 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 39.6901 | 125.7456 | 205.6136 | (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 | | | | | | | | | | | | | |
| | 176.3238 | 155.5486 | 164.9078 | 144.8833 | 140.2097 | 126.1417 | 124.6601 | 129.9311 | 131.6455 | 146.9641 | 156.3595 | 174.4482 | (64) |
| Efficiency of water heater | | | | | | | | | | | | 220.6850 | (216) |
| (217)m | 220.6850 | 220.6850 | 220.6850 | 220.6850 | 220.6850 | 220.6850 | 220.6850 | 220.6850 | 220.6850 | 220.6850 | 220.6850 | 220.6850 | (217) |
| Fuel for water heating, kWh/month | | | | | | | | | | | | | |
| | 79.8984 | 70.4844 | 74.7254 | 65.6516 | 63.5338 | 57.1592 | 56.4878 | 58.8763 | 59.6531 | 66.5945 | 70.8519 | 79.0485 | (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 | 18.1825 | 14.5867 | 13.1337 | 9.6223 | 7.4326 | 6.0725 | 6.7802 | 8.8132 | 11.4475 | 15.0197 | 16.9647 | 18.6879 | (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 | 820.4895 | (211) |
| Space heating fuel - main system 2 | 0.0000 | (213) |
| Space heating fuel - secondary | 0.0000 | (215) |
| Efficiency of water heater | 220.6850 | |
| Water heating fuel used | 802.9650 | (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) | 146.7435 | (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 | 1770.1980 | (238) |

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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 | 820.4895 | 0.1574 | 129.1273 | (261) |
| Total CO2 associated with community systems | | | 0.0000 | (373) |
| Water heating (other fuel) | 802.9650 | 0.1409 | 113.1501 | (264) |
| Space and water heating | | | 242.2774 | (265) |
| Pumps, fans and electric keep-hot | 0.0000 | 0.0000 | 0.0000 | (267) |
| Energy for lighting | 146.7435 | 0.1443 | 21.1796 | (268) |
| Total CO2, kg/year | | | 263.4570 | (272) |
| EPC Dwelling Carbon Dioxide Emission Rate (DER) | | | 3.8700 | (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 | 820.4895 | 1.5826 | 1298.4888 | (275) |
| Total CO2 associated with community systems | | | 0.0000 | (473) |
| Water heating (other fuel) | 802.9650 | 1.5211 | 1221.3531 | (278) |
| Space and water heating | | | 2519.8419 | (279) |
| Pumps, fans and electric keep-hot | 0.0000 | 0.0000 | 0.0000 | (281) |
| Energy for lighting | 146.7435 | 1.5338 | 225.0801 | (282) |
| Total Primary energy kWh/year | | | 2744.9220 | (286) |
| Dwelling Primary energy Rate (DPER) | | | 40.3200 | (287) |

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

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1. Overall dwelling characteristics

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| | Area (m2) | | Storey height (m) | | Volume (m3) | |
|---|---|---|---|---|---|---|
| Basement floor | 44.3400 (1a) | x | 2.5000 (2a) | = | 110.8500 | (1a) - (3a) |
| Ground floor | 23.7400 (1b) | x | 3.1000 (2b) | = | 73.5940 | (1b) - (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 68.0800 | | | | | (4) |
| Dwelling volume | | | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = | 184.4440 | (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 | 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) = | 0.1084 | (8) |
| Pressure test | | Yes | |
| Pressure Test Method | | Blower Door | |
| Measured/design AP50 | | 5.0000 | (17) |
| Infiltration rate | | 0.3584 | (18) |
| Number of sides sheltered | | 2 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.8500 | (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) = | 0.3047 | (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 | 0.3885 | 0.3808 | 0.3732 | 0.3351 | 0.3275 | 0.2894 | 0.2894 | 0.2818 | 0.3047 | 0.3275 | 0.3428 | 0.3580 | (22b) |
| Effective ac | 0.5754 | 0.5725 | 0.5696 | 0.5562 | 0.5536 | 0.5419 | 0.5419 | 0.5397 | 0.5464 | 0.5536 | 0.5587 | 0.5641 | (25) |

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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 | | | 2.0000 | 1.0000 | 2.0000 | | | (26) |
| TER Opening Type (Uw = 1.20) | | | 13.0300 | 1.1450 | 14.9198 | | | (27) |
| Opening | | | 1.9900 | 2.0221 | 4.0239 | | | (27a) |
| GF | | | 37.5000 | 0.1300 | 4.8750 | | | (28a) |
| EW | 150.5700 | 15.0300 | 135.5400 | 0.1800 | 24.3972 | | | (29a) |
| External Roof 1 | 44.3400 | 1.9900 | 42.3500 | 0.1100 | 4.6585 | | | (30) |
| Total net area of external elements Aum(A, m2) | | | 232.4100 | | | | | (31) |
| Fabric heat loss, W/K = Sum (A x U) | | | (26)...(30) + (32) = | | 54.8744 | | | (33) |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K | | | | | | | 357.7247 | (35) |

List of Thermal Bridges

| | Length | Psi-value | Total | |
|---|---|---|---|---|
| K1 Element | | | | |
| E1 Steel lintel with perforated steel base plate | 60.0000 | 0.0500 | 3.0000 | |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K) | | | 3.0000 | (36) |
| Point Thermal bridges | | (36a) = | 0.0000 | |
| Total fabric heat loss | | (33) + (36) + (36a) = | 57.8744 | (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 | 35.0255 | 34.8472 | 34.6724 | 33.8514 | 33.6978 | 32.9827 | 32.9827 | 32.8503 | 33.2582 | 33.6978 | 34.0085 | 34.3334 | (38) |
| Heat transfer coeff | 92.8999 | 92.7216 | 92.5468 | 91.7258 | 91.5722 | 90.8572 | 90.8572 | 90.7248 | 91.1326 | 91.5722 | 91.8830 | 92.2078 | (39) |
| Average = Sum(39)m / 12 = | | | | | | | | | | | | 91.7251 | |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HLP | 1.3646 | 1.3620 | 1.3594 | 1.3473 | 1.3451 | 1.3346 | 1.3346 | 1.3326 | 1.3386 | 1.3451 | 1.3496 | 1.3544 | (40) |
| | | | | | | | | | | | | 1.3473 | |
| Days in month | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |

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4. Water heating energy requirements (kWh/year)

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Assumed occupancy | | | | | | | | | | | | 2.1986 | (42) |
| Hot water usage for mixer showers | 61.0833 | 60.1654 | 58.8277 | 56.2683 | 54.3796 | 52.2733 | 51.0761 | 52.4036 | 53.8588 | 56.1204 | 58.7347 | 60.8493 | (42a) |
| Hot water usage for baths | 26.3911 | 25.9991 | 25.4472 | 24.4295 | 23.6675 | 22.8225 | 22.3661 | 22.9142 | 23.5109 | 24.4151 | 25.4537 | 26.3018 | (42b) |
| Hot water usage for other uses | 37.1461 | 35.7953 | 34.4446 | 33.0938 | 31.7430 | 30.3923 | 30.3923 | 31.7430 | 33.0938 | 34.4446 | 35.7953 | 37.1461 | (42c) |
| Average daily hot water use (litres/day) | | | | | | | | | | | | 114.5546 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily hot water use | 124.6205 | 121.9598 | 118.7194 | 113.7916 | 109.7901 | 105.4881 | 103.8344 | 107.0608 | 110.4636 | 114.9800 | 119.9837 | 124.2972 | (44) |
| Energy conte | 197.3684 | 173.6691 | 182.4674 | 155.7751 | 147.7986 | 129.7099 | 125.5788 | 132.5637 | 136.2126 | 156.0268 | 170.9388 | 194.6194 | (45) |
| Energy content (annual) | | | | | | | | | | Total = Sum(45)m = | | 1902.7285 | |
| Distribution loss (46)m = 0.15 x (45)m | 29.6053 | 26.0504 | 27.3701 | 23.3663 | 22.1698 | 19.4565 | 18.8368 | 19.8845 | 20.4319 | 23.4040 | 25.6408 | 29.1929 | (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 | 243.9633 | 215.7549 | 229.0623 | 200.8669 | 194.3935 | 174.8017 | 172.1737 | 179.1586 | 181.3045 | 202.6217 | 216.0307 | 241.2143 | (62) |
| WWHRS | -27.9247 | -24.6969 | -25.8611 | -21.4140 | -19.9571 | -17.0775 | -16.0074 | -17.0223 | -17.6690 | -20.8298 | -23.5976 | -27.4076 | (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 | 216.0385 | 191.0580 | 203.2011 | 179.4529 | 174.4364 | 157.7243 | 156.1663 | 162.1363 | 163.6355 | 181.7919 | 192.4330 | 213.8067 | (64) |
| | | | | | | | | | | Total per year (kWh/year) = Sum(64)m = | | 2191.8808 | (64) |
| 12Total per year (kWh/year) | | | | | | | | | | | | 2192 | (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 | 102.9009 | 91.4136 | 97.9463 | 87.8687 | 86.4190 | 79.2020 | 79.0309 | 81.3533 | 81.3642 | 89.1548 | 92.9106 | 101.9869 | (65) |

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

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Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | 109.9312 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 97.2138 | 107.6296 | 97.2138 | 100.4543 | 97.2138 | 100.4543 | 97.2138 | 97.2138 | 100.4543 | 97.2138 | 100.4543 | 97.2138 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 192.7750 | 194.7755 | 189.7345 | 179.0029 | 165.4562 | 152.7242 | 144.2185 | 142.2181 | 147.2590 | 157.9906 | 171.5373 | 184.2693 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | 33.9931 | (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) | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | -87.9449 | (71) |
| Water heating gains (Table 5) | 138.3077 | 136.0321 | 131.6483 | 122.0398 | 116.1545 | 110.0028 | 106.2243 | 109.3459 | 113.0058 | 119.8318 | 129.0425 | 137.0791 | (72) |
| Total internal gains | 487.2759 | 497.4165 | 477.5759 | 460.4764 | 437.8039 | 419.1607 | 403.6359 | 404.7571 | 416.6984 | 434.0155 | 460.0135 | 477.5416 | (73) |

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6. Solar gains

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| [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 | |
|---|---|---|---|---|---|---|---|
| Southeast | 3.0300 | 36.7938 | 0.6300 | 0.7000 | 0.7700 | 34.0714 | (77) |
| Southwest | 10.0000 | 36.7938 | 0.6300 | 0.7000 | 0.7700 | 112.4467 | (79) |
| North | 1.9900 | 26.0000 | 0.6300 | 0.7000 | 1.0000 | 20.5356 | (82) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains | 167.0537 | 292.2254 | 417.3025 | 541.5834 | 625.5646 | 628.4561 | 602.8805 | 539.7007 | 460.5798 | 327.9619 | 201.5593 | 141.9754 | (83) |
| Total gains | 654.3296 | 789.6419 | 894.8785 | 1002.0598 | 1063.3685 | 1047.6168 | 1006.5165 | 944.4578 | 877.2783 | 761.9774 | 661.5728 | 619.5170 | (84) |

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7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ni1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tau | 72.8200 | 72.9600 | 73.0978 | 73.7521 | 73.8758 | 74.4572 | 74.4572 | 74.5659 | 74.2322 | 73.8758 | 73.6260 | 73.3666 | |
| alpha | 5.8547 | 5.8640 | 5.8732 | 5.9168 | 5.9251 | 5.9638 | 5.9638 | 5.9711 | 5.9488 | 5.9251 | 5.9084 | 5.8911 | |
| util living area | 0.9963 | 0.9886 | 0.9671 | 0.8953 | 0.7464 | 0.5476 | 0.3962 | 0.4400 | 0.6857 | 0.9322 | 0.9900 | 0.9973 | (86) |
| MIT | 19.9734 | 20.1870 | 20.4559 | 20.7567 | 20.9337 | 20.9910 | 20.9989 | 20.9980 | 20.9688 | 20.7231 | 20.2885 | 19.9358 | (87) |
| Th 2 | 19.7906 | 19.7926 | 19.7946 | 19.8039 | 19.8057 | 19.8139 | 19.8139 | 19.8154 | 19.8107 | 19.8057 | 19.8022 | 19.7985 | (88) |
| util rest of house | 0.9946 | 0.9835 | 0.9527 | 0.8546 | 0.6707 | 0.4500 | 0.2900 | 0.3278 | 0.5821 | 0.8951 | 0.9846 | 0.9960 | (89) |
| MIT 2 | 18.6362 | 18.9074 | 19.2409 | 19.5929 | 19.7631 | 19.8105 | 19.8137 | 19.8150 | 19.7964 | 19.5694 | 19.0454 | 18.5942 | (90) |
| Living area fraction | | | | | | | | | | fLA = Living area / (4) = | | 0.3183 | (91) |
| MIT | 19.0619 | 19.3147 | 19.6276 | 19.9633 | 20.1357 | 20.1862 | 20.1909 | 20.1915 | 20.1696 | 19.9366 | 19.4411 | 19.0212 | (92) |
| adjustment | | | | | | | | | | | | 0.0000 | |
| adjusted MIT | 19.0619 | 19.3147 | 19.6276 | 19.9633 | 20.1357 | 20.1862 | 20.1909 | 20.1915 | 20.1696 | 19.9366 | 19.4411 | 19.0212 | (93) |

---

## 8. Space heating requirement

---

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation | 0.9931 | 0.9808 | 0.9502 | 0.8608 | 0.6929 | 0.4811 | 0.3239 | 0.3637 | 0.6149 | 0.9000 | 0.9823 | 0.9948 | (94) |
| Useful gains | 649.8062 | 774.4718 | 850.2920 | 862.5418 | 736.7604 | 504.0545 | 325.9945 | 343.4588 | 539.4326 | 685.7421 | 649.8707 | 616.2998 | (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 | 1371.3759 | 1336.5555 | 1214.9204 | 1014.7925 | 772.4736 | 507.5505 | 326.2610 | 343.9849 | 553.1363 | 854.9726 | 1133.9353 | 1366.6335 | (97) |
| Space heating kWh | 536.8478 | 377.7202 | 271.2835 | 109.6205 | 26.5706 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 125.9074 | 348.5265 | 558.2483 | (98a) |
| Space heating requirement - total per year (kWh/year) | | | | | | | | | | | | 2354.7249 | |
| 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 | 536.8478 | 377.7202 | 271.2835 | 109.6205 | 26.5706 | 0.0000 | 0.0000 | 0.0000 | 125.9074 | 348.5265 | 558.2483 | (98c) | |
| Space heating requirement after solar contribution - total per year (kWh/year) | | | | | | | | | | | | 2354.7249 | |
| Space heating per m2 | | | | | | | | | | | (98c) / (4) = | 34.5876 | (99) |

---

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

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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 | 536.8478 | 377.7202 | 271.2835 | 109.6205 | 26.5706 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 125.9074 | 348.5265 | 558.2483 | (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) | 581.6336 | 409.2310 | 293.9149 | 118.7655 | 28.7872 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 136.4111 | 377.6018 | 604.8193 | (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 | 216.0385 | 191.0580 | 203.2011 | 179.4529 | 174.4364 | 157.7243 | 156.1663 | 162.1363 | 163.6355 | 181.7919 | 192.4330 | 213.8067 | (64) |
| Efficiency of water heater | | | | | | | | | | | | 79.8000 | (216) |
| (217)m | 86.0163 | 85.5587 | 84.7086 | 82.9896 | 80.8836 | 79.8000 | 79.8000 | 79.8000 | 79.8000 | 83.2526 | 85.3748 | 86.1105 | (217) |
| Fuel for water heating, kWh/month | 251.1600 | 223.3064 | 239.8825 | 216.2354 | 215.6634 | 197.6495 | 195.6971 | 203.1783 | 205.0570 | 218.3617 | 225.3979 | 248.2934 | (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 | 20.1991 | 16.2045 | 14.5903 | 10.6895 | 8.2569 | 6.7459 | 7.5322 | 9.7906 | 12.7171 | 16.6855 | 18.8462 | 20.7605 | (232) |
| Electricity generated by PVs (Appendix M) (negative quantity) | | | | | | | | | | | | | |
| (233a)m | -39.1032 | -53.9554 | -75.9473 | -83.5948 | -88.6950 | -82.3092 | -81.3024 | -77.4481 | -70.4400 | -60.8509 | -42.5754 | -33.9478 | (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 | -25.8193 | -53.8371 | -106.1301 | -158.1482 | -207.9106 | -208.4429 | -205.9715 | -174.9255 | -128.9386 | -76.5445 | -34.3259 | -20.4520 | (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 2551.1645 (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 2639.8825 (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) 163.0184 (232)

Energy saving/generation technologies (Appendices M ,N and Q)

PV generation -2191.6156 (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 | 3248.4498 | (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 | 2551.1645 | 0.2100 | 535.7446 | (261) |
| Total CO2 associated with community systems | | | 0.0000 | (373) |
| Water heating (other fuel) | 2639.8825 | 0.2100 | 554.3753 | (264) |
| Space and water heating | | | 1090.1199 | (265) |
| Pumps, fans and electric keep-hot | 86.0000 | 0.1387 | 11.9293 | (267) |
| Energy for lighting | 163.0184 | 0.1443 | 23.5286 | (268) |
| Energy saving/generation technologies | | | | |
| PV Unit electricity used in dwelling | -790.1695 | 0.1350 | -106.6961 | |
| PV Unit electricity exported | -1401.4461 | 0.1261 | -176.7684 | |
| Total | | | -283.4645 | (269) |
| Total CO2, kg/year | | | 842.1132 | (272) |
| EPC Target Carbon Dioxide Emission Rate (TER) | | | 12.3700 | (273) |

---

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 | 2551.1645 | 1.1300 | 2882.8159 | (275) |
| Total CO2 associated with community systems | | | 0.0000 | (473) |
| Water heating (other fuel) | 2639.8825 | 1.1300 | 2983.0672 | (278) |
| Space and water heating | | | 5865.8831 | (279) |
| Pumps, fans and electric keep-hot | 86.0000 | 1.5128 | 130.1008 | (281) |
| Energy for lighting | 163.0184 | 1.5338 | 250.0430 | (282) |
| Energy saving/generation technologies | | | | |
| PV Unit electricity used in dwelling | -790.1695 | 1.4991 | -1184.5193 | |
| PV Unit electricity exported | -1401.4461 | 0.4630 | -648.8773 | |
| Total | | | -1833.3966 | (283) |
| Total Primary energy kWh/year | | | 4412.6303 | (286) |
| Target Primary Energy Rate (TPER) | | | 64.8200 | (287) |

Full SAP Calculation Printout
energyvoltmeter

# Appendix D

**GLA Part L2021 Reporting Spreadsheet**

# Part L 2021 Performance

## Residential

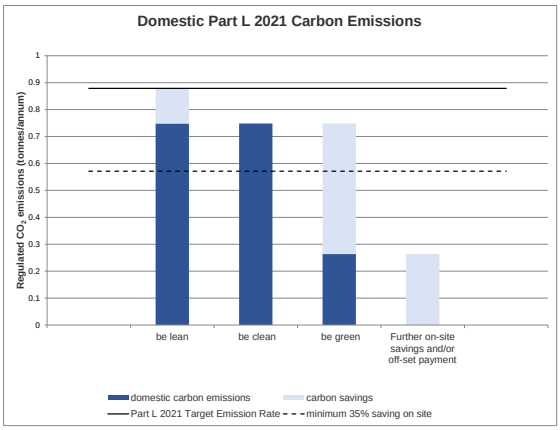
**Table 1:** Carbon Dioxide Emissions after each stage of the Energy Hierarchy for residential buildings

| | Carbon Dioxide Emissions for residential buildings (Tonnes $CO_2$ per annum) | |
|---|---|---|
| | Regulated | Unregulated |
| Baseline: Part L 2021 of the Building Regulations Compliant Development | 0.9 | 0.2 |
| After energy demand reduction (be lean) | 0.7 | 0.2 |
| After heat network connection (be clean) | 0.7 | 0.2 |
| After renewable energy (be green) | 0.3 | 0.2 |

**Table 2:** Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for residential buildings

| | Regulated residential carbon dioxide savings | |
|---|---|---|
| | (Tonnes $CO_2$ per annum) | (%) |
| Be lean: savings from energy demand reduction | 0.1 | 15% |
| Be clean: savings from heat network | 0.0 | 0% |
| Be green: savings from renewable energy | 0.5 | 55% |
| **Cumulative on site savings** | **0.6** | **70%** |
| Annual savings from off-set payment | 0.3 | - |
| | (Tonnes $CO_2$) | |
| **Cumulative savings for off-set payment** | **8** | - |
| **Cash in-lieu contribution (£)** | **751** | |

*carbon price is based on GLA recommended price of £95 per tonne of carbon dioxide unless Local Planning Authority price is inputted in the 'Development Information' tab




## Non-residential

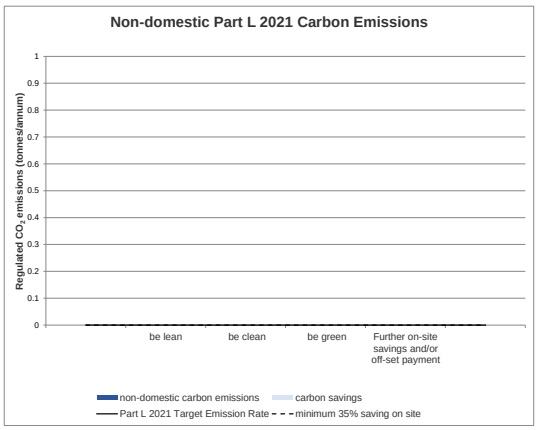
**Table 3:** Carbon Dioxide Emissions after each stage of the Energy Hierarchy for non-residential buildings

| | Carbon Dioxide Emissions for non-residential buildings (Tonnes $CO_2$ per annum) | |
|---|---|---|
| | Regulated | Unregulated |
| Baseline: Part L 2021 of the Building Regulations Compliant Development | 0.0 | |
| After energy demand reduction (be lean) | 0.0 | |
| After heat network connection (be clean) | 0.0 | |
| After renewable energy (be green) | 0.0 | |

**Table 4:** Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for non-residential buildings

| | Regulated non-residential carbon dioxide savings | |
|---|---|---|
| | (Tonnes $CO_2$ per annum) | (%) |
| Be lean: savings from energy demand reduction | 0.0 | 0% |
| Be clean: savings from heat network | 0.0 | 0% |
| Be green: savings from renewable energy | 0.0 | 0% |
| **Total Cumulative Savings** | **0.0** | **0%** |
| Annual savings from off-set payment | 0.0 | - |
| | (Tonnes $CO_2$) | |
| **Cumulative savings for off-set payment** | **0** | - |
| **Cash in-lieu contribution (£)** | **0** | |

*carbon price is based on GLA recommended price of £95 per tonne of carbon dioxide unless Local Planning Authority price is inputted in the 'Development Information' tab




## SITE-WIDE

| | Total regulated emissions (Tonnes $CO_2$ / year) | $CO_2$ savings (Tonnes $CO_2$ / year) | Percentage savings (%) |
|---|---|---|---|
| Part L 2021 baseline | 0.9 | | |
| Be lean | 0.7 | 0.1 | 15% |
| Be clean | 0.7 | 0.0 | 0% |
| Be green | 0.3 | 0.5 | 55% |
| Total Savings | - | 0.6 | 70% |
| | - | $CO_2$ savings off-set (Tonnes $CO_2$) | - |
| Off-set | - | **7.9** | - |

| | Target Fabric Energy Efficiency (kWh/m²) | Dwelling Fabric Energy Efficiency (kWh/m²) | Improvement (%) |
|---|---|---|---|
| **Development total** | 43.07 | 39.18 | 9% |

| | Area weighted non-residential cooling demand ($MJ/m^2$) | Total non-residential cooling demand (MJ/year) |
|---|---|---|
| **Actual** | | |
| **Notional** | | |

## EUI & space heating demand (predicted energy use)

### Residential

| Building type | EUI (kWh/m²/year) (excluding renewable energy) | Space heating demand (kWh/m²/year) (excluding renewable energy) | EUI value from Table 4 of the guidance (kWh/m²/year) (excluding renewable energy) | Space heating demand from Table 4 of the guidance(kWh/m²/year) (excluding renewable energy) | Methodology used (e.g. 'be seen' methodology or an alternative predictive energy modelling methodology) | Explanatory notes (if expected performance differs from the Table 4 values in the guidance) |
|---|---|---|---|---|---|---|
| Residential | 0.472385429 | 36.9706228 | 35 | 15 | Part L1 - SAP 10.2 & none dwellings / & Landlord Circulation | |

### Non-residential

| Building type | EUI (kWh/m²/year) (excluding renewable energy) | Space heating demand (kWh/m²/year) (excluding renewable energy) | EUI value from Table 4 of the guidance (kWh/m²/year) (excluding renewable energy) | Space heating demand from Table 4 of the guidance(kWh/m²/year) (excluding renewable energy) | Methodology used (e.g. 'be seen' methodology or an alternative predictive energy modelling methodology) | Explanatory notes (if expected performance differs from the Table 4 values in the guidance) |
|---|---|---|---|---|---|---|
| | | | | | | |
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# Appendix E

**Internal Water Use**

**Part G Calculation**

| | |
|---|---|
| **Job no:** | 23124 |
| **Date:** | Nov-22 |
| **Assessor name:** | Neil Ingham |
| **Registration no:** | STRO010583 |
| **Development name:** | Grove Avenue |
| **Issue Date:** | 21/11/2022 |

Rainwater | Greywater | Results

# WATER EFFICIENCY CALCULATOR FOR NEW DWELLINGS

(for use with the Code for Sustainable Homes issues Wat 1 for the May 2009 and subsequent versions)

| | |
|---|---|
| **Dwelling Description** | Grove Avenue |

## 1st step - Select from options below:

| | |
|---|---|
| Is a Rain and/or Greywater system specified? | **No** |
| Is a shower AND bath present? | **Yes** |
| Has a washing machine been specified? | **No** |
| Has a dishwasher been specified? | **No** |

## 2nd step - Build spreadsheet (click button below)

BUILD SPREADSHEET

As soon as this button is pressed the spreadsheet will change according to the options selected previously in the 1st step. Scroll down to see the changes.

## 3rd step - Enter consumption details for the specified fittings

| **TAPS** (excluding kitchen taps) | Fitting type | Flow rate (litres/min) | Number of fittings |
|---|---|---|---|
| **1** | Basins | 6.50 | 1 |
| **2** | | | |
| **3** | | | |
| **4** | | | |
| | **Proportionate flow rate (litres/min)** | | 4.55 |
| | **Consumption / person / day (Litres)** | | **11.85** |

| BATHS | Fitting type | Capacity to overflow (litres) | Number of fittings |
|---|---|---|---|
| 1 | Bath | 0.00 | 0 |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| | Proportionate capacity to overflow (litres) | | 0.00 |
| | Consumption / person / day (Litres) | | **0.00** |

| SHOWERS | Fitting type | Flow rate (litres/min) | Number of fittings |
|---|---|---|---|
| 1 | Shower | 9.50 | 1 |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| | Proportionate flow rate (litres/min) | | 6.65 |
| | Consumption / person / day (Litres) | | **41.52** |

| DISHWASHER | | |
|---|---|---|
| **Where no dishwasher is specified, a default consumption figure of 1.25 litres per place setting is used.** | | |
| | Consumption / person / day (Litres) | **4.50** |

| WASHING MACHINES | Number of fittings |
|---|---|
| **Where no washing machine is specified, a default consumption figure of 8.17 litres per kilogram of dry load is** | |

| | |
|---|---|
| used. | |
| Where no washing machines have been specified but plumbing for future supply of grey/rainwater was installed, please enter details: | |

| | |
|---|---|
| Consumption / person / day (Litres) | 17.16 |

| WC's | Fitting Type | Flush Type | Volume** | Number of fittings |
|---|---|---|---|---|
| 1 | Toilet | Full Flush | 6.00 | 1 |
| | | Part Flush | 4.00 | |
| 2 | | Full Flush | | |
| | | Part Flush | | |
| 3 | | Full Flush | | |
| | | Part Flush | | |
| 4 | | Full Flush | | |
| | | Part Flush | | |
| | | Average effective flushing volume (litres) | | 4.66 |
| | | Consumption / person / day (Litres) | | 20.60 |

| KITCHEN SINK TAPS | Fitting Type | Flow rate (litres/minute) | Number of fittings |
|---|---|---|---|
| 1 | Kitchen | 6.50 | 1 |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| | Proportionate flow rate (litres/min) | | 4.55 |
| | Consumption / person / day (Litres) | | 13.22 |

## WASTE DISPOSAL UNIT

| | |
|---|---|
| Is a waste disposal unit specified for the dwelling? | No |
| Consumption / person / day (Litres) | 0.00 |

## WATER SOFTENER

| | |
|---|---|
| Water Softener in use? | No |
| Total capacity used per regeneration (%) | |

| | |
|---|---|
| **Water consumed per regeneration** (litres) | |
| **Average number of regeneration cycles per day** (No.) | |
| **Number of occupants served by the system** (No.) | |
| **Water consumed beyond 4% person / day** (Litres) | **0.00** |

## 4th step - Analyse Results

Go to Start

## INTERNAL WATER CONSUMPTION

| | | |
|---|---|---|
| **NET INTERNAL WATER CONSUMPTION** | (litres/person/day) | **108.85** |
| **RAINWATER ONLY COLLECTION SAVING** | (litres/person/day) | **0.00** |
| **GREYWATER ONLY RECYCLING SAVING** | (litres/person/day) | **0.00** |
| **RAIN/GREYWATER COLLECTION SAVING (combined system)** | (litres/person/day) | **0.00** |
| **NORMALISATION FACTOR** | (litres/person/day) | **0.91** |
| **TOTAL WATER CONSUMPTION** | (litres/person/day) | **99.1** |
| **CSH CREDITS ACHIEVED** | | **3** |
| **CSH MANDATORY LEVEL:** | | **Level 3/4** |

## 17. K COMPLIANCE

| | | |
|---|---|---|
| **EXTERNAL WATER USE** | (litres / person / day) | 5.00 |
| **TOTAL WATER CONSUMPTION** | (litres / person / day) | **104.1** |
| **17. K COMPLIANCE?** | | **Yes** |

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**PRINTING:** before printing please make sure that in "Page Setup" you have selected the page to be as "Landscape" and that the Scale has been set up to 75% (maximum)