

4 Ringley Close, Whitefield, MANCHESTER, M45 7HR

**Energy / Sustainability Statement
&
Regulation 25a Low or Zero Carbon (LZC) technology feasibility
study**

AG-78523-LZCR-Rev A

6th February 2025

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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 and a 35.41% reduction in Carbon emissions over and above AD. L1 2013 requirements (Regulated use).

Regulated use

Energy (Consumption)	70.11%
Primary Energy (Total energy)	58.50%
Carbon emissions	84.42% (AD. Part L1 2021)
Carbon emissions	115.42% (AD. Part L1 2013)

Total use

Energy (Consumption)	44.90%
Primary Energy (Total energy)	36.79%
Carbon emissions	65.30%

Proposed Solution

The proposed solution is to adopt a “Fabric First” approach to reduce energy requirements (Be Lean), install high efficient Heat Pump Technology (Be Clean) as well as Photovoltaic technology (Be Green) to meet the regulatory requirements of Approved Document Part L Volume 1 of the Building Regulations 2021.

The Total residual carbon emissions based on the current proposals would be 1314.88 Kg CO₂ PA

2. The development

The residential development at 4 Ringley Close, Whitefield, MANCHESTER, M45 7HR of a single replacement dwelling 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
Replacement Dwelling	1	351.41	351.41
Total	1		351.41

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	Vaillant aroTHERM
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	4Kw Peak of PV to the southeast roof slope

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

Development (Proposed)	m ²
GIFA (Development)	351.41
Energy	KwH
Heating	4,839.73
Hot water	1,151.84
Fans and Pumps	159.44
Lighting	420.63
Appliances	5,698.90
Cooking	610.50
Total Energy use	12,881.04
Energy Kw per m ² of floor area	36.66
Energy (Primary)	Kwpe
Heating	7,264.43
Hot water	1,728.91
Fans and Pumps	239.32
Lighting	631.37
Appliances	8,554.05
Cooking	916.37
Total Energy use	19,334.44
Energy Kw per m ² of floor area	55.02
CO2 emissions	Kg CO2
Heating	658.20
Hot water	156.65
Fans and Pumps	21.68
Lighting	57.21
Appliances	775.05
Cooking	83.03
Total CO2 emissions	1,751.82
Annual predicted carbon emissions per m ² of floor area	4.99
Running Cost	£ pa
Heating	£ 1,281.56
Hot water	£ 305.01
Fans and Pumps	£ 42.22
Lighting	£ 111.38
Appliances	£ 1,509.07
Cooking	£ 161.66
Standing Charges	£ 290.88
Total Running Costs	£ 3,701.78
Average annual Running Costs per residential unit	£ 3,701.78

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	15,683.61	4,839.73
Hot water	3,276.62	1,151.84
Fans and Pumps	86.00	159.44
Lighting	421.71	420.63
Appliances	5,698.90	5,698.90
Cooking	610.50	610.50
Photovoltaic (electricity used in dwelling)	-2,317.44	-1,672.42
Photovoltaic (electricity exported)	-5,912.24	-1,540.36
Total	17,547.66	9,668.26
Reduction in energy		7879.40
Percentage reduction		44.90%

Energy Primary (Kwpe)	NOTIONAL	PROPOSED
Heating	17,722.48	7,264.43
Hot water	3,702.58	1,728.91
Fans and Pumps	129.09	239.32
Lighting	632.99	631.37
Appliances	8,554.05	8,554.05
Cooking	916.37	916.37
Photovoltaic (electricity used in dwelling)	-3,478.48	-2,510.30
Photovoltaic (electricity exported)	-2,660.51	-693.16
Total	25,518.56	16,130.98
Reduction in energy		9387.58
Percentage reduction		36.79%

Carbon emissions (Kg/CO2)	NOTIONAL	PROPOSED
Heating	3,293.56	658.20
Hot water	688.09	156.65
Fans and Pumps	11.70	21.68
Lighting	57.35	57.21
Appliances	775.05	775.05
Cooking	83.03	83.03
Photovoltaic (electricity used in dwelling)	-315.17	-227.45
Photovoltaic (electricity exported)	-804.06	-209.49
Total	3,789.54	1,314.88
Reduction in Carbon emissions		2474.66
Percentage reduction		65.30%

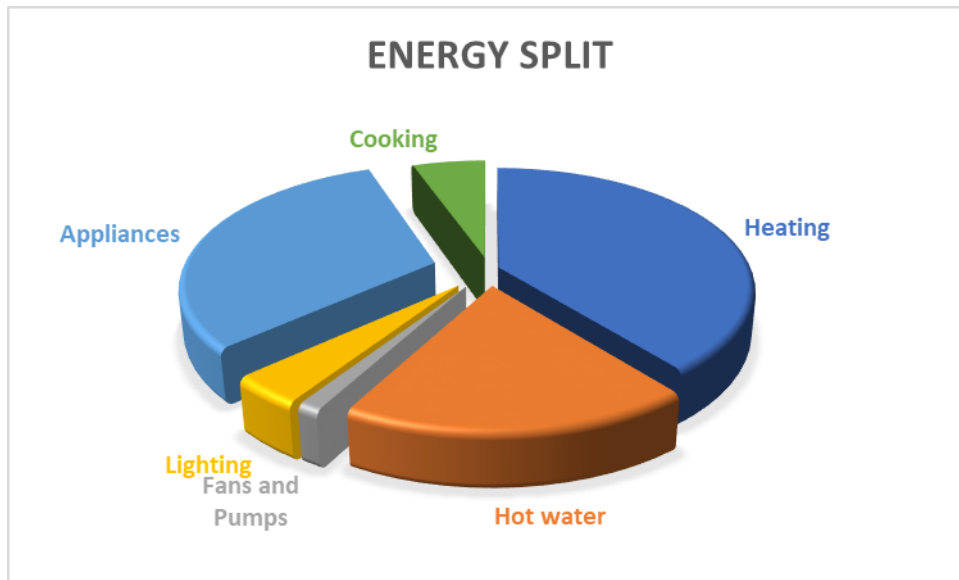
Reduction from Low or Zero Carbon Technologies

Energy	Kwh
Heating	4,839.73
Hot water	1,151.84
Fans and Pumps	159.44
Lighting	420.63
Appliances	5,698.90
Cooking	610.50
Sub TOTAL	12,881.04
Reduction in energy through LZC technology	-15,643.49
Total	-2,762.45
Percentage reduction	121.45%

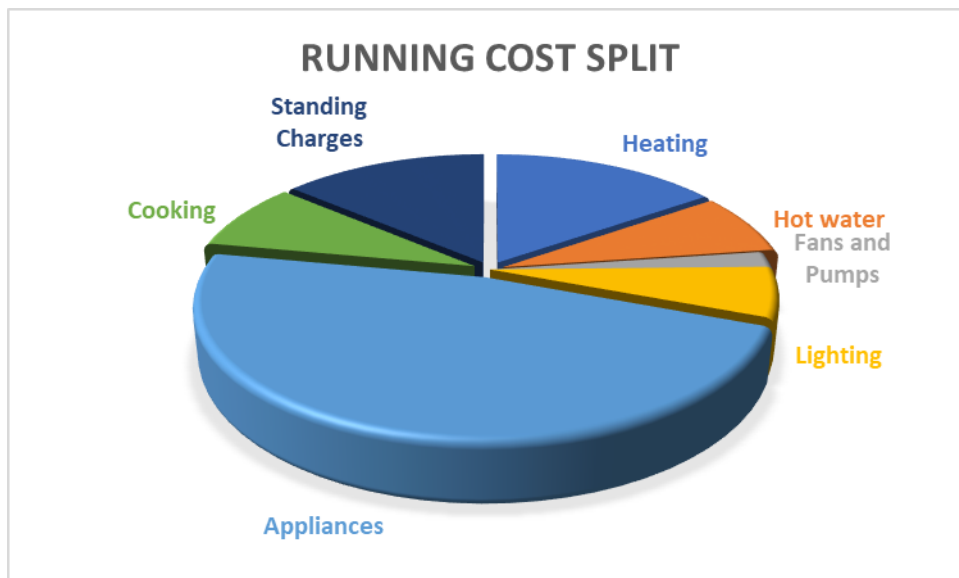
Energy (Primary)	Kwpe
Heating	7,264.43
Hot water	1,728.91
Fans and Pumps	239.32
Lighting	631.37
Appliances	8,554.05
Cooking	916.37
Sub TOTAL	19,334.44
Reduction in PRIMARY energy through LZC technology	-21,849.53
Total	-2,515.09
Percentage reduction	113.01%

Carbon emissions	Kg/CO2
Heating	658.20
Hot water	156.65
Fans and Pumps	21.68
Lighting	57.21
Appliances	775.05
Cooking	83.03
Sub TOTAL	1,751.82
Reduction in Carbon emissions through LZC technology	-2,127.52
Total	-375.69
Percentage reduction	121.45%

Total energy consumption split by use

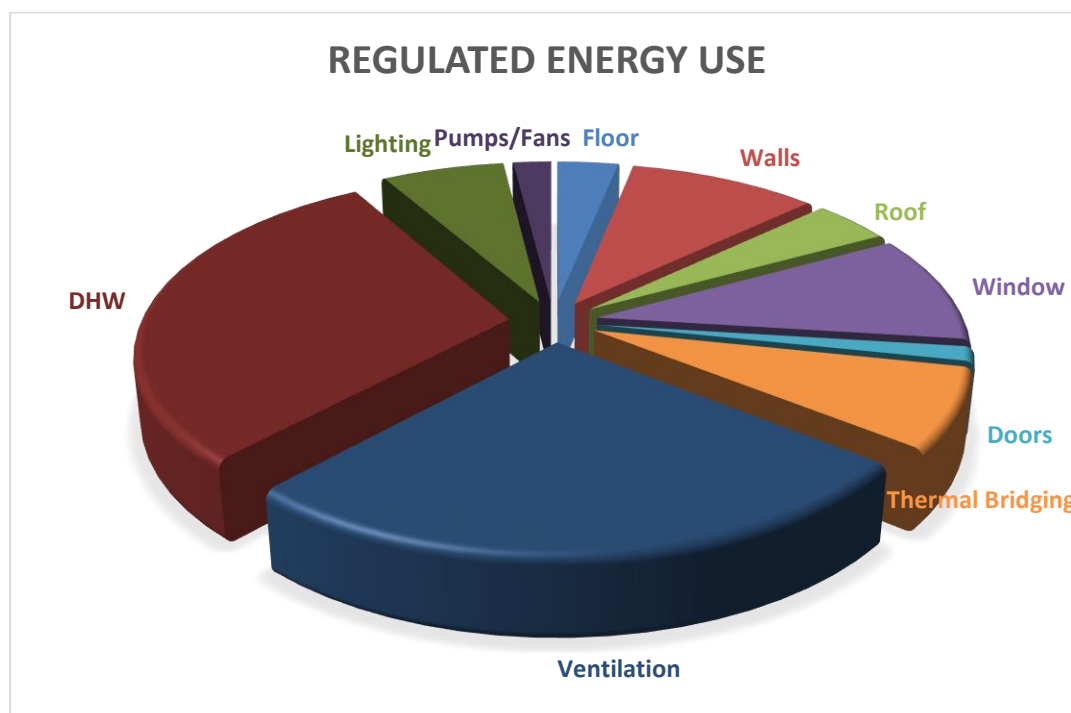


Total running cost split by use (Post April 2022 price cap)



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.

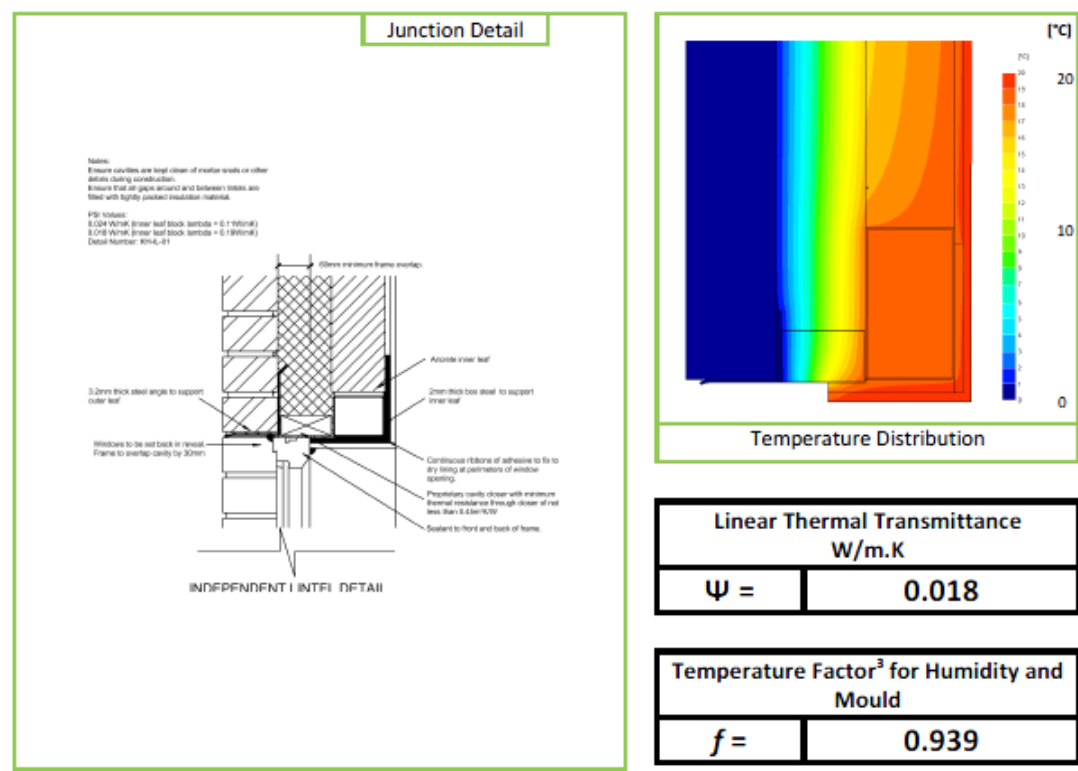
Future retro improvements made to a building's fabric are expensive, disruptive and most of the time impractical and therefore the thermal qualities of the building fabric must be one of the main considerations for long term energy and CO₂ reduction.

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.

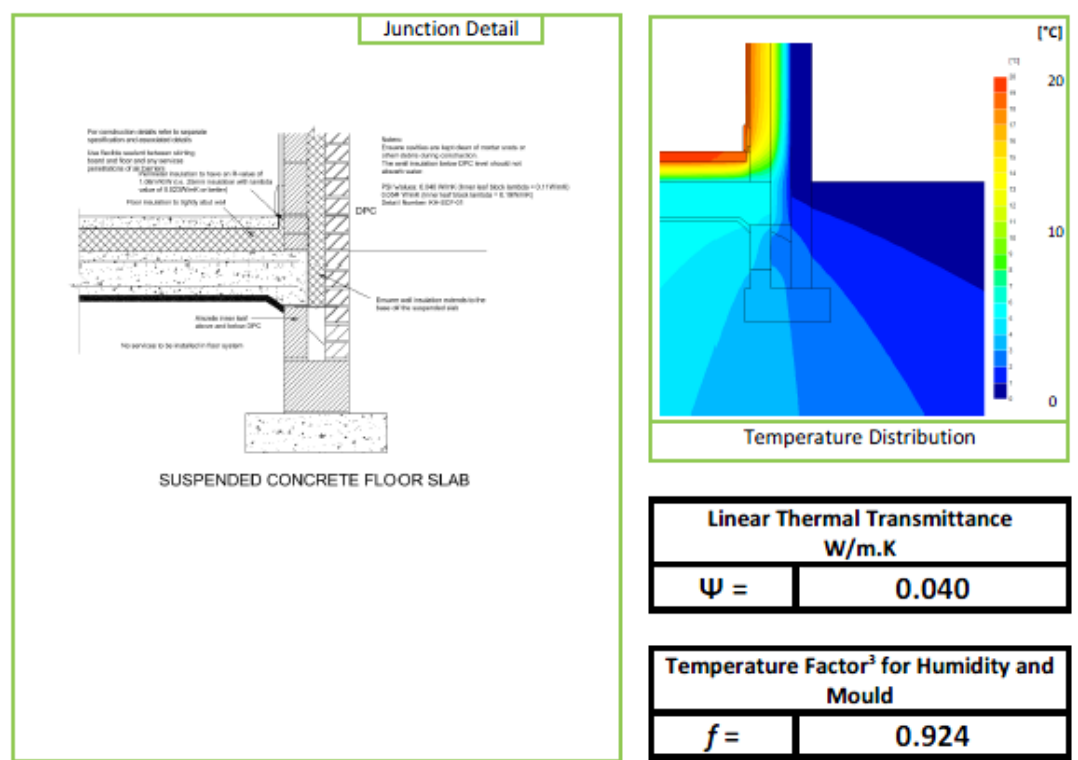
Improving the fabric specification at design stage will ensure that these dwellings do not become the "hard to treat dwellings" of the future.

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 Juan Crous to provide an Energy Statement and Low or Zero Carbon (LZC) feasibility assessment for the proposed development at 4 Ringley Close, Whitefield, MANCHESTER, M45 7HR.

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

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

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

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.

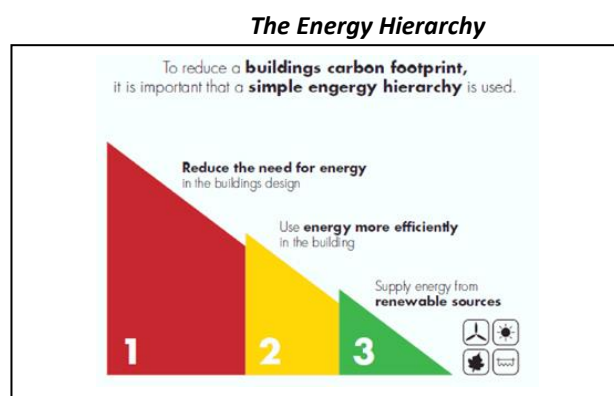
A SAP rating is an indication of heating and lighting costs, the higher the rating the lower the fuel costs will be.

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—
- electrical energy;
 - 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.

3.4 Sustainability

Water Consumption

Wholesome water consumption will be limited to less than 110Litres per person per day

Installation Type	Unit	Capacity / Flow Rate	Use Factor	Fixed Uses	Litres/ Person / Day
WCs (Multiple fittings)	Full flush volume (litres)	3.06	4.42	0	13.53
Taps (Excluding Kitchen and utility)	Flow Rate (litres / minute)	6.00	1.58	1.58	11.06
Bath (Where shower is also present)	Capacity to overflow (litres)	170.00	0.11	0	18.70
Shower (Where bath is also present)	Flow Rate (litres / minute)	8.00	4.37	0	34.96
Bath only	Capacity to overflow (litres)		0.50	0	0.00
Shower only	Flow Rate (litres / minute)		5.60	0	0.00
Kitchen/Utility Tap	Flow Rate (litres / minute)	8.00	0.44	10.36	13.88
Washing Machine	Litres / kg dry load	8.17	2.1	0	17.16
Dishwasher	Litres / place setting	1.25	3.6	0	4.50
Waste Disposal	Litres / use		3.08	0	0.00
Water Softener	Litres / person / day		1	0	0.00
Total (Litres/Person/Day)					113.79
Contribution from grey water (litres/Person/Day)					0.00
Contribution from rainwater (litres/Person/Day)					0.00
Normalisation Factor					0.91
Total (Litres / person / day)					103.55
External water use (litres/Person/Day)					5.00
Total (Litres/person/day) (Total + External use)					108.55

Waste Management

Responsibilities

- All employees should take responsibility in proper disposal of waste
- External contractors must take responsibility in disposing of their wastes effectively either by following waste procedure or taking the waste with them off site.
- Those in management position (including Team Leaders) should take extra care to ensure that their employees are disposing of waste correctly, this includes providing any training where necessary.
- All employees should collaborate to find the most sustainable methods of managing waste as far as reasonably practicable.

Definitions

- Waste: A material or substance that is eliminated or discarded as no longer useful or required after the completion of a process.
- General waste: Any waste that is not currently segregated within waste streams.
- Hazardous waste: Any waste that is considered harmful to humans and/or the environment.
- Recyclable waste: Any waste materials that are able to be converted into usable objects to prevent wastage of material resources and consumption of fresh raw materials.
- Environmental Impact: Activities, products or services that interacts or can interact with the environment

Environmental policy

In order to minimise environmental impacts concerning our activities products and services

The organization shall:

- Comply with applicable legal obligations and other related requirements to which the company subscribes which relate to its environmental aspects.
- To include the consideration of its environmental issues in all business strategies and initiatives
- Be committed to ensure that the protection of the environment is firmly embedded in both the company's and all employees culture and will endeavor to influence its suppliers and customers in a similar strategic environmental manner.
- Prevent pollution, reduce waste and minimise the consumption of resources.
- Consider the wider global impact of all our activities including those of our suppliers' customers and stakeholders
- Continually drive improvement of the environmental management system.
- Educate, train and motivate employees to carry out tasks in an environmentally responsible manner and maintain a continuous professional development strategy
- Encourage environmental protection amongst suppliers and subcontractors
- To investigate the feasibility of influencing its suppliers' customers and third parties with consideration to life cycle impacts of the aspects and activities.
- Encourage and enhance biodiversity and ecology
- Ensure the policy is communicated to employees and relevant third parties. The organisation requires and expects all persons who are employed by the organisation including contractors and visitors to co-operate with and conform to this Policy.
- Ensure that all staff, contractors and others have access to this policy.

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.

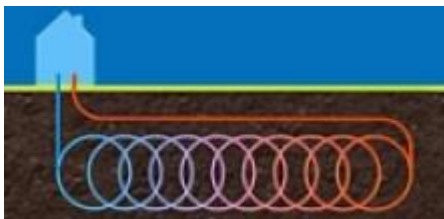
Ground source heat pumps

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.

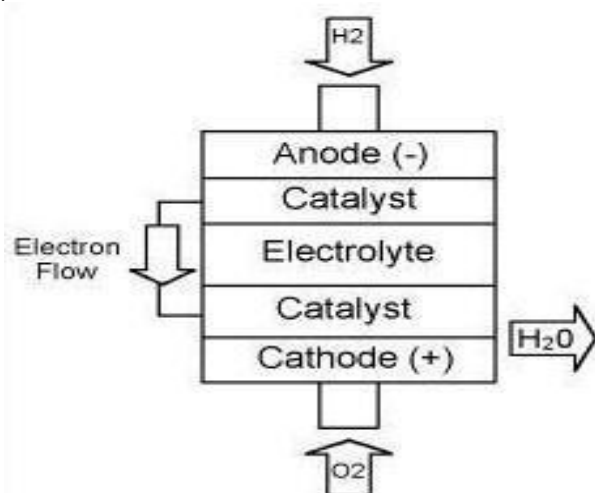
Another very important difference is that fuel cells do not run down like batteries. As long as the fuel and oxygen is supplied to the cell it will keep producing electricity for ever.

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.

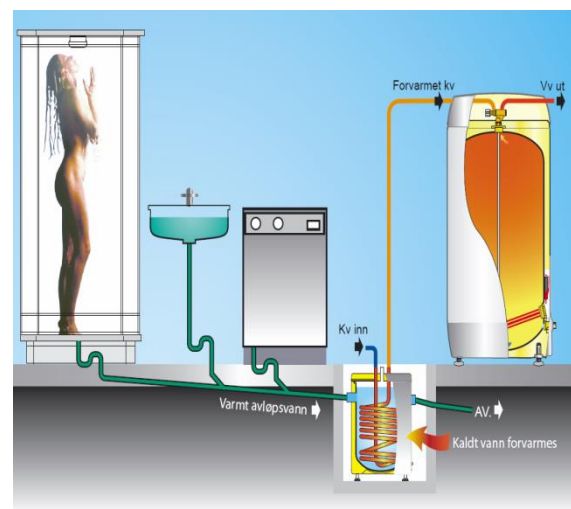
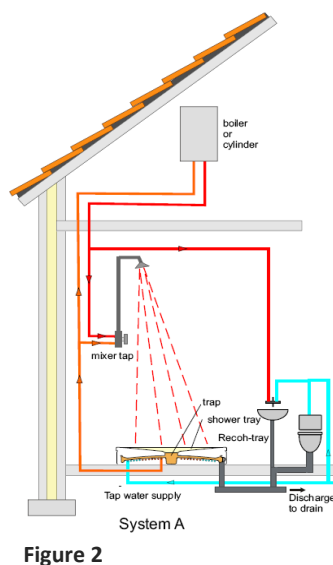
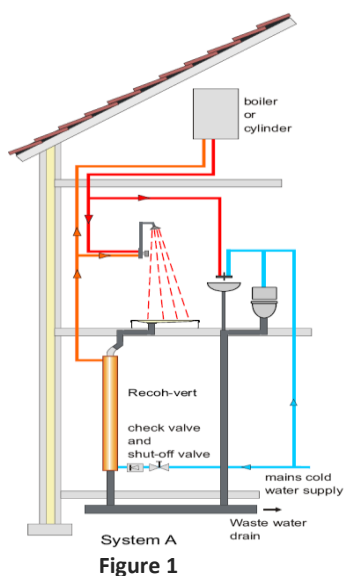
Land use

FGHRS requires no specific land use requirements.

Planning

FGHRS require no additional planning requirements.

5.2 Waste Water Heat Recovery Systems (WWHRs)



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-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.

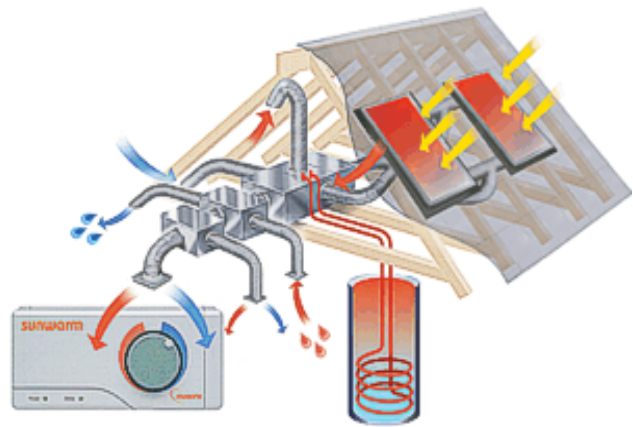
Whilst technically applicable to instantaneous electric showers, these aren't currently modelled by SAP, so it is not possible to apply in Appendix Q either.

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.

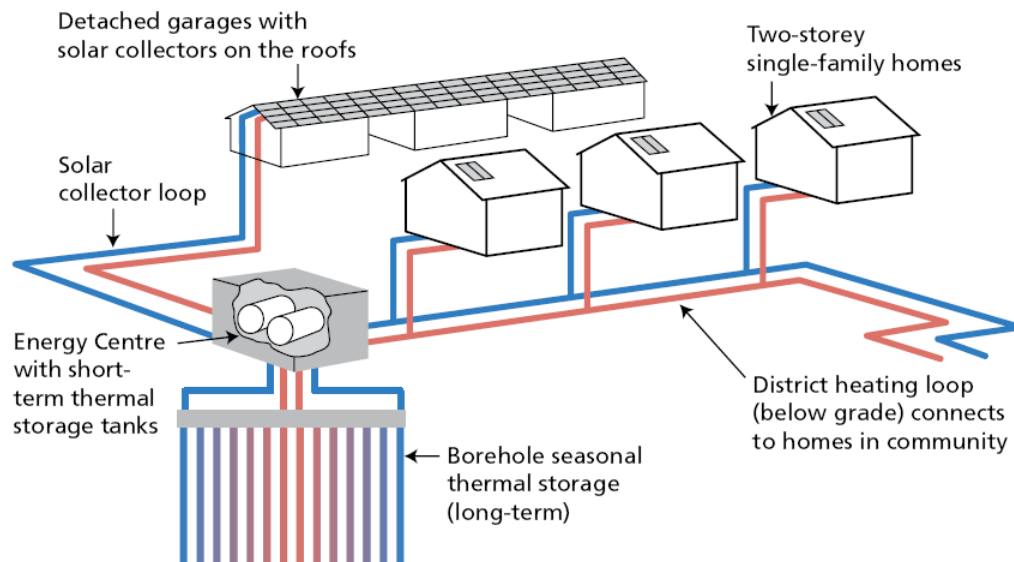
The Sunwarm system is a system that uses solar radiation in the same way Solar thermal uses solar radiation to heat water, the Sunwarm system uses solar radiation to heat air which is then introduced through the ventilation ducting and into the dwelling, the Sunwarm system can also be used to heat water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

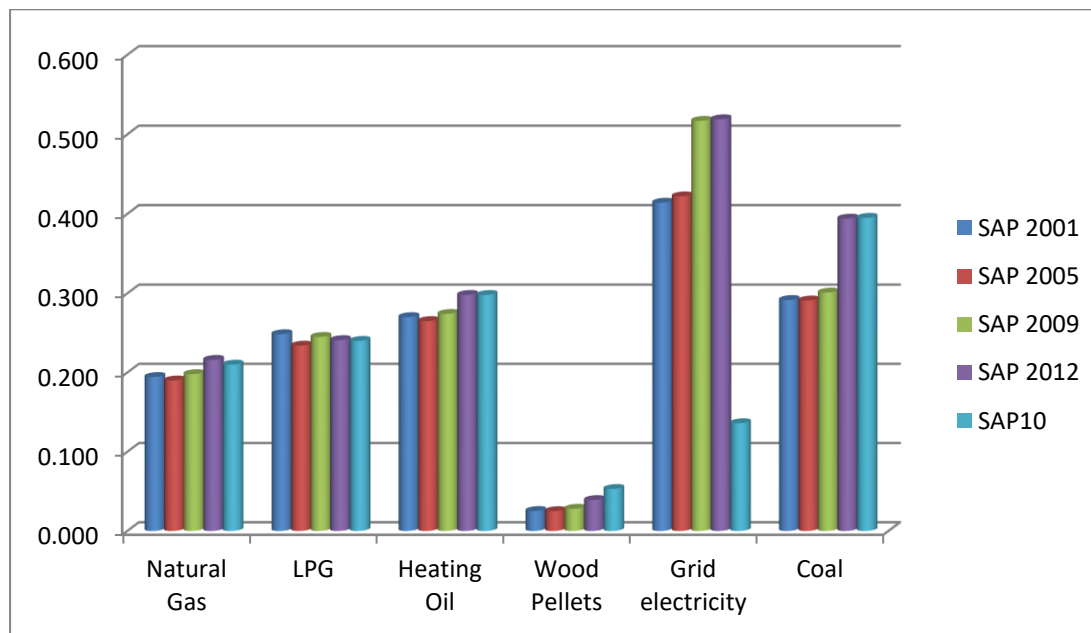
Currently there is no way of assessing the benefit of the Geothermal storage system because of limited test data and therefore the system has not been considered further in this study.

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

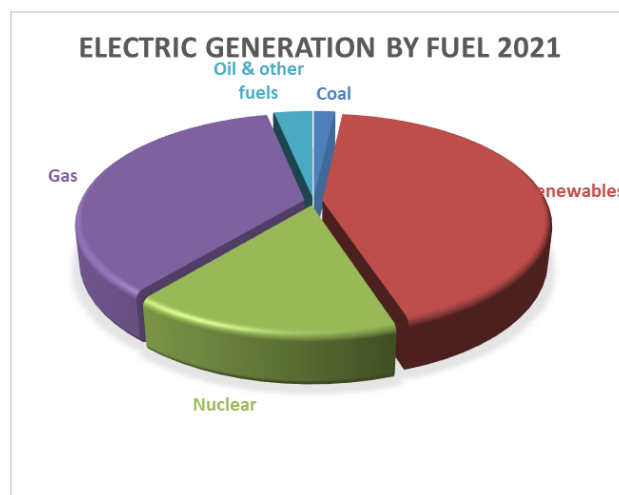
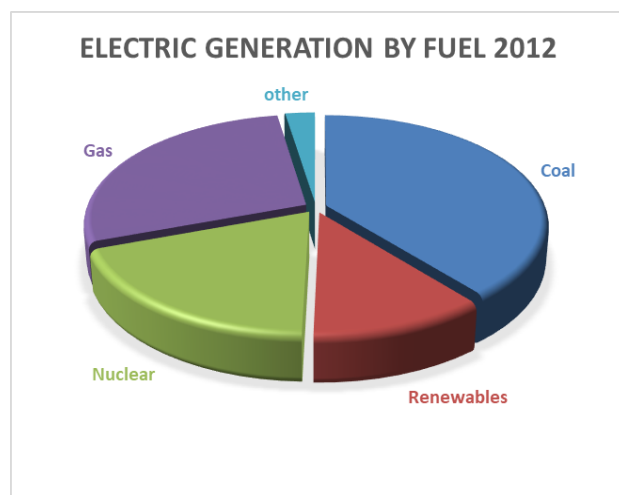
6 Fuel Cost and Carbon

Carbon

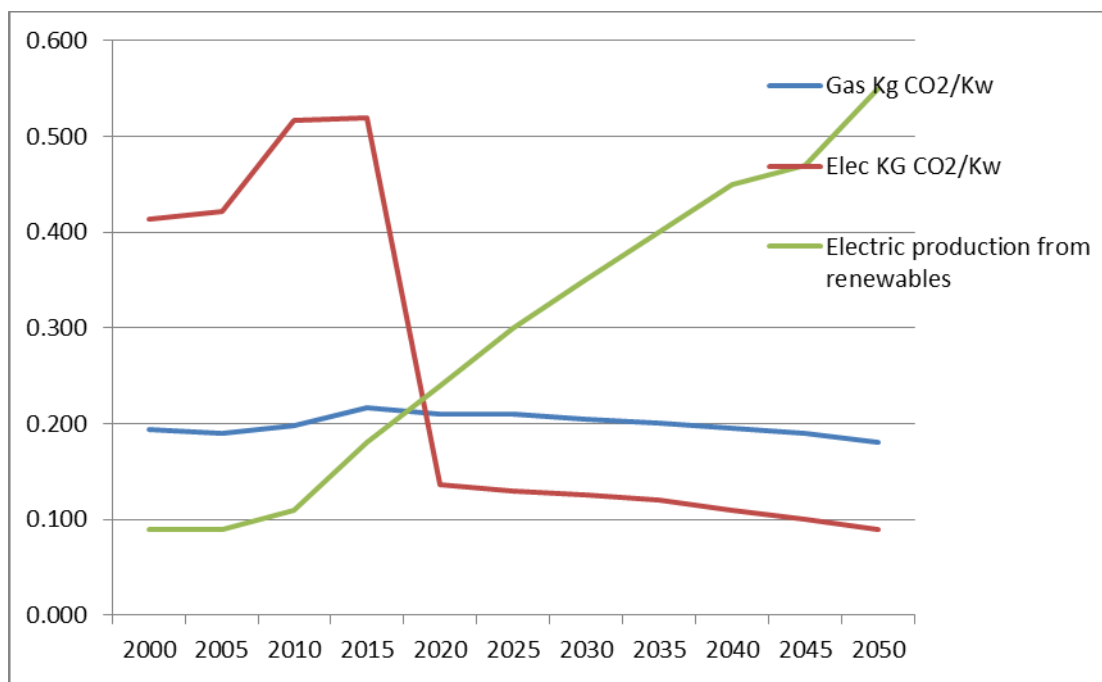
Carbon factors including SAP10.1 estimate, due to the decarbonisation of the grid electricity is now the low carbon fuel



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.

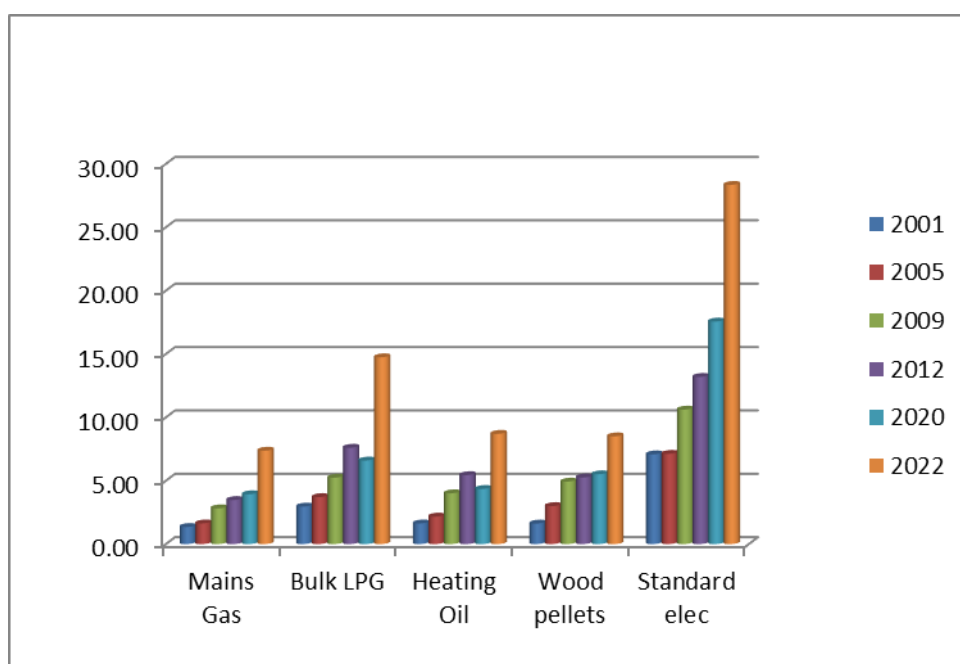


The following graph represents an estimate of CO₂ emissions for both gas and electricity and how they may change over the following years; data has been taken from SAP 2001, 2005, 2009, 2012 and SAP10.1 documents.



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

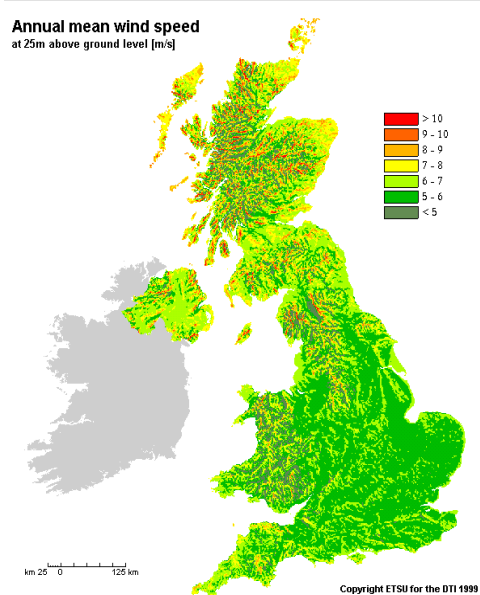
Low or Zero Carbon technologies and other innovative technologies not thought appropriate for use at the proposed development.

- 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.

- Solar Photovoltaic
- Air Source or Ground Source Heat Pump (ASHP & GSHP)

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>

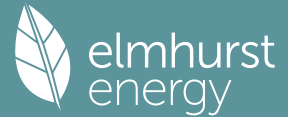
SAP	Standard Assessment Procedure
ENE 1	Energy 1
ENE 7	Energy 7
SAP	Standard Assessment Procedure
LZC	Low or Zero Carbon Technology
CSH	Code for Sustainable Homes
EI	Environmental Impact
FIT	Feed in Tariffs
RHI	Renewable Heat Incentives
DER	Dwelling Emission Rate
TER	Target Emission Rate
DNO	District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

10 Appendix A

Preliminary SAP calculation

- Dwelling Emission Rate (DER)
- Target Emission Rate (TER)
- Dwelling Fabric Energy Efficiency (DFEE)
- Target Fabric Energy Efficiency (TFEE)
- Dwelling Primary Energy Rate (DPER)
- Target Primary Energy Rate (TPER)
- Predictive Energy Assessment (PEA)
- Energy Report (ER)

Full SAP Calculation Printout



Property Reference	78523				Issued on Date	06/02/2025		
Assessment Reference	001			Prop Type Ref				
Property	4 , Ringley Close, Whitefield, MANCHESTER, M45 7HR							
SAP Rating	90 B		DER	1.66		TER	8.51	
Environmental	98 A		% DER < TER				80.49	
CO ₂ Emissions (t/year)	0.59		DFEE	46.29		TFEE	46.31	
Compliance Check	See BREL		% DFEE < TFEE				0.04	
% DPER < TPER	55.78		DPER	20.10		TPER	45.45	
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	166.5000 (1b)	x	2.4500 (2b)	=	407.9250 (1b)	- (3b)
First floor	117.8900 (1c)	x	2.7000 (2c)	=	318.3030 (1c)	- (3c)
Second floor	67.0200 (1d)	x	2.2000 (2d)	=	147.4440 (1d)	- (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	351.4100					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	873.6720	(5)

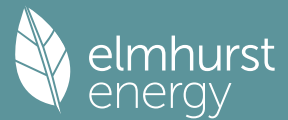
2. Ventilation rate

											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			4.3200	1.0000	4.3200			(26)
Window (Uw = 1.20)			61.3800	1.1450	70.2824			(27)
Lantern			8.4000	1.5918	13.3708			(27a)
RL			2.4000	1.5038	3.6090			(27a)
RL			4.0000	1.5038	6.0150			(27a)
GF			166.5000	0.1100	18.3150	9.0000	1498.5000	(28a)
Main	327.7600	65.7000	262.0600	0.1800	47.1708	110.0000	28826.6000	(29a)
Dwarf	55.2800		55.2800	0.1200	6.6336	110.0000	6080.8000	(29a)
PIR	97.1800	4.0000	93.1800	0.1300	12.1134	9.0000	838.6200	(30)
PIJ	50.8700	2.4000	48.4700	0.0952	4.6162	9.0000	436.2300	(30)
Flat	48.6100	8.4000	40.2100	0.1300	5.2273	9.0000	361.8900	(30)
Total net area of external elements Aum(A, m ²)			746.2000					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	191.6736			(33)
Internal Wall 1			215.3300			75.0000	16149.7500	(32c)

Full SAP Calculation Printout



Internal Wall 2	85.4000	9.0000	768.6000 (32c)
Internal Floor 1	117.8900	18.0000	2122.0200 (32d)
Internal Floor 2	67.0200	18.0000	1206.3600 (32d)
Internal Ceiling 1	117.8900	9.0000	1061.0100 (32e)
Internal Ceiling 2	67.0200	9.0000	603.1800 (32e)

Heat capacity $C_m = \text{Sum}(A \times k)$ (28)...(30) + (32) + (32a)...(32e) = 59953.5600 (34)
Thermal mass parameter (TMP = C_m / TFA) in kJ/m²K 170.6086 (35)

List of Thermal Bridges	Length	Psi-value	Total
K1 Element			
E2 Other lintels (including other steel lintels)	35.3500	0.0500	1.7675
E3 Sill	35.3500	0.0500	1.7675
E4 Jamb	91.3000	0.0500	4.5650
E5 Ground floor (normal)	56.6000	0.1000	5.6600
E16 Corner (normal)	67.8500	0.0600	4.0710
E17 Corner (inverted - internal area greater than external area)	38.4500	-0.0900	-3.4605
E6 Intermediate floor within a dwelling	95.6000	0.0020	0.1912
E10 Eaves (insulation at ceiling level)	37.0500	0.0600	2.2230
E13 Gable (insulation at rafter level)	15.4400	0.0800	1.2352
E15 Flat roof with parapet	22.7000	0.3000	6.8100
R6 Flat ceiling	37.0500	0.1200	4.4460
E24 Eaves (insulation at ceiling level - inverted)	37.0500	0.1500	5.5575
R1 Head of roof window	13.1000	0.2400	3.1440
R2 Sill of roof window	13.1000	0.2400	3.1440
R3 Jamb of roof window	18.4000	0.2400	4.4160
R11 Upstands or kerbs of rooflights	19.6000	0.2400	4.7040
Thermal bridges (Sum(L x Psi) calculated using Appendix K)			50.2414 (36)
Point Thermal Bridges			0.0000 (36a) =
Total fabric heat loss			241.9150 (37) (33) + (36) + (36a) =

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	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	(38)
Heat transfer coeff	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	(39)
Average = Sum(39)m / 12 =													386.0709
HLP	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	(40)
HLP (average)													1.0986
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

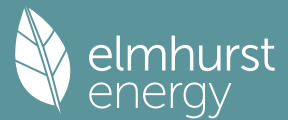
4. Water heating energy requirements (kWh/year)

Assumed occupancy													3.1988 (42)
Hot water usage for mixer showers	107.0474	105.4387	103.0945	98.6093	95.2993	91.6080	89.5099	91.8364	94.3866	98.3499	102.9315	106.6373	(42a)
Hot water usage for baths	33.6024	33.1034	32.4006	31.1049	30.1346	29.0588	28.4776	29.1755	29.9353	31.0865	32.4089	33.4888	(42b)
Hot water usage for other uses	47.3885	45.6653	43.9421	42.2189	40.4957	38.7724	38.7724	40.4957	42.2189	43.9421	45.6653	47.3885	(42c)
Average daily hot water use (litres/day)													172.9293 (43)
Daily hot water use	188.0383	184.2074	179.4372	171.9330	165.9295	159.4392	156.7600	161.5075	166.5408	173.3785	181.0057	187.5146	(44)
Energy conte	297.8068	262.3088	275.7883	235.3677	223.3730	196.0491	189.5876	199.9800	205.3614	235.2730	257.8758	293.6026	(45)
Energy content (annual)										Total = Sum(45)m =			2872.3740
Distribution loss (46)m = 0.15 x (45)m	44.6710	39.3463	41.3682	35.3051	33.5060	29.4074	28.4381	29.9970	30.8042	35.2909	38.6814	44.0404	(46)
Water storage loss:													
Store volume													300.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):													1.5900 (48)
Temperature factor from Table 2b													0.5400 (49)
Enter (49) or (54) in (55)													0.8586 (55)
Total storage loss	26.6166	24.0408	26.6166	25.7580	26.6166	25.7580	26.6166	26.6166	25.7580	26.6166	25.7580	26.6166	(56)
If cylinder contains dedicated solar storage	26.6166	24.0408	26.6166	25.7580	26.6166	25.7580	26.6166	26.6166	25.7580	26.6166	25.7580	26.6166	(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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816	(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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816	(64)
Total per year (kWh/year)										Total per year (kWh/year) = Sum(64)m =			3459.6590 (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	138.9240	123.2593	131.6028	116.8757	114.1747	103.8023	102.9411	106.3966	106.8987	118.1315	124.3597	137.5261	(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	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	251.4859	278.4308	251.4859	259.8688	251.4859	259.8688	251.4859	251.4859	259.8688	251.4859	259.8688	251.4859	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	498.6787	503.8534	490.8133	463.0523	428.0092	395.0736	373.0705	367.8958	380.9359	408.6968	443.7400	476.6756	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	(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)	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	(71)
Water heating gains (Table 5)	186.7257	183.4216	176.8855	162.3274	153.4607	144.1699	138.3617	143.0061	148.4704	158.7788	172.7218	184.8468	(72)
Total internal gains	1007.8718	1036.6872	990.1661	956.2300	903.9372	870.0937	833.8996	833.3693	860.2566	889.9431	947.3121	983.9899	(73)

Full SAP Calculation Printout



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				36.9900	11.2829	0.4200		0.7000		0.7700		85.0329 (75)			
Southeast				5.8800	36.7938	0.4200		0.7000		0.7700		44.0791 (77)			
Southwest				16.7300	36.7938	0.4200		0.7000		0.7700		125.4156 (79)			
Northwest				1.7800	11.2829	0.4200		0.7000		0.7700		4.0919 (81)			
East				8.4000	26.0000	0.6300		0.7000		1.0000		86.6830 (82)			
Northeast				2.4000	16.3666	0.6300		0.7000		1.0000		15.5902 (82)			
Southwest				4.0000	39.9751	0.6300		0.7000		1.0000		63.4645 (82)			
Solar gains				424.3572	798.9105	1279.1127	1870.4321	2336.6916	2421.0189	2292.3690	1932.3963	1483.7409	934.6700	522.5250	353.7344 (83)
Total gains				1432.2290	1835.5978	2269.2788	2826.6621	3240.6288	3291.1126	3126.2685	2765.7656	2343.9975	1824.6131	1469.8370	1337.7243 (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	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366
alpha	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758
util living area	0.9977	0.9937	0.9818	0.9383	0.8335	0.6689	0.5188	0.5955	0.8424	0.9738	0.9952	0.9983 (86)
Living	19.3680	19.5619	19.8779	20.2958	20.6453	20.8371	20.8966	20.8805	20.7071	20.2280	19.7128	19.3271
Non living	18.0604	18.3084	18.7108	19.2328	19.6444	19.8418	19.8891	19.8800	19.7243	19.1573	18.5024	18.0080
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	20.1651	19.5619	19.8779	20.2958	20.6453	20.8371	20.8966	20.8805	20.7071	20.2280	19.7128	19.5611 (87)
Th 2	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019 (88)
util rest of house	0.9972	0.9922	0.9771	0.9219	0.7905	0.5893	0.4115	0.4848	0.7835	0.9642	0.9938	0.9978 (89)
MIT 2	19.2279	18.3084	18.7108	19.2328	19.6444	19.8418	19.8891	19.8800	19.7243	19.1573	18.5024	18.3673 (90)
Living area fraction									FLA = Living area / (4) =			0.0664 (91)
MIT	19.2901	18.3916	18.7883	19.3034	19.7108	19.9078	19.9560	19.9464	19.7895	19.2283	18.5827	18.4465 (92)
Temperature adjustment												0.0000
adjusted MIT	19.2901	18.3916	18.7883	19.3034	19.7108	19.9078	19.9560	19.9464	19.7895	19.2283	18.5827	18.4465 (93)

8. Space heating requirement

Utilisation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	0.9966	0.9886	0.9692	0.9074	0.7759	0.5811	0.4063	0.4781	0.7683	0.9537	0.9907	0.9968 (94)
Useful gains	1427.4149	1814.5971	2199.4434	2564.8719	2514.5246	1912.3384	1270.3367	1322.3248	1800.9354	1740.0750	1456.1558	1333.4974 (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	5787.2462	5208.7055	4744.1372	4016.4424	3092.7404	2049.1910	1295.6527	1369.1543	2196.5665	3331.1439	4433.1454	5500.1771 (97)
Space heating kWh	3243.7145	2280.8409	1893.2521	1045.1307	430.1925	0.0000	0.0000	0.0000	0.0000	1183.7553	2143.4325	3100.0097 (98a)
Space heating requirement - total per year (kWh/year)												15320.3283
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	3243.7145	2280.8409	1893.2521	1045.1307	430.1925	0.0000	0.0000	0.0000	0.0000	1183.7553	2143.4325	3100.0097 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												15320.3283
Space heating per m2										(98c) / (4) =		43.5967 (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 %)												316.5531 (206)
Efficiency of main space heating system 2 (in %)												0.0000 (207)
Efficiency of secondary/supplementary heating system, %												0.0000 (208)
Space heating requirement	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	3243.7145	2280.8409	1893.2521	1045.1307	430.1925	0.0000	0.0000	0.0000	0.0000	1183.7553	2143.4325	3100.0097 (98)
Space heating efficiency (main heating system 1)	316.5531	316.5531	316.5531	316.5531	316.5531	0.0000	0.0000	0.0000	0.0000	316.5531	316.5531	316.5531 (210)
Space heating fuel (main heating system)	1024.6984	720.5239	598.0836	330.1597	135.8990	0.0000	0.0000	0.0000	0.0000	373.9516	677.1163	979.3016 (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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816 (64)
Efficiency of water heater (217)m	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597 (216)
Fuel for water heating, kWh/month	115.7565	102.3309	108.4258	94.4327	90.9749	81.3422	79.7266	83.1866	84.4426	94.9368	101.9264	114.3567 (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	13.5414	12.2309	13.5414	13.1046	13.5414	13.1046	13.5414	13.5414	13.1046	13.5414	13.1046	13.5414 (231)
Lighting	52.1186	41.8115	37.6466	27.5815	21.3048	17.4062	19.4349	25.2623	32.8132	43.0527	48.6279	53.5672 (232)
Electricity generated by PVs (Appendix M) (negative quantity)												
(233a)m	-75.6149	-112.8164	-169.5997	-192.4937	-200.4979	-173.7313	-171.3413	-159.8923	-139.7496	-128.0104	-84.3256	-64.3512 (233a)

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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	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	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	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)														
(233b)m	-19.5579	-45.2016	-97.3156	-161.8883	-234.3096	-252.4953	-249.7864	-210.0735	-152.5284	-73.4036	-28.4076	-15.3960		(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	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													4839.7340	(211)
Space heating fuel - main system 2													0.0000	(213)
Space heating fuel - secondary													0.0000	(215)
Efficiency of water heater													300.3597	
Water heating fuel used													1151.8386	(219)
Space cooling fuel													0.0000	(221)
Electricity for pumps and fans:														
(MEVDecentralised, Database: total watage = 11.5180, total flow = 77.0000, SFP = 0.1496)														
mechanical ventilation fans (SFP = 0.1496)													159.4390	(230a)
Total electricity for the above, kWh/year													159.4390	(231)
Electricity for lighting (calculated in Appendix L)													420.6273	(232)
Energy saving/generation technologies (Appendices M ,N and Q)														
PV generation													-3212.7879	(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													3358.8511	(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	4839.7340	0.1553	751.6961	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	1151.8386	0.1411	162.5150	(264)
Space and water heating			914.2111	(265)
Pumps, fans and electric keep-hot	159.4390	0.1387	22.1162	(267)
Energy for lighting	420.6273	0.1443	60.7095	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1672.4242	0.1350	-225.7728	
PV Unit electricity exported	-1540.3636	0.1224	-188.4701	
Total			-414.2429	(269)
Total CO2, kg/year			582.7939	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			1.6600	(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	4839.7340	1.5750	7622.5527	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	1151.8386	1.5217	1752.7713	(278)
Space and water heating			9375.3240	(279)
Pumps, fans and electric keep-hot	159.4390	1.5128	241.1993	(281)
Energy for lighting	420.6273	1.5338	645.1722	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1672.4242	1.4990	-2506.9289	
PV Unit electricity exported	-1540.3636	0.4489	-691.4657	
Total			-3198.3946	(283)
Total Primary energy kWh/year			7063.3010	(286)
Dwelling Primary energy Rate (DPER)			20.1000	(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	166.5000 (1b)	x 2.4500 (2b)	= 407.9250 (1b) - (3b)	
First floor	117.8900 (1c)	x 2.7000 (2c)	= 318.3030 (1c) - (3c)	
Second floor	67.0200 (1d)	x 2.2000 (2d)	= 147.4440 (1d) - (3d)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	351.4100		(4)	
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 873.6720 (5)	

2. Ventilation rate

m3 per hour

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Number of open chimneys	0 * 80 =	0.0000 (6a)
Number of open flues	0 * 20 =	0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000 (6d)
Number of flues attached to other heater	0 * 35 =	0.0000 (6e)
Number of blocked chimneys	0 * 20 =	0.0000 (6f)
Number of intermittent extract fans	4 * 10 =	40.0000 (7a)
Number of passive vents	0 * 10 =	0.0000 (7b)
Number of flueless gas fires	0 * 40 =	0.0000 (7c)

Air changes per hour
 Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = 40.0000 / (5) = 0.0458 (8)
 Pressure test Yes
 Pressure Test Method Blower Door
 Measured/design AP50 5.0000 (17)
 Infiltration rate 0.2958 (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) = 0.2514 (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												
	0.3206	0.3143	0.3080	0.2766	0.2703	0.2388	0.2388	0.2326	0.2514	0.2703	0.2828	0.2954 (22b)
Effective ac	0.5514	0.5494	0.5474	0.5382	0.5365	0.5285	0.5285	0.5270	0.5316	0.5365	0.5400	0.5436 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K
TER Opaque door			4.3200	1.0000	4.3200		(26)
TER Opening Type (Uw = 1.20)			61.3800	1.1450	70.2824		(27)
RL			2.4000	1.8519	4.4444		(27a)
RL			4.0000	1.8519	7.4074		(27a)
Lantern			8.4000	2.0221	16.9853		(27a)
GF			166.5000	0.1300	21.6450		(28a)
Main	327.7600	65.7000	262.0600	0.1800	47.1708		(29a)
Dwarf	55.2800		55.2800	0.1800	9.9504		(29a)
PIR	97.1800	4.0000	93.1800	0.1100	10.2498		(30)
PIJ	50.8700	2.4000	48.4700	0.1100	5.3317		(30)
Flat	48.6100	8.4000	40.2100	0.1100	4.4231		(30)
Total net area of external elements Aum(A, m2)			746.2000				(31)
Fabric heat loss, W/K = Sum (A x U)					202.2104		(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 170.6086 (35)

List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	35.3500	0.0500	1.7675
E3 Sill	35.3500	0.0500	1.7675
E4 Jamb	91.3000	0.0500	4.5650
E5 Ground floor (normal)	56.6000	0.1600	9.0560
E16 Corner (normal)	67.8500	0.0900	6.1065
E17 Corner (inverted - internal area greater than external area)	38.4500	-0.0900	-3.4605
E6 Intermediate floor within a dwelling	95.6000	0.0000	0.0000
E10 Eaves (insulation at ceiling level)	37.0500	0.0600	2.2230
E13 Gable (insulation at rafter level)	15.4400	0.0800	1.2352
E15 Flat roof with parapet	22.7000	0.5600	12.7120
R6 Flat ceiling	37.0500	0.0600	2.2230
E24 Eaves (insulation at ceiling level - inverted)	37.0500	0.2400	8.8920
R1 Head of roof window	13.1000	0.0800	1.0480
R2 Sill of roof window	13.1000	0.0600	0.7860
R3 Jamb of roof window	18.4000	0.0800	1.4720
R11 Upstands or kerbs of rooflights	19.6000	0.0800	1.5680

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 51.9612 (36)
 Point Thermal bridges (36a) = 0.0000
 Total fabric heat loss (33) + (36) + (36a) = 254.1716 (37)

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

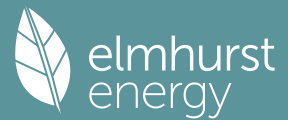
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	158.9688	158.3936	157.8297	155.1815	154.6861	152.3796	152.3796	151.9524	153.2680	154.6861	155.6884	156.7363 (38)
Heat transfer coeff	413.1403	412.5651	412.0013	409.3531	408.8576	406.5511	406.5511	406.1240	407.4396	408.8576	409.8600	410.9079 (39)
Average = Sum(39)m / 12 =												409.3507

HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	1.1757	1.1740	1.1724	1.1649	1.1635	1.1569	1.1569	1.1557	1.1594	1.1635	1.1663	1.1693 (40)
HLP (average)												1.1649
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31

4. Water heating energy requirements (kWh/year)

Assumed occupancy												3.1988 (42)
Hot water usage for mixer showers												
	77.8527	76.6827	74.9778	71.7158	69.3086	66.6240	65.0981	66.7901	68.6448	71.5272	74.8592	77.5544 (42a)
Hot water usage for baths												
	33.6024	33.1034	32.4006	31.1049	30.1346	29.0588	28.4776	29.1755	29.9353	31.0865	32.4089	33.4888 (42b)
Hot water usage for other uses												
	47.3885	45.6653	43.9421	42.2189	40.4957	38.7724	38.7724	40.4957	42.2189	43.9421	45.6653	47.3885 (42c)
Average daily hot water use (litres/day)												146.0128 (43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	158.8436	155.4514	151.3205	145.0395	139.9388	134.4552	132.3482	136.4612	140.7990	146.5558	152.9335	158.4317 (44)
Energy conte	251.5694	221.3607	232.5740	198.5519	188.3845	165.3283	160.0636	168.9675	173.6192	198.8748	217.8818	248.0658 (45)
Energy content (annual)												2425.2416
Distribution loss (46)m = 0.15 x (45)m												
	37.7354	33.2041	34.8861	29.7828	28.2577	24.7993	24.0095	25.3451	26.0429	29.8312	32.6823	37.2099 (46)
Water storage loss:												
Store volume												300.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):												2.1127 (48)

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Temperature factor from Table 2b												0.5400 (49)
Enter (49) or (54) in (55)												1.1409 (55)
Total storage loss	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664 (56)
If cylinder contains dedicated solar storage	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664 (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	310.1982	274.3157	291.2028	255.2894	247.0134	222.0659	218.6925	227.5963	230.3568	257.5036	274.6194	306.6946 (62)
WWHRS	-35.5910	-31.4770	-32.9609	-27.2929	-25.4360	-21.7658	-20.4019	-21.6954	-22.5197	-26.5482	-30.0759	-34.9319 (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	274.6073	242.8388	258.2419	227.9966	221.5774	200.3001	198.2905	205.9009	207.8371	230.9554	244.5434	271.7627 (64)
12Total per year (kWh/year)												2784.8520 (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	130.5499	115.9665	124.2339	111.4086	109.5409	100.3617	100.1242	103.0847	103.1184	113.0289	117.8357	129.3849 (65)

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

Metabolic gains (Table 5), Watts												
(66)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	251.4859	278.4308	251.4859	259.8688	251.4859	259.8688	251.4859	251.4859	259.8688	251.4859	259.8688	251.4859 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	498.6787	503.8534	490.8133	463.0523	428.0092	395.0736	373.0705	367.8958	380.9359	408.6968	443.7400	476.6756 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938 (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)	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505 (71)
Water heating gains (Table 5)	175.4703	172.5691	166.9810	154.7341	147.2324	139.3913	134.5756	138.5548	143.2200	151.9206	163.6608	173.9045 (72)
Total internal gains	999.6163	1028.8348	983.2617	951.6367	900.7090	865.3151	830.1135	828.9179	855.0062	886.0848	941.2510	976.0475 (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					36.9900	11.2829	0.6300	0.7000	0.7700	127.5494 (75)						
Southeast					5.8800	36.7938	0.6300	0.7000	0.7700	66.1187 (77)						
Southwest					16.7300	36.7938	0.6300	0.7000	0.7700	188.1234 (79)						
Northwest					1.7800	11.2829	0.6300	0.7000	0.7700	6.1378 (81)						
Northeast					2.4000	16.3666	0.6300	0.7000	1.0000	15.5902 (82)						
East					8.4000	26.0000	0.6300	0.7000	1.0000	86.6830 (82)						
Southwest					4.0000	39.9751	0.6300	0.7000	1.0000	63.4645 (82)						
Solar gains					553.6669	1033.9747	1640.0541	2383.5562	2971.5839	3077.7783	2914.5444	2459.6821	1896.7456	1205.0667	680.1038	462.6524 (83)
Total gains					1553.2833	2062.8096	2623.3158	3335.1928	3872.2929	3943.0934	3744.6578	3288.6001	2751.7518	2091.1515	1621.3548	1438.6999 (84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	40.3102	40.3664	40.4216	40.6831	40.7324	40.9635	40.9635	41.0066	40.8742	40.7324	40.6328	40.5292
alpha	3.6873	3.6911	3.6948	3.7122	3.7155	3.7309	3.7309	3.7338	3.7249	3.7155	3.7089	3.7019
util living area	0.9968	0.9908	0.9726	0.9109	0.7807	0.6045	0.4614	0.5362	0.7967	0.9623	0.9932	0.9976 (86)
MIT	18.8340	19.1379	19.6136	20.2228	20.6836	20.9113	20.9751	20.9573	20.7485	20.0907	19.3421	18.7833 (87)
Th 2	19.9395	19.9408	19.9421	19.9482	19.9493	19.9546	19.9546	19.9556	19.9526	19.9493	19.9470	19.9446 (88)
util rest of house	0.9960	0.9885	0.9657	0.8888	0.7305	0.5234	0.3588	0.4275	0.7286	0.9489	0.9912	0.9970 (89)
MIT 2	17.3871	17.7760	18.3802	19.1366	19.6658	19.8956	19.9441	19.9356	19.7547	18.9917	18.0426	17.3253 (90)
Living area fraction	fLA = Living area / (4) =											
MIT	17.4831	17.8664	18.4620	19.2087	19.7334	19.9630	20.0125	20.0034	19.8206	19.0646	18.1288	17.4221 (92)
Temperature adjustment												
adjusted MIT	17.4831	17.8664	18.4620	19.2087	19.7334	19.9630	20.0125	20.0034	19.8206	19.0646	18.1288	17.4221 (93)

8. Space heating requirement

Utilisation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	0.9930	0.9816	0.9520	0.8694	0.7189	0.5241	0.3647	0.4327	0.7186	0.9329	0.9856	0.9946 (94)
Useful gains	1542.3801	2024.7613	2497.3931	2899.4607	2783.6038	2066.5687	1365.6662	1423.0547	1977.4272	1950.7839	1597.9697	1430.9568 (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	5446.4723	5349.4789	4928.3684	4219.8978	3284.5134	2180.3399	1387.3591	1463.4418	2330.8035	3460.8217	4520.2628	5433.0596 (97)
Space heating kWh	2904.6446	2234.2102	1808.6456	950.7147	372.6767	0.0000	0.0000	0.0000	0.0000	1123.4682	2104.0510	2977.5645 (98a)
Space heating requirement - total per year (kWh/year)												14475.9755
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	2904.6446	2234.2102	1808.6456	950.7147	372.6767	0.0000	0.0000	0.0000	0.0000	1123.4682	2104.0510	2977.5645 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												14475.9755

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Space heating per m2

(98c) / (4) = 41.1940 (99)

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

Fraction of space heat from secondary/supplementary system (Table 11)												0.0000 (201)
Fraction of space heat from main system(s)												1.0000 (202)
Efficiency of main space heating system 1 (in %)												92.3000 (206)
Efficiency of main space heating system 2 (in %)												0.0000 (207)
Efficiency of secondary/supplementary heating system, %												0.0000 (208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating requirement	2904.6446	2234.2102	1808.6456	950.7147	372.6767	0.0000	0.0000	0.0000	0.0000	1123.4682	2104.0510	2977.5645 (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)	3146.9605	2420.5961	1959.5294	1030.0268	403.7667	0.0000	0.0000	0.0000	0.0000	1217.1919	2279.5785	3225.9637 (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	274.6073	242.8388	258.2419	227.9966	221.5774	200.3001	198.2905	205.9009	207.8371	230.9554	244.5434	271.7627 (64)
Efficiency of water heater (217)m	87.9433	87.8289	87.5661	86.9042	85.2164	79.8000	79.8000	79.8000	79.8000	87.1245	87.7693	79.8000 (216)
Fuel for water heating, kWh/month	312.2549	276.4907	294.9109	262.3540	260.0172	251.0027	248.4844	258.0212	260.4475	265.0867	278.6207	308.9259 (219)
Space cooling fuel requirement												
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041 (231)
Lighting	52.2538	41.9199	37.7443	27.6531	21.3600	17.4513	19.4853	25.3278	32.8983	43.1643	48.7540	53.7061 (232)
Electricity generated by PVs (Appendix M) (negative quantity)												
(233a)m	-129.7118	-171.0580	-230.0154	-241.1283	-245.7749	-223.9915	-220.6164	-214.5848	-202.8439	-186.1467	-138.0399	-113.5219 (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	-114.0770	-233.7110	-453.6986	-666.6346	-868.0010	-867.8043	-858.1185	-733.0967	-545.8374	-329.7829	-150.7305	-90.7537 (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												15683.6137 (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												3276.6166 (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)												421.7182 (232)
Energy saving/generation technologies (Appendices M ,N and Q)												
PV generation												-8229.6797 (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												11238.2689 (238)

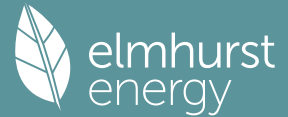
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating - main system 1	15683.6137	0.2100	3293.5589 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	3276.6166	0.2100	688.0895 (264)
Space and water heating			3981.6484 (265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293 (267)
Energy for lighting	421.7182	0.1443	60.8670 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-2317.4335	0.1361	-315.4402
PV Unit electricity exported	-5912.2462	0.1265	-748.1449
Total			-1063.5851 (269)
Total CO2, kg/year			2990.8595 (272)
EPC Target Carbon Dioxide Emission Rate (TER)			8.5100 (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	15683.6137	1.1300	17722.4835 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	3276.6166	1.1300	3702.5768 (278)
Space and water heating			21425.0603 (279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008 (281)
Energy for lighting	421.7182	1.5338	646.8454 (282)
Energy saving/generation technologies			

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PV Unit electricity used in dwelling	-2317.4335	1.5031	-3483.4413
PV Unit electricity exported	-5912.2462	0.4645	-2746.3680
Total			-6229.8093 (283)
Total Primary energy kWh/year			15972.1972 (286)
Target Primary Energy Rate (TPER)			45.4500 (287)

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

1. Overall dwelling characteristics

	Area (m ²)	Storey height (m)	Volume (m ³)
Ground floor	166.5000 (1b)	x 2.4500 (2b)	= 407.9250 (1b) - (3b)
First floor	117.8900 (1c)	x 2.7000 (2c)	= 318.3030 (1c) - (3c)
Second floor	67.0200 (1d)	x 2.2000 (2d)	= 147.4440 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	351.4100		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 873.6720 (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	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) =	
Pressure test	40.0000 / (5) =	
Pressure Test Method	Yes	
Measured/design AP50	Blower Door	
Infiltration rate	4.0000 (17)	
Number of sides sheltered	0.2458 (18)	
	2 (19)	
Shelter factor	(20) = 1 - [0.075 x (19)] =	
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	
	0.8500 (20)	
	0.2089 (21)	

Wind speed	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind factor	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)
Adj infilt rate	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)
	0.2664	0.2611	0.2559	0.2298	0.2246	0.1985	0.1985	0.1932	0.2089	0.2246	0.2350	0.2455 (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	0.5355	0.5341	0.5327	0.5264	0.5252	0.5197	0.5197	0.5187	0.5218	0.5252	0.5276	0.5301 (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			4.3200	1.0000	4.3200			(26)
Window (Uw = 1.20)			61.3800	1.1450	70.2824			(27)
Lantern			8.4000	1.5918	13.3708			(27a)
RL			2.4000	1.5038	3.6090			(27a)
RL			4.0000	1.5038	6.0150			(27a)
GF			166.5000	0.1100	18.3150	9.0000	1498.5000	(28a)
Main	327.7600	65.7000	262.0600	0.1800	47.1708	110.0000	28826.6000	(29a)
Dwarf	55.2800		55.2800	0.1200	6.6336	110.0000	6080.8000	(29a)
PIR	97.1800	4.0000	93.1800	0.1300	12.1134	9.0000	838.6200	(30)
PIJ	50.8700	2.4000	48.4700	0.0952	4.6162	9.0000	436.2300	(30)
Flat	48.6100	8.4000	40.2100	0.1300	5.2273	9.0000	361.8900	(30)
Total net area of external elements Aum(A, m2)			746.2000					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		191.6736			(33)
Internal Wall 1			215.3300			75.0000	16149.7500	(32c)
Internal Wall 2			85.4000			9.0000	768.6000	(32c)
Internal Floor 1			117.8900			18.0000	2122.0200	(32d)
Internal Floor 2			67.0200			18.0000	1206.3600	(32d)
Internal Ceiling 1			117.8900			9.0000	1061.0100	(32e)
Internal Ceiling 2			67.0200			9.0000	603.1800	(32e)
Heat capacity Cm = Sum(A x k)				(28)...(30) + (32) + (32a)...(32e) =		59953.5600		(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K						170.6086		(35)
List of Thermal Bridges								
K1 Element				Length	Psi-value		Total	
E2 Other lintels (including other steel lintels)				35.3500	0.0500		1.7675	
E3 Sill				35.3500	0.0500		1.7675	
E4 Jamb				91.3000	0.0500		4.5650	
E5 Ground floor (normal)				56.6000	0.1000		5.6600	
E16 Corner (normal)				67.8500	0.0600		4.0710	
E17 Corner (inverted - internal area greater than external area)				38.4500	-0.0900		-3.4605	
E6 Intermediate floor within a dwelling				95.6000	0.0020		0.1912	
E10 Eaves (insulation at ceiling level)				37.0500	0.0600		2.2230	
E13 Gable (insulation at rafter level)				15.4400	0.0800		1.2352	
E15 Flat roof with parapet				22.7000	0.3000		6.8100	

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R6 Flat ceiling									37.0500	0.1200	4.4460		
E24 Eaves (insulation at ceiling level - inverted)									37.0500	0.1500	5.5575		
R1 Head of roof window									13.1000	0.2400	3.1440		
R2 Sill of roof window									13.1000	0.2400	3.1440		
R3 Jamb of roof window									18.4000	0.2400	4.4160		
R11 Upstands or kerbs of rooflights									19.6000	0.2400	4.7040		
Thermal bridges (Sum(L x Psi) calculated using Appendix K)											50.2414	(36)	
Point Thermal bridges											0.0000		
Total fabric heat loss										(33) + (36) + (36a) =	241.9150	(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	154.3840	153.9869	153.5975	151.7690	151.4269	149.8343	149.8343	149.5393	150.4477	151.4269	152.1190	152.8425	(38)
Average = Sum(39)m / 12 =	396.2990	395.9018	395.5125	393.6840	393.3418	391.7492	391.7492	391.4543	392.3627	393.3418	394.0340	394.7575	(39)
												393.6823	
HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP (average)	1.1277	1.1266	1.1255	1.1203	1.1193	1.1148	1.1148	1.1140	1.1165	1.1193	1.1213	1.1234	(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												3.1988	(42)
Hot water usage for mixer showers												0.0000	(42a)
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Hot water usage for baths												33.6024	(42b)
	33.6024	33.1034	32.4006	31.1049	30.1346	29.0588	28.4776	29.1755	29.9353	31.0865	32.4089	33.4888	
Hot water usage for other uses												47.3885	(42c)
	47.3885	45.6653	43.9421	42.2189	40.4957	38.7724	38.7724	40.4957	42.2189	43.9421	45.6653	47.3885	
Average daily hot water use (litres/day)												74.2352	(43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	80.9909	78.7687	76.3427	73.3237	70.6303	67.8312	67.2501	69.6711	72.1542	75.0286	78.0742	80.8773	(44)
Energy conte	128.2699	112.1655	117.3359	100.3765	95.0819	83.4064	81.3331	86.2674	88.9733	101.8131	111.2311	126.6344	(45)
Energy content (annual)										Total = Sum(45)m =		1232.8884	
Distribution loss (46)m = 0.15 x (45)m												0.0000	(46)
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Water storage loss:												0.0000	(46)
Total storage loss												0.0000	(56)
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
If cylinder contains dedicated solar storage												0.0000	(57)
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
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												107.6392	(62)
	109.0294	95.3407	99.7355	85.3200	80.8196	70.8954	69.1332	73.3273	75.6273	86.5411	94.5464	107.6392	
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	109.0294	95.3407	99.7355	85.3200	80.8196	70.8954	69.1332	73.3273	75.6273	86.5411	94.5464	107.6392	(64)
												1047.9552	(64)
12Total per year (kWh/year)												1048	(64)
Electric shower(s)												62.3470	(64a)
	62.3470	55.5517	60.6603	57.8874	58.9736	56.2551	58.1303	58.9736	57.8874	60.6603	59.5197	62.3470	(64a)
Heat gains from water heating, kWh/month												709.1935	(64a)
	42.8441	37.7231	40.0990	35.8019	34.9483	31.7876	31.8159	33.0752	33.3787	36.8004	38.5165	42.4966	(65)

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

Metabolic gains (Table 5), Watts													
(66)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	251.4859	278.4308	251.4859	259.8688	251.4859	259.8688	251.4859	251.4859	259.8688	251.4859	259.8688	251.4859	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	498.6787	503.8534	490.8133	463.0523	428.0092	395.0736	373.0705	367.8958	380.9359	408.6968	443.7400	476.6756	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	(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)													
	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	(71)
Water heating gains (Table 5)													
	57.5861	56.1356	53.8964	49.7248	46.9735	44.1495	42.7633	44.4560	46.3593	49.4629	53.4952	57.1190	(72)
Total internal gains													
	878.7322	909.4013	867.1771	843.6274	797.4501	770.0733	738.3012	734.8191	758.1455	780.6271	828.0854	856.2620	(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	36.9900								0.7000		0.7700	85.0329	(75)
Southeast	5.8800								0.4200		0.7000	44.0791	(77)
Southwest	16.7300								0.4200		0.7000	125.4156	(79)
Northwest	1.7800								0.4200		0.7000	4.0919	(81)
East	8.4000								0.6300		1.0000	86.6830	(82)
Northeast	2.4000								0.6300		1.0000	15.5902	(82)
Southwest	4.0000								0.6300		1.0000	63.4645	(82)

Solar gains	424.3572	798.9105	1279.1127	1870.4321	2336.6916	2421.0189	2292.3690	1932.3963	1483.7409	934.6700	522.5250	353.7344	(83)
Total gains	1303.0894	1708.3118	2146.2898	2714.0595	3134.1417	3191.0922	3030.6701	2667.2155	2241.8864	1715.2971	1350.6104	1209.9965	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000 (85)	
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	42.0232	42.0654	42.1068	42.3024	42.3392	42.5113	42.5113	42.5433	42.4448	42.3392	42.2648	42.1873	
alpha	3.8015	3.8044	3.8071	3.8202	3.8226	3.8341	3.8341	3.8362	3.8297	3.8226	3.8177	3.8125	
util living area	0.9983	0.9951	0.9850	0.9463	0.8491	0.6887	0.5386	0.6180	0.8604	0.9787	0.9964	0.9988 (86)	
MIT	18.8225	19.0854	19.5164	20.0993	20.5909	20.8728	20.9625	20.9374	20.6803	20.0102	19.3055	18.7766 (87)	
Th 2	19.9782	19.9792	19.9801	19.9843	19.9851	19.9888	19.9888	19.9895	19.9873	19.9851	19.9835	19.9818 (88)	
util rest of house	0.9979	0.9939	0.9811	0.9314	0.8078	0.6084	0.4274	0.5045	0.8046	0.9707	0.9953	0.9984 (89)	
MIT 2	17.9663	18.2292	18.6583	19.2312	19.6867	19.9191	19.9756	19.9650	19.7795	19.1535	18.4526	17.9231 (90)	
Living area fraction									fLA = Living area / (4) =				0.0664 (91)
MIT	18.0231	18.2860	18.7152	19.2888	19.7467	19.9824	20.0411	20.0295	19.8393	19.2103	18.5092	17.9797 (92)	
Temperature adjustment												0.0000	
adjusted MIT	18.0231	18.2860	18.7152	19.2888	19.7467	19.9824	20.0411	20.0295	19.8393	19.2103	18.5092	17.9797 (93)	

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9967	0.9908	0.9742	0.9185	0.7965	0.6079	0.4335	0.5094	0.7947	0.9619	0.9929	0.9975 (94)
Useful gains	1298.7483	1692.6455	2090.8376	2492.8034	2496.4151	1939.7130	1313.8477	1358.5603	1781.6448	1649.9978	1340.9969	1206.9409 (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	5438.4672	5299.5515	4831.2750	4089.8912	3165.1148	2108.5508	1348.0393	1420.7872	2251.8930	3386.8016	4495.6285	5439.6389 (97)
Space heating kWh	3079.9509	2423.8408	2038.8855	1149.9033	497.5126	0.0000	0.0000	0.0000	0.0000	1292.1820	2271.3348	3149.1273 (98a)
Space heating requirement - total per year (kWh/year)												15902.7371
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	3079.9509	2423.8408	2038.8855	1149.9033	497.5126	0.0000	0.0000	0.0000	0.0000	1292.1820	2271.3348	3149.1273 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												15902.7371
Space heating per m2										(98c) / (4) =		45.2541 (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	3682.4428	2898.9443	2975.0527	0.0000	0.0000	0.0000	0.0000 (100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.7628	0.8355	0.7768	0.0000	0.0000	0.0000	0.0000 (101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	2809.1184	2422.2020	2310.9141	0.0000	0.0000	0.0000	0.0000 (102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	3419.9640	3247.1818	2856.2668	0.0000	0.0000	0.0000	0.0000 (103)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	439.8088	613.7850	405.7424	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	109.9522	153.4462	101.4356	0.0000	0.0000	0.0000	0.0000 (107)
Space cooling requirement												364.8341 (107)
Energy for space heating												45.2541 (99)
Energy for space cooling												1.0382 (108)
Total												46.2923 (109)
Fabric Energy Efficiency (DFEE)												46.3 (109)

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)

CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY

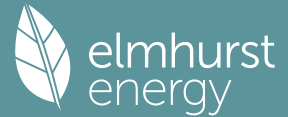
1. Overall dwelling characteristics

	Area (m2)	Storey height (m)	Volume (m3)
Ground floor	166.5000 (1b)	x 2.4500 (2b)	= 407.9250 (1b) - (3b)
First floor	117.8900 (1c)	x 2.7000 (2c)	= 318.3030 (1c) - (3c)
Second floor	67.0200 (1d)	x 2.2000 (2d)	= 147.4440 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	351.4100		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =	873.6720 (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)

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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) =
Pressure Test
Pressure Test Method
Measured/design AP50
Infiltration rate
Number of sides sheltered

Air changes per hour
40.0000 / (5) = 0.0458 (8)
Yes
Blower Door
5.0000 (17)
0.2958 (18)
2 (19)

Shelter factor (20) = 1 - [0.075 x (19)] = 0.8500 (20)
Infiltration rate adjusted to include shelter factor (21) = (18) x (20) = 0.2514 (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	0.3206	0.3143	0.3080	0.2766	0.2703	0.2388	0.2388	0.2326	0.2514	0.2703	0.2828	0.2954 (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	0.5514	0.5494	0.5474	0.5382	0.5365	0.5285	0.5285	0.5270	0.5316	0.5365	0.5400	0.5436 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K
TER Opaque door			4.3200	1.0000	4.3200		(26)
TER Opening Type (Uw = 1.20)			61.3800	1.1450	70.2824		(27)
RL			2.4000	1.8519	4.4444		(27a)
RL			4.0000	1.8519	7.4074		(27a)
Lantern			8.4000	2.0221	16.9853		(27a)
GF			166.5000	0.1300	21.6450		(28a)
Main	327.7600	65.7000	262.0600	0.1800	47.1708		(29a)
Dwarf	55.2800		55.2800	0.1800	9.9504		(29a)
PIR	97.1800	4.0000	93.1800	0.1100	10.2498		(30)
PIJ	50.8700	2.4000	48.4700	0.1100	5.3317		(30)
Flat	48.6100	8.4000	40.2100	0.1100	4.4231		(30)
Total net area of external elements Aum(A, m2)			746.2000				(31)
Fabric heat loss, W/K = Sum (A x U)					202.2104		(33)
					(26)...(30) + (32) =		170.6086 (35)

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

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element	35.3500	0.0500	1.7675
E2 Other lintels (including other steel lintels)	35.3500	0.0500	1.7675
E3 Sill	91.3000	0.0500	4.5650
E4 Jamb	56.6000	0.1600	9.0560
E5 Ground floor (normal)	67.8500	0.0900	6.1065
E16 Corner (normal)	38.4500	-0.0900	-3.4605
E6 Intermediate floor within a dwelling	95.6000	0.0000	0.0000
E10 Eaves (insulation at ceiling level)	37.0500	0.0600	2.2230
E13 Gable (insulation at rafter level)	15.4400	0.0800	1.2352
E15 Flat roof with parapet	22.7000	0.5600	12.7120
R6 Flat ceiling	37.0500	0.0600	2.2230
E24 Eaves (insulation at ceiling level - inverted)	37.0500	0.2400	8.8920
R1 Head of roof window	13.1000	0.0800	1.0480
R2 Sill of roof window	13.1000	0.0600	0.7860
R3 Jamb of roof window	18.4000	0.0800	1.4720
R11 Upstands or kerbs of rooflights	19.6000	0.0800	1.5680

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

Point Thermal Bridges

Total fabric heat loss

(36a) = 51.9612 (36)
(33) + (36) + (36a) = 254.1716 (37)

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

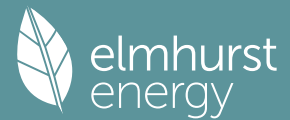
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m	158.9688	158.3936	157.8297	155.1815	154.6861	152.3796	152.3796	151.9524	153.2680	154.6861	155.6884	156.7363 (38)
Heat transfer coeff	413.1403	412.5651	412.0013	409.3531	408.8576	406.5511	406.5511	406.1240	407.4396	408.8576	409.8600	410.9079 (39)
Average = Sum(39)m / 12 =												409.3507

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP	1.1757	1.1740	1.1724	1.1649	1.1635	1.1569	1.1569	1.1557	1.1594	1.1635	1.1663	1.1693 (40)
HLP (average)												1.1649
Days in month	31	28	31	30	31	30	31	31	30	31	30	31

4. Water heating energy requirements (kWh/year)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Assumed occupancy												3.1988 (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	33.6024	33.1034	32.4006	31.1049	30.1346	29.0588	28.4776	29.1755	29.9353	31.0865	32.4089	33.4888 (42b)
Hot water usage for other uses	47.3885	45.6653	43.9421	42.2189	40.4957	38.7724	38.7724	40.4957	42.2189	43.9421	45.6653	47.3885 (42c)
Average daily hot water use (litres/day)												74.2352 (43)
Daily hot water use	80.9909	78.7687	76.3427	73.3237	70.6303	67.8312	67.2501	69.6711	72.1542	75.0286	78.0742	80.8773 (44)
Energy conte	128.2699	112.1655	117.3359	100.3765	95.0819	83.4064	81.3331	86.2674	88.9733	101.8131	111.2311	126.6344 (45)
Energy content (annual)										Total = Sum(45)m =		1232.8884
Distribution loss (46)m = 0.15 x (45)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (46)
Water storage loss:												
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (61)
Total heat required for water heating calculated for each month	109.0294	95.3407	99.7355	85.3200	80.8196	70.8954	69.1332	73.3273	75.6273	86.5411	94.5464	107.6392 (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)

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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	109.0294	95.3407	99.7355	85.3200	80.8196	70.8954	69.1332	73.3273	75.6273	86.5411	94.5464	107.6392	(64)
12Total per year (kWh/year)	Total per year (kWh/year) = Sum(64)m =											1047.9552	(64)
Electric shower(s)	62.3470	55.5517	60.6603	57.8874	58.9736	56.2551	58.1303	58.9736	57.8874	60.6603	59.5197	62.3470	(64a)
	Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =											709.1935	(64a)
Heat gains from water heating, kWh/month	42.8441	37.7231	40.0990	35.8019	34.9483	31.7876	31.8159	33.0752	33.3787	36.8004	38.5165	42.4966	(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	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	159.9381	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	251.4859	278.4308	251.4859	259.8688	251.4859	259.8688	251.4859	251.4859	259.8688	251.4859	259.8688	251.4859	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	498.6787	503.8534	490.8133	463.0523	428.0092	395.0736	373.0705	367.8958	380.9359	408.6968	443.7400	476.6756	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	38.9938	(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)	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	(71)
Water heating gains (Table 5)	57.5861	56.1356	53.8964	49.7248	46.9735	44.1495	42.7633	44.4560	46.3593	49.4629	53.4952	57.1190	(72)
Total internal gains	878.7322	909.4013	867.1771	843.6274	797.4501	770.0733	738.3012	734.8191	758.1455	780.6271	828.0854	856.2620	(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				36.9900	11.2829	0.6300	0.7000	0.7700	127.5494 (75)			
Southeast				5.8800	36.7938	0.6300	0.7000	0.7700	66.1187 (77)			
Southwest				16.7300	36.7938	0.6300	0.7000	0.7700	188.1234 (79)			
Northwest				1.7800	11.2829	0.6300	0.7000	0.7700	6.1378 (81)			
Northeast				2.4000	16.3666	0.6300	0.7000	1.0000	15.5902 (82)			
East				8.4000	26.0000	0.6300	0.7000	1.0000	86.6830 (82)			
Southwest				4.0000	39.9751	0.6300	0.7000	1.0000	63.4645 (82)			
Solar gains	553.6669	1033.9747	1640.0541	2383.5562	2971.5839	3077.7783	2914.5444	2459.6821	1896.7456	1205.0667	680.1038	462.6524 (83)
Total gains	1432.3991	1943.3760	2507.2312	3227.1836	3769.0340	3847.8516	3652.8455	3194.5013	2654.8911	1985.6938	1508.1892	1318.9145 (84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)													21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	40.3102	40.3664	40.4216	40.6831	40.7324	40.9635	40.9635	41.0066	40.8742	40.7324	40.6328	40.5292	
alpha	3.6873	3.6911	3.6948	3.7122	3.7155	3.7309	3.7309	3.7338	3.7249	3.7155	3.7089	3.7019	
util living area	0.9976	0.9924	0.9761	0.9181	0.7914	0.6159	0.4717	0.5492	0.8103	0.9676	0.9947	0.9982	(86)
MIT	18.7857	19.0913	19.5714	20.1923	20.6673	20.9056	20.9732	20.9538	20.7318	20.0538	19.2974	18.7352	(87)
Th 2	19.9395	19.9408	19.9421	19.9482	19.9493	19.9546	19.9546	19.9526	19.9493	19.9493	19.9470	19.9446	(88)
util rest of house	0.9970	0.9905	0.9700	0.8972	0.7422	0.5343	0.3674	0.4390	0.7441	0.9558	0.9931	0.9978	(89)
MIT 2	17.9022	18.2076	18.6838	19.2878	19.7157	19.9054	19.9457	19.9386	19.7864	19.1680	18.4185	17.8554	(90)
Living area fraction	17.9608	18.2662	18.7427	19.3479	19.7788	19.9718	20.0139	20.0060	19.8491	19.2268	18.4768	17.9138	(91)
MIT	17.9608	18.2662	18.7427	19.3479	19.7788	19.9718	20.0139	20.0060	19.8491	19.2268	18.4768	17.9138	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.9608	18.2662	18.7427	19.3479	19.7788	19.9718	20.0139	20.0060	19.8491	19.2268	18.4768	17.9138	(93)

8. Space heating requirement

Utilisation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Useful gains	0.9952	0.9861	0.9605	0.8826	0.7331	0.5357	0.3735	0.4446	0.7365	0.9446	0.9897	0.9965	(94)
Ext temp.	1425.5794	1916.3820	2408.2258	2848.2022	2763.2556	2061.3623	1364.4204	1420.2574	1955.2060	1875.7185	1492.6002	1314.2358	(95)
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	(96)
Space heating kWh	5643.8381	5514.4263	5044.0245	4276.8644	3303.0812	2183.8990	1387.9338	1464.4737	2342.4191	3527.1320	4662.9026	5635.0944	(97)
Space heating requirement - total per year (kWh/year)	3138.3845	2417.8857	1961.0343	1028.6368	401.6302	0.0000	0.0000	0.0000	0.0000	1228.6516	2282.6177	3214.7188	(98a)
Solar heating kWh												15673.5596	
Solar heating contribution - total per year (kWh/year)	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)
Space heating kWh	3138.3845	2417.8857	1961.0343	1028.6368	401.6302	0.0000	0.0000	0.0000	0.0000	1228.6516	2282.6177	3214.7188	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												15673.5596	
Space heating per m ²	(98c) / (4) =												44.6019 (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													

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Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	3821.5808	3008.4785	3086.5425	0.0000	0.0000	0.0000	0.0000	(100)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.8231	0.8825	0.8326	0.0000	0.0000	0.0000	0.0000	(101)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	3145.5492	2655.0769	2569.7060	0.0000	0.0000	0.0000	0.0000	(102)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	4187.6048	3974.3998	3472.5749	0.0000	0.0000	0.0000	0.0000	(103)
Cooled fraction	0.0000	0.0000	0.0000	0.0000	0.0000	750.2800	981.5763	671.7345	0.0000	0.0000	0.0000	0.0000	(104)
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	(105)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	187.5700	245.3941	167.9336	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling requirement												600.8977	(107)
Energy for space heating												44.6019	(99)
Energy for space cooling												1.7100	(108)
Total												46.3119	(109)
Fabric Energy Efficiency (TFEE)												46.3	(109)

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

1. Overall dwelling characteristics

	Area (m ²)	Storey height (m)	Volume (m ³)
Ground floor	166.5000 (1b)	x 2.4500 (2b)	= 407.9250 (1b) - (3b)
First floor	117.8900 (1c)	x 2.7000 (2c)	= 318.3030 (1c) - (3c)
Second floor	67.0200 (1d)	x 2.2000 (2d)	= 147.4440 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	351.4100		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 873.6720 (5)

2. Ventilation rate

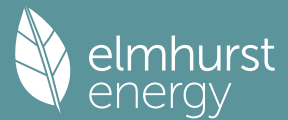
	m ³ per hour
Number of open chimneys	0 * 80 = 0.0000 (6a)
Number of open flues	0 * 20 = 0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 = 0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 = 0.0000 (6d)
Number of flues attached to other heater	0 * 35 = 0.0000 (6e)
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)

	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
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
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
Mechanical extract ventilation - decentralised												0.5000
If mechanical ventilation												0.5000
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)												0.5000
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

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			4.3200	1.0000	4.3200		(26)
Window (Uw = 1.20)			61.3800	1.1450	70.2824		(27)
Lantern			8.4000	1.5918	13.3708		(27a)
RL			2.4000	1.5038	3.6090		(27a)
RL			4.0000	1.5038	6.0150		(27a)
GF			166.5000	0.1100	18.3150	9.0000	1498.5000
Main	327.7600	65.7000	262.0600	0.1800	47.1708	110.0000	28826.6000
Dwarf	55.2800		55.2800	0.1200	6.6336	110.0000	6080.8000
PIR	97.1800	4.0000	93.1800	0.1300	12.1134	9.0000	838.6200
PIJ	50.8700	2.4000	48.4700	0.0952	4.6162	9.0000	436.2300
Flat	48.6100	8.4000	40.2100	0.1300	5.2273	9.0000	361.8900
Total net area of external elements Aum(A, m ²)			746.2000				(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	191.6736		(33)
Internal Wall 1			215.3300			75.0000	16149.7500
Internal Wall 2			85.4000			9.0000	768.6000
Internal Floor 1			117.8900			18.0000	2122.0200
Internal Floor 2			67.0200			18.0000	1206.3600
Internal Ceiling 1			117.8900			9.0000	1061.0100
Internal Ceiling 2			67.0200			9.0000	603.1800
Heat capacity Cm = Sum(A x k)						(28)...(30) + (32) + (32a)...(32e) =	59953.5600

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

170.6086 (35)

List of Thermal Bridges

	Length	Psi-value	Total
K1 Element	35.3500	0.0500	1.7675
E2 Other lintels (including other steel lintels)	35.3500	0.0500	1.7675
E3 Sill	91.3000	0.0500	4.5650
E4 Jamb	56.6000	0.1000	5.6600
E5 Ground floor (normal)	67.8500	0.0600	4.0710
E16 Corner (normal)	38.4500	-0.0900	-3.4605
E17 Corner (inverted - internal area greater than external area)	95.6000	0.0020	0.1912
E6 Intermediate floor within a dwelling	37.0500	0.0600	2.2230
E10 Eaves (insulation at ceiling level)	15.4400	0.0800	1.2352
E13 Gable (insulation at rafter level)	22.7000	0.3000	6.8100
E15 Flat roof with parapet	37.0500	0.1200	4.4460
R6 Flat ceiling	37.0500	0.1500	5.5575
E24 Eaves (insulation at ceiling level - inverted)	13.1000	0.2400	3.1440
R1 Head of roof window	13.1000	0.2400	3.1440
R2 Sill of roof window	18.4000	0.2400	4.4160
R3 Jamb of roof window	19.6000	0.2400	4.7040
R11 Upstands or kerbs of rooflights			

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

50.2414 (36)

Point Thermal bridges

(36a) = 0.0000

Total fabric heat loss

(33) + (36) + (36a) = 241.9150 (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	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	(38)
Heat transfer coeff	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	(39)
Average = Sum(39)m / 12 =													386.0709

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	(40)
HLP (average)													1.0986
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy

3.1988 (42)

Hot water usage for mixer showers

107.0474 105.4387 103.0945 98.6093 95.2993 91.6080 89.5099 91.8364 94.3866 98.3499 102.9315 106.6373 (42a)

Hot water usage for baths

33.6024 33.1034 32.4006 31.1049 30.1346 29.0588 28.4776 29.1755 29.9353 31.0865 32.4089 33.4888 (42b)

Hot water usage for other uses

47.3885 45.6653 43.9421 42.2189 40.4957 38.7724 38.7724 40.4957 42.2189 43.9421 45.6653 47.3885 (42c)

Average daily hot water use (litres/day)

172.9293 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	188.0383	184.2074	179.4372	171.9330	165.9295	159.4392	156.7600	161.5075	166.5408	173.3785	181.0057	187.5146	(44)
Energy conte	297.8068	262.3088	275.7883	235.3677	223.3730	196.0491	189.5876	199.9800	205.3614	235.2730	257.8758	293.6026	(45)
Energy content (annual)													
Distribution loss (46)m = 0.15 x (45)m													
44.6710 39.3463 41.3682 35.3051 33.5060 29.4074 28.4381 29.9970 30.8042 35.2909 38.6814 44.0404 (46)													

Water storage loss:

Store volume

300.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day):

Temperature factor from Table 2b

Enter (49) or (54) in (55)

0.5900 (48)

0.5400 (49)

0.8586 (55)

Total storage loss

26.6166 24.0408 26.6166 25.7580 26.6166 25.7580 26.6166 26.6166 25.7580 26.6166 25.7580 26.6166 (56)

If cylinder contains dedicated solar storage

26.6166 24.0408 26.6166 25.7580 26.6166 25.7580 26.6166 26.6166 25.7580 26.6166 25.7580 26.6166 (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

347.6858 307.3608 325.6673 283.6377 273.2520 244.3191 239.4666 249.8590 253.6314 285.1520 306.1458 343.4816 (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

347.6858 307.3608 325.6673 283.6377 273.2520 244.3191 239.4666 249.8590 253.6314 285.1520 306.1458 343.4816 (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

138.9240 123.2593 131.6028 116.8757 114.1747 103.8023 102.9411 106.3966 106.8987 118.1315 124.3597 137.5261 (65)

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

Metabolic gains (Table 5), Watts

(66)m 191.9258 191.9258 191.9258 191.9258 191.9258 191.9258 191.9258 191.9258 191.9258 191.9258 191.9258 191.9258 (66)

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

59.5442 52.8866 43.0103 32.5615 24.3401 20.5490 22.2039 28.8614 38.7378 49.1865 57.4079 61.1991 (67)

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

744.2965 752.0200 732.5571 691.1229 638.8197 589.6620 556.8217 549.0982 568.5611 609.9953 662.2985 711.4562 (68)

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

57.3913 57.3913 57.3913 57.3913 57.3913 57.3913 57.3913 57.3913 57.3913 57.3913 57.3913 57.3913 (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)

-127.9505 -127.9505 -127.9505 -127.9505 -127.9505 -127.9505 -127.9505 -127.9505 -127.9505 -127.9505 -127.9505 -127.9505 (71)

Water heating gains (Table 5)

186.7257 183.4216 176.8855 162.3274 153.4607 144.1699 138.3617 143.0061 148.4704 158.7788 172.7218 184.8468 (72)

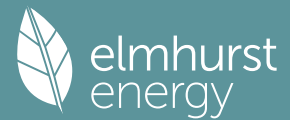
Total internal gains

1111.9330 1109.6947 1073.8194 1007.3785 937.9871 875.7475 838.7538 842.3324 877.1359 939.3272 1013.7948 1078.8687 (73)

6. Solar gains

[Jan] Area Solar flux g FF Access Gains

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	m2	Table 6a W/m2	Specific data or Table 6b	Specific data or Table 6c	factor Table 6d	W
Northeast	36.9900	11.2829	0.4200	0.7000	0.7700	85.0329 (75)
Southeast	5.8800	36.7938	0.4200	0.7000	0.7700	44.0791 (77)
Southwest	16.7300	36.7938	0.4200	0.7000	0.7700	125.4156 (79)
Northwest	1.7800	11.2829	0.4200	0.7000	0.7700	4.0919 (81)
East	8.4000	26.0000	0.6300	0.7000	1.0000	86.6830 (82)
Northeast	2.4000	16.3666	0.6300	0.7000	1.0000	15.5902 (82)
Southwest	4.0000	39.9751	0.6300	0.7000	1.0000	63.4645 (82)

Solar gains	424.3572	798.9105	1279.1127	1870.4321	2336.6916	2421.0189	2292.3690	1932.3963	1483.7409	934.6700	522.5250	353.7344 (83)
Total gains	1536.2902	1908.6053	2352.9322	2877.8106	3274.6787	3296.7664	3131.1228	2774.7287	2360.8768	1873.9972	1536.3198	1432.6031 (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	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366
alpha	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758
util living area	0.9971	0.9928	0.9796	0.9352	0.8298	0.6681	0.5181	0.5939	0.8399	0.9715	0.9944	0.9978 (86)
Living	19.3998	19.5838	19.9017	20.3078	20.6503	20.8374	20.8967	20.8808	20.7097	20.2415	19.7329	19.3562
Non living	18.1011	18.3363	18.7406	19.2472	19.6496	19.8420	19.8892	19.8802	19.7268	19.1739	18.5280	18.0453
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	20.1814	19.5838	19.9017	20.3078	20.6503	20.8374	20.8967	20.8808	20.7097	20.2415	19.7329	19.5861 (87)
Th 2	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019 (88)
util rest of house	0.9963	0.9911	0.9743	0.9181	0.7863	0.5885	0.4109	0.4834	0.7806	0.9611	0.9927	0.9972 (89)
MIT 2	19.2441	18.3363	18.7406	19.2472	19.6496	19.8420	19.8892	19.8802	19.7268	19.1739	18.5280	18.3979 (90)
Living area fraction									fLA = Living area / (4) =			0.0664 (91)
MIT	19.3063	18.4191	18.8177	19.3176	19.7160	19.9081	19.9561	19.9466	19.7920	19.2448	18.6080	18.4767 (92)
Temperature adjustment												0.0000
adjusted MIT	19.3063	18.4191	18.8177	19.3176	19.7160	19.9081	19.9561	19.9466	19.7920	19.2448	18.6080	18.4767 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9957	0.9871	0.9659	0.9034	0.7719	0.5803	0.4058	0.4768	0.7655	0.9502	0.9893	0.9960 (94)
Useful gains	1529.6974	1883.8917	2272.5813	2599.7386	2527.5874	1913.0664	1270.4836	1322.8543	1807.2010	1780.6445	1519.8301	1426.8747 (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	5793.5111	5219.3270	4755.5030	4021.9249	3094.7434	2049.2981	1295.6747	1369.2332	2197.5332	3337.4947	4442.8863	5511.8204 (97)
Space heating kWh	3172.2774	2241.4126	1847.2937	1023.9741	421.9641	0.0000	0.0000	0.0000	0.0000	1158.2965	2104.6004	3039.1996 (98a)
Space heating requirement - total per year (kWh/year)												15009.0185
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	3172.2774	2241.4126	1847.2937	1023.9741	421.9641	0.0000	0.0000	0.0000	0.0000	1158.2965	2104.6004	3039.1996 (98c)
Space heating requirement after solar contribution - total per year (kWh/year)												15009.0185
Space heating per m2										(98c) / (4) =		42.7108 (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 %)												316.5531 (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	3172.2774	2241.4126	1847.2937	1023.9741	421.9641	0.0000	0.0000	0.0000	0.0000	1158.2965	2104.6004	3039.1996 (98)
Space heating efficiency (main heating system 1)	316.5531	316.5531	316.5531	316.5531	316.5531	0.0000	0.0000	0.0000	0.0000	316.5531	316.5531	316.5531 (210)
Space heating fuel (main heating system)	1002.1312	708.0684	583.5652	323.4763	133.2996	0.0000	0.0000	0.0000	0.0000	365.9091	664.8491	960.0916 (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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816 (64)
Efficiency of water heater	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597 (216)
Fuel for water heating, kWh/month	115.7565	102.3309	108.4258	94.4327	90.9749	81.3422	79.7266	83.1866	84.4426	94.9368	101.9264	114.3567 (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	13.5414	12.2309	13.5414	13.1046	13.5414	13.1046	13.5414	13.5414	13.1046	13.5414	13.1046	13.5414 (231)
Lighting	52.1186	41.8115	37.6466	27.5815	21.3048	17.4062	19.4349	25.2623	32.8132	43.0527	48.6279	53.5672 (232)
Electricity generated by PVs (Appendix M) (negative quantity)												
(233a)m	-75.5012	-112.6425	-169.1651	-192.0832	-200.2248	-173.7313	-171.3413	-159.8923	-139.7496	-127.7704	-84.2100	-64.2713 (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	-19.6716	-45.3754	-97.7503	-162.2987	-234.5827	-252.4953	-249.7864	-210.0735	-152.5284	-73.6436	-28.5231	-15.4759 (233b)

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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														4741.3904	(211)
Space heating fuel - main system 2														0.0000	(213)
Space heating fuel - secondary														0.0000	(215)
Efficiency of water heater														300.3597	
Water heating fuel used														1151.8386	(219)
Space cooling fuel														0.0000	(221)

Electricity for pumps and fans:															
(MEVDecentralised, Database: total watage = 11.5180, total flow = 77.0000, SFP = 0.1496)															
mechanical ventilation fans (SFP = 0.1496)														159.4390	(230a)
Total electricity for the above, kWh/year														159.4390	(231)
Electricity for lighting (calculated in Appendix L)														420.6273	(232)

Energy saving/generation technologies (Appendices M ,N and Q)															
PV generation														-3212.7879	(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														3260.5075	(238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year
Space heating - main system 1	4741.3904	16.4900	781.8553 (240)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	1151.8386	16.4900	189.9382 (247)
Energy for instantaneous electric shower(s)	0.0000	16.4900	0.0000 (247a)
Pumps, fans and electric keep-hot	159.4390	16.4900	26.2915 (249)
Energy for lighting	420.6273	16.4900	69.3614 (250)
Additional standing charges			0.0000 (251)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-1670.5829	16.4900	-275.4791
PV Unit electricity exported	-1542.2049	5.5900	-86.2093
Total			-361.6884 (252)
Total energy cost			705.7580 (255)

11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12):		0.3600 (256)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	0.6409 (257)
SAP value		89.6105
SAP rating (Section 12)		90 (258)
SAP band		B

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

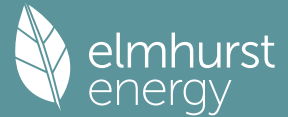
	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating - main system 1	4741.3904	0.1553	736.4272 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	1151.8386	0.1411	162.5150 (264)
Space and water heating			898.9422 (265)
Pumps, fans and electric keep-hot	159.4390	0.1387	22.1162 (267)
Energy for lighting	420.6273	0.1443	60.7095 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-1670.5829	0.1350	-225.5021
PV Unit electricity exported	-1542.2049	0.1224	-188.7679
Total			-414.2700 (269)
Total CO2, kg/year			567.4979 (272)
CO2 emissions per m2			1.6100 (273)
EI value			98.0817
EI rating			98 (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	166.5000 (1b)	x 2.4500 (2b)	= 407.9250 (1b) - (3b)
First floor	117.8900 (1c)	x 2.7000 (2c)	= 318.3030 (1c) - (3c)
Second floor	67.0200 (1d)	x 2.2000 (2d)	= 147.4440 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	351.4100		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =	873.6720 (5)

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2. Ventilation rate

											m3 per hour		
Number of open chimneys												0 * 80 =	0.0000 (6a)
Number of open flues												0 * 20 =	0.0000 (6b)
Number of chimneys / flues attached to closed fire												0 * 10 =	0.0000 (6c)
Number of flues attached to solid fuel boiler												0 * 20 =	0.0000 (6d)
Number of flues attached to other heater												0 * 35 =	0.0000 (6e)
Number of blocked chimneys												0 * 20 =	0.0000 (6f)
Number of intermittent extract fans												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	4.6000	4.6000	4.6000	4.2000	4.3000	3.8000	3.7000	3.7000	3.7000	4.2000	4.1000	4.4000 (22)	
Wind factor	1.1500	1.1500	1.1500	1.0500	1.0750	0.9500	0.9250	0.9250	0.9250	1.0500	1.0250	1.1000 (22a)	
Adj infilt rate	0.1955	0.1955	0.1955	0.1785	0.1827	0.1615	0.1573	0.1573	0.1573	0.1785	0.1742	0.1870 (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

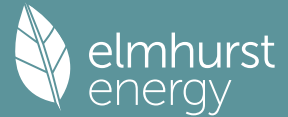
Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K
Door			4.3200	1.0000	4.3200		(26)
Window (Uw = 1.20)			61.3800	1.1450	70.2824		(27)
Lantern			8.4000	1.5918	13.3708		(27a)
RL			2.4000	1.5038	3.6090		(27a)
RL			4.0000	1.5038	6.0150		(27a)
GF			166.5000	0.1100	18.3150	9.0000	1498.5000 (28a)
Main	327.7600	65.7000	262.0600	0.1800	47.1708	110.0000	28826.6000 (29a)
Dwarf	55.2800		55.2800	0.1200	6.6336	110.0000	6080.8000 (29a)
PIR	97.1800	4.0000	93.1800	0.1300	12.1134	9.0000	838.6200 (30)
PIJ	50.8700	2.4000	48.4700	0.0952	4.6162	9.0000	436.2300 (30)
Flat	48.6100	8.4000	40.2100	0.1300	5.2273	9.0000	361.8900 (30)
Total net area of external elements Aum(A, m2)			746.2000				(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	191.6736		(33)
Internal Wall 1			215.3300			75.0000	16149.7500 (32c)
Internal Wall 2			85.4000			9.0000	768.6000 (32c)
Internal Floor 1			117.8900			18.0000	2122.0200 (32d)
Internal Floor 2			67.0200			18.0000	1206.3600 (32d)
Internal Ceiling 1			117.8900			9.0000	1061.0100 (32e)
Internal Ceiling 2			67.0200			9.0000	603.1800 (32e)
Heat capacity Cm = Sum(A x k)						(28)...(30) + (32) + (32a)...(32e) =	59953.5600 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							170.6086 (35)
List of Thermal Bridges							
K1 Element				Length	Psi-value	Total	
E2 Other lintels (including other steel lintels)				35.3500	0.0500	1.7675	
E3 Sill				35.3500	0.0500	1.7675	
E4 Jamb				91.3000	0.0500	4.5650	
E5 Ground floor (normal)				56.6000	0.1000	5.6600	
E16 Corner (normal)				67.8500	0.0600	4.0710	
E17 Corner (inverted - internal area greater than external area)				38.4500	-0.0900	-3.4605	
E6 Intermediate floor within a dwelling				95.6000	0.0020	0.1912	
E10 Eaves (insulation at ceiling level)				37.0500	0.0600	2.2230	
E13 Gable (insulation at rafter level)				15.4400	0.0800	1.2352	
E15 Flat roof with parapet				22.7000	0.3000	6.8100	
R6 Flat ceiling				37.0500	0.1200	4.4460	
E24 Eaves (insulation at ceiling level - inverted)				37.0500	0.1500	5.5575	
R1 Head of roof window				13.1000	0.2400	3.1440	
R2 Sill of roof window				13.1000	0.2400	3.1440	
R3 Jamb of roof window				18.4000	0.2400	4.4160	
R11 Upstands or kerbs of rooflights				19.6000	0.2400	4.7040	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)						50.2414	(36)
Point Thermal bridges						(36a) =	0.0000
Total fabric heat loss						(33) + (36) + (36a) =	241.9150 (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	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559	144.1559 (38)
Average = Sum(39)m / 12 =	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709	386.0709 (39)
HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP (average)	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986 (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	3.1988 (42)
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Hot water usage for mixer showers	107.0474	105.4387	103.0945	98.6093	95.2993	91.6080	89.5099	91.8364	94.3866	98.3499	102.9315	106.6373 (42a)
Hot water usage for baths	33.6024	33.1034	32.4006	31.1049	30.1346	29.0588	28.4776	29.1755	29.9353	31.0865	32.4089	33.4888 (42b)
Hot water usage for other uses	47.3885	45.6653	43.9421	42.2189	40.4957	38.7724	38.7724	40.4957	42.2189	43.9421	45.6653	47.3885 (42c)
Average daily hot water use (litres/day)												172.9293 (43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Energy content (annual)	188.0383	184.2074	179.4372	171.9330	165.9295	159.4392	156.7600	161.5075	166.5408	173.3785	181.0057	187.5146 (44)
Distribution loss (46)m = 0.15 x (45)m	297.8068	262.3088	275.7883	235.3677	223.3730	196.0491	189.5876	199.9800	205.3614	235.2730	257.8758	293.6026 (45)
Total storage loss	44.6710	39.3463	41.3682	35.3051	33.5060	29.4074	28.4381	29.9970	30.8042	35.2909	38.6814	44.0404 (46)
Water storage loss:												
Store volume												300.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):												1.5900 (48)
Temperature factor from Table 2b												0.5400 (49)
Enter (49) or (54) in (55)												0.8586 (55)
Total storage loss	26.6166	24.0408	26.6166	25.7580	26.6166	25.7580	26.6166	26.6166	25.7580	26.6166	25.7580	26.6166 (56)
If cylinder contains dedicated solar storage	26.6166	24.0408	26.6166	25.7580	26.6166	25.7580	26.6166	26.6166	25.7580	26.6166	25.7580	26.6166 (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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816 (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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816 (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	138.9240	123.2593	131.6028	116.8757	114.1747	103.8023	102.9411	106.3966	106.8987	118.1315	124.3597	137.5261 (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	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	59.5442	52.8866	43.0103	32.5615	24.3401	20.5490	22.2039	28.8614	38.7378	49.1865	57.4079	61.1991 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	744.2965	752.0200	732.5571	691.1229	638.8197	589.6620	556.8217	549.0982	568.5611	609.9953	662.2985	711.4562 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913 (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)	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505 (71)
Water heating gains (Table 5)	186.7257	183.4216	176.8855	162.3274	153.4607	144.1699	138.3617	143.0061	148.4704	158.7788	172.7218	184.8468 (72)
Total internal gains	1111.9330	1109.6947	1073.8194	1007.3785	937.9871	875.7475	838.7538	842.3324	877.1359	939.3272	1013.7948	1078.8687 (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					36.9900	9.5471		0.4200	0.7000	0.7700		71.9510 (75)	
Southeast					5.8800	31.1332		0.4200	0.7000	0.7700		37.2977 (77)	
Southwest					16.7300	31.1332		0.4200	0.7000	0.7700		106.1209 (79)	
Northwest					1.7800	9.5471		0.4200	0.7000	0.7700		3.4624 (81)	
East					8.4000	22.0000		0.6300	0.7000	1.0000		73.3471 (82)	
Northeast					2.4000	13.8486		0.6300	0.7000	1.0000		13.1917 (82)	
Southwest					4.0000	33.8251		0.6300	0.7000	1.0000		53.7008 (82)	
Solar gains	359.0715	710.1427	1185.8441	1783.1453	2166.3078	2287.8629	2122.5638	1760.0807	1406.3283	863.8617	459.1886	320.0454	(83)
Total gains	1471.0045	1819.8374	2259.6635	2790.5237	3104.2949	3163.6104	2961.3177	2602.4131	2283.4642	1803.1889	1472.9834	1398.9141	(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	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366
alpha	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758
util living area	0.9973	0.9935	0.9812	0.9362	0.8332	0.6726	0.5535	0.6342	0.8559	0.9747	0.9948	0.9978 (86)
Living	19.4275	19.5927	19.8985	20.3193	20.6576	20.8381	20.8900	20.8696	20.6890	20.2220	19.7494	19.3816
Non living	18.1367	18.3479	18.7370	19.2622	19.6597	19.8436	19.8855	19.8733	19.7057	19.1500	18.5493	18.0779
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	20.1956	19.5927	19.8985	20.3193	20.6576	20.8381	20.8900	20.8696	20.6890	20.2220	19.7494	19.6080 (87)
Th 2	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019 (88)
util rest of house	0.9966	0.9919	0.9763	0.9188	0.7879	0.5901	0.4444	0.5235	0.8007	0.9654	0.9932	0.9973 (89)
MIT 2	19.2583	18.3479	18.7370	19.2622	19.6597	19.8436	19.8855	19.8733	19.7057	19.1500	18.5493	18.4246 (90)
Living area fraction	19.3205	18.4305	18.8141	19.3323	19.7260	19.9096	19.9522	19.9394	19.7710	19.2211	18.6289	0.0664 (91)
MIT	19.3205	18.4305	18.8141	19.3323	19.7260	19.9096	19.9522	19.9394	19.7710	19.2211	18.6289	18.5032 (92)
Temperature adjustment												0.0000
adjusted MIT	19.3205	18.4305	18.8141	19.3323	19.7260	19.9096	19.9522	19.9394	19.7710	19.2211	18.6289	18.5032 (93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9960	0.9881	0.9683	0.9041	0.7733	0.5817	0.4386	0.5159	0.7850	0.9551	0.9899	0.9961	(94)
Useful gains	1465.0671	1798.2397	2187.9346	2522.9642	2400.6726	1840.4044	1298.8813	1342.6774	1792.5659	1722.3010	1458.0845	1393.4077	(95)
Ext temp.	4.7000	5.2000	6.7000	9.2000	12.1000	14.8000	16.5000	16.3000	14.0000	10.6000	7.4000	4.5000	(96)
Heat loss rate W	5644.5630	5107.9276	4676.8971	3911.7967	2944.1572	1972.6795	1332.7803	1405.0716	2228.0136	3328.3638	4335.1586	5406.2122	(97)
Space heating kWh	3109.5449	2224.1102	1851.7881	999.9594	404.3525	0.0000	0.0000	0.0000	0.0000	1194.9107	2071.4934	2985.5266	(98a)
Space heating requirement - total per year (kWh/year)												14841.6858	
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	3109.5449	2224.1102	1851.7881	999.9594	404.3525	0.0000	0.0000	0.0000	0.0000	1194.9107	2071.4934	2985.5266	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												14841.6858	
Space heating per m2											(98c) / (4) =	42.2347	(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 %)													316.5531	(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	3109.5449	2224.1102	1851.7881	999.9594	404.3525	0.0000	0.0000	0.0000	0.0000	1194.9107	2071.4934	2985.5266	(98)	
Space heating efficiency (main heating system 1)	316.5531	316.5531	316.5531	316.5531	316.5531	0.0000	0.0000	0.0000	0.0000	316.5531	316.5531	316.5531	(210)	
Space heating fuel (main heating system)	982.3138	702.6026	584.9850	315.8899	127.7361	0.0000	0.0000	0.0000	0.0000	377.4756	654.3905	943.1361	(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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816	(64)	
Efficiency of water heater (217)m	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	(216)	
Fuel for water heating, kWh/month	115.7565	102.3309	108.4258	94.4327	90.9749	81.3422	79.7266	83.1866	84.4426	94.9368	101.9264	114.3567	(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	13.5414	12.2309	13.5414	13.1046	13.5414	13.1046	13.5414	13.5414	13.1046	13.5414	13.1046	13.5414	(231)	
Lighting	52.1186	41.8115	37.6466	27.5815	21.3048	17.4062	19.4349	25.2623	32.8132	43.0527	48.6279	53.5672	(232)	
Electricity generated by PVs (Appendix M) (negative quantity) (233a)m	-65.0271	-102.0603	-159.6069	-185.4013	-190.6287	-168.4285	-164.2478	-151.4413	-135.1246	-120.5419	-75.3114	-58.7169	(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	-15.5037	-38.4001	-87.8459	-152.4428	-212.4740	-234.3556	-225.6853	-185.5339	-141.9041	-65.6134	-23.7571	-13.4353	(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												4688.5295	(211)	
Space heating fuel - main system 2												0.0000	(213)	
Space heating fuel - secondary												0.0000	(215)	
Efficiency of water heater												300.3597		
Water heating fuel used												1151.8386	(219)	
Space cooling fuel												0.0000	(221)	
Electricity for pumps and fans:														
(MEVDecentralised, Database: total watage = 11.5180, total flow = 77.0000, SFP = 0.1496)														
mechanical ventilation fans (SFP = 0.1496)													159.4390	(230a)
Total electricity for the above, kWh/year													159.4390	(231)
Electricity for lighting (calculated in Appendix L)													420.6273	(232)
Energy saving/generation technologies (Appendices M ,N and Q)														
PV generation													-2973.4880	(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													3446.9464	(238)

10a. Fuel costs - using BEDF prices (561)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	4688.5295	26.0600	1221.8308	(240)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	1151.8386	26.0600	300.1691	(247)
Energy for instantaneous electric shower(s)	0.0000	26.0600	0.0000	(247a)
Pumps, fans and electric keep-hot	159.4390	26.0600	41.5498	(249)

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Energy for lighting	420.6273	26.0600	109.6155 (250)
Additional standing charges			0.0000 (251)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-1576.5368	26.0600	-410.8455
PV Unit electricity exported	-1396.9512	5.8100	-81.1629
Total			-492.0084 (252)
Total energy cost			1181.1569 (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	4688.5295	0.1553	727.9505 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	1151.8386	0.1411	162.5150 (264)
Space and water heating			890.4655 (265)
Pumps, fans and electric keep-hot	159.4390	0.1387	22.1162 (267)
Energy for lighting	420.6273	0.1443	60.7095 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-1576.5368	0.1346	-212.2504
PV Unit electricity exported	-1396.9512	0.1221	-170.6259
Total			-382.8763 (269)
Total CO2, kg/year			590.4149 (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	4688.5295	1.5748	7383.4781 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	1151.8386	1.5217	1752.7713 (278)
Space and water heating			9136.2494 (279)
Pumps, fans and electric keep-hot	159.4390	1.5128	241.1993 (281)
Energy for lighting	420.6273	1.5338	645.1722 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-1576.5368	1.4976	-2361.0372
PV Unit electricity exported	-1396.9512	0.4482	-626.0662
Total			-2987.1034 (283)
Total Primary energy kWh/year			7035.5176 (286)

SAP 10 EPC IMPROVEMENTS

001

Current energy efficiency rating:	B 90
Current environmental impact rating:	A 98

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	+ 0.3	-£ 32	-16 kg (2.7%)
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Recommended measures	Typical annual savings	Energy efficiency	Environmental impact
(none)			
	Total Savings	£0	0.00 kg/m²

Potential energy efficiency rating:	B 90
Potential environmental impact rating:	A 98

Fuel prices for cost data on this page from database revision number 561 TEST (31 Jan 2025)
Recommendation texts revision number 6.1 (11 Jun 2019)

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

	Current	Potential	Saving
Electricity	£1673	£1673	£0
Space heating	£1263	£1263	£0
Water heating	£300	£300	£0
Lighting	£110	£110	£0
Generated (PV)	-£492	-£492	£0
Total cost of fuels	£1181	£1181	£0
Total cost of uses	£1181	£1181	£0
Delivered energy	10 kWh/m²	10 kWh/m²	0 kWh/m²
Carbon dioxide emissions	0.6 tonnes	0.6 tonnes	0.0 tonnes
CO2 emissions per m²	2 kg/m²	2 kg/m²	0 kg/m²
Primary energy	20 kWh/m²	20 kWh/m²	0 kWh/m²

Full SAP Calculation Printout



CALCULATION OF ENERGY RATING FOR IMPROVED DWELLING

1. Overall dwelling characteristics

	Area (m ²)	Storey height (m)	Volume (m ³)
Ground floor	166.5000 (1b)	x 2.4500 (2b)	= 407.9250 (1b) - (3b)
First floor	117.8900 (1c)	x 2.7000 (2c)	= 318.3030 (1c) - (3c)
Second floor	67.0200 (1d)	x 2.2000 (2d)	= 147.4440 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	351.4100		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 873.6720 (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)

	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			4.3200	1.0000	4.3200		(26)
Window (Uw = 1.20)			61.3800	1.1450	70.2824		(27)
Lantern			8.4000	1.5918	13.3708		(27a)
RL			2.4000	1.5038	3.6090		(27a)
RL			4.0000	1.5038	6.0150		(27a)
GF			166.5000	0.1100	18.3150	9.0000	1498.5000 (28a)
Main	327.7600	65.7000	262.0600	0.1800	47.1708	110.0000	28826.6000 (29a)
Dwarf	55.2800		55.2800	0.1200	6.6336	110.0000	6080.8000 (29a)
PIR	97.1800	4.0000	93.1800	0.1300	12.1134	9.0000	838.6200 (30)
PIJ	50.8700	2.4000	48.4700	0.0952	4.6162	9.0000	436.2300 (30)
Flat	48.6100	8.4000	40.2100	0.1300	5.2273	9.0000	361.8900 (30)
Total net area of external elements Aum(A, m ²)			746.2000				(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	191.6736		(33)
Internal Wall 1			215.3300			75.0000	16149.7500 (32c)
Internal Wall 2			85.4000			9.0000	768.6000 (32c)
Internal Floor 1			117.8900			18.0000	2122.0200 (32d)
Internal Floor 2			67.0200			18.0000	1206.3600 (32d)
Internal Ceiling 1			117.8900			9.0000	1061.0100 (32e)
Internal Ceiling 2			67.0200			9.0000	603.1800 (32e)

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 59953.5600 (34)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m²K 170.6086 (35)

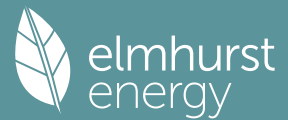
List of Thermal Bridges

K1 Element	Length	Psi-value	Total
E2 Other lintels (including other steel lintels)	35.3500	0.0500	1.7675
E3 Sill	35.3500	0.0500	1.7675
E4 Jamb	91.3000	0.0500	4.5650
E5 Ground floor (normal)	56.6000	0.1000	5.6600
E16 Corner (normal)	67.8500	0.0600	4.0710
E17 Corner (inverted - internal area greater than external area)	38.4500	-0.0900	-3.4605
E6 Intermediate floor within a dwelling	95.6000	0.0020	0.1912
E10 Eaves (insulation at ceiling level)	37.0500	0.0600	2.2230
E13 Gable (insulation at rafter level)	15.4400	0.0800	1.2352
E15 Flat roof with parapet	22.7000	0.3000	6.8100
R6 Flat ceiling	37.0500	0.1200	4.4460
E24 Eaves (insulation at ceiling level - inverted)	37.0500	0.1500	5.5575
R1 Head of roof window	13.1000	0.2400	3.1440
R2 Sill of roof window	13.1000	0.2400	3.1440
R3 Jamb of roof window	18.4000	0.2400	4.4160
R11 Upstands or kerbs of rooflights	19.6000	0.2400	4.7040
Thermal bridges (Sum(L x Psi) calculated using Appendix K)			50.2414 (36)
Point Thermal bridges		(36a) =	0.0000
Total fabric heat loss		(33) + (36) + (36a) =	241.9150 (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
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(38)m 144.1559 144.1559 144.1559 144.1559 144.1559 144.1559 144.1559 144.1559 144.1559 144.1559 144.1559 144.1559 (38)
 Heat transfer coeff 386.0709 386.0709 386.0709 386.0709 386.0709 386.0709 386.0709 386.0709 386.0709 386.0709 386.0709 386.0709 (39)
 Average = Sum(39)m / 12 = 386.0709

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	1.0986	(40)
HLP (average)												1.0986	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy 3.1988 (42)
 Hot water usage for mixer showers 107.0474 105.4387 103.0945 98.6093 95.2993 91.6080 89.5099 91.8364 94.3866 98.3499 102.9315 106.6373 (42a)
 Hot water usage for baths 33.6024 33.1034 32.4006 31.1049 30.1346 29.0588 28.4776 29.1755 29.9353 31.0865 32.4089 33.4888 (42b)
 Hot water usage for other uses 47.3885 45.6653 43.9421 42.2189 40.4957 38.7724 38.7724 40.4957 42.2189 43.9421 45.6653 47.3885 (42c)
 Average daily hot water use (litres/day) 172.9293 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	188.0383	184.2074	179.4372	171.9330	165.9295	159.4392	156.7600	161.5075	166.5408	173.3785	181.0057	187.5146	(44)
Energy conte	297.8068	262.3088	275.7883	235.3677	223.3730	196.0491	189.5876	199.9800	205.3614	235.2730	257.8758	293.6026	(45)
Energy content (annual)										Total = Sum(45)m =		2872.3740	
Distribution loss (46)m = 0.15 x (45)m	44.6710	39.3463	41.3682	35.3051	33.5060	29.4074	28.4381	29.9970	30.8042	35.2909	38.6814	44.0404	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.5900	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.8586	(55)
Total storage loss	26.6166	24.0408	26.6166	25.7580	26.6166	25.7580	26.6166	26.6166	25.7580	26.6166	25.7580	26.6166	(56)
If cylinder contains dedicated solar storage	26.6166	24.0408	26.6166	25.7580	26.6166	25.7580	26.6166	26.6166	25.7580	26.6166	25.7580	26.6166	(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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816	(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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816	(64)
										Total per year (kWh/year) = Sum(64)m =		3459.6590	(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)
												0.0000	(64a)
Heat gains from water heating, kWh/month	138.9240	123.2593	131.6028	116.8757	114.1747	103.8023	102.9411	106.3966	106.8987	118.1315	124.3597	137.5261	(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	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	59.5442	52.8866	43.0103	32.5615	24.3401	20.5490	22.2039	28.8614	38.7378	49.1865	57.4079	61.1991	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	744.2965	752.0200	732.5571	691.1229	638.8197	589.6620	556.8217	549.0982	568.5611	609.9953	662.2985	711.4562	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	(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)	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	(71)
Water heating gains (Table 5)	186.7257	183.4216	176.8855	162.3274	153.4607	144.1699	138.3617	143.0061	148.4704	158.7788	172.7218	184.8468	(72)
Total internal gains	1111.9330	1109.6947	1073.8194	1007.3785	937.9871	875.7475	838.7538	842.3324	877.1359	939.3272	1013.7948	1078.8687	(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	36.9900	11.2829	0.4200	0.7000	0.7700	85.0329	(75)
Southeast	5.8800	36.7938	0.4200	0.7000	0.7700	44.0791	(77)
Southwest	16.7300	36.7938	0.4200	0.7000	0.7700	125.4156	(79)
Northwest	1.7800	11.2829	0.4200	0.7000	0.7700	4.0919	(81)
East	8.4000	26.0000	0.6300	0.7000	1.0000	86.6830	(82)
Northeast	2.4000	16.3666	0.6300	0.7000	1.0000	15.5902	(82)
Southwest	4.0000	39.9751	0.6300	0.7000	1.0000	63.4645	(82)

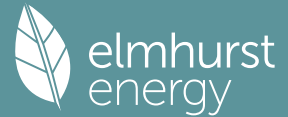
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	424.3572	798.9105	1279.1127	1870.4321	2336.6916	2421.0189	2292.3690	1932.3963	1483.7409	934.6700	522.5250	353.7344	(83)
Total gains	1536.2902	1908.6053	2352.9322	2877.8106	3274.6787	3296.7664	3131.1228	2774.7287	2360.8768	1873.9972	1536.3198	1432.6031	(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	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	
alpha	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	

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util living area	0.9971	0.9928	0.9796	0.9352	0.8298	0.6681	0.5181	0.5939	0.8399	0.9715	0.9944	0.9978 (86)
Living	19.3998	19.5838	19.9017	20.3078	20.6503	20.8374	20.8967	20.8808	20.7097	20.2415	19.7329	19.3562
Non living	18.1011	18.3363	18.7406	19.2472	19.6496	19.8420	19.8892	19.8802	19.7268	19.1739	18.5280	18.0453
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	20.1814	19.5838	19.9017	20.3078	20.6503	20.8374	20.8967	20.8808	20.7097	20.2415	19.7329	19.5861 (87)
Th 2	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019 (88)
util rest of house												
MIT	0.9963	0.9911	0.9743	0.9181	0.7863	0.5885	0.4109	0.4834	0.7806	0.9611	0.9927	0.9972 (89)
MIT 2	19.2441	18.3363	18.7406	19.2472	19.6496	19.8420	19.8892	19.8802	19.7268	19.1739	18.5280	18.3979 (90)
Living area fraction									fLA = Living area / (4) =			0.0664 (91)
MIT	19.3063	18.4191	18.8177	19.3176	19.7160	19.9081	19.9561	19.9466	19.7920	19.2448	18.6080	18.4767 (92)
Temperature adjustment												0.0000
adjusted MIT	19.3063	18.4191	18.8177	19.3176	19.7160	19.9081	19.9561	19.9466	19.7920	19.2448	18.6080	18.4767 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9957	0.9871	0.9659	0.9034	0.7719	0.5803	0.4058	0.4768	0.7655	0.9502	0.9893	0.9960	(94)
Useful gains	1529.6974	1883.8917	2272.5813	2599.7386	2527.5874	1913.0664	1270.4836	1322.8543	1807.2010	1780.6445	1519.8301	1426.8747	(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	5793.5111	5219.3270	4755.5030	4021.9249	3094.7434	2049.2981	1295.6747	1369.2332	2197.5332	3337.4947	4442.8863	5511.8204	(97)
Space heating kWh	3172.2774	2241.4126	1847.2937	1023.9741	421.9641	0.0000	0.0000	0.0000	0.0000	1158.2965	2104.6004	3039.1996	(98a)
Space heating requirement - total per year (kWh/year)												15009.0185	
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	3172.2774	2241.4126	1847.2937	1023.9741	421.9641	0.0000	0.0000	0.0000	0.0000	1158.2965	2104.6004	3039.1996	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												15009.0185	
Space heating per m2										(98c) / (4) =		42.7108	(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 %)												316.5531	(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	3172.2774	2241.4126	1847.2937	1023.9741	421.9641	0.0000	0.0000	0.0000	0.0000	1158.2965	2104.6004	3039.1996	(98)
Space heating efficiency (main heating system 1)	316.5531	316.5531	316.5531	316.5531	316.5531	0.0000	0.0000	0.0000	0.0000	316.5531	316.5531	316.5531	(210)
Space heating fuel (main heating system)	1002.1312	708.0684	583.5652	323.4763	133.2996	0.0000	0.0000	0.0000	0.0000	365.9091	664.8491	960.0916	(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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816	(64)
Efficiency of water heater (217)m	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	(216)
Fuel for water heating, kWh/month	115.7565	102.3309	108.4258	94.4327	90.9749	81.3422	79.7266	83.1866	84.4426	94.9368	101.9264	114.3567	(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	13.5414	12.2309	13.5414	13.1046	13.5414	13.1046	13.5414	13.5414	13.1046	13.5414	13.1046	13.5414	(231)
Lighting	52.1186	41.8115	37.6466	27.5815	21.3048	17.4062	19.4349	25.2623	32.8132	43.0527	48.6279	53.5672	(232)
Electricity generated by PVs (Appendix M) (negative quantity) (233a)m	-75.5012	-112.6425	-169.1651	-192.0832	-200.2248	-173.7313	-171.3413	-159.8923	-139.7496	-127.7704	-84.2100	-64.2713	(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	-19.6716	-45.3754	-97.7503	-162.2987	-234.5827	-252.4953	-249.7864	-210.0735	-152.5284	-73.6436	-28.5231	-15.4759	(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												4741.3904	(211)
Space heating fuel - main system 2												0.0000	(213)
Space heating fuel - secondary												0.0000	(215)
Efficiency of water heater												300.3597	
Water heating fuel used												1151.8386	(219)
Space cooling fuel												0.0000	(221)
Electricity for pumps and fans:													
(MEV)Decentralised, Database: total watage = 11.5180, total flow = 77.0000, SFP = 0.1496)													
mechanical ventilation fans (SFP = 0.1496)												159.4390	(230a)
Total electricity for the above, kWh/year												159.4390	(231)
Electricity for lighting (calculated in Appendix L)												420.6273	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation												-3212.7879	(233)
Wind generation												0.0000	(234)
Hydro-electric generation (Appendix N)												0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)												0.0000	(235)

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Appendix Q - special features

Energy saved or generated	-0.0000 (236)
Energy used	0.0000 (237)
Total delivered energy for all uses	3260.5075 (238)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year
Space heating - main system 1	4741.3904	16.4900	781.8553 (240)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	1151.8386	16.4900	189.9382 (247)
Energy for instantaneous electric shower(s)	0.0000	16.4900	0.0000 (247a)
Pumps, fans and electric keep-hot	159.4390	16.4900	26.2915 (249)
Energy for lighting	420.6273	16.4900	69.3614 (250)
Additional standing charges			0.0000 (251)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-1670.5829	16.4900	-275.4791
PV Unit electricity exported	-1542.2049	5.5900	-86.2093
Total			-361.6884 (252)
Total energy cost			705.7580 (255)

11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12):		0.3600 (256)
Energy cost factor (ECF)	$[(255) \times (256)] / [(4) + 45.0] =$	0.6409 (257)
SAP value		89.6105
SAP rating (Section 12)		90 (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	4741.3904	0.1553	736.4272 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	1151.8386	0.1411	162.5150 (264)
Space and water heating			898.9422 (265)
Pumps, fans and electric keep-hot	159.4390	0.1387	22.1162 (267)
Energy for lighting	420.6273	0.1443	60.7095 (268)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-1670.5829	0.1350	-225.5021
PV Unit electricity exported	-1542.2049	0.1224	-188.7679
Total			-414.2700 (269)
Total CO2, kg/year			567.4979 (272)
CO2 emissions per m2			1.6100 (273)
EI value			98.0817
EI rating			98 (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

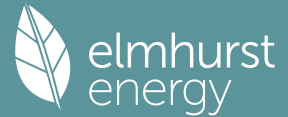
1. Overall dwelling characteristics

	Area (m2)	Storey height (m)	Volume (m3)
Ground floor	166.5000 (1b)	x 2.4500 (2b)	= 407.9250 (1b) - (3b)
First floor	117.8900 (1c)	x 2.7000 (2c)	= 318.3030 (1c) - (3c)
Second floor	67.0200 (1d)	x 2.2000 (2d)	= 147.4440 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	351.4100		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =	873.6720 (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)

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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	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind factor	4.6000	4.6000	4.6000	4.2000	4.3000	3.8000	3.7000	3.7000	3.7000	4.2000	4.1000	4.4000 (22)
Adj infilt rate	1.1500	1.1500	1.1500	1.0500	1.0750	0.9500	0.9250	0.9250	0.9250	1.0500	1.0250	1.1000 (22a)
Mechanical extract ventilation - decentralised	0.1955	0.1955	0.1955	0.1785	0.1827	0.1615	0.1573	0.1573	0.1573	0.1785	0.1742	0.1870 (22b)
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)

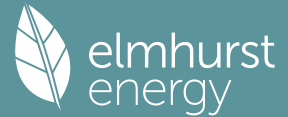
3. Heat losses and heat loss parameter

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			4.3200	1.0000	4.3200			(26)
Window (Uw = 1.20)			61.3800	1.1450	70.2824			(27)
Lantern			8.4000	1.5918	13.3708			(27a)
RL			2.4000	1.5038	3.6090			(27a)
RL			4.0000	1.5038	6.0150			(27a)
GF			166.5000	0.1100	18.3150	9.0000	1498.5000	(28a)
Main	327.7600	65.7000	262.0600	0.1800	47.1708	110.0000	28826.6000	(29a)
Dwarf	55.2800		55.2800	0.1200	6.6336	110.0000	6080.8000	(29a)
PIR	97.1800	4.0000	93.1800	0.1300	12.1134	9.0000	838.6200	(30)
PIJ	50.8700	2.4000	48.4700	0.0952	4.6162	9.0000	436.2300	(30)
Flat	48.6100	8.4000	40.2100	0.1300	5.2273	9.0000	361.8900	(30)
Total net area of external elements Aum(A, m2)			746.2000					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	191.6736			(33)
Internal Wall 1			215.3300			75.0000	16149.7500	(32c)
Internal Wall 2			85.4000			9.0000	768.6000	(32c)
Internal Floor 1			117.8900			18.0000	2122.0200	(32d)
Internal Floor 2			67.0200			18.0000	1206.3600	(32d)
Internal Ceiling 1			117.8900			9.0000	1061.0100	(32e)
Internal Ceiling 2			67.0200			9.0000	603.1800	(32e)
Heat capacity Cm = Sum(A x k)						(28)...(30) + (32) + (32a)...(32e) =	59953.5600	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							170.6086	(35)
List of Thermal Bridges								
K1 Element				Length	Psi-value	Total		
E2 Other lintels (including other steel lintels)				35.3500	0.0500	1.7675		
E3 Sill				35.3500	0.0500	1.7675		
E4 Jamb				91.3000	0.0500	4.5650		
E5 Ground floor (normal)				56.6000	0.1000	5.6600		
E16 Corner (normal)				67.8500	0.0600	4.0710		
E17 Corner (inverted - internal area greater than external area)				38.4500	-0.0900	-3.4605		
E6 Intermediate floor within a dwelling				95.6000	0.0020	0.1912		
E10 Eaves (insulation at ceiling level)				37.0500	0.0600	2.2230		
E13 Gable (insulation at rafter level)				15.4400	0.0800	1.2352		
E15 Flat roof with parapet				22.7000	0.3000	6.8100		
R6 Flat ceiling				37.0500	0.1200	4.4460		
E24 Eaves (insulation at ceiling level - inverted)				37.0500	0.1500	5.5575		
R1 Head of roof window				13.1000	0.2400	3.1440		
R2 Sill of roof window				13.1000	0.2400	3.1440		
R3 Jamb of roof window				18.4000	0.2400	4.4160		
R11 Upstands or kerbs of rooflights				19.6000	0.2400	4.7040		
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							50.2414	(36)
Point Thermal Bridges						(36a) =	0.0000	
Total fabric heat loss						(33) + (36) + (36a) =	241.9150	(37)

4. Water heating energy requirements (kWh/year)

Assumed occupancy												3.1988 (42)
Hot water usage for mixer showers												
Hot water usage for baths	107.0474	105.4387	103.0945	98.6093	95.2993	91.6080	89.5099	91.8364	94.3866	98.3499	102.9315	106.6373 (42a)
Hot water usage for other uses	33.6024	33.1034	32.4006	31.1049	30.1346	29.0588	28.4776	29.1755	29.9353	31.0865	32.4089	33.4888 (42b)
Average daily hot water use (litres/day)	47.3885	45.6653	43.9421	42.2189	40.4957	38.7724	38.7724	40.4957	42.2189	43.9421	45.6653	47.3885 (42c)
Daily hot water use	188.0383	184.2074	179.4372	171.9330	165.9295	159.4392	156.7600	161.5075	166.5408	173.3785	181.0057	187.5146 (44)
Energy conte	297.8068	262.3088	275.7883	235.3677	223.3730	196.0491	189.5876	199.9800	205.3614	235.2730	257.8758	293.6026 (45)
Energy content (annual)										Total = Sum(45)m =		2872.3740
Distribution loss (46)m = 0.15 x (45)m	44.6710	39.3463	41.3682	35.3051	33.5060	29.4074	28.4381	29.9970	30.8042	35.2909	38.6814	44.0404 (46)
Water storage loss:												
Store volume												300.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):												1.5900 (48)
Temperature factor from Table 2b												0.5400 (49)
Enter (49) or (54) in (55)												0.8586 (55)
Total storage loss	26.6166	24.0408	26.6166	25.7580	26.6166	25.7580	26.6166	26.6166	25.7580	26.6166	25.7580	26.6166 (56)
If cylinder contains dedicated solar storage	26.6166	24.0408	26.6166	25.7580	26.6166	25.7580	26.6166	26.6166	25.7580	26.6166	25.7580	26.6166 (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)

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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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816 (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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816 (64)
	Total per year (kWh/year) = Sum(64)m =											3459.6590 (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	138.9240	123.2593	131.6028	116.8757	114.1747	103.8023	102.9411	106.3966	106.8987	118.1315	124.3597	137.5261 (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	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	191.9258	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	59.5442	52.8866	43.0103	32.5615	24.3401	20.5490	22.2039	28.8614	38.7378	49.1865	57.4079	61.1991	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	744.2965	752.0200	732.5571	691.1229	638.8197	589.6620	556.8217	549.0982	568.5611	609.9953	662.2985	711.4562	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	57.3913	(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)	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	-127.9505	(71)
Water heating gains (Table 5)	186.7257	183.4216	176.8855	162.3274	153.4607	144.1699	138.3617	143.0061	148.4704	158.7788	172.7218	184.8468	(72)
Total internal gains	1111.9330	1109.6947	1073.8194	1007.3785	937.9871	875.7475	838.7538	842.3324	877.1359	939.3272	1013.7948	1078.8687	(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					36.9900	9.5471		0.4200	0.7000	0.7700		71.9510 (75)				
Southeast					5.8800	31.1332		0.4200	0.7000	0.7700		37.2977 (77)				
Southwest					16.7300	31.1332		0.4200	0.7000	0.7700		106.1209 (79)				
Northwest					1.7800	9.5471		0.4200	0.7000	0.7700		3.4624 (81)				
East					8.4000	22.0000		0.6300	0.7000	1.0000		73.3471 (82)				
Northeast					2.4000	13.8486		0.6300	0.7000	1.0000		13.1917 (82)				
Southwest					4.0000	33.8251		0.6300	0.7000	1.0000		53.7008 (82)				
Solar gains					359.0715	710.1427	1185.8441	1783.1453	2166.3078	2287.8629	2122.5638	1760.0807	1406.3283	863.8617	459.1886	320.0454 (83)
Total gains					1471.0045	1819.8374	2259.6635	2790.5237	3104.2949	3163.6104	2961.3177	2602.4131	2283.4642	1803.1889	1472.9834	1398.9141 (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	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366	43.1366
alpha	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758	3.8758
util living area	0.9973	0.9935	0.9812	0.9362	0.8332	0.6726	0.5535	0.6342	0.8559	0.9747	0.9948	0.9978 (86)
Living	19.4275	19.5927	19.8985	20.3193	20.6576	20.8381	20.8900	20.8696	20.6890	20.2220	19.7494	19.3816
Non living	18.1367	18.3479	18.7370	19.2622	19.6597	19.8436	19.8855	19.8733	19.7057	19.1500	18.5493	18.0779
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	20.1956	19.5927	19.8985	20.3193	20.6576	20.8381	20.8900	20.8696	20.6890	20.2220	19.7494	19.6080 (87)
Th 2	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019	20.0019 (88)
util rest of house	0.9966	0.9919	0.9763	0.9188	0.7879	0.5901	0.4444	0.5235	0.8007	0.9654	0.9932	0.9973 (89)
MIT 2	19.2583	18.3479	18.7370	19.2622	19.6597	19.8436	19.8855	19.8733	19.7057	19.1500	18.5493	18.4246 (90)
Living area fraction	19.3205	18.4305	18.8141	19.3323	19.7260	19.9096	19.9522	19.9394	fLA = Living area / (4) = 19.7710	19.2211	18.6289	0.0664 (91)
MIT	19.3205	18.4305	18.8141	19.3323	19.7260	19.9096	19.9522	19.9394	19.7710	19.2211	18.6289	18.5032 (92)
Temperature adjustment												0.0000
adjusted MIT	19.3205	18.4305	18.8141	19.3323	19.7260	19.9096	19.9522	19.9394	19.7710	19.2211	18.6289	18.5032 (93)

8. Space heating requirement

Utilisation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Useful gains	1465.0671	1798.2397	2187.9346	2522.9642	2400.6726	1840.4044	1298.8813	1342.6774	1792.5659	1722.3010	1458.0845	1393.4077	(94)
Ext temp.	4.7000	5.2000	6.7000	9.2000	12.1000	14.8000	16.5000	16.3000	14.0000	10.6000	7.4000	4.5000	(96)
Heat loss rate W	5644.5630	5107.9276	4676.8971	3911.7967	2944.1572	1972.6795	1332.7803	1405.0716	2228.0136	3328.3638	4335.1586	5406.2122	(97)
Space heating kWh	3109.5449	2224.1102	1851.7881	999.9594	404.3525	0.0000	0.0000	0.0000	0.0000	1194.9107	2071.4934	2985.5266	(98a)
Space heating requirement - total per year (kWh/year)												14841.6858	
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	3109.5449	2224.1102	1851.7881	999.9594	404.3525	0.0000	0.0000	0.0000	0.0000	1194.9107	2071.4934	2985.5266	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												14841.6858	
Space heating per m2												(98c) / (4) =	42.2347 (99)

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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 %)												316.5531 (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	3109.5449	2224.1102	1851.7881	999.9594	404.3525	0.0000	0.0000	0.0000	0.0000	1194.9107	2071.4934	2985.5266 (98)
Space heating efficiency (main heating system 1)	316.5531	316.5531	316.5531	316.5531	316.5531	0.0000	0.0000	0.0000	0.0000	316.5531	316.5531	316.5531 (210)
Space heating fuel (main heating system)	982.3138	702.6026	584.9850	315.8899	127.7361	0.0000	0.0000	0.0000	0.0000	377.4756	654.3905	943.1361 (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	347.6858	307.3608	325.6673	283.6377	273.2520	244.3191	239.4666	249.8590	253.6314	285.1520	306.1458	343.4816 (64)
Efficiency of water heater (217)m	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597	300.3597 (216)
Fuel for water heating, kWh/month	115.7565	102.3309	108.4258	94.4327	90.9749	81.3422	79.7266	83.1866	84.4426	94.9368	101.9264	114.3567 (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	13.5414	12.2309	13.5414	13.1046	13.5414	13.1046	13.5414	13.5414	13.1046	13.5414	13.1046	13.5414 (231)
Lighting	52.1186	41.8115	37.6466	27.5815	21.3048	17.4062	19.4349	25.2623	32.8132	43.0527	48.6279	53.5672 (232)
Electricity generated by PVs (Appendix M) (negative quantity)	-65.0271	-102.0603	-159.6069	-185.4013	-190.6287	-168.4285	-164.2478	-151.4413	-135.1246	-120.5419	-75.3114	-58.7169 (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)	-15.5037	-38.4001	-87.8459	-152.4428	-212.4740	-234.3556	-225.6853	-185.5339	-141.9041	-65.6134	-23.7571	-13.4353 (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												4688.5295 (211)
Space heating fuel - main system 2												0.0000 (213)
Space heating fuel - secondary												0.0000 (215)
Efficiency of water heater												300.3597
Water heating fuel used												1151.8386 (219)
Space cooling fuel												0.0000 (221)
Electricity for pumps and fans:												
(MEV)Decentralised, Database: total watage = 11.5180, total flow = 77.0000, SFP = 0.1496)												
mechanical ventilation fans (SFP = 0.1496)												159.4390 (230a)
Total electricity for the above, kWh/year												159.4390 (231)
Electricity for lighting (calculated in Appendix L)												420.6273 (232)
Energy saving/generation technologies (Appendices M ,N and Q)												
PV generation												-2973.4880 (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												3446.9464 (238)

10a. Fuel costs - using BEDF prices (561)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year
Space heating - main system 1	4688.5295	26.0600	1221.8308 (240)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	1151.8386	26.0600	300.1691 (247)
Energy for instantaneous electric shower(s)	0.0000	26.0600	0.0000 (247a)
Pumps, fans and electric keep-hot	159.4390	26.0600	41.5498 (249)
Energy for lighting	420.6273	26.0600	109.6155 (250)
Additional standing charges			0.0000 (251)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-1576.5368	26.0600	-410.8455
PV Unit electricity exported	-1396.9512	5.8100	-81.1629
Total			-492.0084 (252)
Total energy cost			1181.1569 (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	4688.5295	0.1553	727.9505 (261)
Total CO2 associated with community systems			0.0000 (373)
Water heating (other fuel)	1151.8386	0.1411	162.5150 (264)
Space and water heating			890.4655 (265)
Pumps, fans and electric keep-hot	159.4390	0.1387	22.1162 (267)
Energy for lighting	420.6273	0.1443	60.7095 (268)
Energy saving/generation technologies			

Full SAP Calculation Printout



PV Unit electricity used in dwelling	-1576.5368	0.1346	-212.2504
PV Unit electricity exported	-1396.9512	0.1221	-170.6259
Total			-382.8763 (269)
Total CO2, kg/year			590.4149 (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	4688.5295	1.5748	7383.4781 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	1151.8386	1.5217	1752.7713 (278)
Space and water heating			9136.2494 (279)
Pumps, fans and electric keep-hot	159.4390	1.5128	241.1993 (281)
Energy for lighting	420.6273	1.5338	645.1722 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-1576.5368	1.4976	-2361.0372
PV Unit electricity exported	-1396.9512	0.4482	-626.0662
Total			-2987.1034 (283)
Total Primary energy kWh/year			7035.5176 (286)

Thermal Bridging

Property Reference	78523	Issued on Date	06/02/2025
Assessment Reference	001	Prop Type Ref	Detached House
Property	4 , Ringley Close, Whitefield, MANCHESTER, M45 7HR		

SAP Rating	90 B	DER	1.66	TER	8.51
Environmental	98 A	% DER < TER			80.49
CO ₂ Emissions (t/year)	0.59	DFEE	46.29	TFEE	46.31
Compliance Check	See BREL	% DFEE < TFEE			0.04
% DPER < TPER	55.78	DPER	20.10	TPER	45.45

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	35.35	1.77	To be modelled
External wall	E3 Sill	Independently assessed	0.050	35.35	1.77	To be modelled
External wall	E4 Jamb	Independently assessed	0.050	91.30	4.57	To be modelled
External wall	E5 Ground floor (normal)	Independently assessed	0.100	56.60	5.66	To be modelled
External wall	E16 Corner (normal)	Independently assessed	0.060	67.85	4.07	To be modelled
External wall	E17 Corner (inverted – internal area greater than external area)	Independently assessed	-0.090	38.45	-3.46	To be modelled
External wall	E6 Intermediate floor within a dwelling	Independently assessed	0.002	95.60	0.19	To be modelled
External wall	E10 Eaves (insulation at ceiling level)	Independently assessed	0.060	37.05	2.22	To be modelled
External wall	E13 Gable (insulation at rafter level)	Independently assessed	0.080	15.44	1.24	To be modelled
External wall	E15 Flat roof with parapet	Table K1 - Default	0.300	22.70	6.81	To be modelled
External roof	R6 Flat ceiling	Table K1 - Default	0.120	37.05	4.45	To be modelled
External wall	E24 Eaves (insulation at ceiling level - inverted)	Table K1 - Default	0.150	37.05	5.56	To be modelled
External roof	R1 Head of roof window	Table K1 - Default	0.240	13.10	3.14	To be modelled
External roof	R2 Sill of roof window	Table K1 - Default	0.240	13.10	3.14	To be modelled
External roof	R3 Jamb of roof window	Table K1 - Default	0.240	18.40	4.42	To be modelled
External roof	R11 Upstands or kerbs of rooflights	Table K1 - Default	0.240	19.60	4.70	To be modelled

Total: 633.99 W/mK:
Y-Value: 0.07 W/m²K:

Predicted Energy Assessment



4 , Ringley Close, Whitefield, MANCHESTER, M45 7HR

Dwelling type:

House, Detached

Date of assessment:

06/02/2025

Produced by:

Paul Goddard

Total floor area:

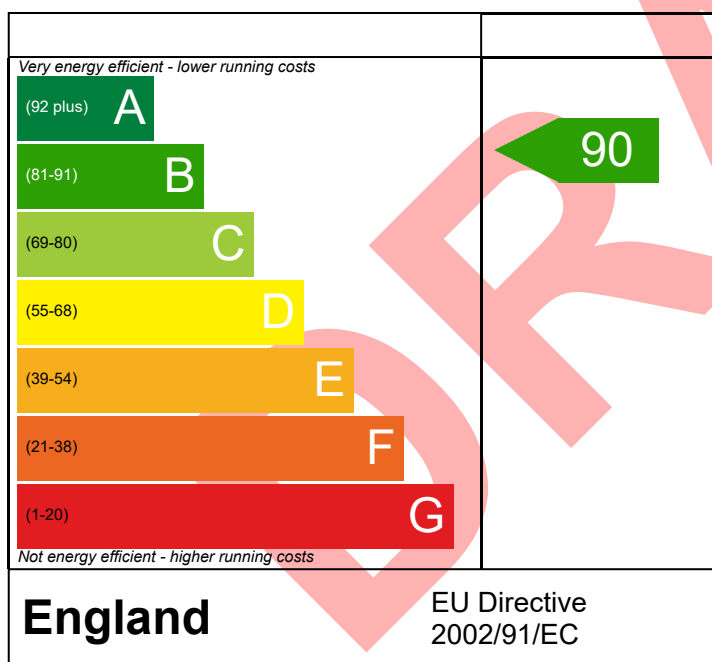
351.41 m²

DRRN:

This document is a Predicted Energy Assessment for properties marketed when they are incomplete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, this rating will be updated and an official Energy Performance Certificate will be created for the property. This will include more detailed information about the energy performance of the completed property.

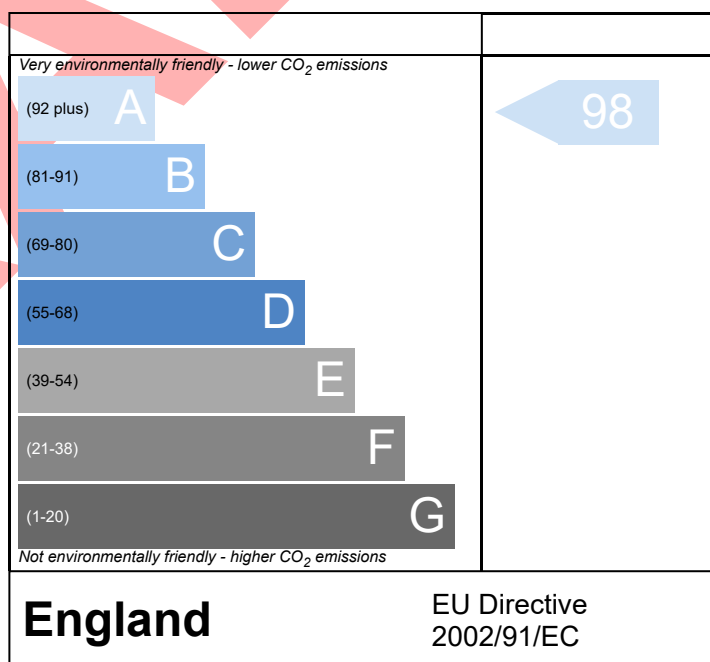
The energy performance has been assessed using the Government approved SAP 10 methodology and is rated in terms of the energy use per square meter of floor area; the energy efficiency is based on fuel costs and the environmental impact is based on carbon dioxide (CO₂) emissions.

Energy Efficiency Rating



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

Environmental Impact (CO₂) Rating



The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO₂) emissions. The higher the rating the less impact it has on the environment.

Energy Report

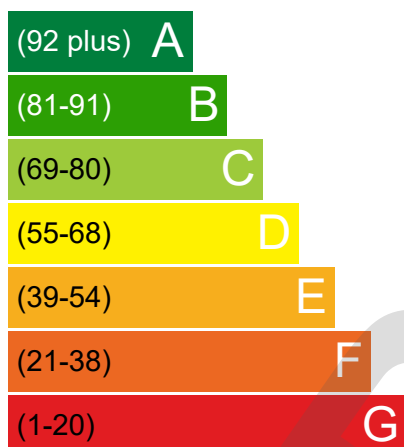
Dwelling Address	4 , Ringley Close, Whitefield, MANCHESTER, M45 7HR
Reference	78523-001
Assessment Date	06/02/2025
Submission Date	
Property Type	House, Detached
Total Floor Area	351

This Energy Report has been generated using the UK's National Calculation Methodology for dwellings, Standard Assessment Procedure (SAP). This methodology is used to assess the energy efficiency of dwellings which is calculated based on a dwelling's heating, hot water, ventilation and lighting usage.

This document is not an Energy Performance Certificate (EPC) as required by the Energy Performance of Buildings Regulations

Energy Efficiency Rating

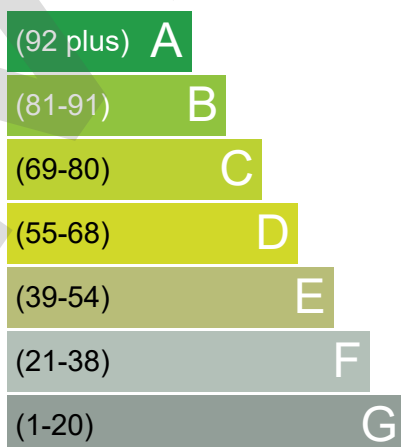
Most energy efficient - lower running costs



CURRENT	POTENTIAL
90	90

Carbon Dioxide (CO2) Emissions Rating

Very environmentally friendly - lower CO2 emissions



CURRENT	POTENTIAL
98	98

Additional ratings for your home

	Primary Energy	Energy	Carbon	Cost	HTC
CURRENT	20.02 kWh	3447 kWh	590 kg	1181.16 £	386 W/K
POTENTIAL	20.02 kWh	3447 kWh	590 kg	1181.16 £	386 W/K

Breakdown of property's energy performance

Each feature is assessed as one of the following:

Very Poor	Poor	Average	Good	Very Good
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Feature	Description	Energy Performance
Walls	Average thermal transmittance 0.17 W/m ² K	Very Good
Roof	Average thermal transmittance 0.12 W/m ² K	Very Good
Floor	Average thermal transmittance 0.11 W/m ² K	Very Good
Windows	High performance glazing	Good
Main heating	Air source heat pump, radiators and underfloor, electric	Good
Main heating controls	Time and temperature zone control	Very Good
Secondary heating	None	
Hot water	From main system	Very Good
Lighting	Good lighting efficiency	Good
Air tightness	Air permeability [AP50] = 4.0 m ³ /h.m ² (assumed)	Good

Recommendations

The recommended measures provided below will help to improve the energy efficiency of the dwelling. To reach the dwelling's potential energy rating all of the recommended measures shown below would need to be installed. Having these measures installed individually or in any other order may give a different result when compared with the cumulative potential rating.

Recommended measures	Cumulative savings (per year)	Cumulative rating	Typical costs	Incremental savings (per year)	Cumulative CO2 rating
Solar water heating	£32	B 90			A 98

The typical cost is based on average installation prices across the country so may not be representative of the actual costs in your area.

Estimated energy costs of the dwelling

The table below shows the estimated running costs of the space and water heating and lighting within the dwelling. It does not include the energy used from household appliances. The estimated annual costs after potential improvements indicates the total energy cost if all recommended measures named above were installed.

		Estimated annual costs	Estimated annual costs after potential improvements	Potential future savings
Lighting		£110	£110	
Heating		£1263	£1263	
Hot Water		£300	£300	
New Technologies e.g. Impact of PV		-(£492)	-(£492)	
TOTAL		£1181	£1181	

Estimated energy use and potential savings



Space Heating
4689
kWh per year



Water Heating
1152
kWh per year

About this document

Created by:	Mr. Paul Goddard
Company/Trading name:	Anderson Goddard Limited
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Disclaimer

This Energy Report should not under any circumstances be treated as a Condition Survey and cannot be used to indicate that any element of the dwelling (e.g. heating system) is working correctly.

This Energy Report must not be used in situations where an Energy Performance Certificate (EPC) is required.

This Energy Report is generated from a set of data inputs which may not reflect the actual dimensions, services or construction of the dwelling.

The calculation used to generate this report reflects the SAP Methodology current at the time of report generation.

Glossary terms for additional metrics

Primary Energy	The measure of the energy required for lighting, heating and hot water in a property. This includes the efficiency of the property's heating system, power station efficiency for electricity and the energy used to produce the fuel and deliver it to the property.
Energy Used	The estimated amount of fuel energy for lighting, heating and hot water for the property. The estimate is based on typical usage which is likely to be different to actual consumption.
Carbon (CO ₂)	The current emissions based on the energy estimates.
Cost	The estimated cost of energy. The cost of each unit of fuel is based on an industry standard which is likely to be different to those the occupier actually pays.
Heat Transfer Coefficient	Heat flow through the property envelope where internal and external temperatures are different.

Building Regulations England Part L (BREL) Compliance Report

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

Date: Thu 06 Feb 2025 11:48:35

Project Information			
Assessed By	Paul Goddard	Building Type	House, Detached
OCDEA Registration	EES/005113	Assessment Date	2025-02-06

Dwelling Details			
Assessment Type	As designed	Total Floor Area	351 m ²
Site Reference	78523	Plot Reference	001
Address	4 Ringley Close, Whitefield, MANCHESTER, M45 7HR		

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	8.51 kgCO ₂ /m ²		
Dwelling carbon dioxide emission rate	1.66 kgCO ₂ /m ²		OK
1b Target primary energy rate and dwelling primary energy			
Target primary energy	45.45 kWh _{PE} /m ²		
Dwelling primary energy	20.1 kWh _{PE} /m ²		OK
1c Target fabric energy efficiency and dwelling fabric energy efficiency			
Target fabric energy efficiency	46.3 kWh/m ²		
Dwelling fabric energy efficiency	46.3 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	0.12	Roof (1) (0.13)	OK
Windows, doors, and roof windows	1.6	1.19	Front (1.2)	OK
Rooflights	2.2	1.66	Lantern, East (1.7)	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)	262.06	0.18
Sheltered wall: Walls (2)	55.28	0.12 (!)
Ground floor: GF, GF	166.5	0.11
Exposed roof: Roof (1)	93.18	0.13
Exposed roof: Roof (2)	48.47	0.1 (!)
Exposed roof: Roof (3)	40.21	0.13

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]
Door, Door	4.32	South West	N/A	1 (!)
Front, Window	16.73	South West	0.7	1.2
Side, Window	5.88	South East	0.7	1.2
Rear, Window	36.99	North East	0.7	1.2
Side, Window	1.78	North West	0.7	1.2
RL, Rooflight	2.4	North East	0.7	1.6
RL, Rooflight	4	South West	0.7	1.6
Lantern, Lantern	8.4	East	0.7	1.7

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	To be modelled
External wall	E3: Sill	Calculated by person with suitable expertise	0.05	To be modelled
External wall	E4: Jamb	Calculated by person with suitable expertise	0.05	To be modelled
External wall	E5: Ground floor (normal)	Calculated by person with suitable expertise	0.1	To be modelled
External wall	E16: Corner (normal)	Calculated by person with suitable expertise	0.06	To be modelled
External wall	E17: Corner (inverted - internal area greater than external area)	Calculated by person with suitable expertise	-0.09	To be modelled
External wall	E6: Intermediate floor within a dwelling	Calculated by person with suitable expertise	0.002 (!)	To be modelled
External wall	E10: Eaves (insulation at ceiling level)	Calculated by person with suitable expertise	0.06	To be modelled
External wall	E13: Gable (insulation at rafter level)	Calculated by person with suitable expertise	0.08	To be modelled
External wall	E15: Flat roof with parapet	SAP table default	0.3	To be modelled
Roof	R6: Flat ceiling	SAP table default	0.12	To be modelled
External wall	E24: Eaves (insulation at ceiling level - inverted)	SAP table default	0.15	To be modelled
Roof	R1: Head of roof window	SAP table default	0.24	To be modelled
Roof	R2: Sill of roof window	SAP table default	0.24	To be modelled
Roof	R3: Jamb of roof window	SAP table default	0.24	To be modelled
Roof	R11: Upstands or kerbs of rooflights	SAP table default	0.24	To be modelled

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	316.6%
Emitter type	Both radiators and underfloor
Flow temperature	45°C
System type	Heat Pump
Manufacturer	Vaillant Group UK Ltd
Model	aroTHERM plus 12kW & AI 300I
Commissioning	
Secondary heating system: N/A	
Fuel	N/A
Efficiency	N/A
Commissioning	

5 Hot water

Cylinder/store - type: Cylinder	
Capacity	300 litres
Declared heat loss	1.59 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	80.6 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	Lo-Carbon NBR dMEV C 100, 498095	
Commissioning		
9 Local generation		
Technology type: Photovoltaic system (1)		
Peak power	4 kWp	
Orientation	South East	
Pitch	45°	
Overshading	None or very little	
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		