

Rainsough Hill, Prestwich, MANCHESTER, M25 9SU

Energy Statement

AG-77826-LZCR-Rev A

20th May 2024

Abacus House, 450 Warrington Road, Culcheth, Cheshire, WA3 5QX

Index

1. Executive summary	3
2. The development	4
2.1 Housing mix	5
2.2 Proposed specification & assessment	6
2.3 Reduction in Carbon, energy	8
2.4 Fabric (Be Lean)	10
3. Introduction	12
3.1 Assessment methodology	12
3.2 Energy Hierarchy	14
3.3 Building regulation requirements	16
4. Low or Zero Carbon Technologies (Be Green)	18
4.1 Solar Water	19
4.2 Solar Photovoltaic	20
4.3 Solar PV / Thermal	21
4.4 Hydro	22
4.5 Micro wind	23
4.6 Bio Mass	25
4.7 Heat Pumps	26
4.8 CHP	29
4.9 Fuel Cells	30
5. Other innovative technologies	31
5.1 Flue Gas Heat Recovery Systems (FGHRS)	31
5.2 Waste Water Heat Recovery Systems (WWHRS)	32
5.3 Sunwarm	33
5.4 Geothermic Storage	34
6. Fuel Cost and Carbon	35
7. Excluded technology	36
8. Suitable technologies	39
9. Bibliography and definitions	40
10. Preliminary SAP assessment	41

1. Executive Summary

This report has considered the use of high efficiency alternative heating systems in line with the requirements of Regulation 25a, Approved Document Part L Volume 1 of the building regulations (England) 2021.

The proposed fabric and mechanical specification from Table 2 and Table 3 shown on page 6 of this report will achieve a compliance with AD. L1 2021 building regulations of which fabric and PV technology will provide the following reductions in energy, primary energy over and above the requirements of Part L 2021.

Reduction in Regulated use

Energy (Consumption)	60.92%
Primary Energy (Total energy)	49.33%
Carbon emissions	77.74%

Reduction in Total use

Energy (Consumption)	37.87%
Primary Energy (Total energy)	28.68%
Carbon emissions	57.71%

Estimated residual carbon emissions 3,944.78 Kg/CO₂

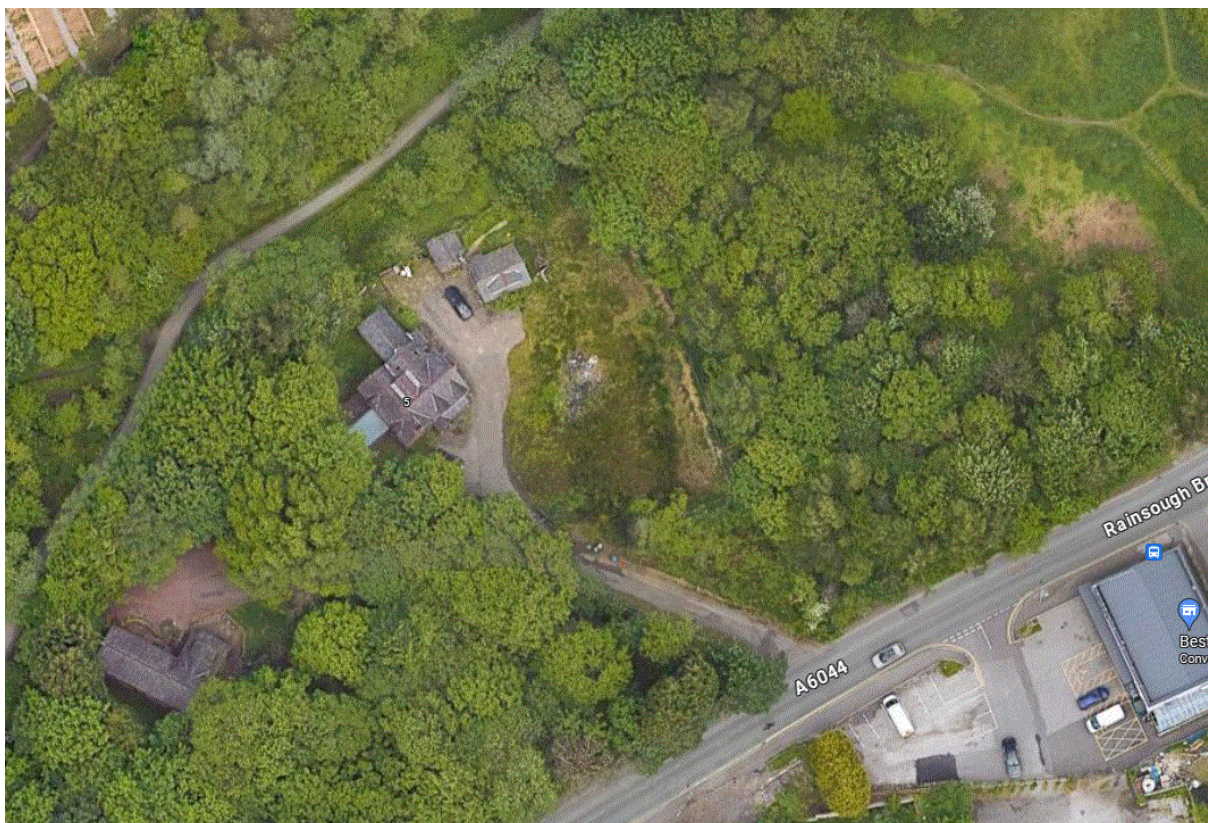
Proposed Solution

The proposed solution is to use a fabric first approach with high efficient heat pump technology to achieve compliance with Approved Document Part L1 of the building regulations 2021.

Photovoltaic panels will be included however roof configurations do not lend themselves to this type of technology also there is site overshadowing from mature trees to the south and southeast of the site which may affect panel performance.

2. The development

The residential development at Rainsough Hill, Prestwich, MANCHESTER, M25 9SU comprises a total of 4 dwellings which are to achieve compliance with approved document Part L1 of the building regulations 2021.



2.1. Housing mix

House types	Number	Area m ²	Total area m ²
A	4	163.40	653.60
Total	4		653.60

2.2. Proposed specification & assessment

The objective of this section of the report is to provide more information on specific requirements and details of the proposed fabric and heating and solutions, from this initial assessment and specific technical requirements a detailed heating design will need to be provided by a specialist who may be required to work with manufacturers. Technical information from the manufacturers will be included as an Appendix to this main report when available.

Table 2: Proposed fabric specification

Roof	0.10	W/m ² K
Walls	0.18	W/m ² K
Floor	0.11	W/m ² K
Windows	1.20	W/m ² K
Doors	1.00	W/m ² K
Thermal Bridging	Modelled Thermal bridging details	
Air permeability	4 m ²	

Table 3: Mechanical Specification

Heating	Highly efficient Heat pump Technology
Controls	Time and Temperature Zone Control
Domestic Hot Water	From main system
Compensator	Delayed start thermostat
Ventilation	Decentralised, Mechanical Extract Ventilation dMEV
Lighting	= > 80lumes / watt
Photovoltaic Panels	1.60Kw Peak PV panels installed to all dwellings

Energy, Primary Energy, Carbon and running costs based current proposals

Development (Proposed)	m²
GIFA (Development)	653.60
Energy	KwH
Heating	9,848.08
Hot water	4,242.76
Fans and Pumps	319.80
Lighting	1,142.80
Appliances	15,302.36
Cooking	2,365.53
Total Energy use	33,221.33
Energy Kw per m ² of floor area	50.83
Energy (Primary)	Kwpe
Heating	14,781.97
Hot water	6,368.38
Fans and Pumps	480.02
Lighting	1,715.34
Appliances	22,968.84
Cooking	3,550.66
Total Energy use	49,865.22
Energy Kw per m ² of floor area	76.29
CO2 emissions	Kg CO2
Heating	1,339.34
Hot water	577.02
Fans and Pumps	43.49
Lighting	155.42
Appliances	2,081.12
Cooking	321.71
Total CO2 emissions	4,518.10
Annual predicted carbon emissions per m ² of floor area	6.91
Running Cost	£ pa
Heating	£ 3,052.90
Hot water	£ 1,315.26
Fans and Pumps	£ 99.14
Lighting	£ 354.27
Appliances	£ 4,743.73
Cooking	£ 733.32
Standing Charges	£ 1,059.38
Total Running Costs	£ 11,357.99
Average annual Running Costs per residential unit	£ 2,839.50

Estimated fuel costs are based on the Government price cap figures from July 2023, running costs are for comparison purposes and actual running costs may differ depending on actual use.

2.3. Reduction in Carbon, Energy from improved fabric and mechanical specification

Energy (KwH)	NOTIONAL	PROPOSED
Heating	28,002.52	9,848.08
Hot water	12,263.52	4,242.76
Fans and Pumps	344.00	319.80
Lighting	1,132.56	1,142.80
Appliances	15,302.36	15,302.36
Cooking	2,365.53	2,365.53
Photovoltaic (electricity used in dwelling)	-4,901.84	-2,647.68
Photovoltaic (electricity exported)	-7,826.72	-1,567.88
Total	46,681.93	29,005.77

Reduction in energy	17676.16
Percentage reduction	37.87%

Energy Primary (Kwpe)	NOTIONAL	PROPOSED
Heating	31,642.85	14,781.97
Hot water	13,857.78	6,368.38
Fans and Pumps	516.34	480.02
Lighting	1,699.97	1,715.34
Appliances	22,968.84	22,968.84
Cooking	3,550.66	3,550.66
Photovoltaic (electricity used in dwelling)	-7,357.66	-3,974.17
Photovoltaic (electricity exported)	-3,522.02	-705.55
Total	63,356.76	45,185.50

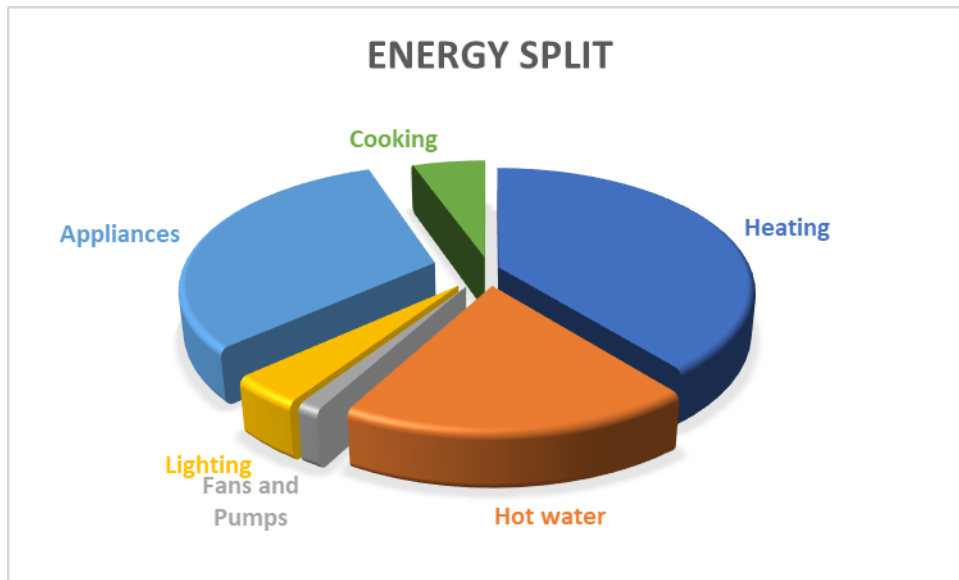
Reduction in energy	18171.26
Percentage reduction	28.68%

Carbon emissions (Kg/CO2)	NOTIONAL	PROPOSED
Heating	5,880.53	1,339.34
Hot water	2,575.34	577.02
Fans and Pumps	46.78	43.49
Lighting	154.03	155.42
Appliances	2,081.12	2,081.12
Cooking	321.71	321.71
Photovoltaic (electricity used in dwelling)	-666.65	-360.08
Photovoltaic (electricity exported)	-1,064.43	-213.23
Total	9,328.43	3,944.78

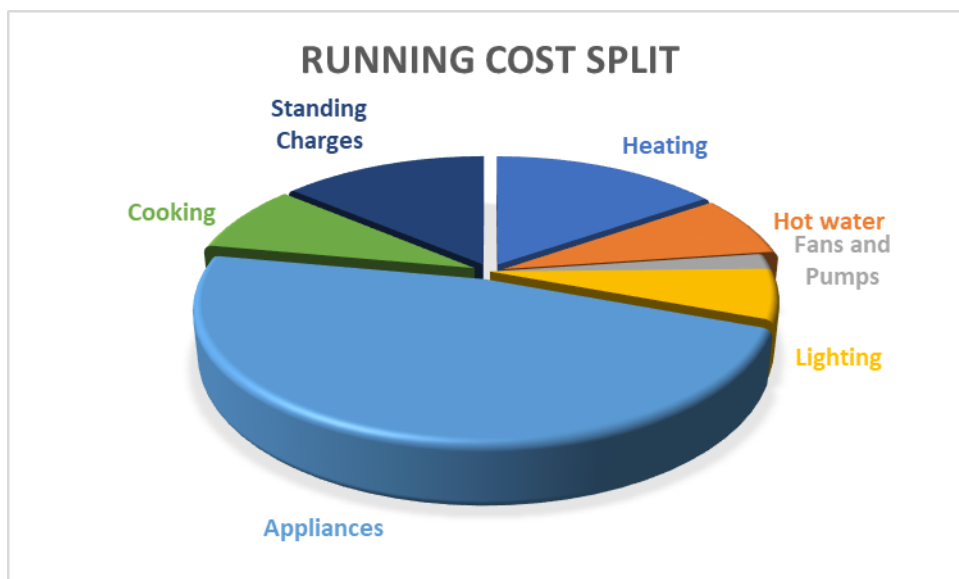
Reduction in Carbon emissions	5383.64
Percentage reduction	57.71%

Total residual Carbon	3,944.78
-----------------------	----------

Total energy consumption split by use

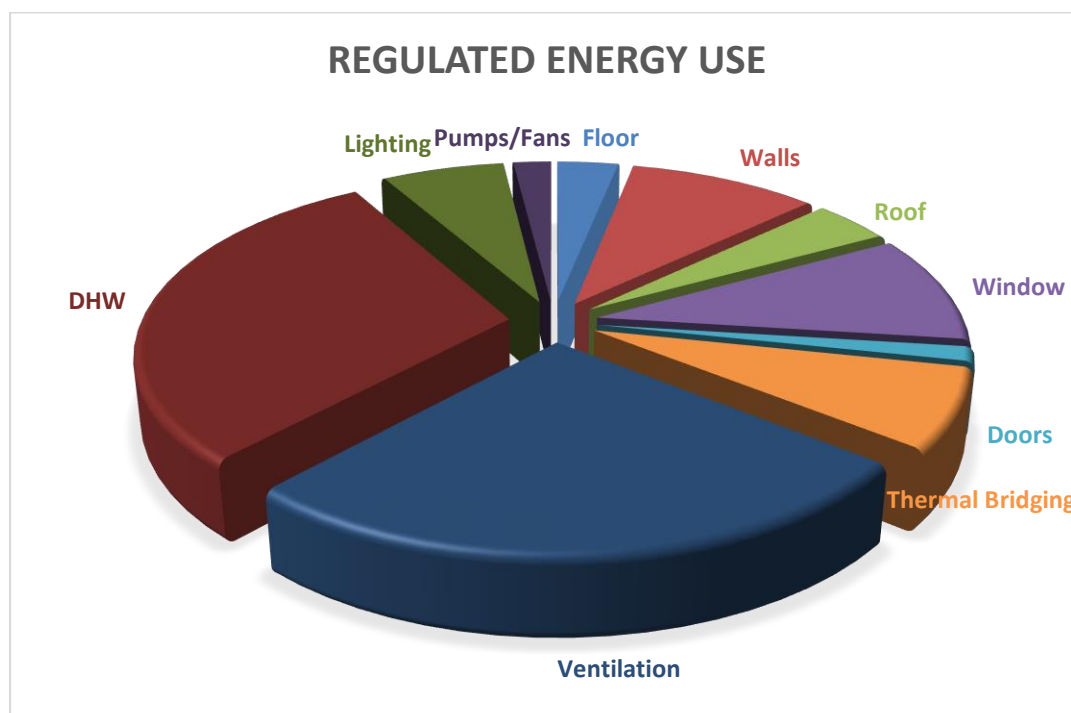


Total running cost split by use (Post April 2022 price cap)



2.4. Fabric (Be Lean)

Split of fabric losses in an average semidetached House with GIFA of 121m² dwelling built to AD. L1 2021 fabric specification (Notional dwelling, please refer to Table 1.1 on Page 17 of this report)



The affects from fabric improvements represent an approximately 25% of the total energy requirements from a typical new build home built to 2013/2021 building regulations standard and approximately 50% of regulated emissions (excluding use .i.e. cooking and appliances) as assessed using steady state assessment methodologies such as SAP etc. Improvements to individual fabric elements can have very limited effect on Energy/Carbon reduction although this is not a reason not to reduce heat loss and reduce heating loads by improving fabric and reducing losses associated with thermal bridging and ventilation losses.

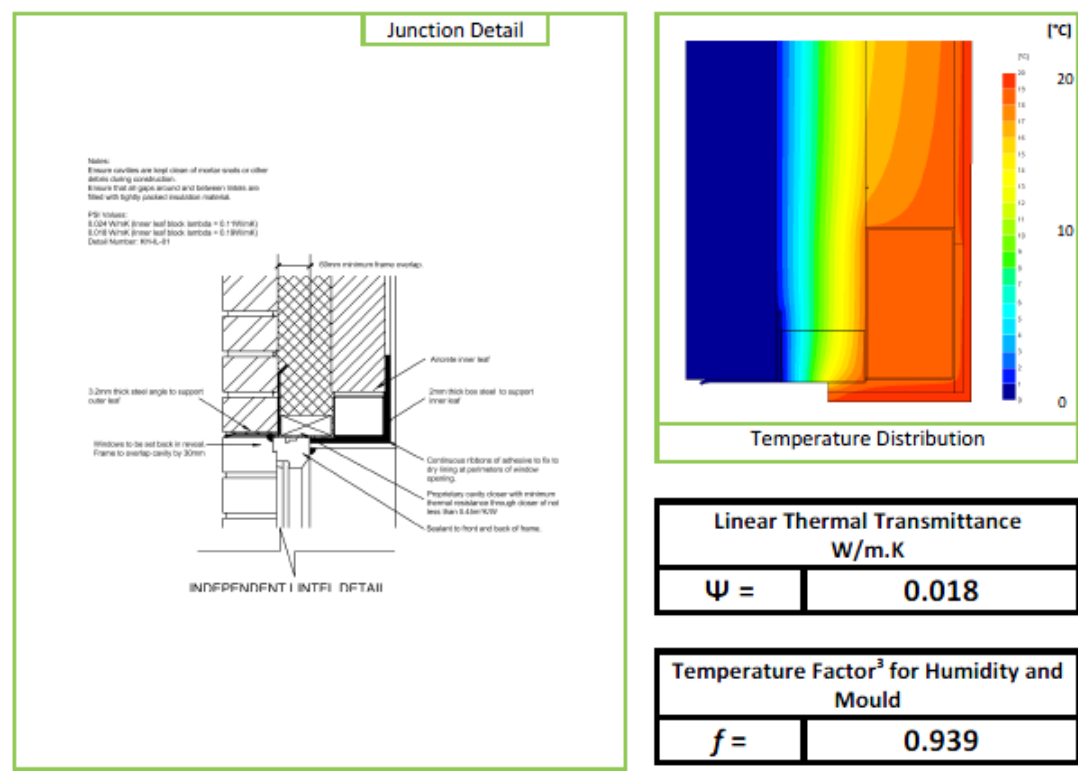
Future retro improvements made to a building's fabric are expensive, disruptive and most of the time impractical and therefore the thermal qualities of the building fabric must be one of the main considerations for long term energy and CO₂ reduction.

Reducing Energy and Carbon emissions from a development by increasing the fabric specification provides the development with a high degree of longevity, by limiting the heat losses across the building envelope over the dwelling's lifetime.

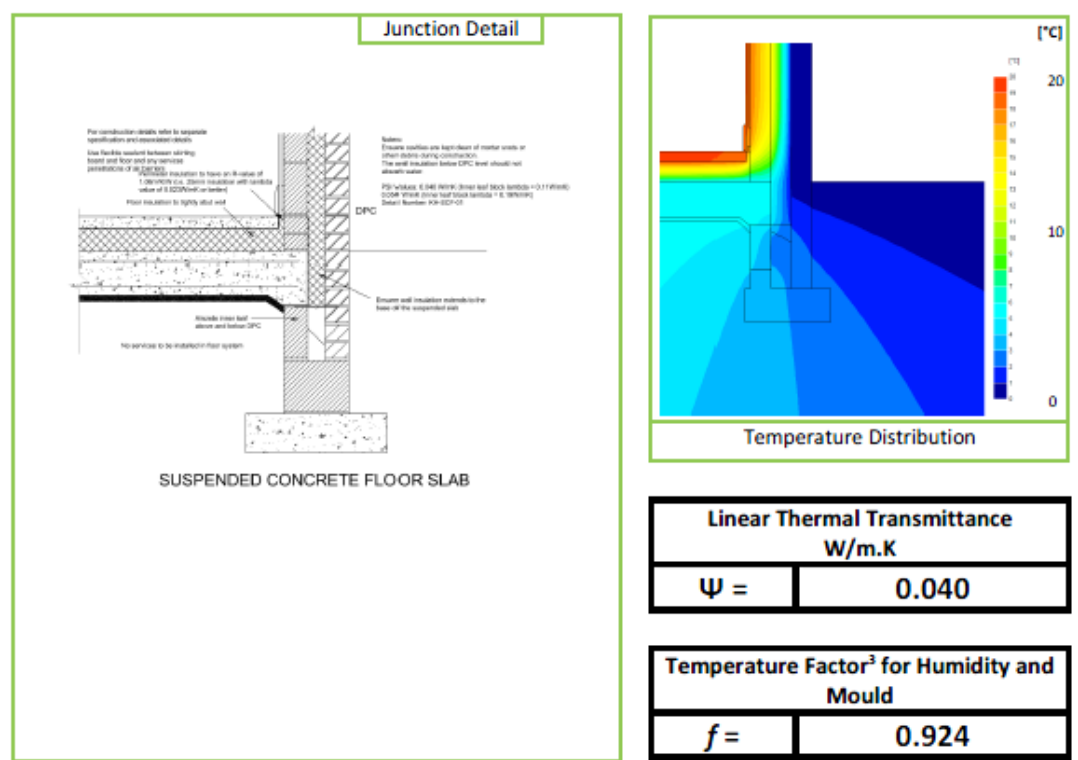
Improving the fabric specification at design stage will ensure that these dwellings do not become the "hard to treat dwellings" of the future.

It can be seen that thermal bridging will contribute to over 15% of a dwellings heating requirements, loses associated from junctions have been considered in detail and have been improved through modelling by the use of specialist 2D/3D thermal modelling software to BR433. Areas of high thermal loss will be identified and improved as required.

Example of a window lintel detail



Example of an exposed ground floor / wall bridging detail.



3. Introduction

Anderson Goddard Ltd has been commissioned by Rainsough Property Ltd to provide an Energy Statement and Low or Zero Carbon (LZC) feasibility assessment for the proposed development at Rainsough Hill, Prestwich, MANCHESTER, M25 9SU. This report will consider the requirements of compliance with the building regulations in terms of Carbon and Primary Energy metrics and will also consider the use of high efficiency alternative systems in line with the requirements of Regulation 25a, Approved Document Part L1 of the building regulations (England) 2021.

The following will be considered.

- Energy generated from the LZC technology
- Payback
- Land use
- Local planning requirements
- Noise
- Whole life costs and lifecycle impact of the potential specification in terms of carbon emissions
- Any available grants
- All technologies appropriate to the site and energy demand of the development
- Reasons for excluding other technologies

3.1 Assessment methodology

The following methodologies approved documentation and practices have been used in the compilation of this report.

- SAP 10.2
- Approved document Part L1 of the building regulations 2021

SAP, the governments “Standard Assessment Procedure” for calculating the energy performance of a dwelling and is used primarily for the purpose of satisfying approved document Part L1 of the Building regulations 2021

Appliances

The second part of the calculation takes into account electrical use from appliances ref appendix L2 SAP 2012

$$E_a = 207.8 \times (TFA \times N)^{0.4714}$$

$$E_a \times EF_{\text{electricity}} / TFA$$

Where TFA is the total floor area in m² and N is the assumed number of occupants

Cooking

$$(119 + 24N) / TFA$$

Where TFA is the total floor area and N is the number of occupants

All assessments of benefit in terms of CO₂ reduction provided by upgrade measures or LZC technologies including heating and innovative technologies will be assessed as a percentage of the total estimated CO₂

emissions which will include heating, ventilation, lighting, pumps and fans from SAP 2005 and also CO₂ emissions provided by the calculation process above for Cooking and appliances.

Regulated Use

- Heating
- Ventilation
- Lighting
- Pumps and fans

Un-Regulated use

- Cooking
- Appliances

A SAP calculation generates four ratings a SAP rating and potential SAP rating and Environmental Impact (EI) rating and potential EI rating, all ratings are out of 100.

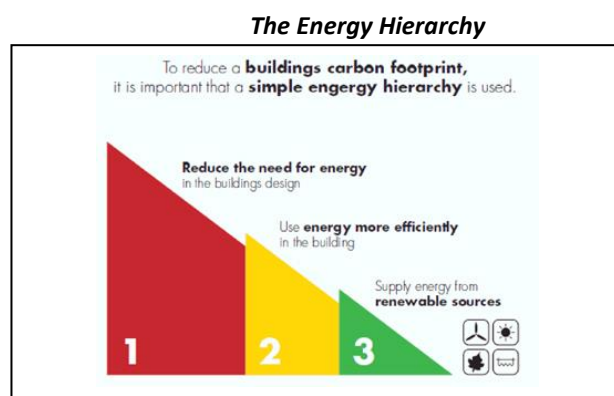
A SAP rating is an indication of heating and lighting costs, the higher the rating the lower the fuel costs will be.

Environmental Impact (EI) rating is an indication of CO₂ emissions produced by heating and lighting, the higher the rating the lower the Carbon emissions will be.

3.2 Energy Hierarchy

In line with best practice, the proposed buildings energy strategy should adhere to the principles of the Energy Hierarchy.

- **Be Lean** – reduce the need for energy.
- **Be Clean** – supply and use energy in the most efficient manner.
- **Be Green** – supply energy from renewable sources.



Adhering to the principles of the Energy Hierarchy has a number of benefits.

- By reducing the energy requirement of the building, the burden of renewable requirement shrinks in proportion. This has obvious financial benefits and will help meet part L of building regulations and any further reductions in carbon emissions required.
- The sustainable credentials of the development are enhanced and are not validated by simply bolting on expensive renewable equipment. By focusing on fabric performance and the provision of efficient heating/cooling systems the building is intrinsically “green”.

The lean measures are those measures which cumulatively reduce the energy requirement of the development through the construction of a thermally efficient building envelope. The measures included in this section of the report constitute the lean efforts.

“Fabric First”

Improved fabric specification

Fabric Enhancements are shown on Page 9 – Be-Lean

High efficient technologies

High efficiency heating technology such as heat pumps will have the greatest effect on reducing carbon emissions.

Energy efficiency within the building – Be Clean

Renewables

Microgeneration technologies including Photovoltaic technology will have the largest benefit in reducing occupiers running costs and reducing Primary Energy.

Installation of Renewable Energy – Be Green

LZC technology

An assessment of renewable technologies has taken place to determine technical and financial viability.

The following technologies would not be technically viable and/or would not provide the required reduction in either CO₂ emissions or energy.

- Solar thermal
- Micro wind
- District heating, CHP

Heat pump technology

Pros

- Would provide the largest reduction in carbon emissions when compared to other LZC technologies
- Maintenance requirements would be lower than more conventional systems

Cons

- Would require additional land use
- May be noisy in operation
- Would be more expensive to operate compared to more conventional systems

Photovoltaic

Pros

- Would provide the most cost-effective solution from a lifetime cost perspective as compared to other technologies
- Dwellings installed with Photovoltaic panels will have an Energy Performance Rating of 'A'
- Would provide the largest reduction in fuel costs as experienced by the occupant
- Would provide high reduction in energy
- Would not require any user operation
- Would require minimal change of habit by the occupant
- Would be silent in operation
- Would require very little maintenance when compared against other LZC technologies

Cons

- Would require suitable roof orientation and configurations, site layout etc
- Would have minimal effect on reducing carbon emissions when compared to Heat Pump technology

3.3 Building regulation requirements

Approved Document Part L1 of the Building Regulations 2021 (England)

Regulation 25

Regulation 25 requires the Secretary of State to approve minimum energy performance requirements. These requirements are in the form of a target primary energy rate, a target emission rate and a target fabric energy efficiency rate.

The targets are set out in Section 1 of this approved document.

Regulations 26, 26A and 26C

A newly constructed dwelling must be shown to meet regulations 26, 26A and 26C by producing calculations to show that the dwelling meets all of the following.

- a. Target primary energy rate.
- b. Target emission rate.
- c. Target fabric energy efficiency rate.

Section 2 of this approved document sets out how to produce these calculations.

Regulations 27, 27A and 27C

Both before and after a newly constructed dwelling is built, a notice must be given to the building control body of the calculations.

Regulation 25A: Consideration of high-efficiency alternative systems

This section deals with the requirements of regulation 25A of the Building Regulations 2010.

Regulation

Consideration of high-efficiency alternative systems for new buildings

- 25A.** (1) Before construction of a new building starts, the person who is to carry out the work must analyse and take into account the technical, environmental and economic feasibility of using high-efficiency alternative systems (such as the following systems) in the construction, if available—
- (a) decentralised energy supply systems based on energy from renewable sources;
 - (b) cogeneration;
 - (c) district or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources; and
 - (d) heat pumps.
- (2) The person carrying out the work must—
- (a) not later than the beginning of the day before the day on which the work starts, give the local authority a notice which states that the analysis referred to in paragraph (1)—
 - (i) has been undertaken;
 - (ii) is documented; and
 - (iii) the documentation is available to the authority for verification purposes; and
 - (b) ensure that a copy of the analysis is available for inspection at all reasonable times upon request by an officer of the local authority.
- (3) An authorised officer of the local authority may require production of the documentation in order to verify that this regulation has been complied with.
- (4) The analysis referred to in paragraph (1)—
- (a) may be carried out for individual buildings or for groups of similar buildings or for common typologies of buildings in the same area; and
 - (b) in so far as it relates to collective heating and cooling systems, may be carried out for all buildings connected to the system in the same area.

Regulation continued

- (5) In this regulation—
- (a) "cogeneration" means simultaneous generation in one process of thermal energy and one or both of the following—
 - (i) electrical energy;
 - (ii) mechanical energy;
 - (b) "district or block heating or cooling" means the distribution of thermal energy in the form of steam, hot water or chilled liquids, from a central source of production through a network of multiple buildings or sites, for the use of space or process heating or cooling;
 - (c) "energy from renewable sources" means energy from renewable non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases; and
 - (d) "heat pump" means a machine, a device or installation that transfers heat from natural surroundings such as air, water or ground to buildings or industrial applications by reversing the natural flow of heat such that it flows from a lower to a higher temperature. (For reversible heat pumps, it may also move heat from the building to the natural surroundings.)

Table 1.1 Summary of notional dwelling specification for new dwelling⁽¹⁾

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

NOTE:

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

4 Low or Zero Carbon overview

The following Low or Zero Carbon technologies are commercially available for use in the UK housing sector; the following overview will give a brief description of each technology which will provide a better understanding of how each technology works and its appropriation for use, either for use in this project or for future projects.

Low or zero carbon technologies available in the UK

Zero carbon technologies

- Solar Hot Water
- Solar Photovoltaic
- PV-Thermal
- Small scale hydro power
- Wind turbines
- Solar Air heating

Low carbon technologies

- Biomass
- Combined Heat and Power (CHP) and micro CHP
- Community heating, including utilising waste heat from processes such as large scale power generation where the majority of heating comes from waste heat
- Heat pumps, Ground source heat pumps (GSHP) Geothermic heating systems, Air source.
- Other technologies, Fuel cells using hydrogen from any of the above renewable sources

Other innovative technologies

- Flue Gas Heat recovery systems (FGHRS)
- Shower saver Waste Water Heat Recovery (WWHRS)
- Sunwarm
- Geothermic storage

4.1 Solar Water



Solar water heating systems use heat from the sun to work alongside conventional primary water heaters. The technology is well developed with a large choice of equipment to suit many applications.

For domestic hot water there are three main components

Solar panels or collectors - are fitted to your roof. They collect heat from the sun's radiation. There are 2 main types of collector:

Flat plate systems - which are comprised of an absorber plate with a transparent cover to collect the sun's heat, or

Evacuated tube systems - which are comprised of a row of glass tubes that each contains an absorber plate feeding into a manifold which transports the heated fluid.

A heat transfer system - uses the collected heat to heat water;

Hot water cylinder - stores the hot water that is heated during the day and supplies it for use later.

Fuel Displaced	£ Saving per year	CO2 saving per year
Gas	£50	325 kg
Electricity	£80	635 kg
Oil	£65	365 kg
Solid	£55	645 kg

All savings are approximate and are based on the hot water heating requirements of a 3 bed semidetached home.

Solar water heating can be used in the home or for larger applications, such as swimming pools. For a domestic system you will need 3-4 square metres of southeast to southwest facing roof receiving direct sunlight for the main part of the day, a space to locate an additional water cylinder if required.

In England, changes to permitted development rights for micro generation technologies introduced on 6th April 2008 have lifted the requirements for planning permission for most solar water heating installations. Roof mounted and stand-alone systems can now be installed in most dwellings, as long as they respect certain size criteria. Exceptions apply for Listed Buildings, and buildings in Conservation Areas and World Heritage Sites.

In Wales, Scotland and Northern Ireland, the devolved governments are currently all considering changes to their legislation on permitted developments, to facilitate installations of micro generation technologies, including solar water heating. Legislation is expected in all three countries later this year. Until then, householders in Wales, Scotland and Northern Ireland must consult with their local authority regarding planning permission.

Solar water heating systems tend to require little maintenance Installation and maintenance costs.

The typical installation cost for a domestic system is £3,000 - £5,000. Evacuated tube systems are more advanced in design than flat plate, and so tend to be more expensive.

Solar water heating systems generally come with a 5-10 year warranty and require regular maintenance. A yearly check by the householder and a more detailed check by a professional installer every 3-5 years should be sufficient.

4.2 Solar Photovoltaic



Solar PV (photovoltaic) uses energy from the sun to create electricity to run appliances and lighting. PV requires only daylight - not direct sunlight - to generate electricity.

How it works

Photovoltaic systems use cells to convert solar radiation into electricity. The PV cell consists of one or two layers of a semi conducting material, usually silicon. When light shines on the cell it creates an electric field across the layers, causing electricity to flow. The greater the intensity of the light, the greater the flow of electricity...PV systems generate no greenhouse gases, saving approximately 325kg of carbon dioxide emissions per year - adding up to about 8 tonnes over a system's lifetime - for each kilowatt peak (kWp - PV cells are referred to in terms of the amount of energy they generate in full sun light).

PV arrays now come in a variety of shapes and colours, ranging from grey 'solar tiles' that look like roof tiles, to panels and transparent cells that you can use on conservatories and glass to provide shading as well as generating electricity. As well as enabling you to generate free electricity they can provide an interesting alternative to conventional roof tiles!

PV systems for a building with a roof or wall that faces within 90 degrees of south, as long as no other buildings or large trees overshadow it.

If the roof surface is in shadow for parts of the day, the output of the system decreases. Solar panels are not light and the roof must be strong enough to take their weight, especially if the panel is placed on top of existing tiles. Solar PV installations should always be carried out by a trained and experienced installer. The area of PV required to generate 1 kw hour peak varies but generally 6-8m² for Môn crystalline or 10² for polycrystalline modules of PV will produce 1 Kw peak of electricity.

Cost and maintenance

Prices for PV systems vary, depending on the size of the system to be installed, type of PV cell used and the nature of the actual building on which the PV is mounted. The size of the system is dictated by the amount of electricity required. For the average domestic system, costs can be around £4,000- £9,000 per kWp installed, with most domestic systems usually between 1.5 and 2 kWp. Solar tiles cost more than conventional panels, and panels that are integrated into a roof are more expensive than those that sit on top. Grid connected systems require very little maintenance, generally limited to ensuring that the panels are kept relatively clean and that shade from trees has not become a problem.

The wiring and components of the system should however be checked regularly by a qualified technician. Stand-alone systems, i.e. those not connected to the grid, need maintenance on other system components, such as batteries.

4.3 Solar PV / Thermal



PV-T is an integrated panel that produces both electricity and heat.

Benefit

Traditional PV systems produce heat as a by product of the electric production which causes the PV collector to reduce in efficiency, as a rule of thumb a PV collector will reduce in efficiency by 0.5% for every 1°C increase in temperature above normal operating temperatures, PV temperatures can exceed 85°C. PV-T systems are designed to cool the collectors and use the collected heat for water and space heating.

How it works

By cooling the PV panel with either water or air the collector will operate up to 25% more efficiently resulting in a smaller area of PV required to generate the same amount of energy compared to a typical PV collector, the heated water or air can then be used to provide the dwelling with heating and or hot water depending on system design.

Cost and Maintenance

The cost of the PV-T system will be very similar to the combined cost of Solar thermal and solar PV and the technology is more suited to Code 5 or code 6 plots because of the reduced area of PV required which would free up available roof area.

4.4 Hydro



Hydro power systems use running water turning a turbine to produce electricity. A micro hydro plant is one that generates less than 100kW. Improvements in small turbine and generator technology mean that micro hydro schemes are an attractive means of producing electricity. Useful power may be produced from even a small stream.

Benefits

For houses with no mains connection but with access to a micro hydro site, a good hydro system can generate a steady, more reliable electricity supply than other renewable technologies at a lower cost. Total system costs can be high but often less than the cost of a grid connection and with no electricity bills to follow. It should be noted that in off grid applications the power is used for lighting and electrical appliances. However, space and water heating can be supplied when available power exceeds demand. Hydro power systems convert potential energy stored in water held at height to kinetic energy

How it works

Hydro power systems convert potential energy stored in water held at height to kinetic energy (or the energy used in movement) to turn a turbine to produce electricity.

Energy available in a body of water depends on the water's flow rate and the height (or head) that the water falls. These are divided into low head, medium head and high head, where the height drop is greater. The scheme's actual output will depend on how efficiently it converts the power of the water into electrical power (maximum efficiencies of over 90% are possible but for small systems 60 - 80% is more realistic).

Hydro power requires the source to be relatively close to where the power will be used or to a suitable grid connection. Hydro systems can be connected to the main electricity grid or as a part of a standalone (off grid) power system. In a grid connected system, any electricity generated but not used can be sold to electricity companies.

In an off grid hydro system, electricity can be supplied directly to the devices powered or through a battery bank and inverter set up. A back up power system may be needed to compensate for seasonal variations in water flow.

Costs and savings

Hydro costs are very site specific and are related to energy output. For low head systems (assuming there is an existing pond or weir), costs may be in the region of £4,000 per kW installed up to about 10kW and would drop per kW for larger schemes.

For medium heads, there is a fixed cost of about £10,000 and then about £2,500 per kW up to around 10kW - so a typical 5kW domestic scheme might cost £20-£25,000. Unit costs drop for larger schemes. Maintenance costs vary but small scale hydro systems are very reliable.

4.5 Micro wind



Wind turbines use the wind's lift forces to rotate aerodynamic blades that turn a rotor which creates electricity. In the UK we have 40% of Europe's total wind energy. But it's still largely untapped and only 0.5% of our electricity requirements are currently generated by wind power.

How does it work? Most small wind turbines generate direct current (DC) electricity. Systems that are not connected to the national grid require battery storage and an inverter to convert DC electricity to AC (alternating current - mains electricity).

Wind systems can also be connected to the national electricity grid. A special inverter and controller convert DC electricity to AC at a quality and standard acceptable to the grid. No battery storage is required. Any unused or excess electricity may be able to be exported to the grid and sold to the local electricity supply company.

There are two types of wind turbines:

Mast mounted - which are free standing and located near the building(s) that will be using the electricity.

Roof mounted - which can be installed on house roofs and other buildings.

Benefits

Wind power is a clean, renewable source of energy which produces no carbon dioxide emissions or waste products.

In the UK we have 40% of Europe's total wind energy

Individual turbines vary in size and power output from a few hundred watts to two or three megawatts (as a guide, a typical domestic system would be 1 - 6 kilowatts). Uses range from very small turbines supplying energy for battery charging systems (e.g. on boats or in homes), to turbines on wind farms supplying electricity to the grid.

You should consider the following issues if you're thinking about small scale wind. An accredited installer will be able to provide more detailed advice. Wind speed increases with height so it's best to have the turbine high on a mast or tower.

Generally speaking the ideal site is a smooth top hill with a flat, clear exposure, free from excessive turbulence and obstructions such as large trees, houses or other buildings.

Small scale wind power is particularly suitable for remote off grid locations where conventional methods of supply are expensive or impractical. Please note that the electricity generated at any one time by a wind turbine is highly dependent on the speed and direction of the wind. The wind speed itself is dependent on a number of factors, such as location within the UK, height of the turbine above ground level and nearby obstructions. Ideally, you should undertake a professional assessment of the local wind speed for a full year at the exact location where you plan to install a turbine before proceeding. In practice, this may be difficult, expensive and time consuming to undertake. Therefore I recommend that, if you are considering a domestic building mounted installation and electricity generation is your main motivation, then you only consider a wind turbine under the following circumstances:

The local annual average wind speed is 6 m/s or more. There are no significant nearby obstacles such as buildings, trees or hills that are likely to reduce the wind speed or increase turbulence

Planning issues such as visual impact, noise and conservation issues also have to be considered. System installation normally requires permission from the local authority.

Roof mounted

These cost from £3000. The amount of energy and carbon that roof top micro wind turbines save depends on several things including size, location, wind speed, nearby buildings and the local landscape. At the moment there is not enough data from existing wind turbine installations to provide a figure of how much energy and carbon could typically be saved. The Energy Saving Trust is monitoring up to 100 wind turbine installations; the results of this activity will help to provide further information for householders considering this technology.

Mast mounted

Larger systems in the region of 2.5kW to 6kW would cost between £11,000 - £19,000 installed. These costs are inclusive of the turbine, mast, inverters, battery storage (if required) and installation; however it's important to remember that costs always vary depending on location and the size and type of system. Turbines can have a life of up to 22.5 years but require service checks every few years to ensure they work efficiently. For battery storage systems, typical battery life is around 6-10 years, depending on the type, so batteries may have to be replaced at some point in the system's life.

4.6 Bio Mass



Biomass is produced from organic materials, either directly from plants or indirectly from industrial, commercial, domestic or agricultural products. It is often called 'bio energy' or 'bio fuels'. It doesn't include fossil fuels, which have taken millions of years to be created.

Biomass fall into two main categories:

Woody biomass includes forest products, untreated wood products, energy crops and short rotation coppice (SRC), which are quick-growing trees like willow.

Non-woody biomass includes animal waste, industrial and biodegradable municipal products from food processing and high energy crops. Examples are rape, sugar cane, maize.

For small-scale domestic applications of biomass the fuel usually takes the form of wood pellets, wood chips or wood logs



The benefits

Producing energy from biomass has both environmental and economic advantages.

Although biomass produces CO₂ it only releases the same amount that it absorbed whilst growing, which is why it is considered to be carbon neutral. Furthermore, biomass can contribute to waste management by harnessing energy from products that are often disposed of at landfill sites.

It is most cost effective and sustainable when a local fuel source is used, which results in local investment and employment and also minimises transport miles to your home.

Fuel

It's important to have storage space for the fuel, appropriate access to the boiler for loading and a local fuel supplier.

Flue

The vent material must be specifically designed for wood fuel appliances and there must be sufficient air movement for proper operation of the stove. Chimneys can be fitted with a lined flue.

Regulations

The installation must comply with all safety and building regulations.

See Part L of the Building Regulations, Northern Ireland

See Section 3 of the Technical Handbooks, Scotland

Smokeless zones

Wood can only be burnt in exempted appliances, under the Clean Air Act.

Planning

If the building is listed or in an area of outstanding natural beauty (AONB), then you will need to check with your Local Authority Planning Department before a flue is fitted.

Costs and savings

Standalone room heaters generally cost £2,000 to £4,000 installed. Savings will depend on how much they are used and which fuel you are replacing. A biomass stove which provides a detached home with 10% of annual space heating requirements could save around 840kg of carbon dioxide when installed in an electrically heated home. Due to the higher cost of biomass pellets compared with other traditional heating fuels, and the relatively low efficiency of the stove compared to a central heating system it will cost more to run.

The cost for boilers varies depending on the system choice; a typical 15kW (average size required for a three-bedroom semidetached house) pellet boiler would cost around £5,000 - £14,000 installed, including the cost of the flue and commissioning. A manual log feed system of the same size would be slightly cheaper. A wood pellet boiler could save you around £750 a year in energy bills and around 6 tonnes of CO₂ per year when installed in an electrically heated home.

Unlike other forms of renewable energy, biomass systems require you to pay for the fuel. Fuel costs generally depend on the distance from your supplier and whether you can buy in large quantities.

4.7 Heat Pumps

There are two types of heat pumps, ground source and air source.

Heat pumps work in a very similar way to fridges and air conditioners and absorb heat from the ground or from the air.

Ground or air source heat pumps are mainly designed to work with under floor heating systems because of the lower design temperatures of under floor systems.

Efficiencies of ground source heat pumps are between 350%-400% and air source between 200%-250%.

Heat pumps are a viable alternative to electric, LPG and oil fuel boilers, but are not considered as an alternative to natural gas.

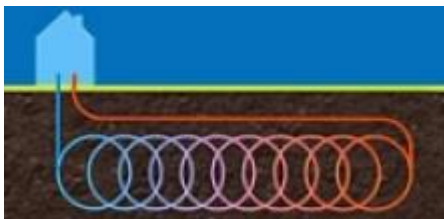
Ground source heat pumps

Ground source heat pumps use a buried ground loop which transfers heat from the ground into a building to provide space heating and, in some cases, to pre-heat domestic hot water. As well as ground source heat pumps, air source and water source heat pumps are also available.

The benefits

The efficiency of a ground source heat pump system is measured by the coefficient of performance (CoP). This is the ratio of units of heat output for each unit of electricity used to drive the compressor and pump for the ground loop. Average CoP over the year, known as seasonal efficiency, is around 3-4 although some systems may produce a greater rate of efficiency. This means that for every unit of electricity used to pump the heat, 3-4 units of heat are produced, making it an efficient way of heating a building. If grid electricity is used for the compressor and pump, then you should consult a range of energy suppliers to benefit from the lowest running costs, for example by choosing an economy 10 or economy 7 tariff.

Ground source heat pumps



How it works

There are three important elements to a ground source heat pump:

1. The ground loop

This is comprised of lengths of pipe buried in the ground, either in a borehole or a horizontal trench. The pipe is usually a closed circuit and is filled with a mixture of water and antifreeze, which is pumped around the pipe absorbing heat from the ground. The ground loop can be:

- Vertical, for use in boreholes
- Horizontal, for use in trenches
- Spiral, coil or 'slinky', also for use in trenches

2. A heat pump

In the same way that your fridge uses refrigerant to extract heat from the inside, keeping your food cool, a ground source heat pump extracts heat from the ground, and uses it to heat your home. A ground source heat pump has three main parts:

- The evaporator, (e.g. the squiggly thing in the cold part of your fridge) absorbs the heat using the liquid in the ground loop;
- The compressor, (this is what makes the noise in a fridge) moves the refrigerant round the heat pump and compresses the gaseous refrigerant to the temperature needed for the heat distribution circuit;
- The condenser, (the hot part at the back of your fridge) gives up heat to a hot water tank which feeds the distribution system.

3. Heat distribution system

This consists of under floor heating or radiators for space heating and in some cases water storage for hot water supply.

You should consider the following issues if you're thinking about installing a ground source heat pump. An accredited installer will be able to provide more detailed advice.

- You will need space outside your house for the ground loop.
- The ground will need to be suitable for digging a trench or borehole.
- What fuel is being replaced? If it's electricity, oil, LPG or coal the savings will be more favourable than gas. Heat pumps are a good option where gas is unavailable.
- The type of heat distribution system. Ground source heat pumps can be combined with radiators but these will normally be larger than with standard boiler systems. Under floor heating is better as it works at a lower temperature.
- Want to further reduce your home's carbon dioxide emissions? Install solar PV or some other form of renewable electricity generating system to power the compressor and pump.
- Is the system for a new building development? Combining the installation with other building works can reduce costs.

Air and water source heat pumps

Air and water source heat pumps use air or water respectively. They do not rely on a collection system and simply extract the heat from the source at the point of use.

Air source heat pumps can be fitted outside a house or in the roof space and generally perform better at slightly warmer air temperatures. Water source heat pumps can be used to provide heating in homes near to rivers, streams, lakes and lochs for example.

Costs and savings

A typical 8 - 12kW system costs £6,000 - £12,000 (not including the price of distribution system). This can vary with property and location. When installed in an electrically heated home a ground source heat pump could save as much as £880 a year on heating bills and almost 7 tonnes of carbon dioxide a year. Savings will vary depending on what fuel is being replaced.

Phase 1 - Householder Stream.

At present, grants are available for non-reversible closed loop systems, utilising a borehole or trenches. A grant of up to £1,200 is available for domestic systems. For details of how to apply for grants, and of energy efficiency measures that must be in place before the grant can be accessed, please visit www.lowcarbonbuildings.org.uk.

Phase 2 - Community Stream.

Phase 2 of the LCBP is for the installation of micro generation technologies in public sector buildings (including schools, hospitals, housing associations and local authorities) and charitable bodies. Grants are available for up to 50% for installations with a maximum of £30,000. Phase 2 is administered by the BRE, for further information please visit www.lowcarbonbuildingsphase2.org.uk.

4.8 CHP

Combined heat and power (Chp) and Micro combined heat and power (Micro Chp)
CHP (combined heat and power) earlier CHP units where basically diesel engines converted to run on oil or gas, electricity been the primary output and heat been the secondary.
They have been around for many years, but mainly used in larger buildings like hotels and large blocks of flats etc. For CHP systems to be economically viable they need to run for at least 4,000 hours per year. They are more suitable for leisure centres with swimming pools and hospitals that have a high, year round heat demand or in mixed use developments with suitable heat demands However, new housing or office developments may be able to make use of existing CHP schemes nearby

Fuel types for Chp / Micro Chp

Natural Gas

Micro CHP units are currently being developed for the domestic market by Potterton Baxi, and Powergen (Whispergen) and it shouldn't be long before they become commercially available.
Micro CHP boilers work using similar principle to their older commercial counterparts, an engine produces heat and electricity, the heat is used in the home much like heat from a conventional boiler and the electricity is either used in the home or exported into the national grid.

Typical estimated boiler efficiencies for use with natural gas

100% Gas	78% heat
	12% electricity
	10% waste

Biogas

Biogas typically refers to a gas produced by the biological breakdown of organic matter in the absence of oxygen. Biogas originates from biogenic material and is a type of bio fuel. One type of biogas is produced by anaerobic digestion or fermentation of biodegradable materials such as biomass, manure or sewage, municipal waste, and energy crops. This type of biogas comprises primarily methane and carbon dioxide. The other principal type of biogas is wood gas which is created by gasification of wood or other biomass. This type of biogas is comprised primarily of nitrogen, hydrogen, and carbon monoxide, with trace amounts of methane. The gases methane, hydrogen and carbon monoxide can be combusted or oxidized with oxygen. Air contains 21% oxygen. This energy release allows biogas to be used as a fuel. Biogas can be used as a low-cost fuel in any country for any heating purpose, such as cooking. It can also be utilized in modern waste management facilities where it can be used to run any type of heat engine, to generate either mechanical or electrical power. Biogas is a renewable fuel and electricity produced from it can be used to attract renewable energy subsidies in some parts of the world.

Bio Mass

(Please see previous description)

4.9 Fuel Cells

In principle, a fuel cell operates like a battery. Unlike a battery, a fuel cell does not run down or require recharging. It will produce energy in the form of electricity and heat as long as fuel is supplied.

A fuel cell consists of two electrodes sandwiched around an electrolyte. Oxygen passes over one electrode and hydrogen over the other, generating electricity, water and heat.

A fuel cell produces electricity.

The fuel cell is similar to a battery. It produces electricity using chemicals. The chemicals are usually very simple, often just hydrogen and oxygen. In this case the hydrogen is the "fuel" that the fuel cell uses to make electricity.

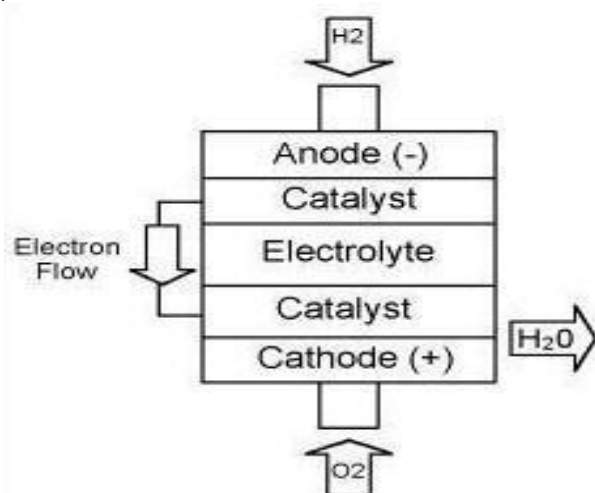
Another very important difference is that fuel cells do not run down like batteries. As long as the fuel and oxygen is supplied to the cell it will keep producing electricity for ever.

The oxygen needed by a fuel cell is usually simply obtained from air.

Although the majority of fuel cells use hydrogen as the fuel, some fuel cells work off methane, and a few use liquid fuels such as methanol.

Fuel cells that use hydrogen can be thought of as devices that do the reverse of the well-known experiment where passing an electric current through water splits it up into hydrogen and oxygen. In the fuel cell hydrogen and oxygen are joined together to produce water and electricity.

Fuel cells can be made in a huge range of sizes. They can be used to produce quite small amounts of electric power, for devices such as portable computers or radio transmitters, right up to very high powers for electric power stations.



Hydrogen fuel is fed into the "anode" of the fuel cell. Oxygen (or air) enters the fuel cell through the cathode. Encouraged by a catalyst, the hydrogen atom splits into a proton and an electron, which take different paths to the cathode. The proton passes through the electrolyte. The electrons create a separate current that can be utilized before they return to the cathode, to be reunited with the hydrogen and oxygen in a molecule of water.

A fuel cell system which includes a "fuel reformer" can utilize the hydrogen from any hydrocarbon fuel - from natural gas to methanol, and even gasoline. Since the fuel cell relies on chemistry and not combustion, emissions from this type of a system would still be much smaller than emissions from the cleanest fuel combustion processes.

FUEL CELLS USING HYDROGEN FROM RENEWABLE SOURCES

Fuel cells can be used as CHP systems in buildings. There are currently several different systems under development using different chemical processes, which operate at different temperatures. They currently use natural gas as the fuel, which is 'reformed' to produce hydrogen, the required fuel for the fuel cell. When and if hydrogen becomes available from renewable sources, e.g. as the storage medium of wind generated energy, fuel cell CHP from renewable sources may be possible in buildings.

5 Innovative technologies

The following technologies are not yet classified as LDC technologies; in reality they provide a large reduction in both CO₂ emissions and provide a good end user benefit in terms of energy savings. This list of technologies will expand over the following years, and this section will expand to include any new available innovative technologies.

5.1 Flue Gas Heat Recovery Systems (FGHRS)



The Flue Gas Heat Recovery System is not considered as a low carbon technology although it will be included in a draft consultation by the Energy Saving Trust.

In reality the FGHRS provides a good reduction in CO₂ emissions compared to some technologies that are classified and listed as LDC technologies yet do not provide a reduction in CO₂ emissions when compared to a Natural Gas energy model.

Background

Condensing combination boilers only condense when the flow and return water temperature differential is large enough, generally 11°C, during hot water mode the primary heating water is just circulated around the boiler through a secondary heat exchanger and the temperature differential between flow and return water will be very low and therefore the boiler will not condense.

How it works

The FGHRS is fitted above the boiler and is connected to the boiler flue outlet; the flue is terminated from the FGHRS as normal.

Cold mains water enters the FGHRS and is pre heated by the waste flue gasses via an air to water heat exchanger, the preheated water is then feed to the inlet cold connection on the boiler therefore reducing the amount of gas required to heat the hot water to a sufficient usable temperature.

Costs and maintenance

FGHRS cost between £500-£650 and according to the manufacture will require none or very little maintenance.

Land use

FGHRS requires no specific land use requirements.

Planning

FGHRS require no additional planning requirements.

5.2 Waste Water Heat Recovery Systems (WWHRs)

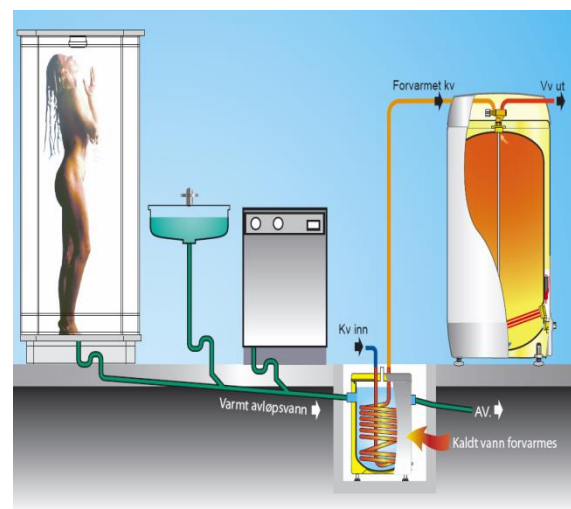
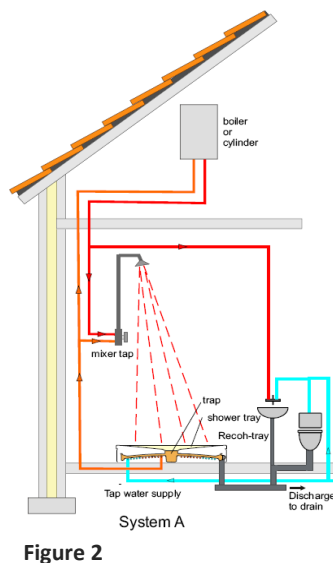
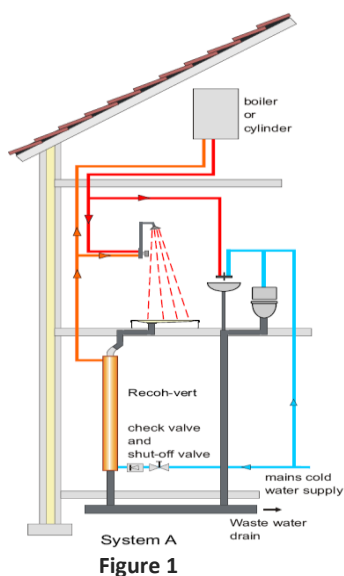


Figure 3

Shower Saver (figure 1 & 2)

Waste Water Heat Recovery Systems (WWHRs) are new to the UK and Appendix Q, following successful experience in The Netherlands where they are fitted to 20% of new dwellings. Although generically classified as a WWHRs the Shower-Save device is primarily applicable to heat recovery from warm shower waste water. Figure 7 shows the most common configuration known as Reco-vert, applicable to upstairs showers, whilst Figure 8 shows the Reco-h-tray which can be used in apartments, bungalows or other single storey properties. The principle of heat recovery is the same in both cases:

Warm shower water passes through the 'grey' water side of a copper counter-flow heat exchanger. Mains pressure water simultaneously passes through the fresh water side of the heat exchanger, where it is pre-heated before passing into both the 'cold' inlet of the mixer shower and the 'cold' inlet to the hot water cylinder, combi boiler or other water heater.

The use of pre-heated water (orange line in Figures 1 and 2) reduces the total volume of hot water required per shower, whilst also pre-heating the cold feed to the hot water heater which increases potential flow rates for combi or shortens the re-heat time of cylinders.

The energy saving applies to whichever fuel is used for water heating, which is therefore not limited solely to gas boilers.

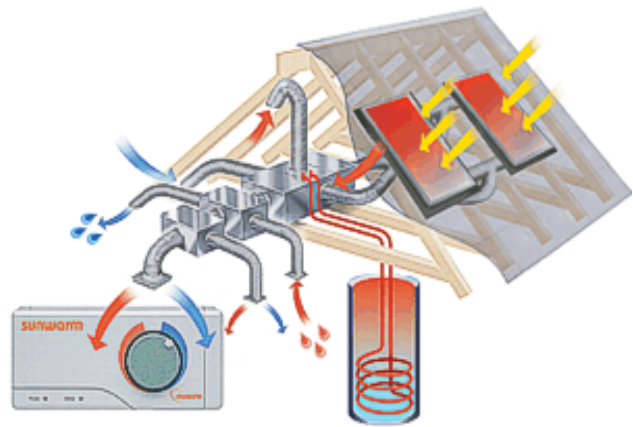
Whilst technically applicable to instantaneous electric showers, these aren't currently modelled by SAP, so it is not possible to apply in Appendix Q either.

Does not save energy from baths, in which hot water use is in advance of grey water disposal, but is applicable to the shower over a bath.

Waste water heat recovery System

Figure 3 depicts a whole house Waste Water Heat Recovery System (WWHRs) which is being developed in the Netherlands and is expected to be available in this country during the next year. It is estimated that the system will provide a reduction in energy consumption of approximately 2500Kw pa or approximately 475 Kg/ CO₂ pa for an average dwelling.

5.3 Sunwarm



The Sunwarm System developed by Nuaire could be classified as a LZC technology and was listed on the DTI clear skies renewable energy grant scheme, the technology has been included in this innovative section subject to confirmation of its exact classification.

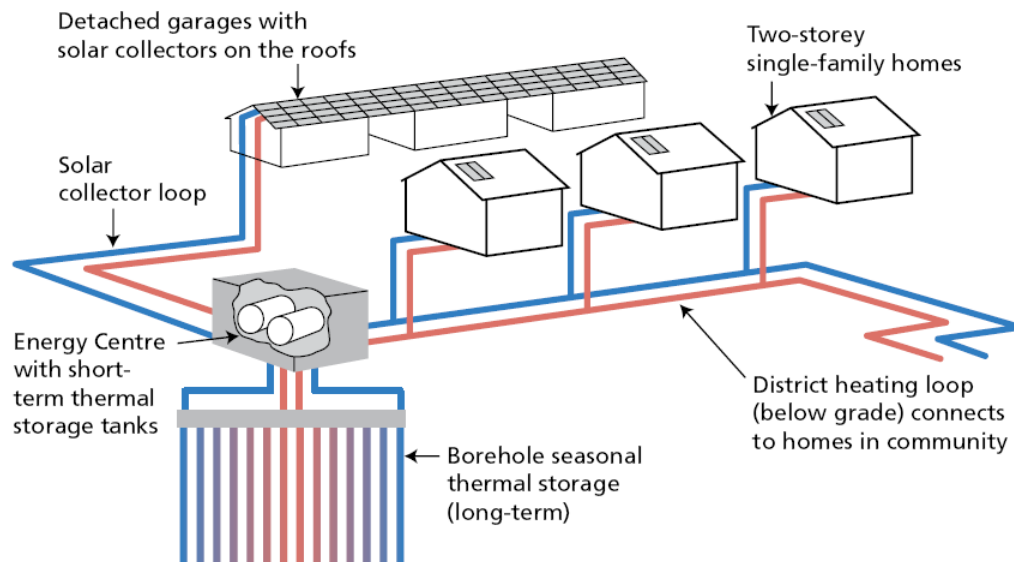
The Sunwarm system is a system that uses solar radiation in the same way Solar thermal uses solar radiation to heat water, the Sunwarm system uses solar radiation to heat air which is then introduced through the ventilation ducting and into the dwelling, the Sunwarm system can also be used to heat water by way of an air to water heat exchanger.

The unit is in the process of being tested by the BRE and will be eventually included in the appendix Q database.

The manufactures claim that the energy saved by the unit as assessed over a winter period will be approximately 1500 Kw and therefore the unit should provide in excess 1500 Kw if assessed over the full year. For the purpose of this feasibility assessment the conservative figure of 1500Kw has been used in the calculation process although this may change when the unit has been entered on the appendix Q database

5.4 Geothermal Storage

Solar Seasonal Storage and District Loop



Geothermal storage systems are and are intended to be used in conjunction with Solar thermal or PV-T systems. The heat produced by both systems can be stored in boreholes in the ground and the heat can then be used throughout the winter period to provide heating through community heating circuits.

The concept was conceived by the Canadian Government and implemented at Drake Landing Okotoks, Alberta, Canada and has successfully integrated the technology and an unlimited solar energy supply feeding 52 homes.

Borehole thermal energy storage allowed water to be heated and collected in large quantities for use in winter, at the end of summer the water was measured to reach temperatures of 80°C and even at the low temperatures associated with the Canadian winters the water temperature at the end of the winter period had been measured at 50°C.

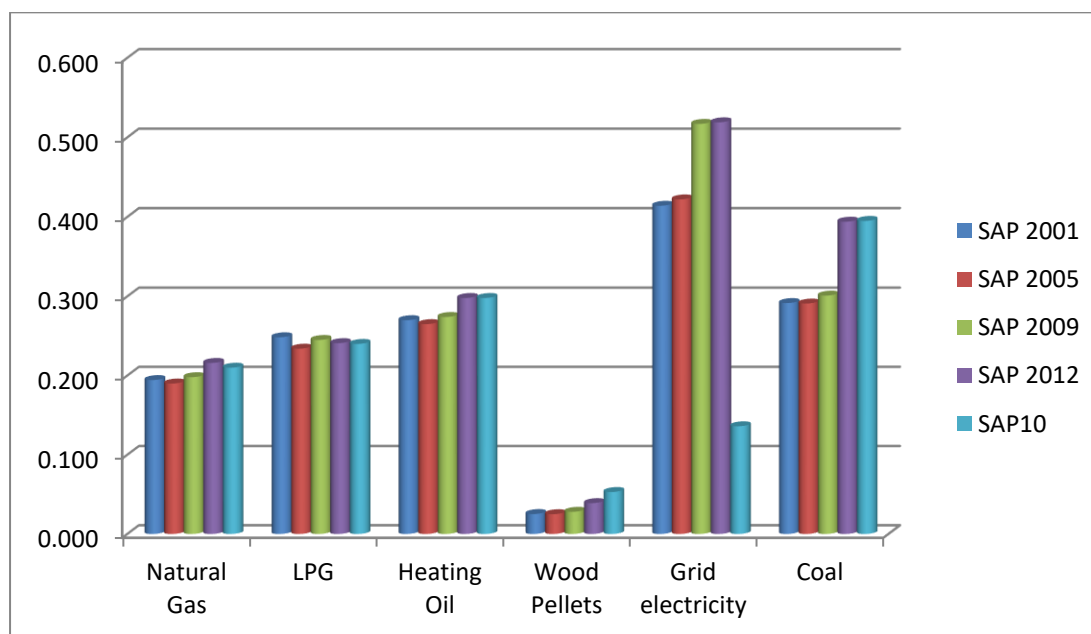
Currently there is no way of assessing the benefit of the Geothermal storage system because of limited test data and therefore the system has not been considered further in this study.

For more information on the Drake landing Solar community please visit www.dlsc.ca

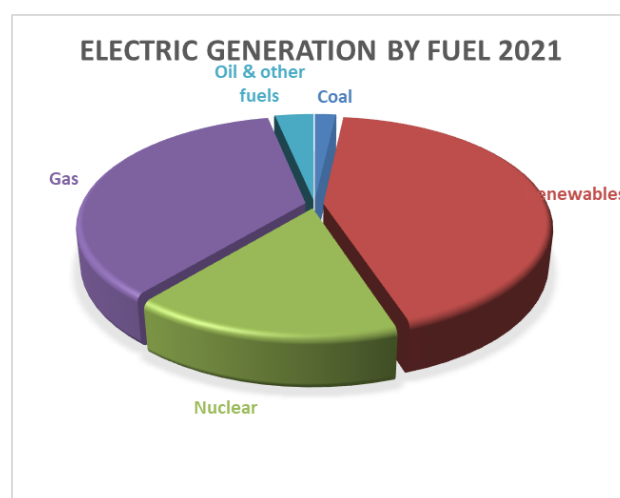
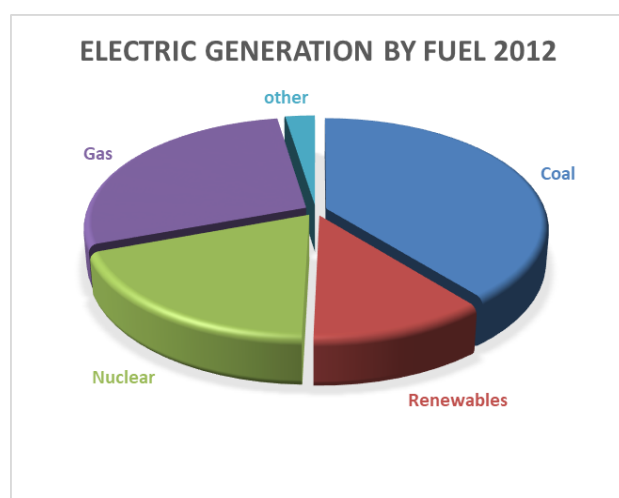
6 Fuel Cost and Carbon

Carbon

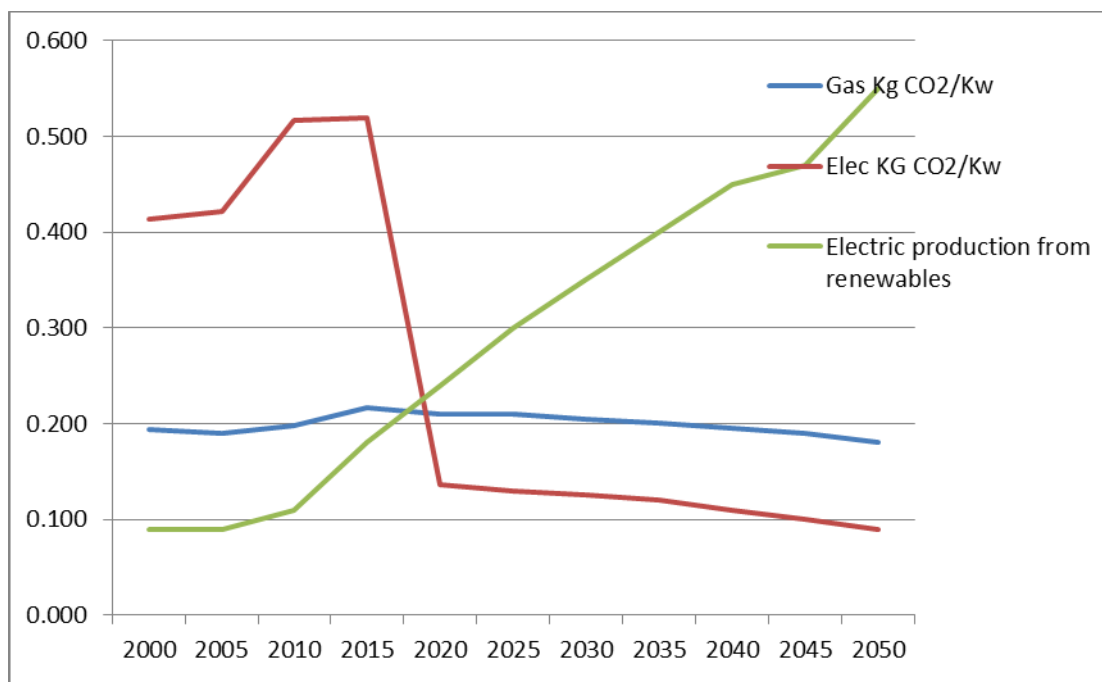
Carbon factors including SAP10.1 estimate, due to the decarbonisation of the grid electricity is now the low carbon fuel



It can be seen that electric generation from renewable technologies has increased as well as a marked reduction in generation from coal however as a consequence the share of electric production from gas has also increased.

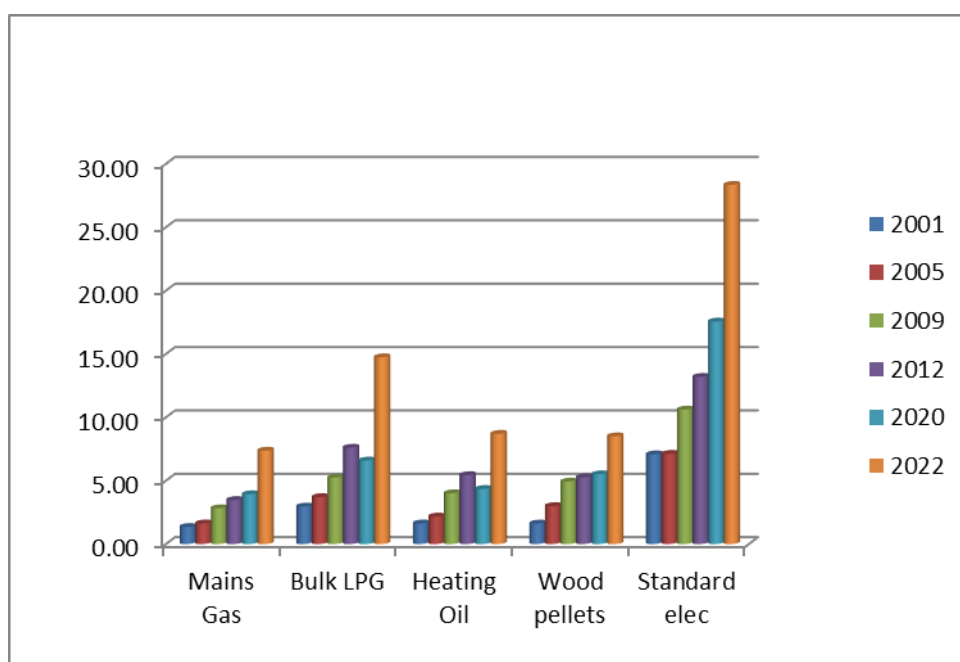


The following graph represents an estimate of CO₂ emissions for both gas and electricity and how they may change over the following years; data has been taken from SAP 2001, 2005, 2009, 2012 and SAP10.1 documents.



Running costs

Electricity is the greener fuel although it is also the most expensive fuel, technologies which high efficiencies which further reduce carbon as well as running costs would be preferred.



7 Excluded technology

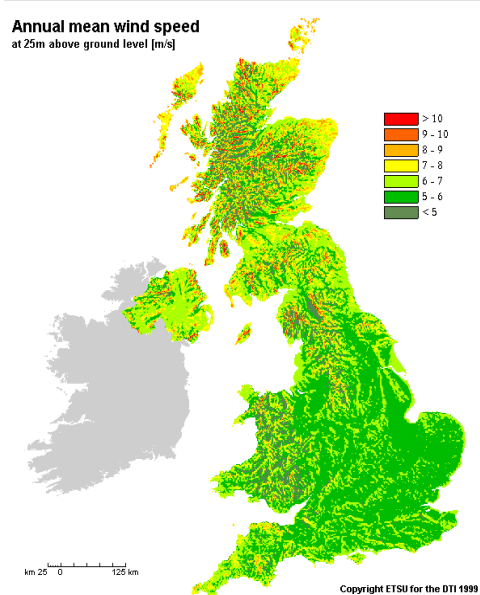
Low or Zero Carbon technologies and other innovative technologies not thought appropriate for use at the proposed development.

- Large Mast Wind turbines
- Small scale hydro power
- Solar thermal
- Waste heat from processes such as large scale power generation where the majority of heating comes from waste heat
- Other technologies, Fuel cells using hydrogen from any of the above renewable sources

LZC technology and reasons for their exclusion

Wind turbines

The UK Department of Trade and Industry used to publish a database of average wind speed data for every 1km grid square in the country, known as the NOABL database. The database no longer appears on the DTI website. The data is estimated rather than measured, and takes no account of local features such as walls, buildings, trees and hilltops, which occur at a scale of much less than 1km. These features make a major difference to the wind. To quote the DTI web page: "The data can only be used as a guide and should be followed by on-site measurements for a proper assessment".



In any case, average wind speed is not a reliable predictor of wind turbine output, because the relationship between wind speed and power output is not linear. For example, compare two days: one when the wind blows steadily at 8 mph all day, and another when the wind blows at 16 mph for 12 hours and there is no wind at all for the other 12 hours. Both days have an average wind speed of 8mph, but most turbines would produce more than twice as much power on the second day. One way to approach the problem is to embark on complex statistical calculations involving the 'Rayleigh wind speed distribution'; a simpler method is to carry out a wind survey in the exact spot where the turbine is to be mounted. The average wind speed for the proposed development is **5 meters per second**, 10 meters above ground level according to the NOABL database; therefore large mast wind turbines may be suitable for use at the proposed site. As previously indicated a detailed on-site assessment to establish the actual average wind speed would be required to determine the potential suitability of the site for the installation of a large mast wind turbine although it is thought that the land use requirements would be Impractical.

5.2	5	4.6
5	5	4.6
4.6	4.8	4.9

<http://www.renew-reuse-recycle.com/noabl.pl?n=503>

Small scale hydro power

Small scale hydro would be inappropriate for integration into the proposed development due to the geographical location of the proposed site and its increased proximity to a natural water feature which would be capable of accommodating this type of technology.

Biomass

As well as the increase in running costs and energy use the fuel would need to be delivered to site and there would be a certain degree of organisation required to source the fuel and arrange for delivery which may cause inconvenience on part of the occupier and or housing management team.

Biomass boilers are very efficient and produce very little waste products even so there would be a requirement to remove and dispose of burnt spent fuel frequently.

The Clean Air Acts of 1956 and 1968 were introduced to deal with the smog's of the 1950s and 1960s which were caused by the widespread burning of coal for domestic heating and by industry. This smog's were blamed for the premature deaths of hundreds of people in the UK. The Acts gave local authorities powers to control emissions of dark smoke, grit, dust and fumes from industrial premises and furnaces and to declare "smoke control areas" in which emissions of smoke from domestic properties are banned. Since then, smoke control areas have been introduced in many of our large towns and cities in the UK and in large parts of the Midlands, North West, South Yorkshire, North East of England, Central and Southern Scotland. The implementation of smoke control areas, the increased popularity of clean natural gas and the changes in the industrial and economic structure of the UK lead to a substantial reduction in concentrations of smoke and associated levels of sulphur dioxide (SO₂) between the 1950s and the present day.

Pollutants associated with biomass combustion include particulate matter (PM₁₀/PM_{2.5}) and nitrogen oxides (NO_x) emissions. These pollution emissions can have an impact on local air quality and affect human health, a report provided by DEFRA concluded that the negative effects on air quality associated with biomass primary installations especially in urban developments could out way any benefit associated with CO₂ reduction.

A permit would be required which would need to be purchased from the local authority and the local authority could refuse or revoke licence at any time in the future.

It is considered that Bio Mass would not be suitable for integration at the proposed development for these reasons.

From wasted heat

Community heating including utilising waste heat from processes such as large scale power generation or industrial heat generation where the majority of heating comes from waste heat would be inappropriate for integration at the proposed development due to the geographical location of the proposed site and its increased proximity to an industrial heating or power generation source that would be capable of supporting this type of technology.

Specific details relating to the new commercial / retail element of the scheme is so far unknown, energy from wasted heat from use of these building may be able to contribute towards the heat requirements of residential units and this should be considered in greater detail once this information becomes available.

Other technologies

Fuel cell etc, not yet fully commercially available.

8 Suitable technologies

The following Low or Zero carbon technologies and innovative technologies are to be considered in more detail for integration at the proposed development.

- Air Source or Ground Source Heat Pump (ASHP & GSHP)
- Solar Photovoltaic (limited available roof space, site overshadowing)

High efficiency technologies such as Ground and Air Source Heat pumps will have the largest effect on Carbon reduction and Primary Energy reduction.

Microgeneration technologies including Photovoltaic technology if coupled with battery storage will have the largest benefit in reducing occupiers running costs and reducing Primary Energy.

Heat Pump Technologies and Solar Photovoltaic technologies are both considered suitable for integration at the proposed development.

9 Bibliography and definitions

DCLG

<http://www.communities.gov.uk/corporate/>

Energy Saving Trust

<http://www.energysavingtrust.org.uk/>

Building Research Establishment (BRE)

<http://www.bre.co.uk/>

Code for Sustainable Homes (CSH) version 2 revised May 2009 incorporating 2014 addendum

<http://www.bre.co.uk/>

London Tool Kit 2004

SAP 2012 version 9.92 (BRE)

<http://projects.bre.co.uk/sap2012/>

Business Enterprise and Regulatory Reform (BERR)

Planning Portal

<http://www.planningportal.gov.uk/>

Department for Environment Food and Rural Affairs

DEFRA

<http://www.defra.gov.uk/>

NOABL database

BERR

<http://www.berr.gov.uk/whatwedo/energy/sources/renewables/explained/wind/windspeed-database/page27326.html>

SAP	Standard Assessment Procedure
ENE 1	Energy 1
ENE 7	Energy 7
SAP	Standard Assessment Procedure
LZC	Low or Zero Carbon Technology
CSH	Code for Sustainable Homes
EI	Environmental Impact
FIT	Feed in Tariffs
RHI	Renewable Heat Incentives
DER	Dwelling Emission Rate
TER	Target Emission Rate
DNO	District Network Operator
PV	Photovoltaic
CHP	Combined Heat and Power
AD	Anaerobic Digestion
ASHP	Air Source Heat Pump
GSHP	Ground Source Heat Pump

10 Preliminary SAP 10.2 calculations

- BREL Report
- Dwelling Emission Rate (DER)
- Target Emission Rate (TER)
- Dwelling Fabric Energy Efficiency (DFEE)
- Target Fabric Energy Efficiency (TFEE)
- Energy Rating
- Energy Performance Data
- Energy Performance Data for improved dwelling
- Thermal Bridging

Building Regulations England Part L (BREL) Compliance Report

Approved Document L1 2021 Edition, England assessed by Array SAP 10 program, Array

Date: Mon 20 May 2024 18:15:53

Project Information			
Assessed By	Paul Goddard	Building Type	House, Detached
OCDEA Registration	EES/005113	Assessment Date	2024-05-20

Dwelling Details			
Assessment Type	As designed	Total Floor Area	163 m ²
Site Reference	77826-LZC	Plot Reference	001
Address	Rainsough Hill, MANCHESTER, M25 9SU		

Client Details	
Name	-
Company	-
Address	-, -, -, -

This report covers items included within the SAP calculations. It is not a complete report of regulations compliance.

1a Target emission rate and dwelling emission rate			
Fuel for main heating system	Electricity		
Target carbon dioxide emission rate	10.74 kgCO ₂ /m ²		
Dwelling carbon dioxide emission rate	2.75 kgCO ₂ /m ²		OK
1b Target primary energy rate and dwelling primary energy			
Target primary energy	56.3 kWh _{PE} /m ²		
Dwelling primary energy	29.95 kWh _{PE} /m ²		OK
1c Target fabric energy efficiency and dwelling fabric energy efficiency			
Target fabric energy efficiency	45.7 kWh/m ²		
Dwelling fabric energy efficiency	45.6 kWh/m ²		OK

2a Fabric U-values				
Element	Maximum permitted average U-Value [W/m ² K]	Dwelling average U-Value [W/m ² K]	Element with highest individual U-Value	
External walls	0.26	0.17	Walls (1) (0.18)	OK
Party walls	0.2	N/A	N/A	N/A
Curtain walls	1.6	N/A	N/A	N/A
Floors	0.18	0.11	GF (0.11)	OK
Roofs	0.16	0.13	Roof (2) (0.15)	OK
Windows, doors, and roof windows	1.6	1.19	Front (1.2)	OK
Rooflights	2.2	1.6	RL, North West (1.6)	OK

2b Envelope elements (better than typically expected values are flagged with a subsequent (!))			
Name	Net area [m ²]	U-Value [W/m ² K]	
Exposed wall: Walls (1)	194.08	0.18	
Exposed wall: Walls (2)	32.16	0.11 (!)	
Ground floor: GF, GF	64.38	0.11	
Exposed roof: Roof (1)	29.74	0.1 (!)	
Exposed roof: Roof (2)	45.86	0.15	

2c Openings (better than typically expected values are flagged with a subsequent (!))				
Name	Area [m ²]	Orientation	Frame factor	U-Value [W/m ² K]
Front, Window	18	South East	0.7	1.2
Rear, Window	15.23	North West	0.7	1.2
Door, Door	2.15	South East	N/A	1 (!)
LH Side, Window	0.72	North East	0.7	1.2
LH Side, Window	0.72	South West	0.7	1.2
RL, Rooflights U+0.3	4.37	North West	0.7	1.6

2d Thermal bridging (better than typically expected values are flagged with a subsequent (!))	
Building part 1 - Main Dwelling: Thermal bridging calculated from linear thermal transmittances for each junction	

Main element	Junction detail	Source	Psi value [W/mK]	Drawing / reference
External wall	E2: Other lintels (including other steel lintels)	Calculated by person with suitable expertise	0.05	Split lintels
External wall	E3: Sill	Calculated by person with suitable expertise	0.05	R2
External wall	E4: Jamb	Calculated by person with suitable expertise	0.05	R2
External wall	E5: Ground floor (normal)	Calculated by person with suitable expertise	0.16	R2
External wall	E16: Corner (normal)	Calculated by person with suitable expertise	0.09	R2
External wall	E6: Intermediate floor within a dwelling	Calculated by person with suitable expertise	0 (!)	R2
External wall	E11: Eaves (insulation at rafter level)	Calculated by person with suitable expertise	0.04	R2
External wall	E13: Gable (insulation at rafter level)	Calculated by person with suitable expertise	0.08	R2
External wall	E17: Corner (inverted - internal area greater than external area)	Calculated by person with suitable expertise	-0.09	R2
Roof	R1: Head of roof window	SAP table default	0.24	
Roof	R2: Sill of roof window	SAP table default	0.24	
Roof	R3: Jamb of roof window	SAP table default	0.24	
Roof	R7: Flat ceiling (inverted)	Calculated by person with suitable expertise	0.04	R2
Roof	R9: Roof to wall (flat ceiling)	Calculated by person with suitable expertise	0.04	R2
Roof	R4: Ridge (vaulted ceiling)	Calculated by person with suitable expertise	0.08	R2

3 Air permeability (better than typically expected values are flagged with a subsequent (!))

Maximum permitted air permeability at 50Pa	8 m ³ /hm ²	
Dwelling air permeability at 50Pa	4 m ³ /hm ² , Design value	OK
Air permeability test certificate reference		

4 Space heating

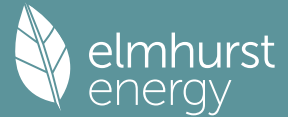
Replace heating	
Main heating system 1: Heat pump with radiators or underfloor heating - Electricity	
Efficiency	261.8%
Emitter type	Radiators
Flow temperature	45°C
System type	Heat Pump
Manufacturer	Daikin Europe NV
Model	EDLA06EV3 PPC
Commissioning	
Secondary heating system: N/A	
Fuel	N/A
Efficiency	N/A
Commissioning	

5 Hot water

Cylinder/store - type: Cylinder	
Capacity	200 litres
Declared heat loss	1.22 kWh/day
Primary pipework insulated	Yes
Manufacturer	
Model	
Commissioning	
Waste water heat recovery system 1 - type: N/A	
Efficiency	
Manufacturer	
Model	

6 Controls		
Main heating 1 - type: Time and temperature zone control by arrangement of plumbing and electrical services		
Function		
Ecodesign class		
Manufacturer		
Model		
Water heating - type: Cylinder thermostat and HW separately timed		
Manufacturer		
Model		
7 Lighting		
Minimum permitted light source efficacy	75 lm/W	
Lowest light source efficacy	80 lm/W	OK
External lights control	N/A	
8 Mechanical ventilation		
System type: Decentralised mechanical extract		
Maximum permitted specific fan power	0.7 W/(l/s)	
Specific fan power	0.15 W/(l/s)	OK
Minimum permitted heat recovery efficiency	N/A	
Heat recovery efficiency	N/A	N/A
Manufacturer/Model	TBC	
Commissioning		
9 Local generation		
Technology type: Photovoltaic system (1)		
Peak power	1.6 kWp	
Orientation	South East	
Pitch	30°	
Overshading	Modest	
Manufacturer		
MCS certificate		
10 Heat networks		
N/A		
11 Supporting documentary evidence		
N/A		
12 Declarations		
a. Assessor Declaration		
This declaration by the assessor is confirmation that the contents of this BREL Compliance Report are a true and accurate reflection based upon the design information submitted for this dwelling for the purpose of carrying out the "As designed" assessment, and that the supporting documentary evidence (SAP Conventions, Appendix 1 (documentary evidence) schedules the minimum documentary evidence required) has been reviewed in the course of preparing this BREL Compliance Report.		
Signed:	Assessor ID:	
Name:	Date:	
b. Client Declaration		
N/A		

Full SAP Calculation Printout



Property Reference	77826-LZC				Issued on Date	20/05/2024	
Assessment Reference	001			Prop Type Ref			
Property	Rainsough Hill, MANCHESTER, M25 9SU						
SAP Rating	86 B		DER	2.75		TER	10.74
Environmental	97 A		% DER < TER				74.39
CO ₂ Emissions (t/year)	0.44		DFEE	45.63		TFEE	45.68
Compliance Check	See BREL		% DFEE < TFEE				0.10
% DPER < TPER	46.81		DPER	29.95		TPER	56.30
Assessor Details	Mr. Paul Goddard					Assessor ID	B342-0001
Client	-, -						

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 (m ²)	Storey height (m)	Volume (m ³)
Ground floor	64.3800 (1b)	x 2.5400 (2b)	= 163.5252 (1b) - (3b)
First floor	64.3800 (1c)	x 2.7700 (2c)	= 178.3326 (1c) - (3c)
Second floor	34.6400 (1d)	x 2.5300 (2d)	= 87.6392 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	163.4000		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 429.4970 (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											0 * 10 =	0.0000 (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) =											0.0000 / (5) =	0.0000 (8)	
Pressure test											Yes		
Pressure Test Method											Blower Door		
Measured/design AP50											4.0000 (17)		
Infiltration rate											0.2000 (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) = 0.1700 (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	0.2167	0.2125	0.2083	0.1870	0.1827	0.1615	0.1615	0.1573	0.1700	0.1827	0.1913	0.1998	(22b)
Mechanical extract ventilation - decentralised													
If mechanical ventilation													0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)													0.5000 (23b)
Effective ac	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	(25)

3. Heat losses and heat loss parameter

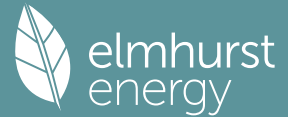
Element	Gross m ²	Openings m ²	NetArea m ²	U-value W/m ² K	A x U W/K	K-value kJ/m ² K	A x K kJ/K
Door			2.1500	1.0000	2.1500		(26)
Window (Uw = 1.20)			34.6700	1.1450	39.6985		(27)
RL			4.3700	1.5038	6.5714		(27a)
GF			64.3800	0.1100	7.0818	75.0000	4828.5000 (28a)
Main	230.9000	36.8200	194.0800	0.1800	34.9344	110.0000	21348.8000 (29a)
Dwarf (PIRx0.72)	32.1600		32.1600	0.1100	3.5376	9.0000	289.4400 (29a)
PIJ	29.7400		29.7400	0.1000	2.9740	9.0000	267.6600 (30)
PIR	50.2300	4.3700	45.8600	0.1500	6.8790	9.0000	412.7400 (30)
Total net area of external elements Aum(A, m ²)			407.4100				(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	103.8267		(33)
Internal Wall 1			72.1900			9.0000	649.7100 (32c)
Internal Wall 2			68.4000			75.0000	5130.0000 (32c)
Internal Floor 1			40.1200			18.0000	722.1600 (32d)
Internal Ceiling 1			40.1200			9.0000	361.0800 (32e)

Full SAP Calculation Printout



Heat capacity Cm = Sum(A x k)												
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K												
List of Thermal Bridges												
K1 Element												
E2 Other lintels (including other steel lintels)												
E3 Sill												
E4 Jamb												
E5 Ground floor (normal)												
E16 Corner (normal)												
E6 Intermediate floor within a dwelling												
E11 Eaves (insulation at rafter level)												
E13 Gable (insulation at rafter level)												
E17 Corner (inverted - internal area greater than external area)												
R1 Head of roof window												
R2 Sill of roof window												
R3 Jamb of roof window												
R7 Flat ceiling (inverted)												
R9 Roof to wall (flat ceiling)												
R4 Ridge (vaulted ceiling)												
Thermal bridges (Sum(L x Psi) calculated using Appendix K)												
Point Thermal bridges												
Total fabric heat loss												
Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m												
Heat transfer coeff												
Average = Sum(39)m / 12 =												
HLP												
HLP (average)												
Days in mont												
4. Water heating energy requirements (kWh/year)												
Assumed occupancy												
Hot water usage for mixer showers												
Hot water usage for baths												
Hot water usage for other uses												
Average daily hot water use (litres/day)												
Daily hot water use												
Energy conte												
Energy content (annual)												
Distribution loss (46)m = 0.15 x (45)m												
Water storage loss:												
Store volume												
a) If manufacturer declared loss factor is known (kWh/day):												
Temperature factor from Table 2b												
Enter (49) or (54) in (55)												
Total storage loss												
If cylinder contains dedicated solar storage												
Primary loss												
Combi loss												
Total heat required for water heating calculated for each month												
WWHRS												
PV diverter												
Solar input												
FGHRS												
Output from w/h												
12Total per year (kWh/year)												
Electric shower(s)												
Heat gains from water heating, kWh/month												
5. Internal gains (see Table 5 and 5a)												
Metabolic gains (Table 5), Watts												
(66)m												
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												
Pumps, fans												
Losses e.g. evaporation (negative values) (Table 5)												
Water heating gains (Table 5)												
Total internal gains												
6. Solar gains												

Full SAP Calculation Printout



[Jan]			Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W
Northeast			0.7200	11.2829	0.5700	0.7000	0.7700	2.2463 (75)
Southeast			18.0000	36.7938	0.5700	0.7000	0.7700	183.1275 (77)
Southwest			0.7200	36.7938	0.5700	0.7000	0.7700	7.3251 (79)
Northwest			15.2300	11.2829	0.5700	0.7000	0.7700	47.5147 (81)
Northwest			4.3700	16.3666	0.6300	0.7000	1.0000	28.3871 (82)

Solar gains	268.6007	484.1257	734.1253	1031.5846	1268.0530	1308.7467	1240.9956	1056.7327	835.7813	554.2971	326.5398	226.7626 (83)
Total gains	992.9719	1227.3134	1445.1757	1718.0275	1918.2382	1935.0238	1842.3127	1658.3451	1456.1944	1195.9587	1008.4737	934.8803 (84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545
alpha	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236
util living area	0.9954	0.9885	0.9706	0.9125	0.7860	0.6059	0.4565	0.5225	0.7762	0.9532	0.9904	0.9964 (86)
Living	19.2966	19.5528	19.9288	20.4036	20.7684	20.9416	20.9860	20.9758	20.8368	20.3320	19.7141	19.2394
Non living	17.9386	18.2647	18.7392	19.3192	19.7270	19.8885	19.9185	19.9139	19.8071	19.2471	18.4724	17.8655
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0
24 / 9	3	0	0	0	0	0	0	0	0	0	0	0
16 / 9	28	0	0	0	0	0	0	0	0	0	0	10
MIT	20.1286	19.5528	19.9288	20.4036	20.7684	20.9416	20.9860	20.9758	20.8368	20.3320	19.7141	19.4857 (87)
Th 2	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235 (88)
util rest of house	0.9941	0.9852	0.9621	0.8876	0.7310	0.5187	0.3496	0.4091	0.6982	0.9347	0.9871	0.9954 (89)
MIT 2	19.1322	18.2647	18.7392	19.3192	19.7270	19.8885	19.9185	19.9139	19.8071	19.2471	18.4724	18.2364 (90)
Living area fraction									fLA = Living area / (4) =			0.0994 (91)
MIT	19.2312	18.3927	18.8575	19.4270	19.8305	19.9932	20.0246	20.0195	19.9094	19.3549	18.5958	18.3605 (92)
Temperature adjustment												0.0000
adjusted MIT	19.2312	18.3927	18.8575	19.4270	19.8305	19.9932	20.0246	20.0195	19.9094	19.3549	18.5958	18.3605 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9930	0.9784	0.9507	0.8736	0.7257	0.5247	0.3599	0.4197	0.6970	0.9215	0.9810	0.9932 (94)
Useful gains	986.0373	1200.8509	1373.8921	1500.8806	1392.0508	1015.2504	663.1391	695.9368	1014.9581	1102.1181	989.2981	928.5265 (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	2917.1800	2636.1297	2414.3375	2056.7030	1588.4931	1053.6901	669.0789	707.1510	1135.0114	1710.4950	2245.9844	2766.6096 (97)
Space heating kWh	1436.7702	964.5074	774.0914	400.1921	146.1531	0.0000	0.0000	0.0000	0.0000	452.6324	904.8142	1367.5338 (98a)
Space heating requirement - total per year (kWh/year)												6446.6944
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	1436.7702	964.5074	774.0914	400.1921	146.1531	0.0000	0.0000	0.0000	0.0000	452.6324	904.8142	1367.5338 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												6446.6944
Space heating per m2										(98c) / (4) =		39.4535 (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 %)												261.8457 (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	1436.7702	964.5074	774.0914	400.1921	146.1531	0.0000	0.0000	0.0000	0.0000	452.6324	904.8142	1367.5338 (98)
Space heating efficiency (main heating system 1)	261.8457	261.8457	261.8457	261.8457	261.8457	0.0000	0.0000	0.0000	0.0000	261.8457	261.8457	261.8457 (210)
Space heating fuel (main heating system)	548.7087	368.3495	295.6288	152.8351	55.8165	0.0000	0.0000	0.0000	0.0000	172.8623	345.5524	522.2670 (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	281.9700	249.1291	263.9781	230.3433	222.1221	198.8743	195.2966	203.7301	206.7269	232.0580	248.6521	278.6513 (64)
Efficiency of water heater	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659 (216)
Fuel for water heating, kWh/month	106.3773	93.9876	99.5896	86.9004	83.7988	75.0282	73.6785	76.8602	77.9908	87.5473	93.8077	105.1253 (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	6.7896	6.1326	6.7896	6.5706	6.7896	6.5706	6.7896	6.7896	6.5706	6.7896	6.5706	6.7896 (231)
Lighting	35.4004	28.3995	25.5706	18.7341	14.4708	11.8228	13.2007	17.1588	22.2876	29.2425	33.0294	36.3843 (232)
Electricity generated by PVs (Appendix M) (negative quantity)												
(233a)m	-24.0670	-38.1596	-61.6054	-75.6525	-84.9003	-78.6338	-77.4372	-70.1425	-57.9696	-45.5699	-27.5750	-20.2091 (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	-4.1452	-10.2046	-23.6240	-41.8148	-62.3661	-66.8650	-65.8500	-53.7471	-36.8919	-17.0889	-6.1556	-3.2122 (233b)

Full SAP Calculation Printout



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	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	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	0.0000	(235d)
Annual totals kWh/year														
Space heating fuel - main system 1													2462.0202	(211)
Space heating fuel - main system 2													0.0000	(213)
Space heating fuel - secondary													0.0000	(215)
Efficiency of water heater													265.0659	
Water heating fuel used													1060.6918	(219)
Space cooling fuel													0.0000	(221)
Electricity for pumps and fans:														
(MEVDecentralised, DataSheet: total watage = 8.0860, total flow = 53.0000, SFP = 0.1526)														
mechanical ventilation fans (SFP = 0.1526)													79.9425	(230a)
Total electricity for the above, kWh/year													79.9425	(231)
Electricity for lighting (calculated in Appendix L)													285.7016	(232)
Energy saving/generation technologies (Appendices M ,N and Q)														
PV generation													-1053.8872	(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													2834.4688	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	2462.0202	0.1558	383.6470	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	1060.6918	0.1411	149.6147	(264)
Space and water heating			533.2617	(265)
Pumps, fans and electric keep-hot	79.9425	0.1387	11.0890	(267)
Energy for lighting	285.7016	0.1443	41.2356	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-661.9218	0.1331	-88.0945	
PV Unit electricity exported	-391.9654	0.1213	-47.5623	
Total			-135.6567	(269)
Total CO2, kg/year			449.9295	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			2.7500	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	2462.0202	1.5769	3882.2665	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	1060.6918	1.5216	1613.9207	(278)
Space and water heating			5496.1871	(279)
Pumps, fans and electric keep-hot	79.9425	1.5128	120.9370	(281)
Energy for lighting	285.7016	1.5338	438.2186	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-661.9218	1.4918	-987.4572	
PV Unit electricity exported	-391.9654	0.4451	-174.4830	
Total			-1161.9402	(283)
Total Primary energy kWh/year			4893.4027	(286)
Dwelling Primary energy Rate (DPER)			29.9500	(287)

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

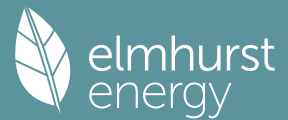
1. Overall dwelling characteristics

	Area (m2)	Storey height (m)	Volume (m3)	
Ground floor	64.3800 (1b)	x 2.5400 (2b)	= 163.5252 (1b) - (3b)	
First floor	64.3800 (1c)	x 2.7700 (2c)	= 178.3326 (1c) - (3c)	
Second floor	34.6400 (1d)	x 2.5300 (2d)	= 87.6392 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	163.4000			
Dwelling volume		(3a) + (3b) + (3c) + (3d) + (3e) ... (3n) =	429.4970 (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)

Full SAP Calculation Printout



Number of passive vents
Number of flueless gas fires

0 * 10 = 0.0000 (7b)
0 * 40 = 0.0000 (7c)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =
Pressure test
Pressure Test Method
Measured/design AP50
Infiltration rate
Number of sides sheltered

Air changes per hour
40.0000 / (5) = 0.0931 (8)
Yes
Blower Door
5.0000 (17)
0.3431 (18)
2 (19)

Shelter factor
Infiltration rate adjusted to include shelter factor

(20) = 1 - [0.075 x (19)] = 0.8500 (20)
(21) = (18) x (20) = 0.2917 (21)

Wind speed	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	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												
Effective ac	0.3719	0.3646	0.3573	0.3208	0.3135	0.2771	0.2771	0.2698	0.2917	0.3135	0.3281	0.3427 (22b)
	0.5691	0.5665	0.5638	0.5515	0.5492	0.5384	0.5384	0.5364	0.5425	0.5492	0.5538	0.5587 (25)

3. Heat losses and heat loss parameter

Element	Gross m ²	Openings m ²	NetArea m ²	U-value W/m ² K	A x U W/K	K-value kJ/m ² K	A x K kJ/K
TER Opaque door			2.1500	1.0000	2.1500		(26)
TER Opening Type (Uw = 1.20)			34.3600	1.1450	39.3435		(27)
RL			4.3300	1.8519	8.0185		(27a)
GF			64.3800	0.1300	8.3694		(28a)
Main	230.9000	36.5100	194.3900	0.1800	34.9902		(29a)
Dwarf (PIRx0.72)	32.1600		32.1600	0.1800	5.7888		(29a)
PIJ	29.7400		29.7400	0.1100	3.2714		(30)
PIR	50.2300	4.3300	45.9000	0.1100	5.0490		(30)
Total net area of external elements Aum(A, m ²)			407.4100				(31)
Fabric heat loss, W/K = Sum (A x U)					(26)...(30) + (32) = 106.9808		(33)

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

208.1401 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	20.4800	0.0500	1.0240
E3 Sill	40.2800	0.0500	2.0140
E4 Jamb	50.0800	0.0500	2.5040
E5 Ground floor (normal)	34.2100	0.1600	5.4736
E16 Corner (normal)	41.9600	0.0900	3.7764
E6 Intermediate floor within a dwelling	59.4500	0.0000	0.0000
E11 Eaves (insulation at rafter level)	30.3200	0.0400	1.2128
E13 Gable (insulation at rafter level)	6.0300	0.0800	0.4824
E17 Corner (inverted - internal area greater than external area)	10.6200	-0.0900	-0.9558
R1 Head of roof window	3.1200	0.0800	0.2496
R2 Sill of roof window	3.1200	0.0600	0.1872
R3 Jamb of roof window	11.2000	0.0800	0.8960
R7 Flat ceiling (inverted)	1.8300	0.0400	0.0732
R9 Roof to wall (flat ceiling)	3.7900	0.0400	0.1516
R4 Ridge (vaulted ceiling)	9.2400	0.0800	0.7392

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

17.8282 (36)

Point Thermal bridges

(36a) = 0.0000

Total fabric heat loss

(33) + (36) + (36a) = 124.8090 (37)

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

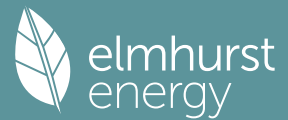
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	80.6670	80.2864	79.9134	78.1614	77.8336	76.3077	76.3077	76.0251	76.8954	77.8336	78.4967	79.1900 (38)
Heat transfer coeff	205.4760	205.0955	204.7225	202.9704	202.6426	201.1167	201.1167	200.8341	201.7045	202.6426	203.3058	203.9990 (39)
Average = Sum(39)m / 12 =												202.9689

HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	1.2575	1.2552	1.2529	1.2422	1.2402	1.2308	1.2308	1.2291	1.2344	1.2402	1.2442	1.2485 (40)
HLP (average)												1.2422
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31

4. Water heating energy requirements (kWh/year)

Assumed occupancy													2.9536 (42)
Hot water usage for mixer showers													
	73.7425	72.6343	71.0194	67.9296	65.6495	63.1066	61.6613	63.2640	65.0208	67.7510	70.9071	73.4600	(42a)
Hot water usage for baths													
	31.8349	31.3621	30.6963	29.4687	28.5495	27.5302	26.9797	27.6408	28.3607	29.4513	30.7042	31.7273	(42b)
Hot water usage for other uses													
	44.8781	43.2462	41.6143	39.9823	38.3504	36.7185	36.7185	38.3504	39.9823	41.6143	43.2462	44.8781	(42c)
Average daily hot water use (litres/day)													(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	150.4555	147.2426	143.3300	137.3807	132.5494	127.3554	125.3595	129.2552	133.3638	138.8166	144.8575	150.0654	(44)
Energy content (annual)	238.2848	209.6715	220.2929	188.0673	178.4369	156.5983	151.6114	160.0449	164.4509	188.3728	206.3761	234.9661	(45)
Distribution loss (46)m = 0.15 x (45)m													
	35.7427	31.4507	33.0439	28.2101	26.7655	23.4897	22.7417	24.0067	24.6676	28.2559	30.9564	35.2449	(46)
Water storage loss:													
Store volume													(47)
a) If manufacturer declared loss factor is known (kWh/day):													(48)
Temperature factor from Table 2b													(49)
Enter (49) or (54) in (55)													(55)
Total storage loss													
	27.6637	24.9865	27.6637	26.7713	27.6637	26.7713	27.6637	27.6637	26.7713	27.6637	26.7713	27.6637	(56)
If cylinder contains dedicated solar storage													
	27.6637	24.9865	27.6637	26.7713	27.6637	26.7713	27.6637	27.6637	26.7713	27.6637	26.7713	27.6637	(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													
	289.2108	255.6692	271.2189	237.3506	229.3630	205.8816	202.5375	210.9710	213.7342	239.2988	255.6594	285.8922	(62)
WWHRS	-33.7120	-29.8152	-31.2207	-25.8520	-24.0931	-20.6167	-19.3248	-20.5500	-21.3308	-25.1466	-28.4881	-33.0877	(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)

Full SAP Calculation Printout



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	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	0.0000 (63d)
Output from w/h	255.4988	225.8541	239.9982	211.4986	205.2699	185.2649	183.2126	190.4210	192.4034	214.1522	227.1713	252.8045	(64)
12Total per year (kWh/year)	Total per year (kWh/year) = Sum(64)m =											2583.5494	(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)
Heat gains from water heating, kWh/month	119.9705	106.5140	113.9882	101.9590	100.0711	91.4956	91.1516	93.9558	94.1065	103.3748	108.0467	118.8671	(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	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	168.8459	186.9366	168.8459	174.4741	168.8459	174.4741	168.8459	168.8459	174.4741	168.8459	174.4741	168.8459	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	334.7559	338.2297	329.4760	310.8405	287.3165	265.2073	250.4370	246.9632	255.7169	274.3524	297.8764	319.9856	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	(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)	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	(71)
Water heating gains (Table 5)	161.2507	158.5029	153.2100	141.6097	134.5042	127.0772	122.5157	126.2847	130.7035	138.9446	150.0648	159.7676	(72)
Total internal gains	735.1570	753.9736	721.8363	697.2288	660.9711	634.0630	609.1030	609.3983	628.1990	652.4474	692.7198	718.9036	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	Specific data or Table 6b	Specific data or Table 6c	Access factor Table 6d	Gains W
Northeast	0.7100	11.2829	0.6300	0.7000	0.7700	2.4482 (75)
Southeast	17.8400	36.7938	0.6300	0.7000	0.7700	200.6050 (77)
Southwest	0.7100	36.7938	0.6300	0.7000	0.7700	7.9837 (79)
Northwest	15.1000	11.2829	0.6300	0.7000	0.7700	52.0680 (81)
Northwest	4.3300	16.3666	0.6300	0.7000	1.0000	28.1272 (82)

Solar gains	291.2322	524.1628	792.8465	1110.9325	1362.9321	1405.5771	1333.2531	1137.0021	901.5835	599.6101	353.9182	245.9549	(83)
Total gains	1026.3892	1278.1364	1514.6829	1808.1612	2023.9032	2039.6401	1942.3561	1746.4003	1529.7825	1252.0575	1046.6380	964.8585	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	45.9774	46.0627	46.1466	46.5449	46.6202	46.9740	46.9740	47.0401	46.8371	46.6202	46.4682	46.3103	
alpha	4.0652	4.0708	4.0764	4.1030	4.1080	4.1316	4.1316	4.1360	4.1225	4.1080	4.0979	4.0874	
util living area	0.9948	0.9870	0.9674	0.9050	0.7745	0.5927	0.4458	0.5104	0.7650	0.9486	0.9892	0.9960	(86)
MIT	19.2177	19.4905	19.8874	20.3921	20.7648	20.9418	20.9858	20.9758	20.8354	20.3175	19.6723	19.1730	(87)
Th 2	19.8743	19.8761	19.8779	19.8864	19.8880	19.8954	19.8954	19.8968	19.8926	19.8880	19.8848	19.8814	(88)
util rest of house	0.9933	0.9834	0.9580	0.8782	0.7174	0.5045	0.3386	0.3965	0.6844	0.9283	0.9855	0.9948	(89)
MIT 2	17.8052	18.1535	18.6549	19.2753	19.6906	19.8611	19.8905	19.8875	19.7768	19.2026	18.3932	17.7529	(90)
Living area fraction	17.9456	18.2863	18.7774	19.3863	19.7973	19.9685	19.9994	19.9956	19.8820	19.3134	18.5203	17.8940	(91)
MIT	17.9456	18.2863	18.7774	19.3863	19.7973	19.9685	19.9994	19.9956	19.8820	19.3134	18.5203	17.8940	(92)
Temperature adjustment	17.9456	18.2863	18.7774	19.3863	19.7973	19.9685	19.9994	19.9956	19.8820	19.3134	18.5203	17.8940	(93)

8. Space heating requirement

Utilisation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.9893	0.9757	0.9454	0.8636	0.7122	0.5106	0.3489	0.4071	0.6835	0.9143	0.9787	0.9915	(94)
Useful gains	1015.3780	1247.0983	1431.9934	1561.4726	1441.3969	1041.5353	677.7135	711.0250	1045.6602	1144.7988	1024.2976	956.6306	(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	2803.8422	2745.4776	2513.4569	2128.4146	1640.8658	1079.6902	683.6684	722.1238	1166.2632	1765.7012	2321.8116	2793.5640	(97)
Space heating kWh	1330.6173	1006.9109	804.6088	408.1983	148.4049	0.0000	0.0000	0.0000	0.0000	461.9514	934.2101	1366.6785	(98a)
Space heating requirement - total per year (kWh/year)												6461.5802	
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	1330.6173	1006.9109	804.6088	408.1983	148.4049	0.0000	0.0000	0.0000	0.0000	461.9514	934.2101	1366.6785	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												6461.5802	
Space heating per m2												39.5446	(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)

Full SAP Calculation Printout



Space heating requirement	1330.6173	1006.9109	804.6088	408.1983	148.4049	0.0000	0.0000	0.0000	0.0000	461.9514	934.2101	1366.6785	(98)
Space heating efficiency (main heating system 1)	92.3000	92.3000	92.3000	92.3000	92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	(210)
Space heating fuel (main heating system)	1441.6222	1090.9110	871.7322	442.2517	160.7854	0.0000	0.0000	0.0000	0.0000	500.4891	1012.1453	1480.6918	(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	255.4988	225.8541	239.9982	211.4986	205.2699	185.2649	183.2126	190.4210	192.4034	214.1522	227.1713	252.8045	(64)
Efficiency of water heater	87.2155	87.0023	86.5572	85.5086	83.3445	79.8000	79.8000	79.8000	79.8000	85.7372	86.8833	79.8000	(216)
Fuel for water heating, kWh/month	292.9511	259.5955	277.2713	247.3418	246.2910	232.1615	229.5898	238.6228	241.1070	249.7774	261.4671	289.7018	(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	7.0685	7.3041	7.0685	7.3041	7.0685	(231)
Lighting	35.0828	28.1448	25.3412	18.5661	14.3410	11.7167	13.0823	17.0049	22.0877	28.9802	32.7331	36.0579	(232)
Electricity generated by PVs (Appendix M) (negative quantity)	-58.8348	-82.2435	-117.1926	-130.5197	-139.5925	-129.7479	-127.9903	-121.2928	-109.4489	-93.2924	-64.3695	-50.9359	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)	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)	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)	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)	-35.4302	-74.2672	-147.1768	-220.4820	-291.0675	-292.4131	-289.1205	-245.1441	-180.0412	-106.2004	-47.2884	-28.0507	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)	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)	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)	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												7000.6286	(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												3065.8783	(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)												283.1387	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation												-3182.1428	(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												7253.5028	(238)

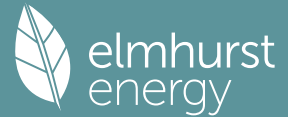
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating - main system 1	7000.6286	0.2100	1470.1320 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	3065.8783	0.2100	643.8344 (264)
Space and water heating			2113.9664 (265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293 (267)
Energy for lighting	283.1387	0.1443	40.8657 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-1225.4607	0.1348	-165.1944
PV Unit electricity exported	-1956.6821	0.1260	-246.4637
Total			-411.6580 (269)
Total CO2, kg/year			1755.1033 (272)
EPC Target Carbon Dioxide Emission Rate (TER)			10.7400 (273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Space heating - main system 1	7000.6286	1.1300	7910.7103 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	3065.8783	1.1300	3464.4424 (278)
Space and water heating			11375.1528 (279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008 (281)
Energy for lighting	283.1387	1.5338	434.2876 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-1225.4607	1.4982	-1836.0062
PV Unit electricity exported	-1956.6821	0.4624	-904.6948
Total			-2740.7010 (283)
Total Primary energy kWh/year			9198.8401 (286)
Target Primary Energy Rate (TPER)			56.3000 (287)

Full SAP Calculation Printout



CALCULATION OF FABRIC ENERGY EFFICIENCY

1. Overall dwelling characteristics

	Area (m ²)		Storey height (m)		Volume (m ³)	
Ground floor	64.3800 (1b)	x	2.5400 (2b)	=	163.5252 (1b) - (3b)	
First floor	64.3800 (1c)	x	2.7700 (2c)	=	178.3326 (1c) - (3c)	
Second floor	34.6400 (1d)	x	2.5300 (2d)	=	87.6392 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	163.4000				(4)	
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =	429.4970 (5)	

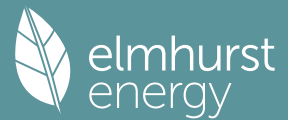
2. Ventilation rate

	m ³ 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)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0931 (8)
Pressure test	Yes	
Pressure Test Method	Blower Door	
Measured/design AP50	4.0000	(17)
Infiltration rate	0.2931	(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) =	0.2492 (21)
Wind speed	Jan 5.1000 Feb 5.0000 Mar 4.9000 Apr 4.4000 May 4.3000 Jun 3.8000 Jul 3.8000 Aug 3.7000 Sep 4.0000 Oct 4.3000 Nov 4.5000 Dec 4.7000	(22)
Wind factor	Jan 1.2750 Feb 1.2500 Mar 1.2250 Apr 1.1000 May 1.0750 Jun 0.9500 Jul 0.9500 Aug 0.9250 Sep 1.0000 Oct 1.0750 Nov 1.1250 Dec 1.1750	(22a)
Adj infilt rate	0.3177 0.3115 0.3052 0.2741 0.2678 0.2367 0.2367 0.2305 0.2492 0.2678 0.2803 0.2928	(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	0.5505 0.5485 0.5466 0.5376 0.5359 0.5280 0.5280 0.5266 0.5310 0.5359 0.5393 0.5429	(25)

3. Heat losses and heat loss parameter

Element	Gross m ²	Openings m ²	NetArea m ²	U-value W/m ² K	A x U W/K	K-value kJ/m ² K	A x K kJ/K	
Door			2.1500	1.0000	2.1500			(26)
Window (Uw = 1.20)			34.6700	1.1450	39.6985			(27)
RL			4.3700	1.5038	6.5714			(27a)
GF			64.3800	0.1100	7.0818	75.0000	4828.5000	(28a)
Main	230.9000	36.8200	194.0800	0.1800	34.9344	110.0000	21348.8000	(29a)
Dwarf (PIRx0.72)	32.1600		32.1600	0.1100	3.5376	9.0000	289.4400	(29a)
PIJ	29.7400		29.7400	0.1000	2.9740	9.0000	267.6600	(30)
PIR	50.2300	4.3700	45.8600	0.1500	6.8790	9.0000	412.7400	(30)
Total net area of external elements Aum(A, m ²)			407.4100					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		103.8267			(33)
Internal Wall 1			72.1900			9.0000	649.7100	(32c)
Internal Wall 2			68.4000			75.0000	5130.0000	(32c)
Internal Floor 1			40.1200			18.0000	722.1600	(32d)
Internal Ceiling 1			40.1200			9.0000	361.0800	(32e)
Heat capacity Cm = Sum(A x k)						(28)...(30) + (32) + (32a)...(32e) =	34010.0900	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m ² K							208.1401	(35)
List of Thermal Bridges								
K1 Element				Length	Psi-value		Total	
E2 Other lintels (including other steel lintels)				20.4800	0.0500		1.0240	
E3 Sill				40.2800	0.0500		2.0140	
E4 Jamb				50.0800	0.0500		2.5040	
E5 Ground floor (normal)				34.2100	0.1600		5.4736	
E16 Corner (normal)				41.9600	0.0900		3.7764	
E6 Intermediate floor within a dwelling				59.4500	0.0000		0.0000	
E11 Eaves (insulation at rafter level)				30.3200	0.0400		1.2128	
E13 Gable (insulation at rafter level)				6.0300	0.0800		0.4824	
E17 Corner (inverted - internal area greater than external area)				10.6200	-0.0900		-0.9558	
R1 Head of roof window				3.1200	0.2400		0.7488	
R2 Sill of roof window				3.1200	0.2400		0.7488	
R3 Jamb of roof window				11.2000	0.2400		2.6880	
R7 Flat ceiling (inverted)				1.8300	0.0400		0.0732	
R9 Roof to wall (flat ceiling)				3.7900	0.0400		0.1516	
R4 Ridge (vaulted ceiling)				9.2400	0.0800		0.7392	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							20.6810	(36)
Point Thermal bridges							0.0000	(36a)
Total fabric heat loss						(33) + (36) + (36a) =	124.5077	(37)
Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)								
(38)m	Jan 78.0190 Feb 77.7413 Mar 77.4691 Apr 76.1905 May 75.9512 Jun 74.8376 Jul 74.8376 Aug 74.6314 Sep 75.2666 Oct 75.9512 Nov 76.4352 Dec 76.9411							(38)
Heat transfer coeff	202.5267 202.2490 201.9768 200.6982 200.4589 199.3453 199.3453 199.1391 199.7743 200.4589 200.9429 201.4488							(39)
Average = Sum(39)m / 12 =							200.6970	
HLP	Jan 1.2395 Feb 1.2378 Mar 1.2361 Apr 1.2283 May 1.2268 Jun 1.2200 Jul 1.2200 Aug 1.2187 Sep 1.2226 Oct 1.2268 Nov 1.2298 Dec 1.2329							(40)
HLP (average)							1.2283	

Full SAP Calculation Printout



Days in mont	31	28	31	30	31	30	31	31	30	31	30	31

4. Water heating energy requirements (kWh/year)												

Assumed occupancy												2.9536 (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												
31.8349	31.3621	30.6963	29.4687	28.5495	27.5302	26.9797	27.6408	28.3607	29.4513	30.7042	31.7273	(42b)
Hot water usage for other uses												
44.8781	43.2462	41.6143	39.9823	38.3504	36.7185	36.7185	38.3504	39.9823	41.6143	43.2462	44.8781	(42c)
Average daily hot water use (litres/day)												70.3143 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily hot water use	76.7130	74.6083	72.3106	69.4510	66.8999	64.2487	63.6982	65.9912	68.3430	71.0656	73.9504	76.6054 (44)
Energy conte	121.4947	106.2412	111.1387	95.0750	90.0601	79.0013	77.0374	81.7109	84.2738	96.4353	105.3559	119.9455 (45)
Energy content (annual)										Total =	Sum(45)m =	1167.7698
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	(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	(61)
Total heat required for water heating calculated for each month												
103.2705	90.3050	94.4679	80.8138	76.5511	67.1511	65.4818	69.4543	71.6327	81.9700	89.5525	101.9537	(62)
WWHRS	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	(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	(63c)
FGHRS	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	103.2705	90.3050	94.4679	80.8138	76.5511	67.1511	65.4818	69.4543	71.6327	81.9700	89.5525	101.9537 (64)
12Total per year (kWh/year)										Total per year (kWh/year) =	Sum(64)m =	992.6043 (64)
Electric shower(s)												993 (64)
59.0555	52.6189	57.4578	54.8313	55.8602	53.2852	55.0614	55.8602	54.8313	57.4578	56.3774	59.0555	(64a)
												Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 671.7523 (64a)
Heat gains from water heating, kWh/month												
40.5815	35.7310	37.9814	33.9113	33.1028	30.1091	30.1358	31.3286	31.6160	34.8570	36.4825	40.2523	(65)

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

Metabolic gains (Table 5), Watts												
(66)m	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												
168.8459	186.9366	168.8459	174.4741	168.8459	174.4741	168.8459	168.8459	174.4741	168.8459	174.4741	168.8459	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												
334.7559	338.2297	329.4760	310.8405	287.3165	265.2073	250.4370	246.9632	255.7169	274.3524	297.8764	319.9856	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												
37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	(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	(70)
Losses e.g. evaporation (negative values) (Table 5)												
-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	(71)
Water heating gains (Table 5)												
54.5450	53.1711	51.0503	47.0990	44.4930	41.8182	40.5051	42.1084	43.9111	46.8508	50.6701	54.1025	(72)
Total internal gains	625.4513	645.6418	616.6766	599.7180	567.9599	548.8040	527.0924	525.2220	541.4066	557.3535	590.3251	610.2385 (73)

6. Solar gains												

[Jan]												
	Area											
	m2											
	Solar flux											
	Table 6a											
	W/m2											
	Specific data											
	or Table 6b											
	g											
	Specific data											
	or Table 6c											
	FF											
	Access											
	factor											
	Table 6d											
	Gains											
	W											
Northeast	0.7200	11.2829	0.5700	0.7700					0.7700			2.2463 (75)
Southeast	18.0000	36.7938	0.5700	0.7700					0.7700			183.1275 (77)
Southwest	0.7200	36.7938	0.5700	0.7700					0.7700			7.3251 (79)
Northwest	15.2300	11.2829	0.5700	0.7700					0.7700			47.5147 (81)
Northwest	4.3700	16.3666	0.6300	0.7700					1.0000			28.3871 (82)
Solar gains	268.6007	484.1257	734.1253	1031.5846	1268.0530	1308.7467	1240.9956	1056.7327	835.7813	554.2971	326.5398	226.7626 (83)
Total gains	894.0520	1129.7675	1350.8019	1631.3026	1836.0129	1857.5507	1768.0881	1581.9547	1377.1878	1111.6507	916.8648	837.0012 (84)

7. Mean internal temperature (heating season)												

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	46.6469	46.7110	46.7739	47.0719	47.1281	47.3914	47.3914	47.4404	47.2896	47.1281	47.0146	46.8965
alpha	4.1098	4.1141	4.1183	4.1381	4.1419	4.1594	4.1594	4.1627	4.1526	4.1419	4.1343	4.1264
util living area	0.9969	0.9916	0.9773	0.9273	0.8116	0.6342	0.4822	0.5524	0.8063	0.9641	0.9933	0.9976 (86)
MIT	19.1513	19.4142	19.8054	20.3188	20.7216	20.9271	20.9817	20.9686	20.8004	20.2461	19.6001	19.1053 (87)
Th 2	19.8886	19.8899	19.8912	19.8975	19.8986	19.9040	19.9040	19.9051	19.9020	19.8986	19.8963	19.8938 (88)
util rest of house												
0.9960	0.9891	0.9705	0.9053	0.7585	0.5443	0.3686	0.4329	0.7310	0.9490	0.9909	0.9969	(89)
MIT 2	18.2063	18.4687	18.8560	19.3541	19.7120	19.8696	19.8989	19.8953	19.7885	19.2966	18.6597	18.1643 (90)
Living area fraction									FLA = Living area / (4) =			0.0994 (91)
MIT	18.3002	18.5627	18.9504	19.4500	19.8123	19.9747	20.0066	20.0019	19.8890	19.3909	18.7531	18.2579 (92)
Temperature adjustment												0.0000
adjusted MIT	18.3002	18.5627	18.9504	19.4500	19.8123	19.9747	20.0066	20.0019	19.8890	19.3909	18.7531	18.2579 (93)

Full SAP Calculation Printout



8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9940	0.9849	0.9626	0.8943	0.7538	0.5505	0.3796	0.4440	0.7299	0.9396	0.9873	0.9954	(94)
Useful gains	888.7064	1112.7400	1300.3403	1458.8803	1384.0040	1022.5937	671.2110	702.4669	1005.2733	1044.4905	905.2093	833.1370	(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	2835.4159	2763.2615	2514.6915	2117.3694	1626.1862	1071.4209	679.0813	717.2864	1156.4995	1762.2242	2341.6173	2831.9398	(97)
Space heating kWh	1448.3519	1109.1504	903.4773	474.1121	180.1836	0.0000	0.0000	0.0000	0.0000	533.9938	1034.2138	1487.1093	(98a)
Space heating requirement - total per year (kWh/year)												7170.5922	
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	1448.3519	1109.1504	903.4773	474.1121	180.1836	0.0000	0.0000	0.0000	0.0000	533.9938	1034.2138	1487.1093	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												7170.5922	
Space heating per m2											(98c) / (4) =	43.8837	(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	1873.8459	1475.1553	1513.4570	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8409	0.9005	0.8597	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1575.6939	1328.3617	1301.0715	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	2051.6819	1953.3777	1748.2454	0.0000	0.0000	0.0000	0.0000	(103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	342.7113	465.0119	332.6974	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	85.6778	116.2530	83.1743	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												285.1052	(107)
Energy for space heating												43.8837	(99)
Energy for space cooling												1.7448	(108)
Total												45.6285	(109)
Fabric Energy Efficiency (DFEE)												45.6	(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 (m2)	Storey height (m)	Volume (m3)	
Ground floor	64.3800 (1b)	x 2.5400 (2b)	= 163.5252 (1b) - (3b)	
First floor	64.3800 (1c)	x 2.7700 (2c)	= 178.3326 (1c) - (3c)	
Second floor	34.6400 (1d)	x 2.5300 (2d)	= 87.6392 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	163.4000		(4)	
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =	429.4970 (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)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0931 (8)
Pressure test	Yes	
Pressure Test Method	Blower Door	
Measured/design AP50	5.0000	(17)
Infiltration rate	0.3431	(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) =	0.2917 (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	0.3719	0.3646	0.3573	0.3208	0.3135	0.2771	0.2771	0.2698	0.2917	0.3135	0.3281	0.3427	(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	0.5691	0.5665	0.5638	0.5515	0.5492	0.5384	0.5384	0.5364	0.5425	0.5492	0.5538	0.5587	(25)

Full SAP Calculation Printout



3. Heat losses and heat loss parameter

Element	Gross m ²	Openings m ²	NetArea m ²	U-value W/m ² K	A x U W/K	K-value kJ/m ² K	A x K kJ/K	
TER Opaque door			2.1500	1.0000	2.1500			(26)
TER Opening Type (Uw = 1.20)			34.3600	1.1450	39.3435			(27)
RL			4.3300	1.8519	8.0185			(27a)
GF			64.3800	0.1300	8.3694			(28a)
Main	230.9000	36.5100	194.3900	0.1800	34.9902			(29a)
Dwarf (PIRx0.72)	32.1600		32.1600	0.1800	5.7888			(29a)
PIJ	29.7400		29.7400	0.1100	3.2714			(30)
PIR	50.2300	4.3300	45.9000	0.1100	5.0490			(30)
Total net area of external elements A _{um} (A, m ²)			407.4100					(31)
Fabric heat loss, W/K = Sum (A x U)					(26)...(30) + (32) =	106.9808		(33)

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

List of Thermal Bridges 208.1401 (35)

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	20.4800	0.0500	1.0240
E3 Sill	40.2800	0.0500	2.0140
E4 Jamb	50.0800	0.0500	2.5040
E5 Ground floor (normal)	34.2100	0.1600	5.4736
E16 Corner (normal)	41.9600	0.0900	3.7764
E6 Intermediate floor within a dwelling	59.4500	0.0000	0.0000
E11 Eaves (insulation at rafter level)	30.3200	0.0400	1.2128
E13 Gable (insulation at rafter level)	6.0300	0.0800	0.4824
E17 Corner (inverted - internal area greater than external area)	10.6200	-0.0900	-0.9558
R1 Head of roof window	3.1200	0.0800	0.2496
R2 Sill of roof window	3.1200	0.0600	0.1872
R3 Jamb of roof window	11.2000	0.0800	0.8960
R7 Flat ceiling (inverted)	1.8300	0.0400	0.0732
R9 Roof to wall (flat ceiling)	3.7900	0.0400	0.1516
R4 Ridge (vaulted ceiling)	9.2400	0.0800	0.7392

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 17.8282 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 124.8090 (37)

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

(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	80.6670	80.2864	79.9134	78.1614	77.8336	76.3077	76.3077	76.0251	76.8954	77.8336	78.4967	79.1900	(38)
Heat transfer coeff	205.4760	205.0955	204.7225	202.9704	202.6426	201.1167	201.1167	200.8341	201.7045	202.6426	203.3058	203.9990	(39)
Average = Sum(39)m / 12 =												202.9689	

HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP (average)	1.2575	1.2552	1.2529	1.2422	1.2402	1.2308	1.2308	1.2291	1.2344	1.2402	1.2442	1.2485	(40)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

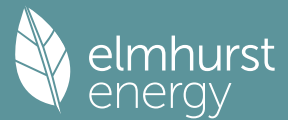
4. Water heating energy requirements (kWh/year)

Assumed occupancy													2.9536 (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	0.0000	(42a)
Hot water usage for baths													
31.8349	31.3621	30.6963	29.4687	28.5495	27.5302	26.9797	27.6408	28.3607	29.4513	30.7042	31.7273	31.7273	(42b)
Hot water usage for other uses													
44.8781	43.2462	41.6143	39.9823	38.3504	36.7185	36.7185	38.3504	39.9823	41.6143	43.2462	44.8781	44.8781	(42c)
Average daily hot water use (litres/day)												70.3143	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	76.7130	74.6083	72.3106	69.4510	66.8999	64.2487	63.6982	65.9912	68.3430	71.0656	73.9504	76.6054	(44)
Energy conte	121.4947	106.2412	111.1387	95.0750	90.0601	79.0013	77.0374	81.7109	84.2738	96.4353	105.3559	119.9455	(45)
Energy content (annual)													
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	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	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													
103.2705	90.3050	94.4679	80.8138	76.5511	67.1511	65.4818	69.4543	71.6327	81.9700	89.5525	101.9537	101.9537	(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	103.2705	90.3050	94.4679	80.8138	76.5511	67.1511	65.4818	69.4543	71.6327	81.9700	89.5525	101.9537	(64)
12Total per year (kWh/year)													
Electric shower(s)	59.0555	52.6189	57.4578	54.8313	55.8602	53.2852	55.0614	55.8602	54.8313	57.4578	56.3774	59.0555	(64a)
Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =												671.7523	(64a)
Heat gains from water heating, kWh/month													
40.5815	35.7310	37.9814	33.9113	33.1028	30.1091	30.1358	31.3286	31.6160	34.8570	36.4825	40.2523	40.2523	(65)

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

Metabolic gains (Table 5), Watts													
(66)m	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	147.6815	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
168.8459	166.9366	168.8459	174.4741	168.8459	174.4741	168.8459	168.8459	174.4741	168.8459	174.4741	168.8459	168.8459	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
334.7559	338.2297	329.4760	310.8405	287.3165	265.2073	250.4370	246.9632	255.7169	274.3524	297.8764	319.9856	319.9856	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													

Full SAP Calculation Printout



Pumps, fans	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681	37.7681 (69)
Losses e.g. evaporation (negative values) (Table 5)	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)
Water heating gains (Table 5)	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452 (71)
Total internal gains	54.5450	53.1711	51.0503	47.0990	44.4930	41.8182	40.5051	42.1084	43.9111	46.8508	50.6701	54.1025 (72)
	625.4513	645.6418	616.6766	599.7180	567.9599	548.8040	527.0924	525.2220	541.4066	557.3535	590.3251	610.2385 (73)

6. Solar gains

[Jan]															
					Area m2	Solar flux Table 6a W/m2		g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W				
Northeast					0.7100	11.2829		0.6300	0.7000	0.7700	2.4482 (75)				
Southeast					17.8400	36.7938		0.6300	0.7000	0.7700	200.6050 (77)				
Southwest					0.7100	36.7938		0.6300	0.7000	0.7700	7.9837 (79)				
Northwest					15.1000	11.2829		0.6300	0.7000	0.7700	52.0680 (81)				
Northwest					4.3300	16.3666		0.6300	0.7000	1.0000	28.1272 (82)				
Solar gains				291.2322	524.1628	792.8465	1110.9325	1362.9321	1405.5771	1333.2531	1137.0021	901.5835	599.6101	353.9182	245.9549 (83)
Total gains				916.6835	1169.8046	1409.5232	1710.6505	1930.8920	1954.3811	1860.3455	1662.2240	1442.9901	1156.9636	944.2432	856.1934 (84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)												
tau	45.9774	46.0627	46.1466	46.5449	46.6202	46.9740	46.9740	47.0401	46.8371	46.6202	46.4682	46.3103
alpha	4.0652	4.0708	4.0764	4.1030	4.1080	4.1316	4.1316	4.1360	4.1225	4.1080	4.0979	4.0874
util living area	0.9966	0.9905	0.9742	0.9183	0.7943	0.6132	0.4638	0.5329	0.7900	0.9597	0.9925	0.9974 (86)
MIT	19.1382	19.4144	19.8192	20.3435	20.7397	20.9341	20.9836	20.9717	20.8129	20.2601	19.5995	19.0937 (87)
Th 2	19.8743	19.8761	19.8779	19.8864	19.8880	19.8954	19.8954	19.8968	19.8926	19.8880	19.8848	19.8814 (88)
util rest of house	0.9956	0.9877	0.9665	0.8942	0.7390	0.5238	0.3530	0.4155	0.7120	0.9431	0.9899	0.9966 (89)
MIT 2	18.1828	18.4586	18.8591	19.3669	19.7156	19.8647	19.8909	19.8881	19.7879	19.3010	18.6506	18.1437 (90)
Living area fraction	18.2777	18.5536	18.9546	19.4640	19.8174	19.9710	19.9995	19.9958	FLA = Living area / (4) =			0.0994 (91)
MIT	18.2777	18.5536	18.9546	19.4640	19.8174	19.9710	19.9995	19.9958	19.8897	19.3963	18.7449	18.2381 (92)
Temperature adjustment												0.0000
adjusted MIT	18.2777	18.5536	18.9546	19.4640	19.8174	19.9710	19.9995	19.9958	19.8897	19.3963	18.7449	18.2381 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9934	0.9831	0.9580	0.8830	0.7351	0.5303	0.3638	0.4265	0.7118	0.9332	0.9860	0.9949 (94)
Useful gains	910.6528	1150.0697	1350.3434	1510.5603	1419.3437	1036.4047	676.7474	708.9935	1027.1307	1079.6942	930.9932	851.8685 (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	2872.0903	2800.2935	2549.7272	2144.1776	1644.9336	1080.1989	683.7035	722.1669	1167.8156	1782.5049	2367.4804	2863.7662 (97)
Space heating kWh	1459.3094	1108.9504	892.3416	456.2045	167.8389	0.0000	0.0000	0.0000	0.0000	522.8911	1034.2708	1496.8519 (98a)
Space heating requirement - total per year (kWh/year)												7138.6586
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	1459.3094	1108.9504	892.3416	456.2045	167.8389	0.0000	0.0000	0.0000	0.0000	522.8911	1034.2708	1496.8519 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												7138.6586
Space heating per m ²										(98c) / (4) =		43.6882 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b												
Ext. temp.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat loss rate W	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8556	0.9109	0.8729	0.0000	0.0000	0.0000	0.0000 (100)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1617.4959	1355.6724	1332.3026	0.0000	0.0000	0.0000	0.0000 (101)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	2165.2739	2061.5969	1842.3697	0.0000	0.0000	0.0000	0.0000 (103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	394.4002	525.2078	379.4899	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	98.6001	131.3020	94.8725	0.0000	0.0000	0.0000	0.0000 (107)
Space cooling requirement												324.7745 (107)
Energy for space heating												43.6882 (99)
Energy for space cooling												1.9876 (108)
Total												45.6758 (109)
Fabric Energy Efficiency (TFEE)												45.7 (109)

Full SAP Calculation Printout



1. Overall dwelling characteristics

	Area (m ²)	Storey height (m)	Volume (m ³)
Ground floor	64.3800 (1b)	x 2.5400 (2b)	= 163.5252 (1b) - (3b)
First floor	64.3800 (1c)	x 2.7700 (2c)	= 178.3326 (1c) - (3c)
Second floor	34.6400 (1d)	x 2.5300 (2d)	= 87.6392 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	163.4000		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 429.4970 (5)

2. Ventilation rate

	m ³ 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	0 * 10 = 0.0000 (7a)
Number of passive vents	0 * 10 = 0.0000 (7b)
Number of flueless gas fires	0 * 40 = 0.0000 (7c)

Infiltration due to chimneys, flues and fans	= (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000 (8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		4.0000	(17)
Infiltration rate		0.2000	(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) =	0.1700	(21)

Wind speed	Jan 5.1000	Feb 5.0000	Mar 4.9000	Apr 4.4000	May 4.3000	Jun 3.8000	Jul 3.8000	Aug 3.7000	Sep 4.0000	Oct 4.3000	Nov 4.5000	Dec 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	0.2167	0.2125	0.2083	0.1870	0.1827	0.1615	0.1615	0.1573	0.1700	0.1827	0.1913	0.1998	(22b)
Mechanical extract ventilation - decentralised													
If mechanical ventilation												0.5000	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)												0.5000	(23b)
Effective ac	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	(25)

3. Heat losses and heat loss parameter

Element	Gross m ²	Openings m ²	NetArea m ²	U-value W/m ² K	A x U W/K	K-value kJ/m ² K	A x K kJ/K
Door			2.1500	1.0000	2.1500		(26)
Window (Uw = 1.20)			34.6700	1.1450	39.6985		(27)
RL			4.3700	1.5038	6.5714		(27a)
GF			64.3800	0.1100	7.0818	75.0000	(28a)
Main	230.9000	36.8200	194.0800	0.1800	34.9344	110.0000	(29a)
Dwarf (PIRx0.72)	32.1600		32.1600	0.1100	3.5376	9.0000	(29a)
PIJ	29.7400		29.7400	0.1000	2.9740	9.0000	(29a)
PIR	50.2300	4.3700	45.8600	0.1500	6.8790	9.0000	(30)
Total net area of external elements Aum(A, m ²)			407.4100				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =	103.8267			(33)
Internal Wall 1			72.1900			9.0000	(32c)
Internal Wall 2			68.4000			75.0000	(32c)
Internal Floor 1			40.1200			18.0000	(32d)
Internal Ceiling 1			40.1200			9.0000	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	34010.0900	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m ² K		208.1401	(35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	20.4800	0.0500	1.0240
E3 Sill	40.2800	0.0500	2.0140
E4 Jamb	50.0800	0.0500	2.5040
E5 Ground floor (normal)	34.2100	0.1600	5.4736
E16 Corner (normal)	41.9600	0.0900	3.7764
E6 Intermediate floor within a dwelling	59.4500	0.0000	0.0000
E11 Eaves (insulation at rafter level)	30.3200	0.0400	1.2128
E13 Gable (insulation at rafter level)	6.0300	0.0800	0.4824
E17 Corner (inverted - internal area greater than external area)	10.6200	-0.0900	-0.9558
R1 Head of roof window	3.1200	0.2400	0.7488
R2 Sill of roof window	3.1200	0.2400	0.7488
R3 Jamb of roof window	11.2000	0.2400	2.6880
R7 Flat ceiling (inverted)	1.8300	0.0400	0.0732
R9 Roof to wall (flat ceiling)	3.7900	0.0400	0.1516
R4 Ridge (vaulted ceiling)	9.2400	0.0800	0.7392

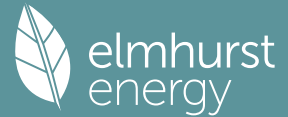
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		20.6810	(36)
Point Thermal bridges		(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	124.5077	(37)

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

(38)m	Jan 70.8670	Feb 70.8670	Mar 70.8670	Apr 70.8670	May 70.8670	Jun 70.8670	Jul 70.8670	Aug 70.8670	Sep 70.8670	Oct 70.8670	Nov 70.8670	Dec 70.8670	(38)
Heat transfer coeff	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	(39)
Average = Sum(39)m / 12 =												195.3747	

HLP	Jan 1.1957	Feb 1.1957	Mar 1.1957	Apr 1.1957	May 1.1957	Jun 1.1957	Jul 1.1957	Aug 1.1957	Sep 1.1957	Oct 1.1957	Nov 1.1957	Dec 1.1957	(40)
HLP (average)												1.1957	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

Full SAP Calculation Printout



4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.9536 (42)
Hot water usage for mixer showers	73.7425	72.6343	71.0194	67.9296	65.6495	63.1066	61.6613	63.2640	65.0208	67.7510	70.9071	73.4600 (42a)
Hot water usage for baths	31.8349	31.3621	30.6963	29.4687	28.5495	27.5302	26.9797	27.6408	28.3607	29.4513	30.7042	31.7273 (42b)
Hot water usage for other uses	44.8781	43.2462	41.6143	39.9823	38.3504	36.7185	36.7185	38.3504	39.9823	41.6143	43.2462	44.8781 (42c)
Average daily hot water use (litres/day)												138.3024 (43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily hot water use	150.4555	147.2426	143.3300	137.3807	132.5494	127.3554	125.3595	129.2552	133.3638	138.8166	144.8575	150.0654 (44)
Energy content	238.2848	209.6715	220.2929	188.0673	178.4369	156.5983	151.6114	160.0449	164.4509	188.3728	206.3761	234.9661 (45)
Energy content (annual)												Total = Sum(45)m = 2297.1737
Distribution loss (46)m = 0.15 x (45)m	35.7427	31.4507	33.0439	28.2101	26.7655	23.4897	22.7417	24.0067	24.6676	28.2559	30.9564	35.2449 (46)
Water storage loss:												
Store volume												200.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):												1.2200 (48)
Temperature factor from Table 2b												0.5400 (49)
Enter (49) or (54) in (55)												0.6588 (55)
Total storage loss	20.4228	18.4464	20.4228	19.7640	20.4228	19.7640	20.4228	20.4228	19.7640	20.4228	19.7640	20.4228 (56)
If cylinder contains dedicated solar storage	20.4228	18.4464	20.4228	19.7640	20.4228	19.7640	20.4228	20.4228	19.7640	20.4228	19.7640	20.4228 (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	281.9700	249.1291	263.9781	230.3433	222.1221	198.8743	195.2966	203.7301	206.7269	232.0580	248.6521	278.6513 (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	281.9700	249.1291	263.9781	230.3433	222.1221	198.8743	195.2966	203.7301	206.7269	232.0580	248.6521	278.6513 (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 per year (kWh/year) = Sum(64)m =											2811.5317 (64)
	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	114.1778	101.2818	108.1955	96.3532	94.2784	85.8897	85.3590	88.1631	88.5007	97.5821	102.4408	113.0744 (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	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	40.4440	35.9220	29.2137	22.1167	16.5325	13.9574	15.0815	19.6035	26.3118	33.4088	38.9930	41.5681 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	499.6357	504.8204	491.7552	463.9410	428.8306	395.8318	373.7865	368.6019	381.6670	409.4812	444.5916	477.5905 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754 (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)	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452 (71)
Water heating gains (Table 5)	153.4648	150.7170	145.4241	133.8239	126.7183	119.2913	114.7298	118.4988	122.9177	131.1587	142.2790	151.9817 (72)
Total internal gains	808.2926	806.2074	781.1411	734.6296	686.8294	643.8285	618.3458	621.4521	645.6444	688.7968	740.6116	785.8882 (73)

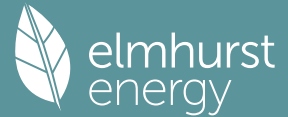
6. Solar gains

[Jan]												
												Gains
												W

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545
alpha	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236
util living area	0.9938	0.9862	0.9656	0.9056	0.7779	0.6015	0.4526	0.5170	0.7686	0.9472	0.9882	0.9952 (86)
Living	19.3579	19.5972	19.9741	20.4274	20.7781	20.9432	20.9864	20.9767	20.8432	20.3601	19.7559	19.2965
Non living	18.0166	18.3208	18.7950	19.3463	19.7361	19.8895	19.9187	19.9143	19.8122	19.2801	18.5251	17.9384
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0
24 / 9	3	0	0	0	0	0	0	0	0	0	0	0
16 / 9	28	0	0	0	0	0	0	0	0	0	0	10
MIT	20.1600	19.5972	19.9741	20.4274	20.7781	20.9432	20.9864	20.9767	20.8432	20.3601	19.7559	19.5348 (87)
Th 2	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235 (88)
util rest of house												

Full SAP Calculation Printout



MIT 2	0.9920	0.9823	0.9559	0.8793	0.7222	0.5146	0.3465	0.4045	0.6899	0.9268	0.9842	0.9938 (89)
Living area fraction	19.1633	18.3208	18.7950	19.3463	19.7361	19.8895	19.9187	19.9143	19.8122	19.2801	18.5251	18.2961 (90)
MIT	19.2623	18.4476	18.9122	19.4537	19.8397	19.9942	20.0248	20.0199	fLA = Living area / (4) =	19.3874	18.6474	0.0994 (91)
Temperature adjustment									19.9147	19.3874	18.6474	18.4192 (92)
adjusted MIT	19.2623	18.4476	18.9122	19.4537	19.8397	19.9942	20.0248	20.0199	19.9147	19.3874	18.6474	18.4192 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9906	0.9748	0.9437	0.8655	0.7173	0.5206	0.3568	0.4150	0.6892	0.9134	0.9772	0.9910	(94)
Useful gains	1066.8189	1257.7643	1429.9469	1528.6624	1402.3026	1016.5441	663.3732	696.4818	1020.9700	1135.4536	1042.8519	1003.5381	(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	2923.2613	2646.8667	2425.0270	2061.9271	1590.2868	1053.8998	669.1167	707.2387	1136.0471	1716.8425	2256.0687	2778.0684	(97)
Space heating kWh	1381.1932	933.4769	740.3396	383.9506	139.8603	0.0000	0.0000	0.0000	0.0000	432.5533	873.5161	1320.2506	(98a)
Space heating requirement - total per year (kWh/year)												6205.1405	
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	1381.1932	933.4769	740.3396	383.9506	139.8603	0.0000	0.0000	0.0000	0.0000	432.5533	873.5161	1320.2506	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												6205.1405	
Space heating per m2												37.9752	(99)

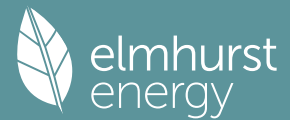
9a. Energy requirements - Individual heating systems, including micro-CHP

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 %)													261.8457 (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	1381.1932	933.4769	740.3396	383.9506	139.8603	0.0000	0.0000	0.0000	0.0000	432.5533	873.5161	1320.2506	(98)
Space heating efficiency (main heating system 1)	261.8457	261.8457	261.8457	261.8457	261.8457	0.0000	0.0000	0.0000	0.0000	261.8457	261.8457	261.8457	(210)
Space heating fuel (main heating system)	527.4836	356.4988	282.7389	146.6324	53.4132	0.0000	0.0000	0.0000	0.0000	165.1940	333.5995	504.2093	(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 requirement	281.9700	249.1291	263.9781	230.3433	222.1221	198.8743	195.2966	203.7301	206.7269	232.0580	248.6521	278.6513	(64)
Efficiency of water heater	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	(216)
Fuel for water heating, kWh/month	106.3773	93.9876	99.5896	86.9004	83.7988	75.0282	73.6785	76.8602	77.9908	87.5473	93.8077	105.1253	(219)
Space cooling fuel requirement	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	6.7896	6.1326	6.7896	6.5706	6.7896	6.5706	6.7896	6.7896	6.5706	6.7896	6.5706	6.7896	(231)
Lighting	35.4004	28.3995	25.5706	18.7341	14.4708	11.8228	13.2007	17.1588	22.2876	29.2425	33.0294	36.3843	(232)
Electricity generated by PVs (Appendix M) (negative quantity)	-24.0283	-38.0948	-61.4415	-75.4804	-84.7848	-78.6338	-77.4372	-70.1425	-57.9696	-45.4774	-27.5330	-20.1825	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)	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)	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)	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)	-4.1838	-10.2694	-23.7879	-41.9868	-62.4816	-66.8650	-65.8500	-53.7471	-36.8919	-17.1814	-6.1976	-3.2389	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)	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)	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)	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												2369.7697	(211)
Space heating fuel - main system 2												0.0000	(213)
Space heating fuel - secondary												0.0000	(215)
Efficiency of water heater												265.0659	
Water heating fuel used												1060.6918	(219)
Space cooling fuel												0.0000	(221)
Electricity for pumps and fans:													
(MEVDecentralised, DataSheet: total watage = 8.0860, total flow = 53.0000, SFP = 0.1526)													
mechanical ventilation fans (SFP = 0.1526)												79.9425	(230a)
Total electricity for the above, kWh/year												79.9425	(231)
Electricity for lighting (calculated in Appendix L)												285.7016	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation												-1053.8872	(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												2742.2183	(238)

10a. Fuel costs - using Table 12 prices

Fuel Fuel price Fuel cost

Full SAP Calculation Printout



	kWh/year	p/kWh	£/year
Space heating - main system 1	2369.7697	16.4900	390.7750 (240)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	1060.6918	16.4900	174.9081 (247)
Energy for instantaneous electric shower(s)	0.0000	16.4900	0.0000 (247a)
Pumps, fans and electric keep-hot	79.9425	16.4900	13.1825 (249)
Energy for lighting	285.7016	16.4900	47.1122 (250)
Additional standing charges			0.0000 (251)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-661.2057	16.4900	-109.0328
PV Unit electricity exported	-392.6815	5.5900	-21.9509
Total			-130.9837 (252)
Total energy cost			494.9941 (255)

11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12):		0.3600 (256)
Energy cost factor (ECF)	$[(255) \times (256)] / [(4) + 45.0] =$	0.8551 (257)
SAP value		86.1392
SAP rating (Section 12)		86 (258)
SAP band		B

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating - main system 1	2369.7697	0.1558	369.3237 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	1060.6918	0.1411	149.6147 (264)
Space and water heating			518.9383 (265)
Pumps, fans and electric keep-hot	79.9425	0.1387	11.0890 (267)
Energy for lighting	285.7016	0.1443	41.2356 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-661.2057	0.1331	-87.9896
PV Unit electricity exported	-392.6815	0.1214	-47.6772
Total			-135.6668 (269)
Total CO2, kg/year			435.5962 (272)
CO2 emissions per m2			2.6700 (273)
EI value			97.1991
EI rating			97 (274)
EI band			A

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022) CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY

1. Overall dwelling characteristics

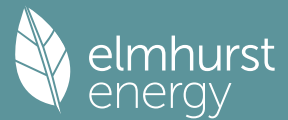
	Area (m2)	Storey height (m)	Volume (m3)
Ground floor	64.3800 (1b)	x 2.5400 (2b)	= 163.5252 (1b) - (3b)
First floor	64.3800 (1c)	x 2.7700 (2c)	= 178.3326 (1c) - (3c)
Second floor	34.6400 (1d)	x 2.5300 (2d)	= 87.6392 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	163.4000		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =	429.4970 (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	0 * 10 = 0.0000 (7a)
Number of passive vents	0 * 10 = 0.0000 (7b)
Number of flueless gas fires	0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) = 0.0000 (8)
Pressure test	Yes
Pressure Test Method	Blower Door
Measured/design AP50	4.0000 (17)
Infiltration rate	0.2000 (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) = 0.1700 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	4.6000	4.5000	4.6000	4.1000	4.3000	3.7000	3.6000	3.7000	3.7000	4.2000	4.1000	4.3000 (22)
Wind factor	1.1500	1.1250	1.1500	1.0250	1.0750	0.9250	0.9000	0.9250	0.9250	1.0500	1.0250	1.0750 (22a)
Adj infilt rate	0.1955	0.1913	0.1955	0.1742	0.1827	0.1573	0.1530	0.1573	0.1573	0.1785	0.1742	0.1827 (22b)
Mechanical extract ventilation - decentralised												

Full SAP Calculation Printout



If mechanical ventilation
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)
Effective ac 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Door			2.1500	1.0000	2.1500			(26)
Window (Uw = 1.20)			34.6700	1.1450	39.6985			(27)
RL			4.3700	1.5038	6.5714			(27a)
GF			64.3800	0.1100	7.0818	75.0000	4828.5000	(28a)
Main	230.9000	36.8200	194.0800	0.1800	34.9344	110.0000	21348.8000	(29a)
Dwarf (PIRx0.72)	32.1600		32.1600	0.1100	3.5376	9.0000	289.4400	(29a)
PIJ	29.7400		29.7400	0.1000	2.9740	9.0000	267.6600	(30)
PIR	50.2300	4.3700	45.8600	0.1500	6.8790	9.0000	412.7400	(30)
Total net area of external elements Aum(A, m2)			407.4100					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	103.8267			(33)
Internal Wall 1			72.1900			9.0000	649.7100	(32c)
Internal Wall 2			68.4000			75.0000	5130.0000	(32c)
Internal Floor 1			40.1200			18.0000	722.1600	(32d)
Internal Ceiling 1			40.1200			9.0000	361.0800	(32e)

Heat capacity Cm = Sum(A x k)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K
(28)...(30) + (32) + (32a)...(32e) = 34010.0900 (34)
List of Thermal Bridges
208.1401 (35)

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	20.4800	0.0500	1.0240
E3 Sill	40.2800	0.0500	2.0140
E4 Jamb	50.0800	0.0500	2.5040
E5 Ground floor (normal)	34.2100	0.1600	5.4736
E16 Corner (normal)	41.9600	0.0900	3.7764
E6 Intermediate floor within a dwelling	59.4500	0.0000	0.0000
E11 Eaves (insulation at rafter level)	30.3200	0.0400	1.2128
E13 Gable (insulation at rafter level)	6.0300	0.0800	0.4824
E17 Corner (inverted - internal area greater than external area)	10.6200	-0.0900	-0.9558
R1 Head of roof window	3.1200	0.2400	0.7488
R2 Sill of roof window	3.1200	0.2400	0.7488
R3 Jamb of roof window	11.2000	0.2400	2.6880
R7 Flat ceiling (inverted)	1.8300	0.0400	0.0732
R9 Roof to wall (flat ceiling)	3.7900	0.0400	0.1516
R4 Ridge (vaulted ceiling)	9.2400	0.0800	0.7392

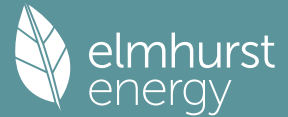
Thermal bridges (Sum(L x Psi) calculated using Appendix K)
Point Thermal Bridges
Total fabric heat loss
(33) + (36) + (36a) = 124.5077 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)													
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat transfer coeff	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	(38)
Average = Sum(39)m / 12 =	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	(39)
HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP (average)	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	(40)
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy													2.9536 (42)
Hot water usage for mixer showers	73.7425	72.6343	71.0194	67.9296	65.6495	63.1066	61.6613	63.2640	65.0208	67.7510	70.9071	73.4600	(42a)
Hot water usage for baths	31.8349	31.3621	30.6963	29.4687	28.5495	27.5302	26.9797	27.6408	28.3607	29.4513	30.7042	31.7273	(42b)
Hot water usage for other uses	44.8781	43.2462	41.6143	39.9823	38.3504	36.7185	36.7185	38.3504	39.9823	41.6143	43.2462	44.8781	(42c)
Average daily hot water use (litres/day)	35.7427	31.4507	33.0439	28.2101	26.7655	23.4897	22.7417	24.0067	24.6676	28.2559	30.9564	35.2449	(43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Energy conte	150.4555	147.2426	143.3300	137.3807	132.5494	127.3554	125.3595	129.2552	133.3638	138.8166	144.8575	150.0654	(44)
Energy content (annual)	238.2848	209.6715	220.2929	188.0673	178.4369	156.5983	151.6114	160.0449	164.4509	188.3728	206.3761	234.9661	(45)
Distribution loss (46)m = 0.15 x (45)m	35.7427	31.4507	33.0439	28.2101	26.7655	23.4897	22.7417	24.0067	24.6676	28.2559	30.9564	35.2449	(46)
Water storage loss:													
Store volume													200.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):													1.2200 (48)
Temperature factor from Table 2b													0.5400 (49)
Enter (49) or (54) in (55)													0.6588 (55)
Total storage loss	20.4228	18.4464	20.4228	19.7640	20.4228	19.7640	20.4228	20.4228	19.7640	20.4228	19.7640	20.4228	(56)
If cylinder contains dedicated solar storage	20.4228	18.4464	20.4228	19.7640	20.4228	19.7640	20.4228	20.4228	19.7640	20.4228	19.7640	20.4228	(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	281.9700	249.1291	263.9781	230.3433	222.1221	198.8743	195.2966	203.7301	206.7269	232.0580	248.6521	278.6513	(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	(64a)
Output from w/h	281.9700	249.1291	263.9781	230.3433	222.1221	198.8743	195.2966	203.7301	206.7269	232.0580	248.6521	278.6513	(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	114.1778	101.2818	108.1955	96.3532	94.2784	85.8897	85.3590	88.1631	88.5007	97.5821	102.4408	113.0744	(65)

Full SAP Calculation Printout



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	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	40.4440	35.9220	29.2137	22.1167	16.5325	13.9574	15.0815	19.6035	26.3118	33.4088	38.9930	41.5681	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	499.6357	504.8204	491.7552	463.9410	428.8306	395.8318	373.7865	368.6019	381.6670	409.4812	444.5916	477.5905	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	(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)	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	(71)
Water heating gains (Table 5)	153.4648	150.7170	145.4241	133.8239	126.7183	119.2913	114.7298	118.4988	122.9177	131.1587	142.2790	151.9817	(72)
Total internal gains	808.2926	806.2074	781.1411	734.6296	686.8294	643.8285	618.3458	621.4521	645.6444	688.7968	740.6116	785.8882	(73)

6. Solar gains

[Jan]					Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d		Gains W	
Northeast					0.7200	9.5471	0.5700	0.7000	0.7700		1.9007 (75)	
Southeast					18.0000	31.1332	0.5700	0.7000	0.7700		154.9541 (77)	
Southwest					0.7200	31.1332	0.5700	0.7000	0.7700		6.1982 (79)	
Northwest					15.2300	9.5471	0.5700	0.7000	0.7700		40.2048 (81)	
Northwest					4.3700	13.8486	0.6300	0.7000	1.0000		24.0198 (82)	
Solar gains	227.2775	430.3340	688.2424	983.4440	1182.1953	1243.3094	1155.6361	969.2326	792.1753	512.3049	286.9592	205.1662 (83)
Total gains	1035.5701	1236.5414	1469.3835	1718.0735	1869.0247	1887.1378	1773.9819	1590.6847	1437.8197	1201.1017	1027.5708	991.0544 (84)

7. Mean internal temperature (heating season)

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

21.0000 (85)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	
alpha	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	
util living area	0.9940	0.9870	0.9667	0.9040	0.7684	0.5868	0.4627	0.5315	0.7816	0.9496	0.9885	0.9951	(86)
Living	19.4004	19.6168	19.9860	20.4513	20.8025	20.9514	20.9856	20.9748	20.8321	20.3617	19.7854	19.3389	
Non living	18.0713	18.3462	18.8108	19.3759	19.7630	19.8963	19.9185	19.9138	19.8031	19.2833	18.5631	17.9927	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	3	0	0	0	0	0	0	0	0	0	0	0	
16 / 9	28	0	0	0	0	0	0	0	0	0	0	10	
MIT	20.1817	19.6168	19.9860	20.4513	20.8025	20.9514	20.9856	20.9748	20.8321	20.3617	19.7854	19.5713	(87)
Th 2	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	(88)
util rest of house	0.9922	0.9833	0.9570	0.8765	0.7076	0.4948	0.3521	0.4141	0.7042	0.9295	0.9845	0.9937	(89)
MIT 2	19.1851	18.3462	18.8108	19.3759	19.7630	19.8963	19.9185	19.9138	19.8031	19.2833	18.5631	18.3407	(90)
Living area fraction	19.2841	18.4725	18.9276	19.4828	19.8663	20.0012	20.0246	20.0192	19.9054	19.3905	18.6846	18.4630	(91)
MIT	19.2841	18.4725	18.9276	19.4828	19.8663	20.0012	20.0246	20.0192	19.9054	19.3905	18.6846	18.4630	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.2841	18.4725	18.9276	19.4828	19.8663	20.0012	20.0246	20.0192	19.9054	19.3905	18.6846	18.4630	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9909	0.9760	0.9450	0.8628	0.7040	0.5018	0.3628	0.4251	0.7027	0.9162	0.9777	0.9909	(94)
Useful gains	1026.1158	1206.8345	1388.5339	1482.3626	1315.7757	946.9088	643.5952	676.1254	1010.4060	1100.4457	1004.6397	982.0101	(95)
Ext temp.	4.8000	5.3000	6.8000	9.3000	12.3000	15.0000	16.7000	16.5000	14.1000	10.8000	7.5000	4.6000	(96)
Heat loss rate W	2829.8322	2573.5737	2369.4212	1989.4613	1478.2670	977.1084	649.5370	687.5646	1134.2248	1678.3633	2185.1785	2708.4716	(97)
Space heating kWh	1341.9650	918.4487	729.7802	365.1110	120.8935	0.0000	0.0000	0.0000	0.0000	429.9707	849.9880	1284.4874	(98a)
Space heating requirement - total per year (kWh/year)												6040.6445	
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	1341.9650	918.4487	729.7802	365.1110	120.8935	0.0000	0.0000	0.0000	0.0000	429.9707	849.9880	1284.4874	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												6040.6445	
Space heating per m2										(98c) / (4) =		36.9684	(99)

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

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

0.0000 (201)

Efficiency of main space heating system 1 (in %)

1.0000 (202)

Efficiency of main space heating system 2 (in %)

261.8457 (206)

Efficiency of secondary/supplementary heating system, %

0.0000 (207)

0.0000 (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1341.9650	918.4487	729.7802	365.1110	120.8935	0.0000	0.0000	0.0000	0.0000	429.9707	849.9880	1284.4874	(98)
Space heating efficiency (main heating system 1)	261.8457	261.8457	261.8457	261.8457	261.8457	0.0000	0.0000	0.0000	0.0000	261.8457	261.8457	261.8457	(210)
Space heating fuel (main heating system)	512.5022	350.7595	278.7062	139.4375	46.1697	0.0000	0.0000	0.0000	0.0000	164.2077	324.6140	490.5512	(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)

Full SAP Calculation Printout



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	281.9700	249.1291	263.9781	230.3433	222.1221	198.8743	195.2966	203.7301	206.7269	232.0580	248.6521	278.6513 (64)
Efficiency of water heater	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659 (216)
Fuel for water heating, kWh/month	106.3773	93.9876	99.5896	86.9004	83.7988	75.0282	73.6785	76.8602	77.9908	87.5473	93.8077	105.1253 (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	6.7896	6.1326	6.7896	6.5706	6.7896	6.5706	6.7896	6.7896	6.5706	6.7896	6.5706	6.7896 (231)
Lighting	35.4004	28.3995	25.5706	18.7341	14.4708	11.8228	13.2007	17.1588	22.2876	29.2425	33.0294	36.3843 (232)
Electricity generated by PVs (Appendix M) (negative quantity)												
(233a)m	-20.5784	-34.3104	-58.1685	-72.5396	-80.2719	-75.9009	-73.7153	-65.9353	-55.6809	-42.5562	-24.4848	-18.3785 (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	-3.2934	-8.6800	-21.7341	-39.4459	-57.0233	-62.3230	-59.7162	-47.6959	-34.2314	-15.3557	-5.1572	-2.8123 (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												2306.9480 (211)
Space heating fuel - main system 2												0.0000 (213)
Space heating fuel - secondary												0.0000 (215)
Efficiency of water heater												265.0659
Water heating fuel used												1060.6918 (219)
Space cooling fuel												0.0000 (221)
Electricity for pumps and fans:												
(MEVDecentralised, DataSheet: total watage = 8.0860, total flow = 53.0000, SFP = 0.1526)												
mechanical ventilation fans (SFP = 0.1526)												79.9425 (230a)
Total electricity for the above, kWh/year												79.9425 (231)
Electricity for lighting (calculated in Appendix L)												285.7016 (232)
Energy saving/generation technologies (Appendices M ,N and Q)												
PV generation												-979.9889 (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												2753.2949 (238)

10a. Fuel costs - using BEDF prices (542)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year
Space heating - main system 1	2306.9480	25.1600	580.4281 (240)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	1060.6918	25.1600	266.8700 (247)
Energy for instantaneous electric shower(s)	0.0000	25.1600	0.0000 (247a)
Pumps, fans and electric keep-hot	79.9425	25.1600	20.1135 (249)
Energy for lighting	285.7016	25.1600	71.8825 (250)
Additional standing charges			0.0000 (251)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-622.5206	25.1600	-156.6262
PV Unit electricity exported	-357.4682	5.8100	-20.7689
Total			-177.3951 (252)
Total energy cost			761.8991 (255)

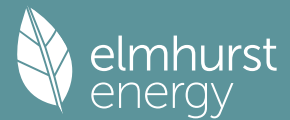
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating - main system 1	2306.9480	0.1559	359.6442 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	1060.6918	0.1411	149.6147 (264)
Space and water heating			509.2589 (265)
Pumps, fans and electric keep-hot	79.9425	0.1387	11.0890 (267)
Energy for lighting	285.7016	0.1443	41.2356 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-622.5206	0.1328	-82.6616
PV Unit electricity exported	-357.4682	0.1212	-43.3354
Total			-125.9970 (269)
Total CO2, kg/year			435.5864 (272)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Space heating - main system 1	2306.9480	1.5771	3638.3545 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	1060.6918	1.5216	1613.9207 (278)
Space and water heating			5252.2752 (279)
Pumps, fans and electric keep-hot	79.9425	1.5128	120.9370 (281)
Energy for lighting	285.7016	1.5338	438.2186 (282)

Full SAP Calculation Printout



Energy saving/generation technologies			
PV Unit electricity used in dwelling	-622.5206	1.4907	-927.9720
PV Unit electricity exported	-357.4682	0.4448	-158.9953
Total			-1086.9673 (283)
Total Primary energy kWh/year			4724.4636 (286)

SAP 10 EPC IMPROVEMENTS

001

Current energy efficiency rating: B 86
Current environmental impact rating: A 97

N Solar water heating SAP increase too small
U Solar photovoltaic panels Already installed
V2 Wind turbine Not applicable

Recommended measures:	SAP change	Cost change	CO2 change
(none)			

Measures omitted - SAP change or cost saving too small:
N Solar water heating + 0.8 -£ 38 -19 kg (4.3%)

Recommended measures	Typical annual savings	Energy efficiency	Environmental impact
(none)			
Total Savings	£0	0.00 kg/m²	

Potential energy efficiency rating: B 86
Potential environmental impact rating: A 97

Fuel prices for cost data on this page from database revision number 542 TEST (30 Apr 2024)
Recommendation texts revision number 6.1 (11 Jun 2019)

Typical heating and lighting costs of this home (per year, West Pennines (England)):

	Current £939	Potential £939	Saving £0
Electricity			
Space heating	£601	£601	£0
Water heating	£267	£267	£0
Lighting	£72	£72	£0
Generated (PV)	-£177	-£177	£0
Total cost of fuels	£762	£762	£0
Total cost of uses	£763	£763	£0
Delivered energy	17 kWh/m²	17 kWh/m²	0 kWh/m²
Carbon dioxide emissions	0.4 tonnes	0.4 tonnes	0.0 tonnes
CO2 emissions per m²	3 kg/m²	3 kg/m²	0 kg/m²
Primary energy	29 kWh/m²	29 kWh/m²	0 kWh/m²

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF ENERGY RATING FOR IMPROVED DWELLING

1. Overall dwelling characteristics

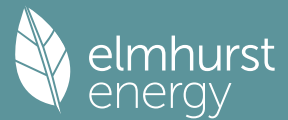
	Area (m2)	Storey height (m)	Volume (m3)
Ground floor	64.3800 (1b)	x 2.5400 (2b)	= 163.5252 (1b) - (3b)
First floor	64.3800 (1c)	x 2.7700 (2c)	= 178.3326 (1c) - (3c)
Second floor	34.6400 (1d)	x 2.5300 (2d)	= 87.6392 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	163.4000		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 429.4970 (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	0 * 10 = 0.0000 (7a)
Number of passive vents	0 * 10 = 0.0000 (7b)
Number of flueless gas fires	0 * 40 = 0.0000 (7c)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = 0.0000 / (5) = 0.0000 (8)
Pressure test Yes
Pressure Test Method Blower Door
Measured/design AP50 4.0000 (17)
Infiltration rate 0.2000 (18)
Number of sides sheltered 2 (19)
Shelter factor (20) = 1 - [0.075 x (19)] = 0.8500 (20)

Full SAP Calculation Printout



Infiltration rate adjusted to include shelter factor

(21) = (18) x (20) = 0.1700 (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	0.2167	0.2125	0.2083	0.1870	0.1827	0.1615	0.1615	0.1573	0.1700	0.1827	0.1913	0.1998	(22b)
Mechanical extract ventilation - decentralised													
If mechanical ventilation													0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)													0.5000 (23b)
Effective ac	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Door			2.1500	1.0000	2.1500			(26)
Window (Uw = 1.20)			34.6700	1.1450	39.6985			(27)
RL			4.3700	1.5038	6.5714			(27a)
GF			64.3800	0.1100	7.0818	75.0000	4828.5000	(28a)
Main	230.9000	36.8200	194.0800	0.1800	34.9344	110.0000	21348.8000	(29a)
Dwarf (PIRx0.72)	32.1600		32.1600	0.1100	3.5376	9.0000	289.4400	(29a)
PIJ	29.7400		29.7400	0.1000	2.9740	9.0000	267.6600	(30)
PIR	50.2300	4.3700	45.8600	0.1500	6.8790	9.0000	412.7400	(30)
Total net area of external elements Aum(A, m2)			407.4100					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	103.8267			(33)
Internal Wall 1			72.1900			9.0000	649.7100	(32c)
Internal Wall 2			68.4000			75.0000	5130.0000	(32c)
Internal Floor 1			40.1200			18.0000	722.1600	(32d)
Internal Ceiling 1			40.1200			9.0000	361.0800	(32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 34010.0900 (34)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 208.1401 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	20.4800	0.0500	1.0240
E3 Sill	40.2800	0.0500	2.0140
E4 Jamb	50.0800	0.0500	2.5040
E5 Ground floor (normal)	34.2100	0.1600	5.4736
E16 Corner (normal)	41.9600	0.0900	3.7764
E6 Intermediate floor within a dwelling	59.4500	0.0000	0.0000
E11 Eaves (insulation at rafter level)	30.3200	0.0400	1.2128
E13 Gable (insulation at rafter level)	6.0300	0.0800	0.4824
E17 Corner (inverted - internal area greater than external area)	10.6200	-0.0900	-0.9558
R1 Head of roof window	3.1200	0.2400	0.7488
R2 Sill of roof window	3.1200	0.2400	0.7488
R3 Jamb of roof window	11.2000	0.2400	2.6880
R7 Flat ceiling (inverted)	1.8300	0.0400	0.0732
R9 Roof to wall (flat ceiling)	3.7900	0.0400	0.1516
R4 Ridge (vaulted ceiling)	9.2400	0.0800	0.7392

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 20.6810 (36)

Point Thermal bridges (36a) = 0.0000

Total fabric heat loss (33) + (36) + (36a) = 124.5077 (37)

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

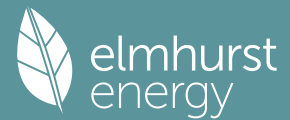
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	70.8670	(38)
Heat transfer coeff	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	195.3747	(39)
Average = Sum(39)m / 12 =													195.3747

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	1.1957	(40)
HLP (average)													1.1957
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy													2.9536 (42)
Hot water usage for mixer showers													
73.7425	72.6343	71.0194	67.9296	65.6495	63.1066	61.6613	63.2640	65.0208	67.7510	70.9071	73.4600	(42a)	
Hot water usage for baths													
31.8349	31.3621	30.6963	29.4687	28.5495	27.5302	26.9797	27.6408	28.3607	29.4513	30.7042	31.7273	(42b)	
Hot water usage for other uses													
44.8781	43.2462	41.6143	39.9823	38.3504	36.7185	36.7185	38.3504	39.9823	41.6143	43.2462	44.8781	(42c)	
Average daily hot water use (litres/day)													138.3024 (43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	150.4555	147.2426	143.3300	137.3807	132.5494	127.3554	125.3595	129.2552	133.3638	138.8166	144.8575	150.0654	(44)
Energy content (annual)	238.2848	209.6715	220.2929	188.0673	178.4369	156.5983	151.6114	160.0449	164.4509	188.3728	206.3761	234.9661	(45)
Distribution loss (46)m = 0.15 x (45)m										Total =	Sum(45)m =	2297.1737	
	35.7427	31.4507	33.0439	28.2101	26.7655	23.4897	22.7417	24.0067	24.6676	28.2559	30.9564	35.2449	(46)
Water storage loss:													
Store volume													200.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):													1.2200 (48)
Temperature factor from Table 2b													0.5400 (49)
Enter (49) or (54) in (55)													0.6588 (55)
Total storage loss													
	20.4228	18.4464	20.4228	19.7640	20.4228	19.7640	20.4228	20.4228	19.7640	20.4228	19.7640	20.4228	(56)
If cylinder contains dedicated solar storage													
	20.4228	18.4464	20.4228	19.7640	20.4228	19.7640	20.4228	20.4228	19.7640	20.4228	19.7640	20.4228	(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													
	281.9700	249.1291	263.9781	230.3433	222.1221	198.8743	195.2966	203.7301	206.7269	232.0580	248.6521	278.6513	(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													

Full SAP Calculation Printout



	281.9700	249.1291	263.9781	230.3433	222.1221	198.8743	195.2966	203.7301	206.7269	232.0580	248.6521	278.6513 (64)
	Total per year (kWh/year) = Sum(64)m =											2811.5317 (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	114.1778	101.2818	108.1955	96.3532	94.2784	85.8897	85.3590	88.1631	88.5007	97.5821	102.4408	113.0744 (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	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	177.2177	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	40.4440	35.9220	29.2137	22.1167	16.5325	13.9574	15.0815	19.6035	26.3118	33.4088	38.9930	41.5681	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	499.6357	504.8204	491.7552	463.9410	428.8306	395.8318	373.7865	368.6019	381.6670	409.4812	444.5916	477.5905	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	55.6754	(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)	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	-118.1452	(71)
Water heating gains (Table 5)	153.4648	150.7170	145.4241	133.8239	126.7183	119.2913	114.7298	118.4988	122.9177	131.1587	142.2790	151.9817	(72)
Total internal gains	808.2926	806.2074	781.1411	734.6296	686.8294	643.8285	618.3458	621.4521	645.6444	688.7968	740.6116	785.8882	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	Specific data or Table 6b	Specific data or Table 6c	Access factor Table 6d	Gains W
Northeast	0.7200	11.2829	0.5700	0.7000	0.7700	2.2463 (75)
Southeast	18.0000	36.7938	0.5700	0.7000	0.7700	183.1275 (77)
Southwest	0.7200	36.7938	0.5700	0.7000	0.7700	7.3251 (79)
Northwest	15.2300	11.2829	0.5700	0.7000	0.7700	47.5147 (81)
Northwest	4.3700	16.3666	0.6300	0.7000	1.0000	28.3871 (82)

Solar gains	268.6007	484.1257	734.1253	1031.5846	1268.0530	1308.7467	1240.9956	1056.7327	835.7813	554.2971	326.5398	226.7626 (83)
Total gains	1076.8933	1290.3332	1515.2663	1766.2141	1954.8824	1952.5752	1859.3414	1678.1849	1481.4257	1243.0939	1067.1514	1012.6509 (84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545
alpha	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236
util living area	0.9938	0.9862	0.9656	0.9056	0.7779	0.6015	0.4526	0.5170	0.7686	0.9472	0.9882	0.9952 (86)
Living	19.3579	19.5972	19.9741	20.4274	20.7781	20.9432	20.9864	20.9767	20.8432	20.3601	19.7559	19.2965
Non living	18.0166	18.3208	18.7950	19.3463	19.7361	19.8895	19.9187	19.9143	19.8122	19.2801	18.5251	17.9384
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0
24 / 9	3	0	0	0	0	0	0	0	0	0	0	0
16 / 9	28	0	0	0	0	0	0	0	0	0	0	10
MIT	20.1600	19.5972	19.9741	20.4274	20.7781	20.9432	20.9864	20.9767	20.8432	20.3601	19.7559	19.5348 (87)
Th 2	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235 (88)
util rest of house	0.9920	0.9823	0.9559	0.8793	0.7222	0.5146	0.3465	0.4045	0.6899	0.9268	0.9842	0.9938 (89)
MIT 2	19.1633	18.3208	18.7950	19.3463	19.7361	19.8895	19.9187	19.9143	19.8122	19.2801	18.5251	18.2961 (90)
Living area fraction	fLA = Living area / (4) =											0.0994 (91)
MIT	19.2623	18.4476	18.9122	19.4537	19.8397	19.9942	20.0248	20.0199	19.9147	19.3874	18.6474	18.4192 (92)
Temperature adjustment												0.0000
adjusted MIT	19.2623	18.4476	18.9122	19.4537	19.8397	19.9942	20.0248	20.0199	19.9147	19.3874	18.6474	18.4192 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9906	0.9748	0.9437	0.8655	0.7173	0.5206	0.3568	0.4150	0.6892	0.9134	0.9772	0.9910	(94)
Useful gains	1066.8189	1257.7643	1429.9469	1528.6624	1402.3026	1016.5441	663.3732	696.4818	1020.9700	1135.4536	1042.8519	1003.5381	(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													
	2923.2613	2646.8667	2425.0270	2061.9271	1590.2868	1053.8998	669.1167	707.2387	1136.0471	1716.8425	2256.0687	2778.0684	(97)
Space heating kWh													
	1381.1932	933.4769	740.3396	383.9506	139.8603	0.0000	0.0000	0.0000	0.0000	432.5533	873.5161	1320.2506	(98a)
Space heating requirement - total per year (kWh/year)												6205.1405	
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													
	1381.1932	933.4769	740.3396	383.9506	139.8603	0.0000	0.0000	0.0000	0.0000	432.5533	873.5161	1320.2506	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												6205.1405	
Space heating per m2													
										(98c) / (4) =		37.9752	(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 %)	261.8457 (206)
Efficiency of main space heating system 2 (in %)	0.0000 (207)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)

Full SAP Calculation Printout



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1381.1932	933.4769	740.3396	383.9506	139.8603	0.0000	0.0000	0.0000	0.0000	432.5533	873.5161	1320.2506	(98)
Space heating efficiency (main heating system 1)	261.8457	261.8457	261.8457	261.8457	261.8457	0.0000	0.0000	0.0000	0.0000	261.8457	261.8457	261.8457	(210)
Space heating fuel (main heating system)	527.4836	356.4988	282.7389	146.6324	53.4132	0.0000	0.0000	0.0000	0.0000	165.1940	333.5995	504.2093	(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 requirement	281.9700	249.1291	263.9781	230.3433	222.1221	198.8743	195.2966	203.7301	206.7269	232.0580	248.6521	278.6513	(64)
Efficiency of water heater (217)m	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	(216)
Fuel for water heating, kWh/month	106.3773	93.9876	99.5896	86.9004	83.7988	75.0282	73.6785	76.8602	77.9908	87.5473	93.8077	105.1253	(219)
Space cooling fuel requirement	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	6.7896	6.1326	6.7896	6.5706	6.7896	6.5706	6.7896	6.7896	6.5706	6.7896	6.5706	6.7896	(231)
Lighting	35.4004	28.3995	25.5706	18.7341	14.4708	11.8228	13.2007	17.1588	22.2876	29.2425	33.0294	36.3843	(232)
Electricity generated by PVs (Appendix M) (negative quantity) (233a)m	-24.0283	-38.0948	-61.4415	-75.4804	-84.7848	-78.6338	-77.4372	-70.1425	-57.9696	-45.4774	-27.5330	-20.1825	(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	-4.1838	-10.2694	-23.7879	-41.9868	-62.4816	-66.8650	-65.8500	-53.7471	-36.8919	-17.1814	-6.1976	-3.2389	(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												2369.7697	(211)
Space heating fuel - main system 2												0.0000	(213)
Space heating fuel - secondary												0.0000	(215)
Efficiency of water heater												265.0659	
Water heating fuel used												1060.6918	(219)
Space cooling fuel												0.0000	(221)
Electricity for pumps and fans:													
(MEVDecentralised, DataSheet: total watage = 8.0860, total flow = 53.0000, SFP = 0.1526)													
mechanical ventilation fans (SFP = 0.1526)												79.9425	(230a)
Total electricity for the above, kWh/year												79.9425	(231)
Electricity for lighting (calculated in Appendix L)												285.7016	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation												-1053.8872	(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												2742.2183	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	2369.7697	16.4900	390.7750	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	1060.6918	16.4900	174.9081	(247)
Energy for instantaneous electric shower(s)	0.0000	16.4900	0.0000	(247a)
Pumps, fans and electric keep-hot	79.9425	16.4900	13.1825	(249)
Energy for lighting	285.7016	16.4900	47.1122	(250)
Additional standing charges			0.0000	(251)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-661.2057	16.4900	-109.0328	
PV Unit electricity exported	-392.6815	5.5900	-21.9509	
Total			-130.9837	(252)
Total energy cost			494.9941	(255)

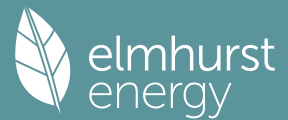
11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12):		0.3600	(256)
Energy cost factor (ECF)		0.8551	(257)
SAP value	[(255) x (256)] / [(4) + 45.0] =	86.1392	
SAP rating (Section 12)		86	(258)
SAP band		B	

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	2369.7697	0.1558	369.3237	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	1060.6918	0.1411	149.6147	(264)
Space and water heating			518.9383	(265)
Pumps, fans and electric keep-hot	79.9425	0.1387	11.0890	(267)
Energy for lighting	285.7016	0.1443	41.2356	(268)

Full SAP Calculation Printout



Energy saving/generation technologies			
PV Unit electricity used in dwelling	-661.2057	0.1331	-87.9896
PV Unit electricity exported	-392.6815	0.1214	-47.6772
Total			-135.6668 (269)
Total CO2, kg/year			435.5962 (272)
CO2 emissions per m2			2.6700 (273)
EI value			97.1991
EI rating			97 (274)
EI band			A

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING

1. Overall dwelling characteristics

	Area (m2)	Storey height (m)	Volume (m3)
Ground floor	64.3800 (1b)	x 2.5400 (2b)	= 163.5252 (1b) - (3b)
First floor	64.3800 (1c)	x 2.7700 (2c)	= 178.3326 (1c) - (3c)
Second floor	34.6400 (1d)	x 2.5300 (2d)	= 87.6392 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	163.4000		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 429.4970 (5)

2. Ventilation rate

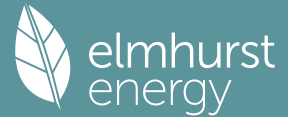
Number of open chimneys	0 * 80 =	0.0000 (6a)
Number of open flues	0 * 20 =	0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000 (6d)
Number of flues attached to other heater	0 * 35 =	0.0000 (6e)
Number of blocked chimneys	0 * 20 =	0.0000 (6f)
Number of intermittent extract fans	0 * 10 =	0.0000 (7a)
Number of passive vents	0 * 10 =	0.0000 (7b)
Number of flueless gas fires	0 * 40 =	0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000 (8)
Pressure test	Yes	
Pressure Test Method	Blower Door	
Measured/design AP50	4.0000	(17)
Infiltration rate	0.2000	(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) =	0.1700 (21)
Wind speed	Jan 4.6000 Feb 4.5000 Mar 4.6000 Apr 4.1000 May 4.3000 Jun 3.7000 Jul 3.6000 Aug 3.7000 Sep 3.7000 Oct 4.2000 Nov 4.1000 Dec 4.3000	(22)
Wind factor	1.1500 1.1250 1.1500 1.0250 1.0750 0.9250 0.9000 0.9250 0.9250 1.0500 1.0250 1.0750	(22a)
Adj infilt rate	0.1955 0.1913 0.1955 0.1742 0.1827 0.1573 0.1530 0.1573 0.1573 0.1785 0.1742 0.1827	(22b)
Mechanical extract ventilation - decentralised		
If mechanical ventilation		0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)		0.5000 (23b)
Effective ac	0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K
Door			2.1500	1.0000	2.1500		(26)
Window (Uw = 1.20)			34.6700	1.1450	39.6985		(27)
RL			4.3700	1.5038	6.5714		(27a)
GF			64.3800	0.1100	7.0818	75.0000	(28a)
Main	230.9000	36.8200	194.0800	0.1800	34.9344	110.0000	21348.8000 (29a)
Dwarf (PIRx0.72)	32.1600		32.1600	0.1100	3.5376	9.0000	289.4400 (29a)
PIJ	29.7400		29.7400	0.1000	2.9740	9.0000	267.6600 (30)
PIR	50.2300	4.3700	45.8600	0.1500	6.8790	9.0000	412.7400 (30)
Total net area of external elements Aum(A, m2)			407.4100				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =	103.8267			(33)
Internal Wall 1			72.1900			9.0000	649.7100 (32c)
Internal Wall 2			68.4000			75.0000	5130.0000 (32c)
Internal Floor 1			40.1200			18.0000	722.1600 (32d)
Internal Ceiling 1			40.1200			9.0000	361.0800 (32e)
Heat capacity Cm = Sum(A x k)			(28)...(30) + (32) + (32a)...(32e) =				34010.0900 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							208.1401 (35)
List of Thermal Bridges							
K1 Element			Length	Psi-value	Total		
E2 Other lintels (including other steel lintels)			20.4800	0.0500	1.0240		
E3 Sill			40.2800	0.0500	2.0140		
E4 Jamb			50.0800	0.0500	2.5040		
E5 Ground floor (normal)			34.2100	0.1600	5.4736		
E16 Corner (normal)			41.9600	0.0900	3.7764		
E6 Intermediate floor within a dwelling			59.4500	0.0000	0.0000		
E11 Eaves (insulation at rafter level)			30.3200	0.0400	1.2128		
E13 Gable (insulation at rafter level)			6.0300	0.0800	0.4824		
E17 Corner (inverted - internal area greater than external area)			10.6200	-0.0900	-0.9558		

6. Solar gains													
[Jan]				Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b		FF Specific data or Table 6c	Access factor Table 6d			Gains W	
Northeast				0.7200	9.5471	0.5700		0.7000	0.7700			1.9007 (75)	
Southeast				18.0000	31.1332	0.5700		0.7000	0.7700			154.9541 (77)	
Southwest				0.7200	31.1332	0.5700		0.7000	0.7700			6.1982 (79)	
Northwest				15.2300	9.5471	0.5700		0.7000	0.7700			40.2048 (81)	
Northwest				4.3700	13.8486	0.6300		0.7000	1.0000			24.0198 (82)	
Solar gains	227.2775	430.3340	688.2424	983.4440	1182.1953	1243.3094	1155.6361	969.2326	792.1753	512.3049	286.9592	205.1662 (83)	
Total gains	1035.5701	1236.5414	1469.3835	1718.0735	1869.0247	1887.1378	1773.9819	1590.6847	1437.8197	1201.1017	1027.5708	991.0544 (84)	

Full SAP Calculation Printout



7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545	48.3545
alpha	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236	4.2236
util living area	0.9940	0.9870	0.9667	0.9040	0.7684	0.5868	0.4627	0.5315	0.7816	0.9496	0.9885	0.9951 (86)
Living	19.4004	19.6168	19.9860	20.4513	20.8025	20.9514	20.9856	20.9748	20.8321	20.3617	19.7854	19.3389
Non living	18.0713	18.3462	18.8108	19.3759	19.7630	19.8963	19.9185	19.9138	19.8031	19.2833	18.5631	17.9927
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0
24 / 9	3	0	0	0	0	0	0	0	0	0	0	0
16 / 9	28	0	0	0	0	0	0	0	0	0	0	10
MIT	20.1817	19.6168	19.9860	20.4513	20.8025	20.9514	20.9856	20.9748	20.8321	20.3617	19.7854	19.5713 (87)
Th 2	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235	19.9235 (88)
util rest of house	0.9922	0.9833	0.9570	0.8765	0.7076	0.4948	0.3521	0.4141	0.7042	0.9295	0.9845	0.9937 (89)
MIT 2	19.1851	18.3462	18.8108	19.3759	19.7630	19.8963	19.9185	19.9138	19.8031	19.2833	18.5631	18.3407 (90)
Living area fraction									fLA =	Living area / (4) =		0.0994 (91)
MIT	19.2841	18.4725	18.9276	19.4828	19.8663	20.0012	20.0246	20.0192	19.9054	19.3905	18.6846	18.4630 (92)
Temperature adjustment												0.0000
adjusted MIT	19.2841	18.4725	18.9276	19.4828	19.8663	20.0012	20.0246	20.0192	19.9054	19.3905	18.6846	18.4630 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9909	0.9760	0.9450	0.8628	0.7040	0.5018	0.3628	0.4251	0.7027	0.9162	0.9777	0.9909 (94)
Useful gains	1026.1158	1206.8345	1388.5339	1482.3626	1315.7757	946.9088	643.5952	676.1254	1010.4060	1100.4457	1004.6397	982.0101 (95)
Ext temp.	4.8000	5.3000	6.8000	9.3000	12.3000	15.0000	16.7000	16.5000	14.1000	10.8000	7.5000	4.6000 (96)
Heat loss rate W	2829.8322	2573.5737	2369.4212	1989.4613	1478.2670	977.1084	649.5370	687.5646	1134.2248	1678.3633	2185.1785	2708.4716 (97)
Space heating kWh	1341.9650	918.4487	729.7802	365.1110	120.8935	0.0000	0.0000	0.0000	0.0000	429.9707	849.9880	1284.4874 (98a)
Space heating requirement - total per year (kWh/year)												6040.6445
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	1341.9650	918.4487	729.7802	365.1110	120.8935	0.0000	0.0000	0.0000	0.0000	429.9707	849.9880	1284.4874 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												6040.6445
Space heating per m2										(98c) / (4) =		36.9684 (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 %)												261.8457 (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	1341.9650	918.4487	729.7802	365.1110	120.8935	0.0000	0.0000	0.0000	0.0000	429.9707	849.9880	1284.4874 (98)
Space heating efficiency (main heating system 1)	261.8457	261.8457	261.8457	261.8457	261.8457	0.0000	0.0000	0.0000	0.0000	261.8457	261.8457	261.8457 (210)
Space heating fuel (main heating system)	512.5022	350.7595	278.7062	139.4375	46.1697	0.0000	0.0000	0.0000	0.0000	164.2077	324.6140	490.5512 (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	281.9700	249.1291	263.9781	230.3433	222.1221	198.8743	195.2966	203.7301	206.7269	232.0580	248.6521	278.6513 (64)
Efficiency of water heater (217)m	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659	265.0659 (216)
Fuel for water heating, kWh/month	106.3773	93.9876	99.5896	86.9004	83.7988	75.0282	73.6785	76.8602	77.9908	87.5473	93.8077	105.1253 (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	6.7896	6.1326	6.7896	6.5706	6.7896	6.5706	6.7896	6.7896	6.5706	6.7896	6.5706	6.7896 (231)
Lighting	35.4004	28.3995	25.5706	18.7341	14.4708	11.8228	13.2007	17.1588	22.2876	29.2425	33.0294	36.3843 (232)
Electricity generated by PVs (Appendix M) (negative quantity)												
(233a)m	-20.5784	-34.3104	-58.1685	-72.5396	-80.2719	-75.9009	-73.7153	-65.9353	-55.6809	-42.5562	-24.4848	-18.3785 (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	-3.2934	-8.6800	-21.7341	-39.4459	-57.0233	-62.3230	-59.7162	-47.6959	-34.2314	-15.3557	-5.1572	-2.8123 (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												2306.9480 (211)
Space heating fuel - main system 2												0.0000 (213)
Space heating fuel - secondary												0.0000 (215)
Efficiency of water heater												265.0659
Water heating fuel used												1060.6918 (219)
Space cooling fuel												0.0000 (221)
Electricity for pumps and fans:												

Full SAP Calculation Printout



(MEVDecentralised, DataSheet: total watage = 8.0860, total flow = 53.0000, SFP = 0.1526)
 mechanical ventilation fans (SFP = 0.1526)
 Total electricity for the above, kWh/year
 Electricity for lighting (calculated in Appendix L)

79.9425 (230a)
 79.9425 (231)
 285.7016 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
 PV generation
 Wind generation
 Hydro-electric generation (Appendix N)
 Electricity generated - Micro CHP (Appendix N)
 Appendix Q - special features
 Energy saved or generated
 Energy used
 Total delivered energy for all uses

-979.9899 (233)
 0.0000 (234)
 0.0000 (235a)
 0.0000 (235)
 -0.0000 (236)
 0.0000 (237)
 2753.2949 (238)

10a. Fuel costs - using BEDF prices (542)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year
Space heating - main system 1	2306.9480	25.1600	580.4281 (240)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	1060.6918	25.1600	266.8700 (247)
Energy for instantaneous electric shower(s)	0.0000	25.1600	0.0000 (247a)
Pumps, fans and electric keep-hot	79.9425	25.1600	20.1135 (249)
Energy for lighting	285.7016	25.1600	71.8825 (250)
Additional standing charges			0.0000 (251)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-622.5206	25.1600	-156.6262
PV Unit electricity exported	-357.4682	5.8100	-20.7689
Total			-177.3951 (252)
Total energy cost			761.8991 (255)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating - main system 1	2306.9480	0.1559	359.6442 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	1060.6918	0.1411	149.6147 (264)
Space and water heating			509.2589 (265)
Pumps, fans and electric keep-hot	79.9425	0.1387	11.0890 (267)
Energy for lighting	285.7016	0.1443	41.2356 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-622.5206	0.1328	-82.6616
PV Unit electricity exported	-357.4682	0.1212	-43.3354
Total			-125.9970 (269)
Total CO2, kg/year			435.5864 (272)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Space heating - main system 1	2306.9480	1.5771	3638.3545 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	1060.6918	1.5216	1613.9207 (278)
Space and water heating			5252.2752 (279)
Pumps, fans and electric keep-hot	79.9425	1.5128	120.9370 (281)
Energy for lighting	285.7016	1.5338	438.2186 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-622.5206	1.4907	-927.9720
PV Unit electricity exported	-357.4682	0.4448	-158.9953
Total			-1086.9673 (283)
Total Primary energy kWh/year			4724.4636 (286)

Thermal Bridging

Property Reference	77826-LZC	Issued on Date	20/05/2024
Assessment Reference	001	Prop Type Ref	Detached House
Property	Rainsough Hill, MANCHESTER, M25 9SU		

SAP Rating	86 B	DER	2.75	TER	10.74
Environmental	97 A	% DER < TER			74.39
CO ₂ Emissions (t/year)	0.44	DFEE	45.63	TFEE	45.68
Compliance Check	See BREL	% DFEE < TFEE			0.10
% DPER < TPER	46.81	DPER	29.95	TPER	56.30

Assessor Details	Mr. Paul Goddard	Assessor ID	B342-0001
Client	-, -		

	Junction details	Source Type	Psi (W/mK)	Length (m)	Result	Reference
External wall	E2 Other lintels (including other steel lintels)	Independently assessed	0.050	20.48	1.02	Split lintels
External wall	E3 Sill	Independently assessed	0.050	40.28	2.01	R2
External wall	E4 Jamb	Independently assessed	0.050	50.08	2.50	R2
External wall	E5 Ground floor (normal)	Independently assessed	0.160	34.21	5.47	R2
External wall	E16 Corner (normal)	Independently assessed	0.090	41.96	3.78	R2
External wall	E6 Intermediate floor within a dwelling	Independently assessed	0.000	59.45	0.00	R2
External wall	E11 Eaves (insulation at rafter level)	Independently assessed	0.040	30.32	1.21	R2
External wall	E13 Gable (insulation at rafter level)	Independently assessed	0.080	6.03	0.48	R2
External wall	E17 Corner (inverted – internal area greater than external area)	Independently assessed	-0.090	10.62	-0.96	R2
External roof	R1 Head of roof window	Table K1 - Default	0.240	3.12	0.75	
External roof	R2 Sill of roof window	Table K1 - Default	0.240	3.12	0.75	
External roof	R3 Jamb of roof window	Table K1 - Default	0.240	11.20	2.69	
External roof	R7 Flat ceiling (inverted)	Independently assessed	0.040	1.83	0.07	R2
External roof	R9 Roof to wall (flat ceiling)	Independently assessed	0.040	3.79	0.15	R2
External roof	R4 Ridge (vaulted ceiling)	Independently assessed	0.080	9.24	0.74	R2

Total: 325.73 W/mK:
Y-Value: 0.05 W/m²K: