



Energy Statement

Silverhill Farm, Rochdale

Client: Barratt David Wilson Homes North West

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www.environmental-economics.co.uk

Revision History

<i>Version</i>	<i>Date Issued</i>	<i>Issued by</i>	<i>QA Check</i>
1	28/06/2022	 Ruth Ferguson BSc	 Tim James C.Eng MCIBSE BSc MSc

About Environmental Economics

Our team of experienced consultants specialise in construction and building energy. We have qualifications in sustainability, energy, engineering, building physics and construction as well as environmental, quality management and auditing.

Over the last decade, we have provided assessments and consultancy for some of the largest UK house builders, including Barratt Developments, David Wilson Homes, Bellway Homes, Abbey New Homes and Davidsons. We develop flexible, practical, cost-effective specifications for our clients through identifying solutions and delivering design advice. This includes the following disciplines:

- *Energy Reports*
- *Sustainability Statements*
- *Compliance assessments and advice covering*
 - *Part L (SAP)*
 - *Part F (ventilation)*
 - *Part G (water)*
- *Overheating assessments*
- *BREEAM*
- *SBEM (existing and new build)*
- *Minimum Energy Efficiency Standards (MEES)*
- *Thermal Bridging (Psi value calculations)*

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1. Project Overview

1.1. Introduction

- 1.1.1. This energy study was prepared by Environmental Economics Ltd on behalf of Barratt and David Wilson Homes North West.

1.2. Description of Site

- 1.2.1. The proposed development at the Silverhill Farm, Rochdale site consists of 64 plots. These units comprise a range of detached, semi-detached, and terraced dwellings.
- 1.2.2. The proposed site location/boundary for the site is shown in Appendix A.
- 1.2.3. This report addresses a domestic development being undertaken by Barratt David Wilson Homes North West, and does not include any further proposals for subsequent developments or non-residential parcels.

1.3. Client Brief

- 1.3.1. The proposed development will be constructed to achieve the newly introduced 2021 Building Regulations, Approved Documents L (Conservation of fuel and power), O (Overheating), and F (Ventilation).
- 1.3.2. Approved Document L 2021 (ADL 2021) provides for a 31% reduction in Carbon emissions over the previous 2013 edition.
- 1.3.3. ADL 2021 came into effect 15th June 2022, with a 12-month transitional arrangement. Sites which have been notified to local authorities prior to this date have 12 months transitional allowance on a plot-by-plot basis. That is to say if a plot has commenced construction prior to 15th June 2023, it will be built under ADL 2013.

2. Improvement Measures

2.1. Assessment Methodology

2.1.1. Environmental Economics have modelled the proposed dwellings using the software Design SAP 10 by Elmhurst and approved by BRE. The software provides a number of outputs, and based on the provided specification for this proposed development, we are able to assess the following areas for our calculations:

- *Building regulations compliance, including:*
 - *Carbon emissions (kg CO₂/m²/year)*
 - *Primary Energy Demand (kWh/m²/annum)*
 - *Fabric Energy Efficiency (kWh/m²/annum)*
- *Energy usage per year (kWh/annum)*
- *Energy costs per year (£/annum)*
- *More detailed breakdowns by end use (space heating, water heating, cooking, lighting, appliances)*

2.1.2. Each of these outputs can be used in different ways to analyse the performance of the dwelling. The total regulated carbon emissions for each property is based upon:

- *Space heating*
- *Water heating*
- *Electricity for pumps and fans*
- *Electricity for lighting*

2.1.3. SAP software is issued by independent software suppliers, and checked and approved on behalf of government by the Building Research Establishment (BRE). At time of writing, SAP 10 software is only approved for specific technologies, and the software available to assessors is still going through revisions due to known bugs which create uncertainty in the results. Refer to Appendix B for the approval status at time of writing.

2.1.4. The specifications and calculation results enclosed should therefore be read as draft, and will be updated and revised once fully compliant software is released.

2.1.5. The draft SAP reports used in this energy report are shown in Appendix E.

2.2. Design Philosophy

- 2.2.1. In order to improve the dwelling performance to achieve ADL 2021, various upgrades have been made to almost all physical elements of the ADL 2013 specification.
- 2.2.2. The proposed development adopts the good design principles endorsed and promoted by The Zero Carbon Hub, the construction industries' key advisors and partners with the Governments Communities and Local Government Department. This guidance follows the general good principles of energy efficiency as the industry moves towards zero carbon. The principles are illustrated in figure 1 below.

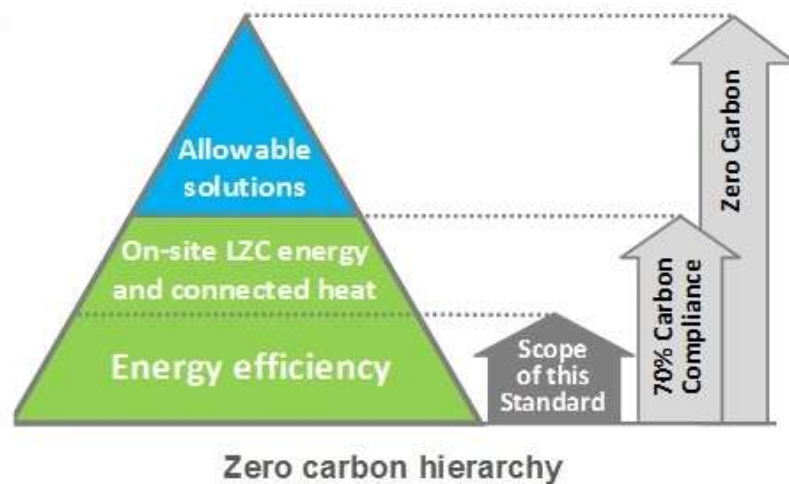


Figure 1

- 2.2.3. To reduce the residual carbon emissions, a number of improvements were made to the standard material and product specification. These improvements include:
- *Improved insulation levels*
 - *Upgraded heating and hot water controls*
 - *Design air permeability of 5.01m³/hr/m²*
 - *Bespoke, low heat loss thermal bridging designs*

2.3. Building Services

- 2.3.1. The systems used in a property to supply hot water and heating, as well as control it, are important to the overall energy demand of a property. ADL 2021 includes requirements for efficiency and controls of such equipment, including space heating, water heating, ventilation and lighting.
- 2.3.2. For a mains gas fired system, the minimum boiler efficiency required is 92%. Compliant Ideal Logic boilers have been adopted which exceed this requirement.
- 2.3.3. Where installed, hot water cylinders can lose a significant amount of energy. To minimise this energy loss and corresponding carbon emissions, cylinders which have higher levels of insulation in comparison to typical hot water cylinders will be used.
- 2.3.4. Lighting provision will be from LED low energy fittings achieving a minimum efficacy of 100 lamp lumens per circuit watt, an improvement of over 50% from ADL 2013 performance levels.

2.4. Fabric Improvements

2.4.1. The building fabric for all dwellings within the proposed development have been improved in comparison to ADL 2013 specifications, and in relation to the ADL 2021 backstop notional specification. These fabric improvements reduce the space heating requirement upon a property. The improvements have been made through a combination of upgraded materials and increased insulation thicknesses. Enhanced glazing with a larger transmittance factor allowing for increased solar gains will also be used.

2.4.2. Uplifts against ADL 2013 (Table 1) and ADL 2021 backstops (Table 2) are given below.

<i>Element</i>	<i>ADL 2013 Performance</i>	<i>ADL 2021 Improved Specification / Performance</i>	
-	<i>W/m²k</i>	<i>Description</i>	<i>W/m²k</i>
Walls	0.27	100mm Alreflex Platinum	0.19
Roof	0.11 0.17	400mm Mineral Wool Horizontal Ceiling, Loft Space	0.11
		Flat Roof	0.15
Floors	0.12 - 0.16	200mm TE Platinum Insulation	0.10 - 0.12
Doors	1.00 – 1.70	Double glazed Low-E, u-PVC frame	1.00 – 1.40
Glazing	1.41	Double glazed Low-E, u-PVC frame	1.2

Table 1 – Uplifts over Part L 2013

<i>Element</i>	<i>Part L 2021 Backstop</i>	<i>ADL 2021 Improved Specification / Performance</i>	
-	<i>W/m²k</i>	<i>Description</i>	<i>W/m²k</i>
Walls	0.26	50mm Alreflex Platinum Cavity	0.19
Roof	0.16	400mm Mineral Wool Horizontal Ceiling, Loft Space	0.11
		Flat Roof	0.15
Floors	0.18	150mm TE Platinum Insulation	0.10 - 0.12
Doors	1.60	Double glazed Low-E, u-PVC frame	1.00 – 1.40
Glazing	1.60	Double glazed Low-E, u-PVC frame	1.2

Table 2 – Uplifts over Part L 2021 Backstops

- 2.4.3. As improvements are made to the thermal conductivity of main elements, thermal bridging and air permeability becomes increasingly significant in the overall fabric performance. Bespoke thermal bridging designs have been utilised, which achieve much lower heat loss levels in comparison with standard practice.
- 2.4.4. As a result of following these junction details and focusing on build quality air permeability will also decrease. A target air pressure rating of 5.01m³/hr.m² has been set for all houses on site which is a 37% improvement on the maximum allowable rating in the 2021 Building Regulations.

3. Low and Zero Carbon Technologies

3.1.1. The following section will outline various renewable technologies and assess their suitability for this scheme.

3.2. Photovoltaic (PV) Cells

3.2.1. The efficiency of PV cells has improved rapidly over the last 15 years. This has made a previously uneconomical technology an increasingly viable solution to rising energy costs and demand. The cells can be produced in a variety of formats but are typically manufactured as a panel or a roof tile for domestic housing applications.

3.2.2. The PV system typically produces direct current (DC) which is then sent through an inverter to supply the house with electricity. If a greater amount of electricity is produced than used by the household, this extra can be exported to the national grid, as can be seen in figure 2.



Figure 2

3.2.3. A PV cell is assessed on its peak power rating. This is tested by exposing the cell to the equivalent of full solar radiation and measuring the power output. The peak power is input into the Design SAP software as well as the physical attributes of the installation such as pitch, orientation and over-shading. A total energy saving per year can then be calculated through SAP for the PV installation. This is then offset against the electricity energy demand for the house.

3.3. Solar Hot Water (SHW)

- 3.3.1. SHW systems generate energy which is used to heat stored water (in a special solar hot water cylinder) which offsets the energy required for the boiler, thereby reducing fuel use and reducing carbon emissions. Therefore, SHW systems are ideally utilised when the design of a dwelling already calls for a hot water cylinder, and not when a combination boiler is specified.
- 3.3.2. There are two main SHW systems: evacuated tubes and flat plate collectors. Evacuated tubes are more efficient at transferring solar irradiation to the fluid although flat plate collectors are considered to be better aesthetically and to install. An example of the latter can be seen in figure 3.



Figure 3

- 3.3.3. The final energy contribution to the household, calculated through SAP, is based on several factors:
- *Pitch, orientation, and over-shading*
 - *Heat absorption efficiency for the collector*
 - *Average hot water usage of the dwelling*
- 3.3.4. Most of the energy savings will be made in the hot water demand for the dwelling however, adding a SHW system will impact upon other energy demands.

3.4. Air Source Heat Pumps (ASHP)

- 3.4.1. ASHP provide heating and hot water to a home through thermal energy gathered from air outside the dwelling. Systems can be designed to work in conjunction with a boiler system but in the case of energy efficient new builds it is possible for an ASHP unit to provide 100% of the heating and hot water demand.



Figure 4

- 3.4.2. The thermal performance of the unit depends on the outside temperature as well as the unit's Coefficient of Performance. This is the ratio of thermal energy produced to energy used. A typical value for this would be around 3.5, meaning that for every 1kW of electricity consumed the unit would provide 3.5kW of thermal energy to the household. This efficiency leads to large carbon and energy savings for both space and water heating.
- 3.4.3. ASHP are assessed by their power output and the size of unit chosen depends on the demand from the household. An example external unit can be seen above in figure 4. The units with a larger power output can provide a larger amount of hotter water even in colder climates.

3.5. Ground Source Heat Pumps (GSHP)

- 3.5.1. GSHP provide heating and hot water to a dwelling through geothermal effects. A GSHP system would offset the energy demand from the main space heating. There is, however, an additional electricity demand for the pump and control system. This would reduce energy savings from the installation.

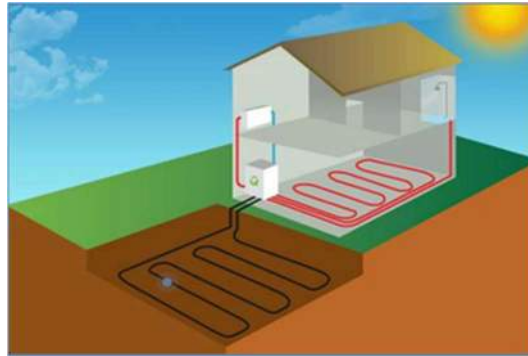


Figure 5

- 3.5.2. GSHP are expensive to install and rely on having appropriate ground conditions and suitable space around the dwelling for the pipe looping. Energy savings are dependent upon the type of system being replaced and the way the system is operated by the homeowner. A typical system can be seen above in figure 5.

3.6. Biomass Heating Systems

- 3.6.1. Biomass heating systems burn fuels, considered carbon neutral, to heat the water required for a dwelling. There are a large variety of systems available, and choice depends on the type of fuel to be burned and the level of automation.
- 3.6.2. The system would offset the energy demand from the hot water and main space heating. However, biomass systems typically require a large amount of maintenance and monitoring. An example system can be seen in figure 6.



Figure 6

- 3.6.3. The savings from such a system, in terms of CO₂ and money, depends upon what it is replacing. The savings are greatest when replacing an electrical hot water system but are considerably less for replacing mains gas.

3.7. Wind Turbines

- 3.7.1. Wind turbines provide electricity directly to a dwelling. They can be added to a property in two ways: pole mounted or building mounted. The pole mounted systems are free standing and therefore require enough space around them to allow for the construction and maintenance of the structure, as well as to allow for efficient operation. The building mounted systems have a lower power output but do not require additional structures, as can be seen in figure 7.



Figure 7

- 3.7.2. The energy produced from a wind turbine is heavily dependent upon the surrounding landscape. The energy saved will be offset against the electricity usage of the dwelling.

3.8. WWHRS

- 3.8.1. Waste water heat recovery system (WWHRS) recovers the energy that is lost from the waste water that is generated from showers. It uses a heat exchange system which recovers a portion of the energy that would normally be wasted. The waste heat is partially transferred to the incoming mains water inlet, which reduces the change in temperature required for the boiler to make. It therefore has the ability to reduce the amount energy required for the boiler to operate at specific points in the day.
- 3.8.2. Typically, the WWHRS performs best with larger households with cylinder boilers. Figure 8 illustrates the WWHRS system in operation.

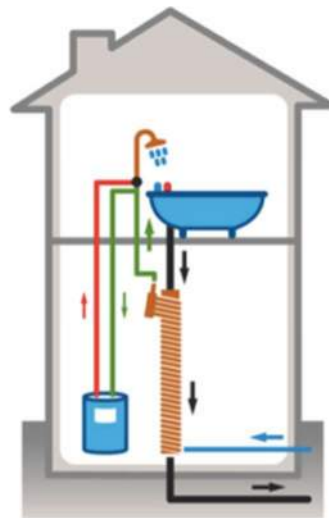


Figure 8

3.9. FGHRs

- 3.9.1. Flue gas heat recovery system (FGHRs) works by recovering waste heat from the flue of a boiler. This waste heat is partially transferred to the main water inlet which raises the temperature of the water which is fed into the boiler. This reduces the amount of energy required to heat the boiler, as it reduces the temperature increase required for the boiler to operate, and therefore reduces the energy demand to heat the dwelling. Figure 9 illustrates the FGHRs in operation.

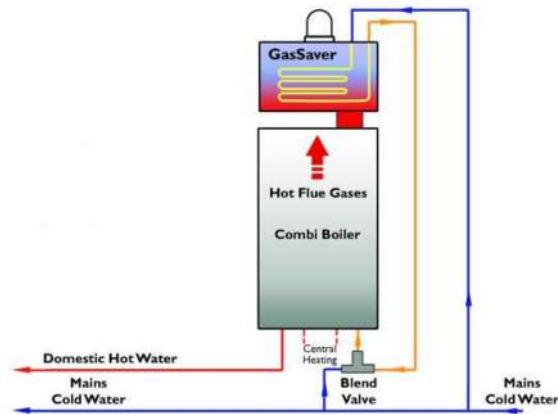


Figure 9

3.10. Comparison - LZC

- 3.10.1. SHW can be incorporated into newbuild dwellings where the design calls for a boiler and cylinder system. In this situation a SHW system can provide up to 50% of the hot water demand. Where the dwelling design utilises a combination boiler (and therefore no cylinder) the dwelling will require a fundamental redesign and therefore these present additional challenges.
- 3.10.2. The procurement and installation of ASHP systems make these a high capital cost (CapEx) option. There is also a degree of uncertainty about the energy saving that can be obtained from the system as it requires diligent design, installation and operation.
- 3.10.3. GSHP systems are more efficient in comparison to ASHP, but have higher CapEx, and require extensive groundwork in order to facilitate the heat recover pipework or boreholes.
- 3.10.4. Biomass hot water systems are more suited to the replacement of inefficient, carbon heavy systems such as electrical immersion heaters. The requirement of maintenance and monitoring makes it unsuitable for large scale new build developments
- 3.10.5. The density of the site is a major restriction on the potential energy that could be generated from wind turbines. Surrounding houses and the urban location would restrict wind speeds.
- 3.10.6. WWHR is suitable for newbuild properties and will significantly reduce the energy required for heating water for showers.
- 3.10.7. FHGR can contribute towards reduction in carbon emissions and energy demand for newbuild properties, particularly when the boiler is operating in hot water only mode.

3.11. Adopted LZC Technologies

- 3.11.1. Using the current issue of SAP 10 software, DesignSAP 10, a draft specification has been prepared which provides compliance with ADL 2021.
- 3.11.2. This work will be reviewed and updated on full approval of the DesignSAP 10 software, expected to be end July 2022.
- 3.11.3. At time of wiring the following LZC technologies are included within each SAP assessment, and are utilised in each house type:

LZC Technology	Description
FGHR	Flue gas heat recovery. Zenex Gas-Saver GS2 on system boilers OR Ideal Logic Code ESP1 combination boilers
WWHR	Waste water heat recovery Recoup Pipe+ HE
PV	Photovoltaic arrays Each plot to have PV array. Size to be confirmed based on plot orientation and final SAP software results

4. Conclusion

- 4.1.1. As shown in Appendix C, the given specifications for building fabric and building services achieves compliance with Approved Document L1A 2021
- 4.1.2. This represents an improvement of 31% over and above developments being built out at the current time.

Appendix A – Site Plan



Appendix B – Software Approval (SAP 10)

Approved software for SAP 10.2*

Updated: 14 June 2022

SAP 10.2 – applicable for building regulations from 15th June 2022 in England, and from 15th June 2022 for EPC lodgements in England.

List of SAP programs tested by BRE* for use in connection with building regulations and Energy Performance Certificates for new dwellings

Phased approval: The following software packages have been granted approval specific to dwellings with the following features:

Phase 1	Building fabric (walls, roofs, floors, windows etc.), Boilers (mains gas, LPG, electric, oil), FGHRs, Secondary room heaters, Instantaneous WWHRs, Solar heating (hot water only), Natural ventilation with intermittent extract fans, Centralised MEV, Decentralised MEV, Balanced ventilation with heat recovery (MVHR), PV (without battery or diverter), and Air conditioning.
Phase 2	All Phase 1, plus Electric heat pumps, Electric immersion, PV with battery, PV with diverter, and Wind turbines.
Phase 3	All Phase 2 plus Heat Networks (not from PCDB), Balanced ventilation without heat recovery.

Full Approval: The following software packages have been tested for full approval covering:

Phase 4	All Phase 3 plus all other systems including Storage WWHRs, Solar heating (space and water heating), and Heat Networks from PCDB
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See also notes on last page.

* The SAP programs listed have been checked by BRE on behalf of BEIS, DLUHC, BSD and the Welsh Government. Whilst BRE has taken due care and precaution in testing the programs, it will not be held liable for any failure or consequence thereof that may occur in their use or application.

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Approved software for SAP 10.2*

Updated: 14 June 2022

Organisation	Contact name	Address, telephone, e-mail, website	Calculation Software	Phase	Version	Building Regulations				EPC				Date of approval
						E	W	S	NI	E	W	S	NI	
Stroma Certification Limited	The SAP Team	6 Silkwood Park, Fryers Way, Wakefield, WF5 9TJ 0345 621 1111 www.stroma.com/certification SAP@stroma.com	FSAP 10.2	1	1.x	Yes	-	-	-	-	-	-	-	08/06/2022
			FSAP 10.2 UI	1	1.x	Yes	-	-	-	-	-	-	-	14/06/2022
Elmhurst Energy Systems Ltd	New Build Dwelling Support Team	16 St Johns Business Park Lutterworth Leicestershire LE17 4HB Tel: 01455 883250 www.elmhurstenergy.co.uk onconstruction.support@elmhurstenergy.co.uk	SAP 10	1	1.x	Yes	-	-	-	-	-	-	-	09/06/2022
			SAP 10	1	1.x	Yes	-	-	-	-	-	-	-	10/06/2022

NOTES

1. E: England; W: Wales; S: Scotland; NI: Northern Ireland. SAP 10.2 is not yet applicable in Wales, Scotland or Northern Ireland.
2. "Building Regulations" indicates whether the software calculates the target and dwelling emissions for building regulations. "EPC" indicates whether the software produces an energy performance certificate.
3. "x" in the version number may be incremented for minor updates that do not affect the calculated results. The software approval applies to any "x".
4. The list of programs is complete as at the date at the top of the page. Additional programs may be added.

For further information on SAP 10.2 see: <https://bregroup.com/sap/sap10/>

* The SAP programs listed have been checked by BRE on behalf of BEIS, DLUHC, BSD and the Welsh Government. Whilst BRE has taken due care and precaution in testing the programs, it will not be held liable for any failure or consequence thereof that may occur in their use or application.

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Appendix C – SAP Reports

SAP worksheets can be found on the following pages

FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)

Property reference	Detached House
Issued on date	28/06/2022
Region	Thames Valley, England
Property	Silverhill Farm, Kingsway

COMPLIANCE CHECK

▼ 1a TER and DER

Fuel for main heating:	Mains gas	
Fuel factor:		
Target Carbon Dioxide Emission Rate (TER)	11.44 kgCO ₂ /m ²	
Dwelling Carbon Dioxide Emission Rate (DER)	11.07 kgCO ₂ /m ²	OK
Excess emissions 1	-0.37 kgCO ₂ /m ² (-3.2%)	
Target Carbon Dioxide Emission Rate (TER2)	11.44 kgCO ₂ /m ²	
Dwelling Carbon Dioxide Emission Rate (DER)	11.07 kgCO ₂ /m ²	
Excess emissions 2	-0.37 kgCO ₂ /m ² (-3.2%)	

▼ 1b TPER and DPER

Target Primary Energy Rate (TPER)		
Dwelling Fabric Energy Efficiency (DPER)	58.55 kWh/m ² /yr	OK
	-1.4 kWh/m ² /yr (-2.3%)	
Target Primary Energy Rate (TPER)	59.89 kWh/m ² /yr	
Dwelling Fabric Energy Efficiency (DPER)	58.55 kWh/m ² /yr	
	-1.4 kWh/m ² /yr (-2.3%)	

▼ 1c TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	46.11 kWh/m ² /yr	
Dwelling Fabric Energy Efficiency (DFEE)	44.01 kWh/m ² /yr	OK
Excess energy	-2.1 kWh/m ² /yr (-4.6%)	

▼ Section 2a

Element	Maximum permitted u-value	Dwelling Average u-value	Element with highest u-value	Compliant?
External walls	0.26	0.20	0.25 (max. 0.70)	OK
Party walls	0.20	0.00	N/A	OK
Curtain walls	1.60	0.00	0.00 (max. 1.60)	OK
Floors	0.18	0.15	0.19 (max. 0.70)	OK
Roofs	0.16	0.12	0.17 (max. 0.35)	OK
Windows, doors, and roof windows	1.60	1.18	1.20 (max. 1.60)	OK
Rooflights	2.20		0.00 (max. 2.20)	OK

▼ 2a Thermal bridging

Thermal bridging calculated using user-specified y-value of 0.040

▼ 3 Design air permeability

Dwelling air permeability at 50Pa	5.01 (design value)	
Maximum permitted air permeability at 50Pa	8.00	OK

▼ 4 Heating efficiency

Main heating system:	Boiler system with radiators or underfloor - Mains gas Data from database Ideal LOGIC HEAT H18 Efficiency: 90.6% SEDBUK2009 Minimum: 88.0%	OK
Secondary heating system:	None	

▼ 5 Cylinder insulation

Hot water storage	Measured cylinder loss: 1.27 kWh/day Permitted by DBSCG 2.10	OK
Primary pipework insulated:	Yes	OK
▼ Solar water heating		OK

▼ 6 Controls

Space heating controls:	Time and temperature zone control	Fail
▼ Hot water controls		
Hot water controls:	Cylinderstat	OK
Independent timer for DHW		OK
Boiler interlock	Yes	OK

Error from Design SAP software, Time & temperature zone controls meets Part L

▼ 7 Lighting

Minimum permitted light source efficacy	75 lm/W	
Lowest light source efficacy:	100 lm/W	OK

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

1. Overall dwelling characteristics

Area Storey height Volume
(m²) (m) (m³)

Ground floor 57.4900 (1b) x 2.6100 (2b) = 150.0489 (1b) - (3b)

First floor 66.8400 (1c) x 2.3000 (2c) = 153.7320 (1c) - (3c)

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 124.3300 (4)

Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 303.7809 (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 4 * 10 = 40.0000 (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) = 40.0000 / (5) = 0.1317 (8)

Pressure test Yes

Pressure Test Method Blower Door

Measured/design AP50 5.0000 (17)

Infiltration rate 0.3817 (18)

Number of sides sheltered 0 (19)

Shelter factor (20) = 1 - [0.075 x (19)] = 1.0000 (20)

Infiltration rate adjusted to include shelter factor (21) = (18) x (20) = 0.3817 (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

0.4866 0.4771 0.4676 0.4198 0.4103 0.3626 0.3626 0.3530 0.3817 0.4103 0.4294 0.4485 (22b)

Effective ac 0.6184 0.6138 0.6093 0.5881 0.5842 0.5657 0.5657 0.5623 0.5728 0.5842 0.5922 0.6006 (25)

3. Heat losses and heat loss parameter

Element Gross Openings NetArea U-value A x U K-value A x K

m² m² m² W/m²K W/K kJ/m²K kJ/K

TER Opaque door 2.3700 1.0000 2.3700 (26)

TER Semi-glazed door 2.0000 1.0000 2.0000 (26a)

TER Opening Type (Uw = 1.20) 22.8000 1.1450 26.1069 (27)

150 P 41.9500 0.1300 5.4535 (28a)

Floor over Garage 15.5400 0.1300 2.0202 (28b)

100 AP 153.2700 27.1700 126.1000 0.1800 22.6980 (29a)

63 TLine PIR 22.1100 22.1100 0.1800 3.9798 (29a)

400 MW 60.6600 60.6600 0.1100 6.6726 (30)

Lightpod 4.2800 4.2800 0.1100 0.4708 (30)

Hexagonal bay 0.5300 0.5300 0.1100 0.0583 (30)

Flat roof above D1 1.3700 1.3700 0.1100 0.1507 (30)

Total net area of external elements Aum(A, m²) 299.7100 (31)

Fabric heat loss, W/K = Sum (A x U) (26)...(30) + (32) = 71.9808 (33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m²K 113.4189 (35)

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 20.4336 (36)

Point Thermal bridges 5.0000 (36a)

Total fabric heat loss (33) + (36) + (36a) = 97.4144 (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 61.9938 61.5329 61.0811 58.9590 58.5620 56.7137 56.7137 56.3714 57.4256 58.5620 59.3652 60.2049 (38)

Heat transfer coeff

159.4082 158.9473 158.4955 156.3734 155.9763 154.1281 154.1281 153.7858 154.8400 155.9763 156.7795 157.6192 (39)

Average = Sum(39)m / 12 = 156.3715

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

HLP 1.2821 1.2784 1.2748 1.2577 1.2545 1.2397 1.2397 1.2369 1.2454 1.2545 1.2610 1.2677 (40)

HLP (average) 1.2577

Days in month 31 28 31 30 31 30 31 31 30 31 30 31

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8786 (42)

Hot water usage for mixer showers

72.4845 71.3952 69.8079 66.7709 64.5296 62.0301 60.6094 62.1848 63.9116 66.5952 69.6975 72.2068 (42a)

Hot water usage for baths

31.2939 30.8292 30.1747 28.9680 28.0644 27.0624 26.5212 27.1711 27.8788 28.9509 30.1825 31.1882 (42b)

Hot water usage for other uses

44.1098 42.5058 40.9018 39.2978 37.6938 36.0898 36.0898 37.6938 39.2978 40.9018 42.5058 44.1098 (42c)

Average daily hot water use (litres/day) 135.9425 (43)

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

Daily hot water use

147.8883 144.7302 140.8844 135.0366 130.2878 125.1824 123.2205 127.0497 131.0882 136.4479 142.3858 147.5048 (44)

Energy conte 234.2189 206.0939 216.5341 184.8584 175.3924 153.9263 149.0245 157.3141 161.6448 185.1585 202.8547 230.9568 (45)

Energy content (annual) Total = Sum(45)m = 2257.9774

Distribution loss (46)m = 0.15 x (45)m

35.1328 30.9141 32.4801 27.7288 26.3089 23.0890 22.3537 23.5971 24.2467 27.7738 30.4282 34.6435 (46)
 Water storage loss:
 Store volume 180.0000 (47)
 a) If manufacturer declared loss factor is known (kWh/day): 1.5520 (48)
 Temperature factor from Table 2b 0.5400 (49)
 Enter (49) or (54) in (55) 0.8381 (55)
 Total storage loss
 25.9803 23.4661 25.9803 25.1422 25.9803 25.1422 25.9803 25.9803 25.1422 25.9803 25.1422 25.9803 (56)
 If cylinder contains dedicated solar storage
 25.9803 23.4661 25.9803 25.1422 25.9803 25.1422 25.9803 25.9803 25.1422 25.9803 25.1422 25.9803 (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
 283.4615 250.5712 265.7768 232.5126 224.6351 201.5805 198.2672 206.5567 209.2990 234.4012 250.5089 280.1995 (62)
 WWHRS -33.1369 -29.3066 -30.6881 -25.4110 -23.6821 -20.2650 -18.9952 -20.1995 -20.9669 -24.7177 -28.0021 -32.5233 (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)
 FGHS 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
 250.3246 221.2646 235.0887 207.1016 200.9529 181.3156 179.2720 186.3573 188.3321 209.6835 222.5067 247.6762 (64)
 Total per year (kWh/year) = Sum(64)m = 2529.8759 (64)
 12Total per year (kWh/year) 2530 (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
 117.2719 104.1080 111.3917 99.5888 97.7121 89.3039 88.9448 91.7011 91.8703 100.9593 105.5725 116.1873 (65)

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

Metabolic gains (Table 5), Watts
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 (66)m 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 (66)
 Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
 149.3474 165.3489 149.3474 154.3257 149.3474 154.3257 149.3474 154.3257 149.3474 154.3257 149.3474 (67)
 Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
 290.7481 293.7652 286.1623 269.9766 249.5452 230.3425 217.5139 214.4969 222.0997 238.2854 258.7168 277.9195 (68)
 Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 (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)
 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 (71)
 Water heating gains (Table 5)
 157.6235 154.9227 149.7201 138.3177 131.3335 124.0332 119.5494 123.2541 127.5976 135.6980 146.6285 156.1657 (72)
 Total internal gains
 666.8981 683.2158 654.4088 631.7991 599.4051 574.8804 552.5898 553.2774 570.2020 592.5099 628.8501 652.6117 (73)

6. Solar gains

[Jan] Area Solar flux g FF Access Gains

m2 Table 6a Specific data Specific data factor W
W/m2 or Table 6b or Table 6c Table 6d

North 2.6200 10.6334 0.6300 0.7000 0.7700 8.5142 (74)
 Northeast 0.8400 11.2829 0.6300 0.7000 0.7700 2.8965 (75)
 East 5.1500 19.6403 0.6300 0.7000 0.7700 30.9119 (76)
 Southeast 0.8400 36.7938 0.6300 0.7000 0.7700 9.4455 (77)
 South 1.9600 46.7521 0.6300 0.7000 0.7700 28.0046 (78)
 West 11.3900 19.6403 0.6300 0.7000 0.7700 68.3664 (80)

Solar gains 148.1392 278.3300 438.5435 621.6240 754.3004 770.7953 734.2580 634.2850 503.0343 324.2708 182.4449 123.3869 (83)
 Total gains 815.0373 961.5458 1092.9523 1253.4230 1353.7055 1345.6757 1286.8479 1187.5625 1073.2364 916.7807 811.2950 775.9986 (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, n1,m (see Table 9a)

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

tau 24.5724 24.6437 24.7139 25.0493 25.1131 25.4142 25.4142 25.4708 25.2974 25.1131 24.9844 24.8513

alpha 2.6382 2.6429 2.6476 2.6700 2.6742 2.6943 2.6943 2.6981 2.6865 2.6742 2.6656 2.6568

util living area

0.9690 0.9517 0.9215 0.8558 0.7525 0.6088 0.4780 0.5259 0.7271 0.8922 0.9537 0.9726 (86)

MIT 18.2739 18.6037 19.1160 19.7978 20.3657 20.7535 20.9070 20.8776 20.5758 19.8191 18.9402 18.2312 (87)

Th 2 19.8549 19.8578 19.8606 19.8741 19.8766 19.8884 19.8884 19.8906 19.8839 19.8766 19.8715 19.8662 (88)

util rest of house

0.9637 0.9435 0.9077 0.8297 0.7058 0.5323 0.3738 0.4213 0.6600 0.8670 0.9445 0.9679 (89)

MIT 2 16.6898 17.1077 17.7531 18.6014 19.2738 19.7015 19.8396 19.8215 19.5300 18.6479 17.5470 16.6418 (90)

Living area fraction fLA = Living area / (4) = 0.1399 (91)

MIT 16.9113 17.3169 17.9438 18.7688 19.4265 19.8486 19.9889 19.9692 19.6762 18.8117 17.7419 16.8641 (92)

Temperature adjustment 0.0000

adjusted MIT 16.9113 17.3169 17.9438 18.7688 19.4265 19.8486 19.9889 19.9692 19.6762 18.8117 17.7419 16.8641 (93)

8. Space heating requirement

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

Utilisation 0.9429 0.9173 0.8766 0.7981 0.6843 0.5293 0.3839 0.4293 0.6455 0.8357 0.9191 0.9487 (94)

Useful gains 768.5260 882.0416 958.0852 1000.4108 926.3308 712.3181 493.9728 509.8481 692.8195 766.1340 745.6369 736.1978 (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

2010.3495 1973.6359 1813.7859 1543.2116 1205.1538 808.9591 522.3240 548.8943 863.4264 1280.8320 1668.4321 1996.1012 (97)

Space heating kWh

923.9166 733.5514 636.6413 390.8166 207.4443 0.0000 0.0000 0.0000 382.9353 664.4125 937.3681 (98a)

Space heating requirement - total per year (kWh/year) 4877.0862

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

923.9166 733.5514 636.6413 390.8166 207.4443 0.0000 0.0000 0.0000 382.9353 664.4125 937.3681 (98c)

Space heating requirement after solar contribution - total per year (kWh/year) 4877.0862

Space heating per m2 (98c) / (4) = 39.2269 (99)

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (201)

Fraction of space heat from main system(s) 1.0000 (202)

Efficiency of main space heating system 1 (in %) 92.3000 (206)

Efficiency of main space heating system 2 (in %) 0.0000 (207)

Efficiency of secondary/supplementary heating system, % 0.0000 (208)

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

Space heating requirement

923.9166 733.5514 636.6413 390.8166 207.4443 0.0000 0.0000 0.0000 382.9353 664.4125 937.3681 (98)

Space heating efficiency (main heating system 1)

92.3000 92.3000 92.3000 92.3000 92.3000 0.0000 0.0000 0.0000 92.3000 92.3000 92.3000 (210)

Space heating fuel (main heating system)

1000.9931 794.7469 689.7522 423.4199 224.7501 0.0000 0.0000 0.0000 414.8812 719.8402 1015.5667 (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 (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 (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 (215)

Water heating

Water heating requirement

250.3246 221.2646 235.0887 207.1016 200.9529 181.3156 179.2720 186.3573 188.3321 209.6835 222.5067 247.6762 (64)

Efficiency of water heater 79.8000 (216)

(217)m 86.7151 86.5383 86.1789 85.4615 84.1312 79.8000 79.8000 79.8000 85.3924 86.3566 86.7550 (217)

Fuel for water heating, kWh/month

288.6747 255.6841 272.7916 242.3332 238.8567 227.2125 224.6516 233.5304 236.0051 245.5529 257.6604 285.4891 (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 (221)

Pumps and Fa 7.3041 6.5973 7.3041 7.0685 7.3041 7.0685 7.3041 7.0685 7.3041 7.0685 7.3041 (231)

Lighting 31.0314 24.8946 22.4148 16.4220 12.6849 10.3636 11.5716 15.0411 19.5370 25.6335 28.9530 31.8939 (232)
 Electricity generated by PVs (Appendix M) (negative quantity)
 (233a)m -52.3140 -73.0102 -103.8787 -115.5303 -123.4568 -114.7512 -113.2384 -107.3902 -96.9904 -82.7916 -57.2107 -45.3082 (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 -31.8627 -66.7506 -132.1977 -197.9069 -261.1137 -262.2299 -259.2329 -219.8303 -161.5183 -95.3513 -42.4975 -25.2252 (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 5283.9503 (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 3008.4424 (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) 250.4415 (232)
 Energy saving/generation technologies (Appendices M, N and Q)
 PV generation -2841.5874 (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 5787.2468 (238)

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

Energy Emission factor Emissions
 kWh/year kg CO₂/kWh kg CO₂/year
 Space heating - main system 1 5283.9503 0.2100 1109.6296 (261)
 Water heating (other fuel) 3008.4424 0.2100 631.7729 (264)
 Space and water heating 1741.4025 (265)
 Pumps, fans and electric keep-hot 86.0000 0.1387 11.9293 (267)
 Energy for lighting 250.4415 0.1443 36.1464 (268)

Energy saving/generation technologies
 PV Unit electricity used in dwelling -1085.8705 0.1348 -146.4032
 PV Unit electricity exported -1755.7169 0.1260 -221.1927
 Total -367.5959 (269)
 Total CO₂, kg/year 1421.8823 (272)
 Target Carbon Dioxide Emission Rate (TER) 11.4400 (273)

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

Energy Primary energy factor Primary energy
 kWh/year kg CO₂/kWh kWh/year
 Space heating - main system 1 5283.9503 1.1300 5970.8639 (275)
 Water heating (other fuel) 3008.4424 1.1300 3399.5399 (278)
 Space and water heating 9370.4037 (279)
 Pumps, fans and electric keep-hot 86.0000 1.5128 130.1008 (281)
 Energy for lighting 250.4415 1.5338 384.1355 (282)

Energy saving/generation technologies
 PV Unit electricity used in dwelling -1085.8705 1.4983 -1626.9666
 PV Unit electricity exported -1755.7169 0.4625 -811.9351
 Total -2438.9017 (283)
 Total Primary energy kWh/year 7445.7384 (286)
 Target Primary Energy Rate (TPER) 59.8900 (287)

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

1. Overall dwelling characteristics

Area Storey height Volume

(m²) (m) (m³)

Ground floor 57.4900 (1b) x 2.6100 (2b) = 150.0489 (1b) - (3b)

First floor 66.8400 (1c) x 2.3000 (2c) = 153.7320 (1c) - (3c)

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 124.3300 (4)

Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 303.7809 (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 5 * 10 = 50.0000 (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) = 50.0000 / (5) = 0.1646 (8)

Pressure test Yes

Pressure Test Method Blower Door

Measured/design AP50 5.0100 (17)

Infiltration rate 0.4151 (18)

Number of sides sheltered 0 (19)

Shelter factor (20) = 1 - [0.075 x (19)] = 1.0000 (20)

Infiltration rate adjusted to include shelter factor (21) = (18) x (20) = 0.4151 (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

0.5292 0.5189 0.5085 0.4566 0.4462 0.3943 0.3943 0.3840 0.4151 0.4462 0.4670 0.4877 (22b)

Effective ac 0.6400 0.6346 0.6293 0.6042 0.5996 0.5778 0.5778 0.5737 0.5862 0.5996 0.6090 0.6189 (25)

3. Heat losses and heat loss parameter

Element Gross Openings NetArea U-value A x U K-value A x K

m2 m2 W/m2K W/K kJ/m2K kJ/K

Front door 2.3700 1.0000 2.3700 (26)

Rear door 2.0000 1.2000 2.4000 (26a)

Lightpod door (Uw = 1.20) 10.9100 1.1450 12.4924 (27)

Window (Uw = 1.20) 11.8900 1.1450 13.6145 (27)

150 P 41.9500 0.1400 5.8730 110.0000 4614.5000 (28a)

Floor over Garage 15.5400 0.1876 2.9156 20.0000 310.8000 (28b)

100 AP 153.2700 27.1700 126.1000 0.1900 23.9590 41.1300 5186.4933 (29a)

63 TLine PIR 22.1100 22.1100 0.2479 5.4813 8.0100 177.1011 (29a)

400 MW 60.6600 60.6600 0.1100 6.6726 9.5000 576.2700 (30)

Lightpod 4.2800 4.2800 0.1700 0.7276 9.0000 38.5200 (30)

Hexagonal bay 0.5300 0.5300 0.1700 0.0901 9.0000 4.7700 (30)

Flat roof above D1 1.3700 1.3700 0.1700 0.2329 9.0000 12.3300 (30)

Total net area of external elements Aum(A, m2) 299.7100 (31)

Fabric heat loss, W/K = Sum (A x U) (26)...(30) + (32) = 76.8290 (33)

GF Timber 78.2900 7.7000 602.8330 (32c)

FF Timber 154.8900 7.7000 1192.6530 (32c)

FF Floor 51.3000 18.0000 923.4000 (32d)

GF Ceiling 51.3000 9.0000 461.7000 (32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 14101.3704 (34)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 113.4189 (35)

Thermal bridges (User defined value 0.040 * total exposed area) 11.9884 (36)

Point Thermal bridges 5.0000 (36a)

Total fabric heat loss (33) + (36) + (36a) = 93.8174 (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 64.1634 63.6183 63.0839 60.5739 60.1043 57.9182 57.9182 57.5134 58.7603 60.1043 61.0543 62.0475 (38)

Heat transfer coeff

157.9808 157.4356 156.9012 154.3913 153.9217 151.7356 151.7356 151.3307 152.5776 153.9217 154.8717 155.8649 (39)

Average = Sum(39)m / 12 = 154.3890

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

HLP 1.2707 1.2663 1.2620 1.2418 1.2380 1.2204 1.2172 1.2272 1.2380 1.2457 1.2536 (40)

HLP (average) 1.2418

Days in month 31 28 31 30 31 30 31 31 30 31 30 31

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8786 (42)

Hot water usage for mixer showers

72.4845 71.3952 69.8079 66.7709 64.5296 62.0301 60.6094 62.1848 63.9116 66.5952 69.6975 72.2068 (42a)

Hot water usage for baths

31.2939 30.8292 30.1747 28.9680 28.0644 27.0624 26.5212 27.1711 27.8788 28.9509 30.1825 31.1882 (42b)

Hot water usage for other uses

44.1098 42.5058 40.9018 39.2978 37.6938 36.0898 36.0898 37.6938 39.2978 40.9018 42.5058 44.1098 (42c)

Average daily hot water use (litres/day) 135.9425 (43)

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 Daily hot water use
 147.8883 144.7302 140.8844 135.0366 130.2878 125.1824 123.2205 127.0497 131.0882 136.4479 142.3858 147.5048 (44)
 Energy conte 234.2189 206.0939 216.5341 184.8584 175.3924 153.9263 149.0245 157.3141 161.6448 185.1585 202.8547 230.9568 (45)
 Energy content (annual) Total = Sum(45)m = 2257.9774
 Distribution loss (46)m = 0.15 x (45)m
 35.1328 30.9141 32.4801 27.7288 26.3089 23.0890 22.3537 23.5971 24.2467 27.7738 30.4282 34.6435 (46)
 Water storage loss:
 Store volume 180.0000 (47)
 a) If manufacturer declared loss factor is known (kWh/day): 1.2700 (48)
 Temperature factor from Table 2b 0.5400 (49)
 Enter (49) or (54) in (55) 0.6858 (55)
 Total storage loss
 21.2598 19.2024 21.2598 20.5740 21.2598 20.5740 21.2598 21.2598 20.5740 21.2598 20.5740 21.2598 (56)
 If cylinder contains dedicated solar storage
 21.2598 19.2024 21.2598 20.5740 21.2598 20.5740 21.2598 21.2598 20.5740 21.2598 20.5740 21.2598 (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
 278.7411 246.3075 261.0563 227.9444 219.9146 197.0123 193.5467 201.8363 204.7308 229.6807 245.9407 275.4790 (62)
 WWHRS -63.0052 -55.7223 -58.3492 -48.3154 -45.0283 -38.5310 -36.1167 -38.4065 -39.8657 -46.9972 -53.2421 -61.8384 (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)
 FGHS -57.3390 -49.3768 -47.2176 -38.6094 -30.9780 -7.1317 -7.0844 -7.3543 -7.4189 -38.8382 -47.5516 -57.5046 (63d) eq.(G6)
 Output from w/h
 158.3969 141.2084 155.4895 141.0195 143.9083 151.3497 150.3457 156.0755 157.4462 143.8453 145.1470 156.1360 (64)
 Total per year (kWh/year) = Sum(64)m = 1800.3679 (64)
 12Total per year (kWh/year) 1800 (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
 113.4955 100.6971 107.6154 95.9342 93.9357 85.6493 85.1684 87.9247 88.2157 97.1830 101.9180 112.4109 (65)

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

Metabolic gains (Table 5), Watts

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 (66)m 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 (66)
 Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
 149.3474 165.3489 149.3474 154.3257 149.3474 154.3257 149.3474 149.3474 154.3257 149.3474 154.3257 149.3474 (67)
 Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
 290.7481 293.7652 286.1623 269.9766 249.5452 230.3425 217.5139 214.4969 222.0997 238.2854 258.7168 277.9195 (68)
 Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 (69)
 Pumps, fans 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 (70)
 Losses e.g. evaporation (negative values) (Table 5)
 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 (71)
 Water heating gains (Table 5)
 152.5478 149.8469 144.6443 133.2420 126.2577 118.9574 114.4737 118.1783 122.5218 130.6223 141.5527 151.0899 (72)
 Total internal gains
 661.8223 678.1400 649.3330 626.7233 594.3293 569.8046 547.5140 548.2017 565.1263 587.4341 623.7743 647.5359 (73)

6. Solar gains

[Jan] Area Solar flux g FF Access Gains
m2 Table 6a Specific data Specific data factor W
W/m2 or Table 6b or Table 6c Table 6d

North 1.9600 10.6334 0.7300 0.7000 0.7700 7.3804 (74)
South 1.9600 46.7521 0.7300 0.7000 0.7700 32.4497 (78)
West 6.9900 19.6403 0.7300 0.7000 0.7700 48.6159 (80)
North 0.6600 10.6334 0.7300 0.7000 0.7700 2.4852 (74)
Northeast 0.8400 11.2829 0.7300 0.7000 0.7700 3.3563 (75)
East 5.1500 19.6403 0.7300 0.7000 0.7700 35.8186 (76)
Southeast 0.8400 36.7938 0.7300 0.7000 0.7700 10.9448 (77)
West 4.4000 19.6403 0.7300 0.7000 0.7700 30.6023 (80)

Solar gains 171.6533 322.5094 508.1536 720.2944 874.0306 893.1438 850.8069 734.9652 582.8810 375.7424 211.4044 142.9721 (83)
Total gains 833.4757 1000.6494 1157.4866 1347.0177 1468.3600 1462.9484 1398.3210 1283.1669 1148.0073 963.1765 835.1787 790.5081 (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, n1,m (see Table 9a)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
tau 24.7945 24.8803 24.9651 25.3709 25.4483 25.8150 25.8150 25.8840 25.6725 25.4483 25.2922 25.1310
alpha 2.6530 2.6587 2.6643 2.6914 2.6966 2.7210 2.7210 2.7256 2.7115 2.6966 2.6861 2.6754
util living area
0.9673 0.9471 0.9114 0.8350 0.7201 0.5703 0.4418 0.4903 0.6982 0.8805 0.9504 0.9713 (86)

MIT 18.3232 18.6780 19.2124 19.9040 20.4479 20.7969 20.9260 20.9005 20.6279 19.8890 18.9989 18.2816 (87)
Th 2 19.8639 19.8673 19.8707 19.8867 19.8897 19.9037 19.9037 19.9063 19.8983 19.8897 19.8837 19.8773 (88)
util rest of house
0.9618 0.9383 0.8963 0.8068 0.6717 0.4955 0.3441 0.3908 0.6299 0.8535 0.9406 0.9664 (89)
MIT 2 16.9805 17.3977 18.0208 18.8167 19.4077 19.7626 19.8680 19.8548 19.6134 18.8215 17.7896 16.9396 (90)
Living area fraction fLA = Living area / (4) = 0.1399 (91)
MIT 17.1683 17.5768 18.1875 18.9688 19.5532 19.9073 20.0160 20.0010 19.7553 18.9708 17.9588 17.1273 (92)
Temperature adjustment -0.1500
adjusted MIT 17.0183 17.4268 18.0375 18.8188 19.4032 19.7573 19.8660 19.8510 19.6053 18.8208 17.8088 16.9773 (93)

8. Space heating requirement

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Utilisation 0.9409 0.9115 0.8641 0.7740 0.6476 0.4847 0.3405 0.3854 0.6091 0.8199 0.9146 0.9473 (94)
Useful gains 784.2505 912.0832 1000.1440 1042.6043 950.9698 709.0479 476.1407 494.5541 699.2241 789.7091 763.8214 748.8706 (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
2009.2532 1972.1590 1810.2457 1531.3768 1185.6911 782.5387 495.5722 522.2465 839.9884 1265.3552 1658.4841 1991.5293 (97)
Space heating kWh
911.4020 712.3710 602.7156 351.9162 174.6327 0.0000 0.0000 0.0000 0.0000 353.8807 644.1571 924.5381 (98a)
Space heating requirement - total per year (kWh/year) 4675.6134
Solar heating kWh
911.4020 712.3710 602.7156 351.9162 174.6327 0.0000 0.0000 0.0000 0.0000 353.8807 644.1571 924.5381 (98c)
Space heating requirement after solar contribution - total per year (kWh/year) 4675.6134
Space heating per m2 (98c) / (4) = 37.6065 (99)

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (201)

Fraction of space heat from main system(s) 1.0000 (202)

Efficiency of main space heating system 1 (in %) 90.6000 (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

911.4020 712.3710 602.7156 351.9162 174.6327 0.0000 0.0000 0.0000 0.0000 353.8807 644.1571 924.5381 (98)

Space heating efficiency (main heating system 1)

90.6000 90.6000 90.6000 90.6000 90.6000 0.0000 0.0000 0.0000 0.0000 90.6000 90.6000 90.6000 (210)

Space heating fuel (main heating system)

1005.9625 786.2814 665.2490 388.4284 192.7513 0.0000 0.0000 0.0000 0.0000 390.5968 710.9902 1020.4615 (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 (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 (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 (215)

Water heating

Water heating requirement

158.3969 141.2084 155.4895 141.0195 143.9083 151.3497 150.3457 156.0755 157.4462 143.8453 145.1470 156.1360 (64)

Efficiency of water heater 79.9000 (216)

(217)m 88.8385 88.6363 88.1783 87.2571 85.4314 79.9000 79.9000 79.9000 79.9000 87.2242 88.4225 88.8803 (217)

Fuel for water heating, kWh/month

178.2975 159.3120 176.3353 161.6138 168.4490 189.4239 188.1673 195.3385 197.0541 164.9145 164.1517 175.6699 (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 (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 38.1427 30.5995 27.5515 20.1854 15.5918 12.7386 14.2233 18.4880 24.0141 31.5078 35.5880 39.2028 (232)

Electricity generated by PVs (Appendix M) (negative quantity)

(233a)m -33.4652 -48.8362 -72.5851 -84.4187 -93.3877 -87.9619 -86.8731 -80.8823 -70.6642 -57.1140 -37.3746 -28.7414 (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 -14.1212 -30.1728 -60.8726 -92.7723 -124.0160 -125.1514 -123.6908 -104.1006 -75.4748 -43.5930 -18.9919 -11.1322 (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 5160.7212 (211)

Space heating fuel - main system 2 0.0000 (213)

Space heating fuel - secondary 0.0000 (215)

Efficiency of water heater 79.9000
 Water heating fuel used 2118.7276 (219)
 Space cooling fuel 0.0000 (221)
 Electricity for pumps and fans:
 central heating pump 41.0000 (230c)
 main heating flue fan 45.0000 (230e)
 Total electricity for the above, kWh/year 86.0000 (231)
 Electricity for lighting (calculated in Appendix L) 307.8338 (232)
 Energy saving/generation technologies (Appendices M, N and Q)
 PV generation -1606.3939 (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 6066.8886 (238)

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

Energy Emission factor Emissions
 kWh/year kg CO₂/kWh kg CO₂/year
 Space heating - main system 1 5160.7212 0.2100 1083.7514 (261)
 Water heating (other fuel) 2118.7276 0.2100 444.9328 (264)
 Space and water heating 1528.6842 (265)
 Pumps, fans and electric keep-hot 86.0000 0.1387 11.9293 (267)
 Energy for lighting 307.8338 0.1443 44.4299 (268)

Energy saving/generation technologies
 PV Unit electricity used in dwelling -782.3042 0.1339 -104.7473
 PV Unit electricity exported -824.0897 0.1255 -103.3932
 Total -208.1405 (269)
 Total CO₂, kg/year 1376.9029 (272)
 Dwelling Carbon Dioxide Emission Rate (DER) 11.0700 (273)

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

Energy Primary energy factor Primary energy
 kWh/year kg CO₂/kWh kWh/year
 Space heating - main system 1 5160.7212 1.1300 5831.6149 (275)
 Water heating (other fuel) 2118.7276 1.1300 2394.1622 (278)
 Space and water heating 8225.7771 (279)
 Pumps, fans and electric keep-hot 86.0000 1.5128 130.1008 (281)
 Energy for lighting 307.8338 1.5338 472.1658 (282)
 Energy saving/generation technologies
 PV Unit electricity used in dwelling -782.3042 1.4948 -1169.4022
 PV Unit electricity exported -824.0897 0.4605 -379.5066
 Total -1548.9088 (283)
 Total Primary energy kWh/year 7279.1349 (286)
 Dwelling Primary energy Rate (DPER) 58.5500 (287)

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF FABRIC ENERGY EFFICIENCY

1. Overall dwelling characteristics

Area Storey height Volume

(m²) (m) (m³)

Ground floor 57.4900 (1b) x 2.6100 (2b) = 150.0489 (1b) - (3b)

First floor 66.8400 (1c) x 2.3000 (2c) = 153.7320 (1c) - (3c)

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 124.3300 (4)

Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 303.7809 (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 4 * 10 = 40.0000 (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)+(7a)+(7b)+(7c) = 40.0000 / (5) = 0.1317 (8)

Pressure test Yes

Pressure Test Method Blower Door

Measured/design AP50 5.0100 (17)

Infiltration rate 0.3822 (18)

Number of sides sheltered 0 (19)

Shelter factor (20) = 1 - [0.075 x (19)] = 1.0000 (20)

Infiltration rate adjusted to include shelter factor (21) = (18) x (20) = 0.3822 (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

0.4873 0.4777 0.4682 0.4204 0.4108 0.3631 0.3631 0.3535 0.3822 0.4108 0.4299 0.4491 (22b)

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) 0.0000 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0.0000 (23c)

Effective ac 0.6187 0.6141 0.6096 0.5884 0.5844 0.5659 0.5659 0.5625 0.5730 0.5844 0.5924 0.6008 (25)

3. Heat losses and heat loss parameter

Element Gross Openings NetArea U-value A x U K-value A x K

m² m² m² W/m²K W/K kJ/m²K kJ/K

Front door 2.3700 1.0000 2.3700 (26)

Rear door 2.0000 1.2000 2.4000 (26a)

Lightpod door (Uw = 1.20) 10.9100 1.1450 12.4924 (27)

Window (Uw = 1.20) 11.8900 1.1450 13.6145 (27)

150 P 41.9500 0.1400 5.8730 110.0000 4614.5000 (28a)

Floor over Garage 15.5400 0.1876 2.9156 20.0000 310.8000 (28b)

100 AP 153.2700 27.1700 126.1000 0.1900 23.9590 41.1300 5186.4933 (29a)

63 TLine PIR 22.1100 22.1100 0.2479 5.4813 8.0100 177.1011 (29a)

400 MW 60.6600 60.6600 0.1100 6.6726 9.5000 576.2700 (30)

Lightpod 4.2800 4.2800 0.1700 0.7276 9.0000 38.5200 (30)

Hexagonal bay 0.5300 0.5300 0.1700 0.0901 9.0000 4.7700 (30)

Flat roof above D1 1.3700 1.3700 0.1700 0.2329 9.0000 12.3300 (30)

Total net area of external elements Aum(A, m²) 299.7100 (31)

Fabric heat loss, W/K = Sum(A x U) (26)...(30) + (32) = 76.8290 (33)

GF Timber 78.2900 7.7000 602.8330 (32c)

FF Timber 154.8900 7.7000 1192.6530 (32c)

FF Floor 51.3000 18.0000 923.4000 (32d)

GF Ceiling 51.3000 9.0000 461.7000 (32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 14101.3704 (34)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m²K 113.4189 (35)

Thermal bridges (User defined value 0.040 * total exposed area) 11.9884 (36)

Point Thermal bridges 5.0000 (36a)

Total fabric heat loss (33) + (36) + (36a) = 93.8174 (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 62.0249 61.5628 61.1098 58.9822 58.5841 56.7310 56.7310 56.3878 57.4448 58.5841 59.3894 60.2313 (38)

Heat transfer coeff

155.8423 155.3802 154.9272 152.7995 152.4015 150.5483 150.5483 150.2052 151.2621 152.4015 153.2068 154.0487 (39)

Average = Sum(39)m / 12 = 152.7976

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

HLP 1.2535 1.2497 1.2461 1.2290 1.2258 1.2109 1.2109 1.2081 1.2166 1.2258 1.2323 1.2390 (40)

HLP (average) 1.2290

Days in month 31 28 31 30 31 30 31 31 30 31 30 31

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8786 (42)

Hot water usage for mixer showers

0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (42a)

Hot water usage for baths

31.2939 30.8292 30.1747 28.9680 28.0644 27.0624 26.5212 27.1711 27.8788 28.9509 30.1825 31.1882 (42b)

Hot water usage for other uses

44.1098 42.5058 40.9018 39.2978 37.6938 36.0898 36.0898 37.6938 39.2978 40.9018 42.5058 44.1098 (42c)

Average daily hot water use (litres/day) 69.1142 (43)

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 Daily hot water use
 75.4037 73.3350 71.0765 68.2658 65.7582 63.1523 62.6111 64.8650 67.1766 69.8527 72.6883 75.2979 (44)
 Energy conte 119.4211 104.4280 109.2419 93.4524 88.5232 77.6531 75.7226 80.3164 82.8354 94.7894 103.5577 117.8984 (45)
 Energy content (annual) Total = Sum(45)m = 1147.8397
 Distribution loss (46)m = 0.15 x (45)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 (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 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
 101.5079 88.7638 92.8557 79.4346 75.2447 66.0051 64.3643 68.2689 70.4101 80.5710 88.0241 100.2136 (62)
 WWHRS 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (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)
 FGHS 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
 101.5079 88.7638 92.8557 79.4346 75.2447 66.0051 64.3643 68.2689 70.4101 80.5710 88.0241 100.2136 (64)
 Total per year (kWh/year) = Sum(64)m = 975.6637 (64)
 12Total per year (kWh/year) 976 (64)
 Electric shower(s)
 58.0480 51.7213 56.4777 53.8959 54.9073 52.3762 54.1221 54.9073 53.8959 56.4777 55.4157 58.0480 (64a)
 Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 660.2931 (64a)
 Heat gains from water heating, kWh/month
 39.8890 35.1213 37.3333 33.3326 32.5380 29.5953 29.6216 30.7940 31.0765 34.2622 35.8599 39.5654 (65)

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

Metabolic gains (Table 5), Watts
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 (66)m 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 (66)
 Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
 149.3474 165.3489 149.3474 154.3257 149.3474 154.3257 149.3474 149.3474 154.3257 149.3474 154.3257 149.3474 (67)
 Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
 290.7481 293.7652 286.1623 269.9766 249.5452 230.3425 217.5139 214.4969 222.0997 238.2854 258.7168 277.9195 (68)
 Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 (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)
 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 (71)
 Water heating gains (Table 5)
 53.6142 52.2638 50.1792 46.2953 43.7339 41.1046 39.8140 41.3898 43.1618 46.0513 49.8055 53.1793 (72)
 Total internal gains
 559.8888 577.5569 551.8679 536.7767 508.8055 491.9518 472.8543 471.4132 485.7663 499.8631 529.0270 546.6253 (73)

6. Solar gains

[Jan] Area Solar flux g FF Access Gains
 m2 Table 6a Specific data Specific data factor W
 W/m2 or Table 6b or Table 6c Table 6d

North 1.9600 10.6334 0.7300 0.7000 0.7700 7.3804 (74)
 South 1.9600 46.7521 0.7300 0.7000 0.7700 32.4497 (78)
 West 6.9900 19.6403 0.7300 0.7000 0.7700 48.6159 (80)
 North 0.6600 10.6334 0.7300 0.7000 0.7700 2.4852 (74)
 Northeast 0.8400 11.2829 0.7300 0.7000 0.7700 3.3563 (75)
 East 5.1500 19.6403 0.7300 0.7000 0.7700 35.8186 (76)
 Southeast 0.8400 36.7938 0.7300 0.7000 0.7700 10.9448 (77)
 West 4.4000 19.6403 0.7300 0.7000 0.7700 30.6023 (80)

Solar gains 171.6533 322.5094 508.1536 720.2944 874.0306 893.1438 850.8069 734.9652 582.8810 375.7424 211.4044 142.9721 (83)
 Total gains 731.5421 900.0664 1060.0215 1257.0711 1382.8361 1385.0956 1323.6613 1206.3784 1068.6473 875.6055 740.4314 689.5975 (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, ni1,m (see Table 9a)

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

tau 25.1347 25.2094 25.2832 25.6352 25.7022 26.0185 26.0780 25.8958 25.7022 25.5671 25.4273

alpha 2.6756 2.6806 2.6855 2.7090 2.7135 2.7346 2.7346 2.7385 2.7264 2.7135 2.7045 2.6952

util living area

0.9757 0.9577 0.9250 0.8521 0.7396 0.5899 0.4597 0.5120 0.7229 0.8995 0.9618 0.9791 (86)

MIT 18.2254 18.5887 19.1362 19.8488 20.4155 20.7820 20.9198 20.8908 20.5971 19.8185 18.9041 18.1775 (87)

Th 2 19.8775 19.8804 19.8833 19.8969 19.8994 19.9113 19.9113 19.9135 19.9067 19.8994 19.8943 19.8889 (88)

util rest of house

0.9714 0.9505 0.9119 0.8259 0.6927 0.5150 0.3599 0.4107 0.6565 0.8758 0.9540 0.9754 (89)

MIT 2 17.3553 17.7154 18.2538 18.9465 19.4672 19.7828 19.8784 19.8654 19.6441 18.9357 18.0404 17.3153 (90)

Living area fraction fLA = Living area / (4) = 0.1399 (91)

MIT 17.4770 17.8375 18.3772 19.0727 19.5999 19.9225 20.0241 20.0088 19.7774 19.0592 18.1612 17.4359 (92)

Temperature adjustment 0.0000

adjusted MIT 17.4770 17.8375 18.3772 19.0727 19.5999 19.9225 20.0241 20.0088 19.7774 19.0592 18.1612 17.4359 (93)

8. Space heating requirement

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

Utilisation 0.9584 0.9324 0.8891 0.8025 0.6783 0.5158 0.3709 0.4202 0.6476 0.8527 0.9371 0.9637 (94)

Useful gains 701.1011 839.2363 942.4445 1008.8302 938.0175 714.4336 490.8851 506.9136 692.0243 746.6131 693.8470 664.5722 (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

2053.5398 2010.2356 1840.1028 1554.3791 1203.9510 801.3007 515.4893 542.0583 858.7756 1289.1932 1694.6464 2038.9664 (97)

Space heating kWh

1006.2144 786.9116 667.8577 392.7952 197.8546 0.0000 0.0000 0.0000 0.0000 403.6796 720.5755 1022.5493 (98a)

Space heating requirement - total per year (kWh/year) 5198.4379

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

1006.2144 786.9116 667.8577 392.7952 197.8546 0.0000 0.0000 0.0000 0.0000 403.6796 720.5755 1022.5493 (98c)

Space heating requirement after solar contribution - total per year (kWh/year) 5198.4379

Space heating per m2 (98c) / (4) = 41.8116 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

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

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

Heat loss rate W

0.0000 0.0000 0.0000 0.0000 0.0000 1415.1544 1114.0578 1141.5593 0.0000 0.0000 0.0000 0.0000 (100)

Utilisation 0.0000 0.0000 0.0000 0.0000 0.0000 0.7656 0.8272 0.7910 0.0000 0.0000 0.0000 0.0000 (101)

Useful loss 0.0000 0.0000 0.0000 0.0000 0.0000 1083.5034 921.5361 902.9664 0.0000 0.0000 0.0000 0.0000 (102)

Total gains 0.0000 0.0000 0.0000 0.0000 0.0000 1554.6233 1485.7532 1351.6603 0.0000 0.0000 0.0000 0.0000 (103)

Space cooling kWh

0.0000 0.0000 0.0000 0.0000 0.0000 339.2063 419.7776 333.8282 0.0000 0.0000 0.0000 0.0000 (104)

Cooled fraction f_c = cooled area / (4) = 1.0000 (105)

Intermittency factor (Table 10b)

0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 (106)

Space cooling kWh

0.0000 0.0000 0.0000 0.0000 0.0000 84.8016 104.9444 83.4571 0.0000 0.0000 0.0000 0.0000 (107)

Space cooling requirement 273.2030 (107)

Energy for space heating 41.8116 (99)

Energy for space cooling 2.1974 (108)

Total 44.0090 (109)

Fabric Energy Efficiency (DFEE) 44.0 (109)

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

1. Overall dwelling characteristics

Area Storey height Volume

(m²) (m) (m³)

Ground floor 57.4900 (1b) x 2.6100 (2b) = 150.0489 (1b) - (3b)

First floor 66.8400 (1c) x 2.3000 (2c) = 153.7320 (1c) - (3c)

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 124.3300 (4)

Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 303.7809 (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 4 * 10 = 40.0000 (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) = 40.0000 / (5) = 0.1317 (8)

Pressure test Yes

Pressure Test Method Blower Door

Measured/design AP50 5.0000 (17)

Infiltration rate 0.3817 (18)

Number of sides sheltered 0 (19)

Shelter factor (20) = 1 - [0.075 x (19)] = 1.0000 (20)

Infiltration rate adjusted to include shelter factor (21) = (18) x (20) = 0.3817 (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

0.4866 0.4771 0.4676 0.4198 0.4103 0.3626 0.3626 0.3530 0.3817 0.4103 0.4294 0.4485 (22b)

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) 0.0000 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0.0000 (23c)

Effective ac 0.6184 0.6138 0.6093 0.5881 0.5842 0.5657 0.5657 0.5623 0.5728 0.5842 0.5922 0.6006 (25)

3. Heat losses and heat loss parameter

Element Gross Openings NetArea U-value A x U K-value A x K
m² m² m² W/m²K W/K kJ/m²K kJ/K

TER Opaque door 2.3700 1.0000 2.3700 (26)
TER Semi-glazed door 2.0000 1.0000 2.0000 (26a)
TER Opening Type (Uw = 1.20) 22.8000 1.1450 26.1069 (27)
150 P 41.9500 0.1300 5.4535 (28a)
Floor over Garage 15.5400 0.1300 2.0202 (28b)
100 AP 153.2700 27.1700 126.1000 0.1800 22.6980 (29a)
63 TLine PIR 22.1100 22.1100 0.1800 3.9798 (29a)
400 MW 60.6600 60.6600 0.1100 6.6726 (30)
Lightpod 4.2800 4.2800 0.1100 0.4708 (30)
Hexagonal bay 0.5300 0.5300 0.1100 0.0583 (30)
Flat roof above D1 1.3700 1.3700 0.1100 0.1507 (30)
Total net area of external elements A_{um}(A, m²) 299.7100 (31)
Fabric heat loss, W/K = Sum (A x U) (26)...(30) + (32) = 71.9808 (33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m²K 113.4189 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K) 20.4336 (36)
Point Thermal bridges 5.0000 (36a)
Total fabric heat loss (33) + (36) + (36a) = 97.4144 (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 61.9938 61.5329 61.0811 58.9590 58.5620 56.7137 56.7137 56.3714 57.4256 58.5620 59.3652 60.2049 (38)
Heat transfer coeff
159.4082 158.9473 158.4955 156.3734 155.9763 154.1281 154.1281 153.7858 154.8400 155.9763 156.7795 157.6192 (39)
Average = Sum(39)m / 12 = 156.3715

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
HLP 1.2821 1.2784 1.2748 1.2577 1.2545 1.2397 1.2397 1.2369 1.2454 1.2545 1.2610 1.2677 (40)
HLP (average) 1.2577
Days in month 31 28 31 30 31 30 31 31 30 31 30 31

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.8786 (42)
Hot water usage for mixer showers
0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (42a)
Hot water usage for baths
31.2939 30.8292 30.1747 28.9680 28.0644 27.0624 26.5212 27.1711 27.8788 28.9509 30.1825 31.1882 (42b)
Hot water usage for other uses
44.1098 42.5058 40.9018 39.2978 37.6938 36.0898 36.0898 37.6938 39.2978 40.9018 42.5058 44.1098 (42c)
Average daily hot water use (litres/day) 69.1142 (43)

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Daily hot water use
75.4037 73.3350 71.0765 68.2658 65.7582 63.1523 62.6111 64.8650 67.1766 69.8527 72.6883 75.2979 (44)
Energy conte 119.4211 104.4280 109.2419 93.4524 88.5232 77.6531 75.7226 80.3164 82.8354 94.7894 103.5577 117.8984 (45)
Energy content (annual) Total = Sum(45)m = 1147.8397
Distribution loss (46)m = 0.15 x (45)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 (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 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

101.5079 88.7638 92.8557 79.4346 75.2447 66.0051 64.3643 68.2689 70.4101 80.5710 88.0241 100.2136 (62)

WWHRS 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (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

101.5079 88.7638 92.8557 79.4346 75.2447 66.0051 64.3643 68.2689 70.4101 80.5710 88.0241 100.2136 (64)

Total per year (kWh/year) = Sum(64)m = 975.6637 (64)

12Total per year (kWh/year) 976 (64)

Electric shower(s)

58.0480 51.7213 56.4777 53.8959 54.9073 52.3762 54.1221 54.9073 53.8959 56.4777 55.4157 58.0480 (64a)

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 660.2931 (64a)

Heat gains from water heating, kWh/month

39.8890 35.1213 37.3333 33.3326 32.5380 29.5953 29.6216 30.7940 31.0765 34.2622 35.8599 39.5654 (65)

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

Metabolic gains (Table 5), Watts

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

(66)m 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 143.9302 (66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

149.3474 165.3489 149.3474 154.3257 149.3474 154.3257 149.3474 149.3474 154.3257 149.3474 154.3257 149.3474 (67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

290.7481 293.7652 286.1623 269.9766 249.5452 230.3425 217.5139 214.4969 222.0997 238.2854 258.7168 277.9195 (68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 37.3930 (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)

-115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 -115.1441 (71)

Water heating gains (Table 5)

53.6142 52.2638 50.1792 46.2953 43.7339 41.1046 39.8140 41.3898 43.1618 46.0513 49.8055 53.1793 (72)

Total internal gains

559.8888 577.5569 551.8679 536.7767 508.8055 491.9518 472.8543 471.4132 485.7663 499.8631 529.0270 546.6253 (73)

6. Solar gains

[Jan] Area Solar flux g FF Access Gains
m2 Table 6a Specific data Specific data factor W
W/m2 or Table 6b or Table 6c Table 6d

North 2.6200 10.6334 0.6300 0.7000 0.7700 8.5142 (74)
Northeast 0.8400 11.2829 0.6300 0.7000 0.7700 2.8965 (75)
East 5.1500 19.6403 0.6300 0.7000 0.7700 30.9119 (76)
Southeast 0.8400 36.7938 0.6300 0.7000 0.7700 9.4455 (77)
South 1.9600 46.7521 0.6300 0.7000 0.7700 28.0046 (78)
West 11.3900 19.6403 0.6300 0.7000 0.7700 68.3664 (80)

Solar gains 148.1392 278.3300 438.5435 621.6240 754.3004 770.7953 734.2580 634.2850 503.0343 324.2708 182.4449 123.3869 (83)
Total gains 708.0280 855.8870 990.4115 1158.4006 1263.1059 1262.7471 1207.1124 1105.6982 988.8006 824.1340 711.4719 670.0122 (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, ni1,m (see Table 9a)

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

tau 24.5724 24.6437 24.7139 25.0493 25.1131 25.4142 25.4142 25.4708 25.2974 25.1131 24.9844 24.8513

alpha 2.6382 2.6429 2.6476 2.6700 2.6742 2.6943 2.6943 2.6981 2.6865 2.6742 2.6656 2.6568

util living area

0.9775 0.9625 0.9357 0.8747 0.7760 0.6343 0.5027 0.5543 0.7563 0.9123 0.9654 0.9805 (86)

MIT 18.1317 18.4706 18.9987 19.7107 20.3093 20.7264 20.8948 20.8605 20.5279 19.7220 18.8128 18.0882 (87)

Th 2 19.8549 19.8578 19.8606 19.8741 19.8766 19.8884 19.8884 19.8906 19.8839 19.8766 19.8715 19.8662 (88)

util rest of house

0.9735 0.9559 0.9241 0.8510 0.7313 0.5577 0.3954 0.4473 0.6917 0.8906 0.9582 0.9770 (89)

MIT 2 17.2482 17.5848 18.1060 18.8028 19.3603 19.7249 19.8448 19.8282 19.5723 18.8297 17.9362 17.2123 (90)

Living area fraction fLA = Living area / (4) = 0.1399 (91)

MIT 17.3718 17.7087 18.2309 18.9297 19.4930 19.8650 19.9916 19.9726 19.7059 18.9545 18.0588 17.3348 (92)

Temperature adjustment 0.0000

adjusted MIT 17.3718 17.7087 18.2309 18.9297 19.4930 19.8650 19.9916 19.9726 19.7059 18.9545 18.0588 17.3348 (93)

8. Space heating requirement

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

Utilisation 0.9610 0.9387 0.9020 0.8266 0.7137 0.5559 0.4061 0.4559 0.6797 0.8674 0.9418 0.9657 (94)

Useful gains 680.3830 803.4307 893.3075 957.4763 901.4983 702.0034 490.1794 504.1205 672.1108 714.8782 670.0888 647.0157 (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

2083.7547 2035.9106 1859.2904 1568.3854 1215.5308 811.4791 522.7453 549.4172 868.0234 1303.1071 1718.1143 2070.2998 (97)

Space heating kWh

1044.1085 828.2265 718.6913 439.8545 233.6401 0.0000 0.0000 0.0000 0.0000 437.6423 754.5784 1058.9234 (98a)

Space heating requirement - total per year (kWh/year) 5515.6650

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

1044.1085 828.2265 718.6913 439.8545 233.6401 0.0000 0.0000 0.0000 0.0000 437.6423 754.5784 1058.9234 (98c)

Space heating requirement after solar contribution - total per year (kWh/year) 5515.6650

Space heating per m² (98c) / (4) = 44.3631 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

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

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

Heat loss rate W

0.0000 0.0000 0.0000 0.0000 0.0000 1448.8040 1140.5478 1168.7722 0.0000 0.0000 0.0000 0.0000 (100)

Utilisation 0.0000 0.0000 0.0000 0.0000 0.0000 0.7198 0.7874 0.7491 0.0000 0.0000 0.0000 0.0000 (101)

Useful loss 0.0000 0.0000 0.0000 0.0000 0.0000 1042.7936 898.0577 875.4991 0.0000 0.0000 0.0000 0.0000 (102)

Total gains 0.0000 0.0000 0.0000 0.0000 0.0000 1411.6186 1349.5273 1233.9822 0.0000 0.0000 0.0000 0.0000 (103)

Space cooling kWh

0.0000 0.0000 0.0000 0.0000 0.0000 265.5540 335.8934 266.7114 0.0000 0.0000 0.0000 0.0000 (104)

Cooled fraction f_C = cooled area / (4) = 1.0000 (105)

Intermittency factor (Table 10b)

0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 (106)

Space cooling kWh

0.0000 0.0000 0.0000 0.0000 0.0000 66.3885 83.9733 66.6778 0.0000 0.0000 0.0000 0.0000 (107)

Space cooling requirement 217.0397 (107)

Energy for space heating 44.3631 (99)

Energy for space cooling 1.7457 (108)

Total 46.1088 (109)

Fabric Energy Efficiency (TFEE1) 46.1 (109)

Fabric Energy Efficiency (TFEE2) 53.0

FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)

Property reference	Mid Terrace
Issued on date	28/06/2022
Region	Thames Valley, England
Property	Silverhill Farm, Kingsway

COMPLIANCE CHECK

▼ 1a TER and DER

Fuel for main heating:	Mains gas	
Fuel factor:		
Target Carbon Dioxide Emission Rate (TER)	11.33 kgCO ₂ /m ²	
Dwelling Carbon Dioxide Emission Rate (DER)	10.83 kgCO ₂ /m ²	OK
Excess emissions 1	-0.50 kgCO ₂ /m ² (-4.4%)	
Target Carbon Dioxide Emission Rate (TER2)	11.33 kgCO ₂ /m ²	
Dwelling Carbon Dioxide Emission Rate (DER)	10.83 kgCO ₂ /m ²	
Excess emissions 2	-0.50 kgCO ₂ /m ² (-4.4%)	

▼ 1b TPER and DPER

Target Primary Energy Rate (TPER)		
Dwelling Fabric Energy Efficiency (DPER)	58.11 kWh/m ² /yr	OK
	-1.1 kWh/m ² /yr (-1.9%)	
Target Primary Energy Rate (TPER)	59.16 kWh/m ² /yr	
Dwelling Fabric Energy Efficiency (DPER)	58.11 kWh/m ² /yr	
	-1.1 kWh/m ² /yr (-1.9%)	

▼ 1c TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	33.74 kWh/m ² /yr	
Dwelling Fabric Energy Efficiency (DFEE)	33.35 kWh/m ² /yr	OK
Excess energy	-0.4 kWh/m ² /yr (-1.2%)	

▼ Section 2a

Element	Maximum permitted u-value	Dwelling Average u-value	Element with highest u-value	Compliant?
External walls	0.26	0.19	0.19 (max. 0.70)	OK
Party walls	0.20	0.00	N/A	OK
Curtain walls	1.60	0.00	0.00 (max. 1.60)	OK
Floors	0.18	0.13	0.13 (max. 0.70)	OK
Roofs	0.16	0.11	0.11 (max. 0.35)	OK
Windows, doors, and roof windows	1.60	1.17	1.20 (max. 1.60)	OK
Rooflights	2.20		0.00 (max. 2.20)	OK

▼ 2a Thermal bridging

Thermal bridging calculated using user-specified y-value of 0.069

▼ 3 Design air permeability

Dwelling air permeability at 50Pa	5.01 (design value)	
Maximum permitted air permeability at 50Pa	8.00	OK

▼ 4 Heating efficiency

Main heating system:	Boiler system with radiators or underfloor - Mains gas Data from database Ideal LOGIC CODE COMBI ESP1 38 Combi boiler Efficiency: 90.5% SEDBUK2009 Minimum: 88.0%	OK
Secondary heating system:	None	

▼ 5 Cylinder insulation

Hot water storage	No cylinder	
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▼ Solar water heating

OK

▼ 6 Controls

Space heating controls:	Time and temperature zone control	Fail
▼ Hot water controls		
Hot water controls:	No cylinder	
Boiler interlock	Yes	OK

Error from Design SAP software, Time & temperature zone controls meets Part L

▼ 7 Lighting

Minimum permitted light source efficacy	75 lm/W	
Lowest light source efficacy:	100 lm/W	OK

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

1. Overall dwelling characteristics

Area Storey height Volume

(m²) (m) (m³)

Ground floor 38.6500 (1b) x 2.3100 (2b) = 89.2815 (1b) - (3b)

First floor 38.6500 (1c) x 2.5600 (2c) = 98.9440 (1c) - (3c)

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 77.3000 (4)

Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 188.2255 (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 4 * 10 = 40.0000 (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) = 40.0000 / (5) = 0.2125 (8)

Pressure test Yes

Pressure Test Method Blower Door

Measured/design AP50 5.0100 (17)

Infiltration rate 0.4630 (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) = 0.3936 (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

0.5018 0.4919 0.4821 0.4329 0.4231 0.3739 0.3739 0.3640 0.3936 0.4231 0.4428 0.4624 (22b)

Effective ac 0.6259 0.6210 0.6162 0.5937 0.5895 0.5699 0.5699 0.5663 0.5774 0.5895 0.5980 0.6069 (25)

3. Heat losses and heat loss parameter

Element Gross Openings NetArea U-value A x U K-value A x K

m2 m2 W/m2K W/K kJ/m2K kJ/K

Front door 2.3700 1.0000 2.3700 (26)

French door (Uw = 1.20) 3.1500 1.1450 3.6069 (27)

Window (Uw = 1.20) 8.2500 1.1450 9.4466 (27)

150 P 38.6500 0.1300 5.0245 110.0000 4251.5000 (28a)

100 AP 46.7500 13.7700 32.9800 0.1900 6.2662 41.1300 1356.4674 (29a)

400 MW 38.6500 38.6500 0.1100 4.2515 9.5000 367.1750 (30)

Total net area of external elements Aum(A, m2) 124.0500 (31)

Fabric heat loss, W/K = Sum (A x U) (26)...(30) + (32) = 30.9656 (33)

E-WM-22 78.4300 0.0000 0.0000 70.5000 5529.3150 (32)

GF Timber 61.0100 7.7000 469.7770 (32c)

FF Timber 95.8100 7.7000 737.7370 (32c)

FF Floor 38.6500 18.0000 695.7000 (32d)

GF Ceiling 38.6500 9.0000 347.8500 (32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 13755.5214 (34)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 177.9498 (35)

Thermal bridges (User defined value 0.069 * total exposed area) 8.5595 (36)

Point Thermal bridges 5.0000 (36a)

Total fabric heat loss (33) + (36) + (36a) = 44.5251 (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 38.8771 38.5735 38.2758 36.8778 36.6162 35.3986 35.3986 35.1731 35.8676 36.6162 37.1454 37.6986 (38)

Heat transfer coeff

83.4022 83.0986 82.8009 81.4029 81.1413 79.9237 79.9237 79.6982 80.3927 81.1413 81.6705 82.2237 (39)

Average = Sum(39)m / 12 = 81.4016

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

HLP 1.0789 1.0750 1.0712 1.0531 1.0497 1.0339 1.0339 1.0310 1.0400 1.0497 1.0565 1.0637 (40)

HLP (average) 1.0531

Days in month 31 28 31 30 31 30 31 31 30 31 30 31

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.4096 (42)

Hot water usage for mixer showers

88.8543 87.5190 85.5732 81.8503 79.1028 76.0389 74.2974 76.2285 78.3453 81.6350 85.4379 88.5139 (42a)

Hot water usage for baths

27.9125 27.4980 26.9142 25.8379 25.0319 24.1382 23.6555 24.2352 24.8664 25.8226 26.9211 27.8182 (42b)

Hot water usage for other uses

39.3071 37.8777 36.4484 35.0190 33.5897 32.1603 32.1603 33.5897 35.0190 36.4484 37.8777 39.3071 (42c)

Average daily hot water use (litres/day) 143.5337 (43)

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

Daily hot water use

156.0739 152.8947 148.9358 142.7072 137.7244 132.3375 130.1132 134.0533 138.2307 143.9060 150.2368 155.6391 (44)

Energy conte 247.1829 217.7201 228.9088 195.3590 185.4035 162.7244 157.3607 165.9860 170.4522 195.2791 214.0398 243.6933 (45)

Energy content (annual) Total = Sum(45)m = 2384.1098
 Distribution loss (46)m = 0.15 x (45)m
 37.0774 32.6580 34.3363 29.3038 27.8105 24.4087 23.6041 24.8979 25.5678 29.2919 32.1060 36.5540 (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 5.0595 4.5699 5.0595 4.8963 5.0595 4.8963 5.0595 5.0595 4.8963 5.0595 4.8963 5.0595 (61)
 Total heat required for water heating calculated for each month
 252.2425 222.2899 233.9683 200.2553 190.4631 167.6207 162.4202 171.0455 175.3485 200.3386 218.9361 248.7528 (62)
 WWHRS -69.0393 -61.0589 -63.9374 -52.9427 -49.3407 -42.2212 -39.5756 -42.0847 -43.6836 -51.4982 -58.3412 -67.7608 (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 -28.7239 -24.1399 -23.0250 -17.0193 -13.5221 -10.6040 -10.3835 -10.8779 -11.1076 -17.4970 -23.1486 -28.7576 (63d) eq.(G2)
 Output from w/h
 154.4792 137.0911 147.0059 130.2933 127.6003 114.7955 112.4610 118.0829 120.5573 131.3434 137.4463 152.2344 (64)
 Total per year (kWh/year) = Sum(64)m = 1583.3906 (64)
 12Total per year (kWh/year) 1583 (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
 83.4532 73.5344 77.3771 66.1809 62.9116 55.3299 53.5873 56.4552 57.8994 66.1952 72.3923 82.2929 (65)

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

Metabolic gains (Table 5), Watts
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 (66)m 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 (66)
 Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
 114.3522 126.6042 114.3522 118.1640 114.3522 118.1640 114.3522 114.3522 118.1640 114.3522 118.1640 114.3522 (67)
 Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
 213.7052 215.9228 210.3345 198.4378 183.4203 169.3060 159.8767 157.6591 163.2474 175.1441 190.1616 204.2759 (68)
 Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 (69)
 Pumps, fans 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 (70)
 Losses e.g. evaporation (negative values) (Table 5)
 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 (71)
 Water heating gains (Table 5)
 112.1683 109.4262 104.0014 91.9180 84.5585 76.8471 72.0259 75.8807 80.4159 88.9720 100.5449 110.6087 (72)
 Total internal gains
 502.3702 514.0977 490.8327 470.6642 444.4756 423.4616 405.3994 407.0365 420.9717 440.6129 471.0150 491.3814 (73)

6. Solar gains

[Jan] Area Solar flux g FF Access Gains
m2 Table 6a Specific data Specific data factor W
W/m2 or Table 6b or Table 6c Table 6d

West 3.1500 19.6403 0.7300 0.7000 0.7700 21.9085 (80)
East 4.9500 19.6403 0.7300 0.7000 0.7700 34.4276 (76)
West 3.3000 19.6403 0.7300 0.7000 0.7700 22.9517 (80)

Solar gains 79.2878 155.1037 255.4338 372.5349 456.5555 467.3658 444.9513 382.2066 297.0800 184.0436 98.8626 65.2024 (83)
Total gains 581.6580 669.2014 746.2664 843.1991 901.0311 890.8274 850.3507 789.2431 718.0518 624.6565 569.8775 556.5838 (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, ni1,m (see Table 9a)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
tau 45.8139 45.9813 46.1466 46.9391 47.0904 47.8078 47.8078 47.9431 47.5289 47.0904 46.7853 46.4705
alpha 4.0543 4.0654 4.0764 4.1293 4.1394 4.1872 4.1872 4.1962 4.1686 4.1394 4.1190 4.0980
util living area
0.9829 0.9692 0.9402 0.8621 0.7283 0.5488 0.4075 0.4544 0.6912 0.9050 0.9700 0.9855 (86)
MIT 19.5002 19.7397 20.0869 20.5257 20.8190 20.9582 20.9905 20.9852 20.8923 20.4876 19.9304 19.4731 (87)
Th 2 20.0181 20.0213 20.0245 20.0393 20.0421 20.0551 20.0551 20.0576 20.0501 20.0421 20.0365 20.0306 (88)
util rest of house
0.9790 0.9624 0.9269 0.8331 0.6770 0.4766 0.3228 0.3658 0.6196 0.8779 0.9622 0.9822 (89)
MIT 2 18.2802 18.5843 19.0191 19.5576 19.8842 20.0280 20.0512 20.0509 19.9709 19.5282 18.8389 18.2545 (90)
Living area fraction fLA = Living area / (4) = 0.1661 (91)
MIT 18.4829 18.7762 19.1965 19.7184 20.0394 20.1825 20.2072 20.2061 20.1240 19.6875 19.0202 18.4569 (92)
Temperature adjustment -0.1500
adjusted MIT 18.3329 18.6262 19.0465 19.5684 19.8894 20.0325 20.0572 20.0561 19.9740 19.5375 18.8702 18.3069 (93)

8. Space heating requirement

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Utilisation 0.9696 0.9493 0.9101 0.8167 0.6681 0.4748 0.3229 0.3656 0.6133 0.8604 0.9492 0.9737 (94)
Useful gains 563.9563 635.2774 679.1832 688.6626 601.9682 422.9376 274.6206 288.5564 440.3994 537.4828 540.9561 541.9551 (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
1170.3718 1140.6269 1038.8616 868.4376 664.5023 434.1872 276.3104 291.3807 472.2256 725.2041 961.2777 1159.9249 (97)
Space heating kWh
451.1731 339.5949 267.6008 129.4380 46.5253 0.0000 0.0000 0.0000 0.0000 139.6646 302.6315 459.7695 (98a)
Space heating requirement - total per year (kWh/year) 2136.3978
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
451.1731 339.5949 267.6008 129.4380 46.5253 0.0000 0.0000 0.0000 0.0000 139.6646 302.6315 459.7695 (98c)
Space heating requirement after solar contribution - total per year (kWh/year) 2136.3978
Space heating per m2 (98c) / (4) = 27.6377 (99)

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (201)
 Fraction of space heat from main system(s) 1.0000 (202)
 Efficiency of main space heating system 1 (in %) 90.5000 (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
 451.1731 339.5949 267.6008 129.4380 46.5253 0.0000 0.0000 0.0000 0.0000 139.6646 302.6315 459.7695 (98)
 Space heating efficiency (main heating system 1)
 90.5000 90.5000 90.5000 90.5000 90.5000 0.0000 0.0000 0.0000 0.0000 90.5000 90.5000 90.5000 (210)
 Space heating fuel (main heating system)
 498.5338 375.2430 295.6915 143.0254 51.4092 0.0000 0.0000 0.0000 0.0000 154.3256 334.3995 508.0326 (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
 154.4792 137.0911 147.0059 130.2933 127.6003 114.7955 112.4610 118.0829 120.5573 131.3434 137.4463 152.2344 (64)
 Efficiency of water heater 87.3000 (216)
 (217)m 89.6617 89.5559 89.3389 88.8659 88.1327 87.3000 87.3000 87.3000 87.3000 88.9203 89.4757 89.6823 (217)
 Fuel for water heating, kWh/month
 172.2911 153.0788 164.5486 146.6178 144.7820 131.4954 128.8213 135.2611 138.0954 147.7090 153.6131 169.7486 (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 22.1089 17.7366 15.9699 11.7002 9.0376 7.3838 8.2444 10.7163 13.9195 18.2631 20.6281 22.7234 (232)
 Electricity generated by PVs (Appendix M) (negative quantity)
 (233a)m -12.7591 -19.4256 -30.1256 -36.6309 -41.9793 -40.0998 -39.6090 -36.1419 -30.5045 -23.3737 -14.5267 -10.8697 (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 -3.4203 -7.4375 -15.2500 -23.6140 -31.9380 -32.3587 -31.9827 -26.7523 -19.1828 -10.8666 -4.6380 -2.6873 (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 2360.6606 (211)
 Space heating fuel - main system 2 0.0000 (213)
 Space heating fuel - secondary 0.0000 (215)
 Efficiency of water heater 87.3000
 Water heating fuel used 1786.0623 (219)
 Space cooling fuel 0.0000 (221)

Electricity for pumps and fans:
 central heating pump 41.0000 (230c)
 main heating flue fan 45.0000 (230e)
 Total electricity for the above, kWh/year 86.0000 (231)
 Electricity for lighting (calculated in Appendix L) 178.4318 (232)
 Energy saving/generation technologies (Appendices M, N and Q)
 PV generation -546.1739 (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 3864.9807 (238)

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

Energy Emission factor Emissions
 kWh/year kg CO₂/kWh kg CO₂/year
 Space heating - main system 1 2360.6606 0.2100 495.7387 (261)
 Water heating (other fuel) 1786.0623 0.2100 375.0731 (264)
 Space and water heating 870.8118 (265)
 Pumps, fans and electric keep-hot 86.0000 0.1387 11.9293 (267)
 Energy for lighting 178.4318 0.1443 25.7532 (268)
 Energy saving/generation technologies
 PV Unit electricity used in dwelling -336.0457 0.1330 -44.6987
 PV Unit electricity exported -210.1282 0.1250 -26.2685
 Total -70.9672 (269)
 Total CO₂, kg/year 837.5271 (272)
 Dwelling Carbon Dioxide Emission Rate (DER) 10.8300 (273)

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

Energy Primary energy factor Primary energy
 kWh/year kg CO₂/kWh kWh/year
 Space heating - main system 1 2360.6606 1.1300 2667.5464 (275)
 Water heating (other fuel) 1786.0623 1.1300 2018.2504 (278)
 Space and water heating 4685.7968 (279)
 Pumps, fans and electric keep-hot 86.0000 1.5128 130.1008 (281)
 Energy for lighting 178.4318 1.5338 273.6847 (282)
 Energy saving/generation technologies
 PV Unit electricity used in dwelling -336.0457 1.4915 -501.2141
 PV Unit electricity exported -210.1282 0.4588 -96.4143
 Total -597.6284 (283)
 Total Primary energy kWh/year 4491.9539 (286)
 Dwelling Primary energy Rate (DPER) 58.1100 (287)

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

1. Overall dwelling characteristics

Area Storey height Volume

(m2) (m) (m3)

Ground floor 38.6500 (1b) x 2.3100 (2b) = 89.2815 (1b) - (3b)

First floor 38.6500 (1c) x 2.5600 (2c) = 98.9440 (1c) - (3c)

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 77.3000 (4)

Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 188.2255 (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 3 * 10 = 30.0000 (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) = 30.0000 / (5) = 0.1594 (8)

Pressure test Yes

Pressure Test Method Blower Door

Measured/design AP50 5.0000 (17)

Infiltration rate 0.4094 (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) = 0.3480 (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 infiltr rate

0.4437 0.4350 0.4263 0.3828 0.3741 0.3306 0.3306 0.3219 0.3480 0.3741 0.3915 0.4089 (22b)

Effective ac 0.5984 0.5946 0.5909 0.5733 0.5700 0.5546 0.5546 0.5518 0.5605 0.5700 0.5766 0.5836 (25)

3. Heat losses and heat loss parameter

Element Gross Openings NetArea U-value A x U K-value A x K
 m2 m2 m2 W/m2K W/K kJ/m2K kJ/K
 TER Opaque door 2.3700 1.0000 2.3700 (26)
 TER Opening Type (Uw = 1.20) 11.4000 1.1450 13.0534 (27)
 150 P 38.6500 0.1300 5.0245 (28a)
 100 AP 46.7500 13.7700 32.9800 0.1800 5.9364 (29a)
 400 MW 38.6500 38.6500 0.1100 4.2515 (30)
 Total net area of external elements Aum(A, m2) 124.0500 (31)
 Fabric heat loss, W/K = Sum (A x U) (26)...(30) + (32) = 30.6358 (33)
 E-WM-22 78.4300 0.0000 0.0000 (32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 177.9498 (35)
 Thermal bridges (Sum(L x Psi) calculated using Appendix K) 8.4603 (36)
 Point Thermal bridges 5.0000 (36a)
 Total fabric heat loss (33) + (36) + (36a) = 44.0961 (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 37.1706 36.9332 36.7005 35.6076 35.4031 34.4512 34.4512 34.2749 34.8178 35.4031 35.8168 36.2492 (38)
 Heat transfer coeff
 81.2667 81.0293 80.7966 79.7037 79.4992 78.5473 78.5473 78.3710 78.9140 79.4992 79.9129 80.3454 (39)
 Average = Sum(39)m / 12 = 79.7027

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 HLP 1.0513 1.0482 1.0452 1.0311 1.0285 1.0161 1.0161 1.0139 1.0209 1.0285 1.0338 1.0394 (40)
 HLP (average) 1.0311
 Days in month 31 28 31 30 31 30 31 31 30 31 30 31

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.4096 (42)
 Hot water usage for mixer showers
 64.6213 63.6502 62.2351 59.5275 57.5293 55.3010 54.0345 55.4389 56.9784 59.3709 62.1367 64.3737 (42a)
 Hot water usage for baths
 27.9125 27.4980 26.9142 25.8379 25.0319 24.1382 23.6555 24.2352 24.8664 25.8226 26.9211 27.8182 (42b)
 Hot water usage for other uses
 39.3071 37.8777 36.4484 35.0190 33.5897 32.1603 32.1603 33.5897 35.0190 36.4484 37.8777 39.3071 (42c)
 Average daily hot water use (litres/day) 121.1917 (43)
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 Daily hot water use
 131.8409 129.0259 125.5977 120.3844 116.1509 111.5996 109.8503 113.2637 116.8638 121.6419 126.9355 131.4990 (44)
 Energy conte 208.8038 183.7312 193.0389 164.8002 156.3615 137.2247 132.8544 140.2442 144.1047 165.0669 180.8429 205.8956 (45)
 Energy content (annual) Total = Sum(45)m = 2012.9690
 Distribution loss (46)m = 0.15 x (45)m
 31.3206 27.5597 28.9558 24.7200 23.4542 20.5837 19.9282 21.0366 21.6157 24.7600 27.1264 30.8843 (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
 259.7627 229.7586 243.9978 214.1153 207.3204 186.5398 183.8133 191.2031 193.4198 216.0258 230.1580 256.8545 (62)
 WWHRS -29.5422 -26.1273 -27.3590 -22.6544 -21.1131 -18.0666 -16.9346 -18.0082 -18.6924 -22.0363 -24.9644 -28.9951 (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)
 FGHS 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
 230.2205 203.6312 216.6388 191.4609 186.2073 168.4732 166.8788 173.1949 174.7274 193.9895 205.1936 227.8594 (64)
 Total per year (kWh/year) = Sum(64)m = 2338.4754 (64)
 12Total per year (kWh/year) 2338 (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
 82.1670 72.5975 76.9252 67.1248 64.7299 57.9560 56.9138 59.3709 60.2436 67.6245 72.4590 81.2000 (65)

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

Metabolic gains (Table 5), Watts
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 (66)m 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 (66)
 Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
 114.3522 126.6042 114.3522 118.1640 114.3522 118.1640 114.3522 114.3522 118.1640 114.3522 118.1640 114.3522 (67)
 Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
 213.7052 215.9228 210.3345 198.4378 183.4203 169.3060 159.8767 157.6591 163.2474 175.1441 190.1616 204.2759 (68)
 Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 (69)
 Pumps, fans 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 3.0000 (70)
 Losses e.g. evaporation (negative values) (Table 5)
 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 (71)
 Water heating gains (Table 5)
 110.4395 108.0319 103.3940 93.2289 87.0026 80.4944 76.4971 79.7996 83.6716 90.8931 100.6376 109.1398 (72)
 Total internal gains
 500.6414 512.7035 490.2253 471.9752 446.9196 427.1089 409.8705 410.9555 424.2275 442.5340 471.1076 489.9125 (73)

6. Solar gains

[Jan] Area Solar flux g FF Access Gains
 m2 Table 6a Specific data Specific data factor W
 W/m2 or Table 6b or Table 6c Table 6d
 East 4.9500 19.6403 0.6300 0.7000 0.7700 29.7115 (76)
 West 6.4500 19.6403 0.6300 0.7000 0.7700 38.7150 (80)
 Solar gains 68.4264 133.8566 220.4428 321.5027 394.0137 403.3431 383.9991 329.8495 256.3841 158.8322 85.3197 56.2706 (83)
 Total gains 569.0679 646.5601 710.6681 793.4779 840.9333 830.4520 793.8696 740.8050 680.6116 601.3662 556.4274 546.1831 (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, ni1,m (see Table 9a)

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

tau 47.0178 47.1555 47.2913 47.9398 48.0631 48.6456 48.6456 48.7550 48.4195 48.0631 47.8143 47.5569

alpha 4.1345 4.1437 4.1528 4.1960 4.2042 4.2430 4.2430 4.2503 4.2280 4.2042 4.1876 4.1705

util living area

0.9838 0.9717 0.9466 0.8773 0.7526 0.5747 0.4280 0.4747 0.7096 0.9116 0.9716 0.9862 (86)

MIT 19.5340 19.7555 20.0814 20.5043 20.8032 20.9529 20.9892 20.9835 20.8859 20.4849 19.9472 19.5042 (87)

Th 2 20.0408 20.0433 20.0458 20.0575 20.0597 20.0699 20.0699 20.0718 20.0660 20.0597 20.0553 20.0506 (88)

util rest of house

0.9802 0.9655 0.9346 0.8506 0.7030 0.5016 0.3409 0.3841 0.6392 0.8862 0.9642 0.9831 (89)

MIT 2 18.3387 18.6199 19.0291 19.5492 19.8856 20.0388 20.0653 20.0642 19.9810 19.5398 18.8734 18.3077 (90)

Living area fraction fLA = Living area / (4) = 0.1661 (91)

MIT 18.5372 18.8086 19.2039 19.7079 20.0380 20.1906 20.2188 20.2169 20.1313 19.6968 19.0518 18.5064 (92)

Temperature adjustment 0.0000

adjusted MIT 18.5372 18.8086 19.2039 19.7079 20.0380 20.1906 20.2188 20.2169 20.1313 19.6968 19.0518 18.5064 (93)

8. Space heating requirement

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

Utilisation 0.9722 0.9548 0.9213 0.8392 0.7018 0.5115 0.3551 0.3987 0.6445 0.8743 0.9537 0.9759 (94)

Useful gains 553.2726 617.3154 654.7629 665.8835 590.1767 424.7638 281.8994 295.3252 438.6592 525.7799 530.6904 533.0300 (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

1157.0121 1127.0014 1026.4300 861.4272 662.8664 439.1296 284.2467 299.1364 475.9537 723.1897 955.1016 1149.4535 (97)

Space heating kWh

449.1821 342.5090 276.5203 140.7915 54.0812 0.0000 0.0000 0.0000 0.0000 146.8729 305.5761 458.6191 (98a)

Space heating requirement - total per year (kWh/year) 2174.1523

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

449.1821 342.5090 276.5203 140.7915 54.0812 0.0000 0.0000 0.0000 0.0000 146.8729 305.5761 458.6191 (98c)

Space heating requirement after solar contribution - total per year (kWh/year) 2174.1523

Space heating per m2 (98c) / (4) = 28.1262 (99)

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (201)

Fraction of space heat from main system(s) 1.0000 (202)

Efficiency of main space heating system 1 (in %) 92.4000 (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	449.1821	342.5090	276.5203	140.7915	54.0812	0.0000	0.0000	0.0000	0.0000	146.8729	305.5761	458.6191	(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)	486.1279	370.6808	299.2644	152.3717	58.5294	0.0000	0.0000	0.0000	0.0000	158.9534	330.7101	496.3410	(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	230.2205	203.6312	216.6388	191.4609	186.2073	168.4732	166.8788	173.1949	174.7274	193.9895	205.1936	227.8594	(64)	
Efficiency of water heater 80.3000 (216)														
Fuel for water heating, kWh/month	268.3639	238.2032	255.1530	228.6580	226.8407	209.8047	207.8191	215.6848	217.5932	231.5112	240.7447	265.4213	(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	(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	23.7601	19.0613	17.1626	12.5740	9.7125	7.9352	8.8601	11.5167	14.9590	19.6271	22.1687	24.4205	(232)	
Electricity generated by PVs (Appendix M) (negative quantity)	(233a)m	-36.1206	-50.8978	-73.1231	-82.1734	-88.5728	-82.6620	-81.6455	-77.1020	-69.0665	-58.1890	-39.7039	-31.2318	(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	-20.4706	-43.0621	-85.5889	-128.5475	-169.9704	-170.7789	-168.7635	-142.8853	-104.7265	-61.5748	-27.3290	-16.1871	(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	2352.9786													(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	2805.7978													(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)	191.7579													(232)

Saved to this PC

Saved to this PC

Energy saving/generation technologies (Appendices M,N and Q)
 PV generation -1910.3732 (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 3526.1612 (238)

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

Energy Emission factor Emissions
 kWh/year kg CO₂/kWh kg CO₂/year
 Space heating - main system 1 2352.9786 0.2100 494.1255 (261)
 Water heating (other fuel) 2805.7978 0.2100 589.2175 (264)
 Space and water heating 1083.3430 (265)
 Pumps, fans and electric keep-hot 86.0000 0.1387 11.9293 (267)
 Energy for lighting 191.7579 0.1443 27.6766 (268)

Energy saving/generation technologies
 PV Unit electricity used in dwelling -770.4885 0.1346 -103.7050
 PV Unit electricity exported -1139.8847 0.1259 -143.5079
 Total -247.2128 (269)
 Total CO₂, kg/year 875.7361 (272)
 Target Carbon Dioxide Emission Rate (TER) 11.3300 (273)

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

Energy Primary energy factor Primary energy
 kWh/year kg CO₂/kWh kWh/year
 Space heating - main system 1 2352.9786 1.1300 2658.8659 (275)
 Water heating (other fuel) 2805.7978 1.1300 3170.5515 (278)
 Space and water heating 5829.4174 (279)
 Pumps, fans and electric keep-hot 86.0000 1.5128 130.1008 (281)
 Energy for lighting 191.7579 1.5338 294.1246 (282)

Energy saving/generation technologies
 PV Unit electricity used in dwelling -770.4885 1.4974 -1153.7649
 PV Unit electricity exported -1139.8847 0.4621 -526.7727
 Total -1680.5376 (283)
 Total Primary energy kWh/year 4573.1052 (286)
 Target Primary Energy Rate (TPER) 59.1600 (287)

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF FABRIC ENERGY EFFICIENCY

1. Overall dwelling characteristics

Area Storey height Volume

(m²) (m) (m³)

Ground floor 38.6500 (1b) x 2.3100 (2b) = 89.2815 (1b) - (3b)

First floor 38.6500 (1c) x 2.5600 (2c) = 98.9440 (1c) - (3c)

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 77.3000 (4)

Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 188.2255 (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 3 * 10 = 30.0000 (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) = 30.0000 / (5) = 0.1594 (8)

Pressure test Yes

Pressure Test Method Blower Door

Measured/design AP50 5.0100 (17)

Infiltration rate 0.4099 (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) = 0.3484 (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

0.4442 0.4355 0.4268 0.3832 0.3745 0.3310 0.3310 0.3223 0.3484 0.3745 0.3920 0.4094 (22b)

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) 0.0000 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0.0000 (23c)

Effective ac 0.5987 0.5948 0.5911 0.5734 0.5701 0.5548 0.5548 0.5519 0.5607 0.5701 0.5768 0.5838 (25)

3. Heat losses and heat loss parameter

Element Gross Openings NetArea U-value A x U K-value A x K
 m² m² m² W/m²K W/K kJ/m²K kJ/K
 Front door 2.3700 1.0000 2.3700 (26)
 French door (U_w = 1.20) 3.1500 1.1450 3.6069 (27)
 Window (U_w = 1.20) 8.2500 1.1450 9.4466 (27)
 150 P 38.6500 0.1300 5.0245 110.0000 4251.5000 (28a)
 100 AP 46.7500 13.7700 32.9800 0.1900 6.2662 41.1300 1356.4674 (29a)
 400 MW 38.6500 38.6500 0.1100 4.2515 9.5000 367.1750 (30)
 Total net area of external elements A_{um}(A, m²) 124.0500 (31)
 Fabric heat loss, W/K = Sum (A x U) (26)...(30) + (32) = 30.9656 (33)
 E-WM-22 78.4300 0.0000 0.0000 70.5000 5529.3150 (32)
 GF Timber 61.0100 7.7000 469.7770 (32c)
 FF Timber 95.8100 7.7000 737.7370 (32c)
 FF Floor 38.6500 18.0000 695.7000 (32d)
 GF Ceiling 38.6500 9.0000 347.8500 (32e)
 Heat capacity C_m = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 13755.5214 (34)
 Thermal mass parameter (TMP = C_m / TFA) in kJ/m²K 177.9498 (35)
 Thermal bridges (User defined value 0.069 * total exposed area) 8.5595 (36)
 Point Thermal bridges 5.0000 (36a)
 Total fabric heat loss (33) + (36) + (36a) = 44.5251 (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 37.1855 36.9476 36.7143 35.6187 35.4137 34.4595 34.4595 34.2828 34.8270 35.4137 35.8284 36.2619 (38)
 Heat transfer coeff
 81.7106 81.4726 81.2394 80.1438 79.9388 78.9846 78.9846 78.8078 79.3521 79.9388 80.3535 80.7870 (39)
 Average = Sum(39)m / 12 = 80.1428

 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 HLP 1.0571 1.0540 1.0510 1.0368 1.0341 1.0218 1.0218 1.0195 1.0265 1.0341 1.0395 1.0451 (40)
 HLP (average) 1.0368
 Days in month 31 28 31 30 31 30 31 31 30 31 30 31

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.4096 (42)
 Hot water usage for mixer showers
 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (42a)
 Hot water usage for baths
 27.9125 27.4980 26.9142 25.8379 25.0319 24.1382 23.6555 24.2352 24.8664 25.8226 26.9211 27.8182 (42b)
 Hot water usage for other uses
 39.3071 37.8777 36.4484 35.0190 33.5897 32.1603 32.1603 33.5897 35.0190 36.4484 37.8777 39.3071 (42c)
 Average daily hot water use (litres/day) 61.6130 (43)

 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 Daily hot water use
 67.2196 65.3757 63.3626 60.8569 58.6216 56.2986 55.8158 57.8249 59.8854 62.2710 64.7988 67.1252 (44)
 Energy conte 106.4594 93.0941 97.3859 83.3100 78.9159 69.2256 67.5044 71.5993 73.8447 84.5011 92.3178 105.1019 (45)
 Energy content (annual) Total = Sum(45)m = 1023.2602
 Distribution loss (46)m = 0.15 x (45)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 (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 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
 90.4905 79.1300 82.7780 70.8135 67.0785 58.8418 57.3788 60.8594 62.7680 71.8260 78.4702 89.3366 (62)
 WWHRS 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (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)
 FGHS 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
 90.4905 79.1300 82.7780 70.8135 67.0785 58.8418 57.3788 60.8594 62.7680 71.8260 78.4702 89.3366 (64)
 Total per year (kWh/year) = Sum(64)m = 869.7712 (64)
 12Total per year (kWh/year) 870 (64)
 Electric shower(s)
 51.7509 46.1105 50.3509 48.0492 48.9509 46.6944 48.2509 48.9509 48.0492 50.3509 49.4041 51.7509 (64a)
 Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 588.6637 (64a)
 Heat gains from water heating, kWh/month
 35.5603 31.3101 33.2822 29.7157 29.0074 26.3840 26.4074 27.4526 27.7043 30.5442 31.9686 35.2719 (65)

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

Metabolic gains (Table 5), Watts
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 (66)m 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 (66)
 Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
 114.3522 126.6042 114.3522 118.1640 114.3522 118.1640 114.3522 114.3522 118.1640 114.3522 118.1640 114.3522 (67)
 Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
 213.7052 215.9228 210.3345 198.4378 183.4203 169.3060 159.8767 157.6591 163.2474 175.1441 190.1616 204.2759 (68)
 Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 (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)
 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 (71)
 Water heating gains (Table 5)
 47.7962 46.5924 44.7342 41.2718 38.9884 36.6445 35.4938 36.8986 38.4782 41.0541 44.4008 47.4084 (72)
 Total internal gains
 434.9981 448.2640 428.5654 417.0181 395.9054 383.2589 368.8673 368.0545 379.0341 389.6949 411.8709 425.1811 (73)

6. Solar gains

[Jan] Area Solar flux g FF Access Gains
m2 Table 6a Specific data Specific data factor W
W/m2 or Table 6b or Table 6c Table 6d

West 3.1500 19.6403 0.7300 0.7000 0.7700 21.9085 (80)
East 4.9500 19.6403 0.7300 0.7000 0.7700 34.4276 (76)
West 3.3000 19.6403 0.7300 0.7000 0.7700 22.9517 (80)

Solar gains 79.2878 155.1037 255.4338 372.5349 456.5555 467.3658 444.9513 382.2066 297.0800 184.0436 98.8626 65.2024 (83)
Total gains 514.2859 603.3677 683.9992 789.5530 852.4609 850.6247 813.8186 750.2611 676.1141 573.7386 510.7334 490.3835 (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, ni1,m (see Table 9a)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
tau 46.7623 46.8989 47.0336 47.6765 47.7988 48.3763 48.4847 48.1522 47.7988 47.5521 47.2969
alpha 4.1175 4.1266 4.1356 4.1784 4.1866 4.2251 4.2251 4.2323 4.2101 4.1866 4.1701 4.1531
util living area
0.9887 0.9777 0.9528 0.8798 0.7484 0.5656 0.4202 0.4714 0.7148 0.9232 0.9789 0.9906 (86)
MIT 19.4281 19.6736 20.0323 20.4925 20.8052 20.9549 20.9898 20.9837 20.8812 20.4430 19.8623 19.3953 (87)
Th 2 20.0361 20.0386 20.0411 20.0528 20.0550 20.0652 20.0652 20.0671 20.0613 20.0550 20.0505 20.0459 (88)
util rest of house
0.9861 0.9726 0.9419 0.8534 0.6984 0.4928 0.3341 0.3810 0.6443 0.9001 0.9731 0.9884 (89)
MIT 2 18.6063 18.8505 19.2029 19.6468 19.9211 20.0421 20.0618 20.0613 19.9921 19.6130 19.0481 18.5811 (90)
Living area fraction fLA = Living area / (4) = 0.1661 (91)
MIT 18.7428 18.9872 19.3407 19.7873 20.0679 20.1937 20.2160 20.2145 20.1398 19.7508 19.1834 18.7164 (92)
Temperature adjustment 0.0000
adjusted MIT 18.7428 18.9872 19.3407 19.7873 20.0679 20.1937 20.2160 20.2145 20.1398 19.7508 19.1834 18.7164 (93)

8. Space heating requirement

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Utilisation 0.9813 0.9653 0.9321 0.8450 0.6991 0.5032 0.3482 0.3956 0.6507 0.8911 0.9663 0.9843 (94)
Useful gains 504.6564 582.4442 637.5750 667.1373 595.9959 428.0341 283.3747 296.8246 439.9491 511.2656 493.4965 482.6640 (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
1180.1268 1147.7232 1043.1703 872.5484 668.9232 441.8195 285.6055 300.6108 479.2683 731.5062 970.9410 1172.7335 (97)
Space heating kWh
502.5500 379.8675 301.7629 147.8960 54.2578 0.0000 0.0000 0.0000 163.8590 343.7601 513.4117 (98a)
Space heating requirement - total per year (kWh/year) 2407.3651
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
502.5500 379.8675 301.7629 147.8960 54.2578 0.0000 0.0000 0.0000 163.8590 343.7601 513.4117 (98c)
Space heating requirement after solar contribution - total per year (kWh/year) 2407.3651
Space heating per m2 (98c) / (4) = 31.1431 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

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

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

Heat loss rate W

0.0000 0.0000 0.0000 0.0000 0.0000 742.4548 584.4857 598.9396 0.0000 0.0000 0.0000 0.0000 (100)

Utilisation 0.0000 0.0000 0.0000 0.0000 0.0000 0.8922 0.9378 0.9154 0.0000 0.0000 0.0000 0.0000 (101)

Useful loss 0.0000 0.0000 0.0000 0.0000 0.0000 662.4490 548.1534 548.2667 0.0000 0.0000 0.0000 0.0000 (102)

Total gains 0.0000 0.0000 0.0000 0.0000 0.0000 945.6772 905.0600 833.0586 0.0000 0.0000 0.0000 0.0000 (103)

Space cooling kWh

0.0000 0.0000 0.0000 0.0000 0.0000 203.9243 265.5385 211.8852 0.0000 0.0000 0.0000 0.0000 (104)

Cooled fraction fC = cooled area / (4) = 1.0000 (105)

Intermittency factor (Table 10b)

0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 (106)

Space cooling kWh

0.0000 0.0000 0.0000 0.0000 0.0000 50.9811 66.3846 52.9713 0.0000 0.0000 0.0000 0.0000 (107)

Space cooling requirement 170.3370 (107)

Energy for space heating 31.1431 (99)

Energy for space cooling 2.2036 (108)

Total 33.3467 (109)

Fabric Energy Efficiency (DFEE) 33.3 (109)

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

1. Overall dwelling characteristics

Area Storey height Volume

(m²) (m) (m³)

Ground floor 38.6500 (1b) x 2.3100 (2b) = 89.2815 (1b) - (3b)

First floor 38.6500 (1c) x 2.5600 (2c) = 98.9440 (1c) - (3c)

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 77.3000 (4)

Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 188.2255 (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 3 * 10 = 30.0000 (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) = 30.0000 / (5) = 0.1594 (8)

Pressure test Yes

Pressure Test Method Blower Door

Measured/design AP50 5.0000 (17)

Infiltration rate 0.4094 (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) = 0.3480 (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

0.4437 0.4350 0.4263 0.3828 0.3741 0.3306 0.3306 0.3219 0.3480 0.3741 0.3915 0.4089 (22b)

If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) 0.0000 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0.0000 (23c)

Effective ac 0.5984 0.5946 0.5909 0.5733 0.5700 0.5546 0.5546 0.5518 0.5605 0.5700 0.5766 0.5836 (25)

3. Heat losses and heat loss parameter

Element Gross Openings NetArea U-value A x U K-value A x K
 m² m² m² W/m²K W/K kJ/m²K kJ/K
 TER Opaque door 2.3700 1.0000 2.3700 (26)
 TER Opening Type (Uw = 1.20) 11.4000 1.1450 13.0534 (27)
 150 P 38.6500 0.1300 5.0245 (28a)
 100 AP 46.7500 13.7700 32.9800 0.1800 5.9364 (29a)
 400 MW 38.6500 38.6500 0.1100 4.2515 (30)
 Total net area of external elements Aum(A, m²) 124.0500 (31)
 Fabric heat loss, W/K = Sum (A x U) (26)...(30) + (32) = 30.6358 (33)
 E-WM-22 78.4300 0.0000 0.0000 (32)
 Thermal mass parameter (TMP = Cm / TFA) in kJ/m²K 177.9498 (35)
 Thermal bridges (Sum(L x Psi) calculated using Appendix K) 8.4603 (36)
 Point Thermal bridges 5.0000 (36a)
 Total fabric heat loss (33) + (36) + (36a) = 44.0961 (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 37.1706 36.9332 36.7005 35.6076 35.4031 34.4512 34.4512 34.2749 34.8178 35.4031 35.8168 36.2492 (38)
 Heat transfer coeff
 81.2667 81.0293 80.7966 79.7037 79.4992 78.5473 78.5473 78.3710 78.9140 79.4992 79.9129 80.3454 (39)
 Average = Sum(39)m / 12 = 79.7027
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 HLP 1.0513 1.0482 1.0452 1.0311 1.0285 1.0161 1.0161 1.0139 1.0209 1.0285 1.0338 1.0394 (40)
 HLP (average) 1.0311
 Days in month 31 28 31 30 31 30 31 31 30 31 30 31

4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.4096 (42)
 Hot water usage for mixer showers
 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (42a)
 Hot water usage for baths
 27.9125 27.4980 26.9142 25.8379 25.0319 24.1382 23.6555 24.2352 24.8664 25.8226 26.9211 27.8182 (42b)
 Hot water usage for other uses
 39.3071 37.8777 36.4484 35.0190 33.5897 32.1603 32.1603 33.5897 35.0190 36.4484 37.8777 39.3071 (42c)
 Average daily hot water use (litres/day) 61.6130 (43)
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 Daily hot water use
 67.2196 65.3757 63.3626 60.8569 58.6216 56.2986 55.8158 57.8249 59.8854 62.2710 64.7988 67.1252 (44)
 Energy conte 106.4594 93.0941 97.3859 83.3100 78.9159 69.2256 67.5044 71.5993 73.8447 84.5011 92.3178 105.1019 (45)
 Energy content (annual) Total = Sum(45)m = 1023.2602
 Distribution loss (46)m = 0.15 x (45)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 (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 0.0000 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
 90.4905 79.1300 82.7780 70.8135 67.0785 58.8418 57.3788 60.8594 62.7680 71.8260 78.4702 89.3366 (62)
 WWHRS 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 (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)
 FGHS 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
 90.4905 79.1300 82.7780 70.8135 67.0785 58.8418 57.3788 60.8594 62.7680 71.8260 78.4702 89.3366 (64)
 Total per year (kWh/year) = Sum(64)m = 869.7712 (64)
 12 Total per year (kWh/year) 870 (64)
 Electric shower(s)
 51.7509 46.1105 50.3509 48.0492 48.9509 46.6944 48.2509 48.9509 48.0492 50.3509 49.4041 51.7509 (64a)
 Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 588.6637 (64a)
 Heat gains from water heating, kWh/month
 35.5603 31.3101 33.2822 29.7157 29.0074 26.3840 26.4074 27.4526 27.7043 30.5442 31.9686 35.2719 (65)

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

Metabolic gains (Table 5), Watts

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 (66)m 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 120.4817 (66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

114.3522 126.6042 114.3522 118.1640 114.3522 118.1640 114.3522 114.3522 118.1640 114.3522 118.1640 114.3522 (67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

213.7052 215.9228 210.3345 198.4378 183.4203 169.3060 159.8767 157.6591 163.2474 175.1441 190.1616 204.2759 (68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 35.0482 (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)

-96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 -96.3854 (71)

Water heating gains (Table 5)

47.7962 46.5924 44.7342 41.2718 38.9884 36.6445 35.4938 36.8986 38.4782 41.0541 44.4008 47.4084 (72)

Total internal gains

434.9981 448.2640 428.5654 417.0181 395.9054 383.2589 368.8673 368.0545 379.0341 389.6949 411.8709 425.1811 (73)

6. Solar gains

[Jan] Area Solar flux g FF Access Gains

m2 Table 6a Specific data Specific data factor W

W/m2 or Table 6b or Table 6c Table 6d

East 4.9500 19.6403 0.6300 0.7000 0.7700 29.7115 (76)

West 6.4500 19.6403 0.6300 0.7000 0.7700 38.7150 (80)

Solar gains 68.4264 133.8566 220.4428 321.5027 394.0137 403.3431 383.9991 329.8495 256.3841 158.8322 85.3197 56.2706 (83)
 Total gains 503.4245 582.1206 649.0083 738.5208 789.9191 786.6020 752.8663 697.9040 635.4182 548.5271 497.1906 481.4517 (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, ni1,m (see Table 9a)
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 tau 47.0178 47.1555 47.2913 47.9398 48.0631 48.6456 48.6456 48.7550 48.4195 48.0631 47.8143 47.5569
 alpha 4.1345 4.1437 4.1528 4.1960 4.2042 4.2430 4.2430 4.2503 4.2280 4.2042 4.1876 4.1705
 util living area
 0.9895 0.9801 0.9597 0.8981 0.7802 0.6009 0.4498 0.5010 0.7417 0.9320 0.9806 0.9912 (86)
 MIT 19.4205 19.6493 19.9896 20.4435 20.7725 20.9443 20.9870 20.9799 20.8644 20.4165 19.8492 19.3909 (87)
 Th 2 20.0408 20.0433 20.0458 20.0575 20.0597 20.0699 20.0699 20.0718 20.0660 20.0597 20.0553 20.0506 (88)
 util rest of house
 0.9871 0.9756 0.9502 0.8744 0.7325 0.5263 0.3589 0.4067 0.6727 0.9110 0.9754 0.9892 (89)
 MIT 2 18.6024 18.8304 19.1660 19.6075 19.9007 20.0409 20.0656 20.0645 19.9856 19.5931 19.0390 18.5804 (90)
 Living area fraction fLA = Living area / (4) = 0.1661 (91)
 MIT 18.7383 18.9664 19.3028 19.7464 20.0455 20.1910 20.2186 20.2165 20.1316 19.7299 19.1736 18.7150 (92)
 Temperature adjustment 0.0000
 adjusted MIT 18.7383 18.9664 19.3028 19.7464 20.0455 20.1910 20.2186 20.2165 20.1316 19.7299 19.1736 18.7150 (93)

8. Space heating requirement

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 Utilisation 0.9825 0.9688 0.9409 0.8653 0.7317 0.5365 0.3737 0.4218 0.6780 0.9019 0.9688 0.9852 (94)
 Useful gains 494.6181 563.9528 610.6392 639.0750 577.9690 421.9916 281.3793 294.3852 430.7925 494.7247 481.6879 474.3163 (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
 1173.3494 1139.7927 1034.4218 864.4976 663.4609 439.1559 284.2332 299.1045 475.9767 725.8179 964.8345 1166.2148 (97)
 Space heating kWh
 504.9761 386.9645 315.2942 162.3043 63.6060 0.0000 0.0000 0.0000 0.0000 171.9334 347.8655 514.7725 (98a)
 Space heating requirement - total per year (kWh/year) 2467.7165
 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
 504.9761 386.9645 315.2942 162.3043 63.6060 0.0000 0.0000 0.0000 0.0000 171.9334 347.8655 514.7725 (98c)
 Space heating requirement after solar contribution - total per year (kWh/year) 2467.7165
 Space heating per m2 (98c) / (4) = 31.9239 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 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
 Heat loss rate W
 0.0000 0.0000 0.0000 0.0000 0.0000 738.3447 581.2501 595.6198 0.0000 0.0000 0.0000 0.0000 (100)
 Utilisation 0.0000 0.0000 0.0000 0.0000 0.0000 0.8696 0.9228 0.8980 0.0000 0.0000 0.0000 0.0000 (101)
 Useful loss 0.0000 0.0000 0.0000 0.0000 0.0000 642.0447 536.4027 534.8406 0.0000 0.0000 0.0000 0.0000 (102)
 Total gains 0.0000 0.0000 0.0000 0.0000 0.0000 870.8454 833.8172 771.8620 0.0000 0.0000 0.0000 0.0000 (103)
 Space cooling kWh
 0.0000 0.0000 0.0000 0.0000 0.0000 164.7366 221.2764 176.3439 0.0000 0.0000 0.0000 0.0000 (104)
 Cooled fraction fC = cooled area / (4) = 1.0000 (105)
 Intermittency factor (Table 10b)
 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 (106)
 Space cooling kWh
 0.0000 0.0000 0.0000 0.0000 0.0000 41.1841 55.3191 44.0860 0.0000 0.0000 0.0000 0.0000 (107)
 Space cooling requirement 140.5892 (107)
 Energy for space heating 31.9239 (99)
 Energy for space cooling 1.8187 (108)
 Total 33.7426 (109)
 Fabric Energy Efficiency (TFEE1) 33.7 (109)
 Fabric Energy Efficiency (TFEE2) 38.8
