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**CLIENT**

Private

**PROJECT**

Energy Statement

57 Leegate Road
Heaton Moore SK4 4AX

**Project No.:** 23/169
**Date:** January 2024
**Revision:** 01

## Contents

# 1 Project Proposal

57 Leegate Road is an existing dwelling located in Heaton Moore. The proposal involves the demolition of the existing dwelling and the construction of new family accommodation. The new dwelling will span 3 floors and have a total floor area of 300 $m^2$. The new dwelling will be constructed in alignment with the relevant planning policies and building regulations.

# 2 Planning Policy

## 2.1 National Planning Policy Framework

The National Planning Policy Framework sets out the Government's planning policies for England and how they should be applied. It provides a framework to which locally-prepared plans for housing and other developments can be produced. Specifically, section 2, 'achieving sustainable development', is relevant to the topics discussed in this energy statement.

### 2.1.1 Achieving Sustainable Development

Achieving sustainable development means that the planning system has three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways (so that opportunities can be taken to secure net gains across each of the different objectives):

a) an economic objective – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure;

b) a social objective – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering well-designed, beautiful and safe places, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and

c) an environmental objective – to protect and enhance our natural, built and historic environment; including making effective use of land, improving biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.

## 3 Building Regulations Baseline

Baseline emissions were calculated using the notional dwelling specification in Building Regulations Part L1. The notional building specification forms the basis of all SAP calculations.

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

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

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

Notional Building Specification – Part L1

## 3.1 Baseline SAP Results

By using Design SAP 10, the baseline emissions for 57 Leegate Road were calculated as follows.

| | |
|---|---|
| **Baseline Emission Rate** | 8.4 kgCO2/yr/$m^2$ |
| **Baseline Primary Energy Rate** | 44.9 kWh/$m^2$/yr |
| **Baseline Fabric Energy Efficiency** | 44.4 kWh/$m^2$/yr |

# 4 Building Fabric

By ensuring the building fabric is as efficient as possible whilst implementing passive design principles, the building's performance can be greatly improved.

## 4.1 Building Fabric U-values

Elements of the building fabric are recommended to achieve the following U-values.

| Element | U-value (W/$m^2K$) |
|---|---|
| External Wall | 0.14 |
| Roof | 0.11 |
| Floor | 0.11 |
| External Windows | 1.2 |
| External Doors | 1.0 |
| Rooflights | 1.2 |

- The U-value of the walls improve on the reference value in Building Regulations Part L1 by 0.04 W/$m^2K$.
- The U-value of the floor improves on the reference value in Building Regulations Part L1 by 0.02 W/$m^2K$.
- The U-value of the rooflights improves on the reference value in Building Regulations Part L1 by 0.5 W/$m^2K$.

## 4.2 Air Permeability

Air permeability is the physical property used to measure the air tightness of a dwelling's building fabric. The greater the air tightness at a given pressure difference across the building envelope, the lower the outside air infiltration.

An air permeability of 3.0 $m^3/(h.m^2)$ at 50 Pa is sought for the property. This is an improvement of 2.0 $m^3/(h.m^2)$ at 50 Pa when compared to the reference value in Building Regulation Part L1.

## 4.3 Thermal Bridging

Thermal bridges or cold bridges are weak points in a building's envelope that allows for heat to pass through more easily. Materials which are good conductors of heat, facilitate heat transfer from inner to outer surfaces. Minimising thermal bridges reduces the heat gains/losses in the property, resulting in an increase in energy efficiency.

The sum of all heat losses from the thermal bridges at 57 Leegate Road will be kept between 0.05 – 0.1 W/$m^2K$.

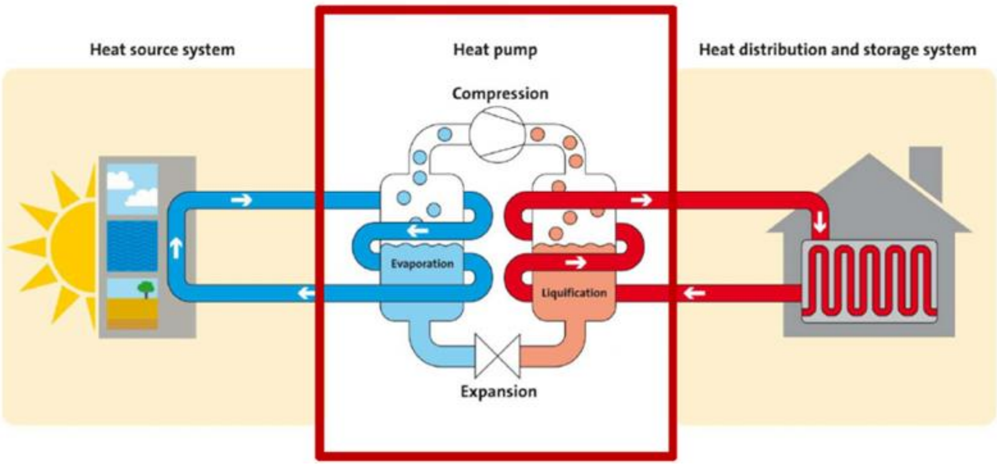
# 5 Space and Water Heating Options

A number of space and water heating options were assessed for the dwelling. They were assessed based on their ability to meet the heating requirement of the dwelling whilst complying with planning policies and building regulations.

## 5.1 Air Source Heat Pump (ASHP)

An Air Source Heat Pump (ASHP) scavenges heat from the air which is then absorbed by a refrigerant. This refrigerant is than utilised in an electrically powered refrigeration cycle to produce hot water. The efficiency of ASHP will vary depending on the outside air temperature.

The majority of heat pumps are capable of heating up the water to 55 °C, and some are capable of supplying water at 80 °C to match that of a traditional gas heating system. However, the heat pump becomes much less efficient the higher the water temperature produced, hence the more electricity it consumes.




Refrigeration Cycle

ASHPs can be located in a plant room or externally. The units require adequate air flow around them. If the units are located externally, they will likely need to be housed in an acoustic enclosure.

### 5.1.1 Recommendation

An ASHP is recommended to provide space and water heating to the property. Due to the building's efficient fabric, the heating requirement of the building will be much lower than an existing older dwelling. The ASHP will be able to provide a reliable, low emission source of heating to the property.

5.2 Ground Source Heat Pump (GSHP)

Ground Source Heat Pumps (GSHP) extract heat from the ground. Below a depth of 10m, the temperature in the ground generally remains at a constant 11-12°C. At depths above 10m, ground temperatures are more susceptible to seasonal changes.

GSHPs scavenge heat from the ground through the use of ground collectors. Heat transfer to the ground collectors is affected by its surface area and properties of the ground.

A detailed geological surveyed is required before all installs to determine the feasibility of the technology. Depending on the thermal properties of the soil, the ground collectors could be installed either vertically or horizontally.

5.2.1 Horizontal Collectors

Horizontal collectors generally require a large area that is free from hard rock and underground services. The horizontal collectors are buried in trenches that range in depth from 0.5m to 1.0m, depending on manufacturer advice and ground conditions.

Horizontal Ground Collectors

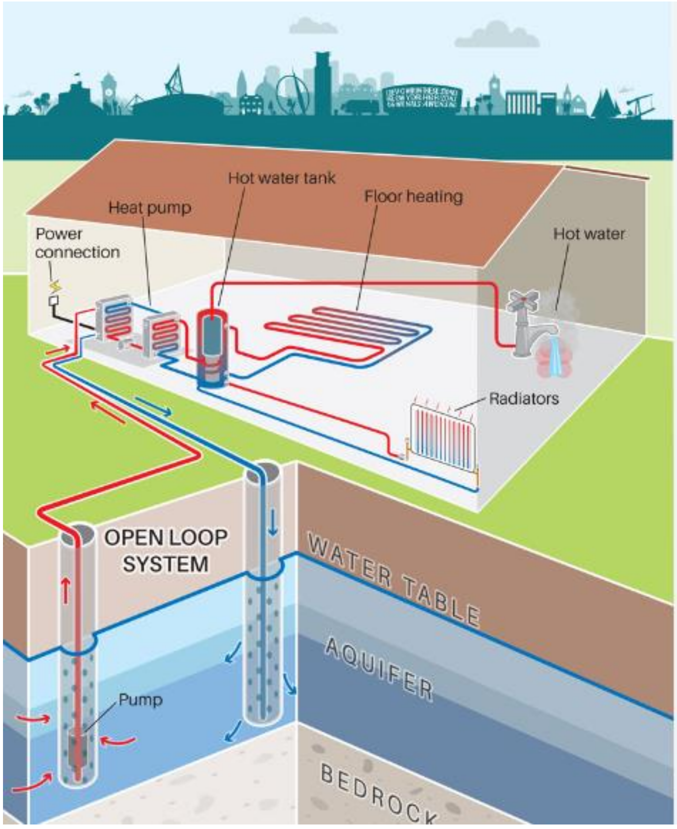
5.2.2 Vertical Collectors

Vertical collectors can be used when land is limited. Boreholes are generally drilled to depths between 150 -180m. Greater depths will add to the complexity of the system install. However, vertical collectors at deep depths benefit from stable ground temperatures.

There are two types of vertical collectors, closed loop and open loop.

A closed loop system consists of a sealed pipe circulating water through each of the boreholes. The pipe is sunk into the borehole and encased in grout which ensures a good contact between the pipe and the surrounding ground. The pipe is then connected back to a heat pump within the building.

An open loop system extracts ground water from one part of the site, extracts (or rejects heat during summer) via a heat pump within the building, and discharges the water back into the ground in a separate part of the site.



GSHP – Open Loop System

5.2.3 Recommendation

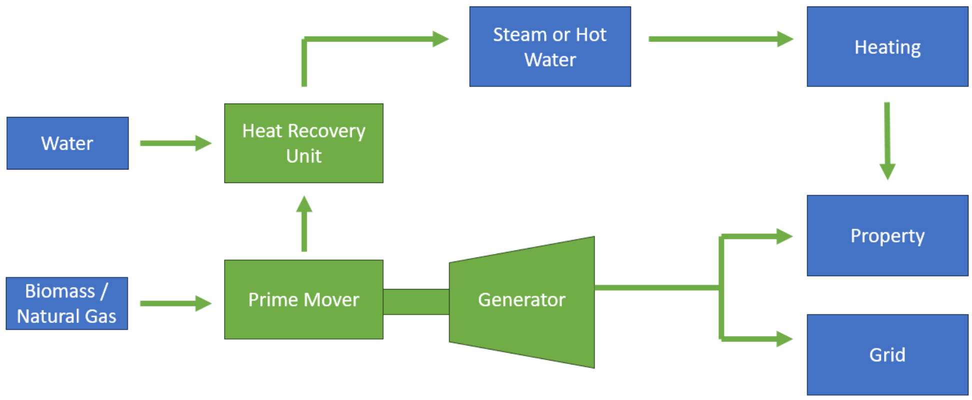
GSHPs are not recommended for the property. A detailed geological survey is required to determine the viability of horizontal or vertical collectors. Depending on the geological conditions, horizontal collectors may require a significant amount of surface area. If vertical collectors are more suited, upfront costs will be significant as the collector will need to be driven to a substantial depth.

5.3 <u>Domestic Combined Heat & Power (CHP)</u>

Combined Heat & Power (CHP) units provide simultaneous generation of electricity and heat from the same source. The primary function of the CHP is to provide heat to the property. The CHP would need to be supplemented by an additional heat source. Fluctuating thermal loads will require a modulating output from the engine which will affect the efficiency of the unit.

The energy generated by a CHP can be used to meet part of the baseload of the property. At times of excess generation, energy could be fed back into the grid on a feed-in tariff, or used to charge an on-site battery system. CHPs are best suited to buildings that have a consistent base electrical and heating load.

The CHP consists of an engine (prime mover) that primarily uses mechanical power to generate electricity. The fuel source for the CHP could either be natural gas or biomass. Other fuel sources such as diesel are considered to be too costly and carbon intensive.




CHP Schematic

The CHP unit will require a reasonable amount of space. It will require an acoustic enclosure to mitigate noise levels during operation. If Biomass is the preferred fuel source, on-site storage will be required.

5.3.1 <u>Recommendation</u>

A CHP will not be feasible for the property due to the high installation costs. Heating loads will not be consistently large enough to benefit from on-site electricity generation.

5.4 Gas Boilers

Gas boilers burn natural gas to generate heat, which is transferred to water. This hot water is then circulated throughout the building.

The UK Government intends to introduce a 20% hydrogen blend to the gas grid. Most new gas boilers are able to effectively operate with a 20% hydrogen blend. Natural gas will become a less carbon intensive fuel source as a hydrogen blend is introduced.

5.4.1 Feasibility

Gas boilers can provide a reliable, low-cost heating option for the property. However, gas boilers will not be able to meet the emissions reduction target stipulated in the SAP calculations.

5.5 Biomass Boilers

Biomass boilers rely on the direct or indirect combustion of fuels derived from plant sources. They operate in a similar manner to a conventional gas boiler, burning a fuel source to heat water.

Start-up times for biomass boilers are longer when compared to conventional gas boilers. As a result, they are not particularly well suited to loads with modulating demands.

Biomass boilers require regular maintenance to ensure it is free from ash or blockages in the feed system. The heat exchanger and flue may become blocked due to soot. Generally, annual maintenance is required, it may be more frequent depending on the manufacturer’s instructions.

5.5.1 Biomass Fuels

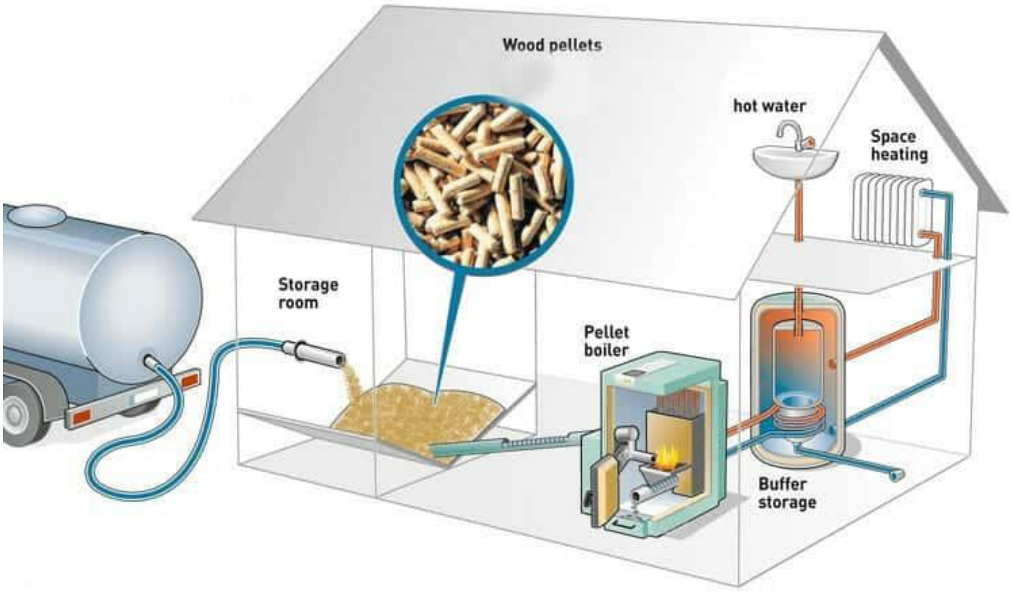
Biomass fuels can produce energy on a consistent basis, unlike some other renewable energy technologies which are weather dependent. They could be used as a potential source of heat and electricity if applied with the appropriate technologies (CHP).

Biomass fuels are derived from organic plants materials. Biomass boilers utilise these fuels in a direct or indirect combustion process.

As plants grow, they absorb carbon from the atmosphere. When they are used in a combustion process, this captured carbon is released back into the atmosphere. As a result, the burning of biomass fuels is considered to produce no net increase to carbon emissions in the atmosphere.

Biomass fuels are not however a completely zero carbon fuel source as carbon emissions are incurred by harvesting, processing, transportation, and storage.

The storage of wood pellets or liquid biofuels require storage space and easy access for lorries to refill the store. The store itself also requires several safety systems to ensure there are no accidental fires or harmful carbon monoxide emissions produced.




Biomass Boiler System

5.5.2 Biomass Fuel Storage

Biomass fuel storage will be required on the property to keep the fuel protected from moisture. The amount of fuel required will be dependent on the capacity of the biomass boilers.

The storage facility needs to have adequate ventilation to prevent mould and to potentially aid in the drying process, as well as limit any chance of dangerous levels of carbon monoxide gas developing.

If the biomass fuel is kept in pristine condition, the risks of fires within the storage facility are low. However, as wood pellets degrade, fine dust may form which will present a fire hazard if it settles on hot surfaces.

Fuel stores therefore require carful design and regular maintenance to prevent the risk of fires.

Recommendation

A biomass boiler is not recommended for the property. The modulating energy demand of the property may not suit the longer start-up times of the biomass boilers. Furthermore, an additional structure will be required on-site fuel storage.

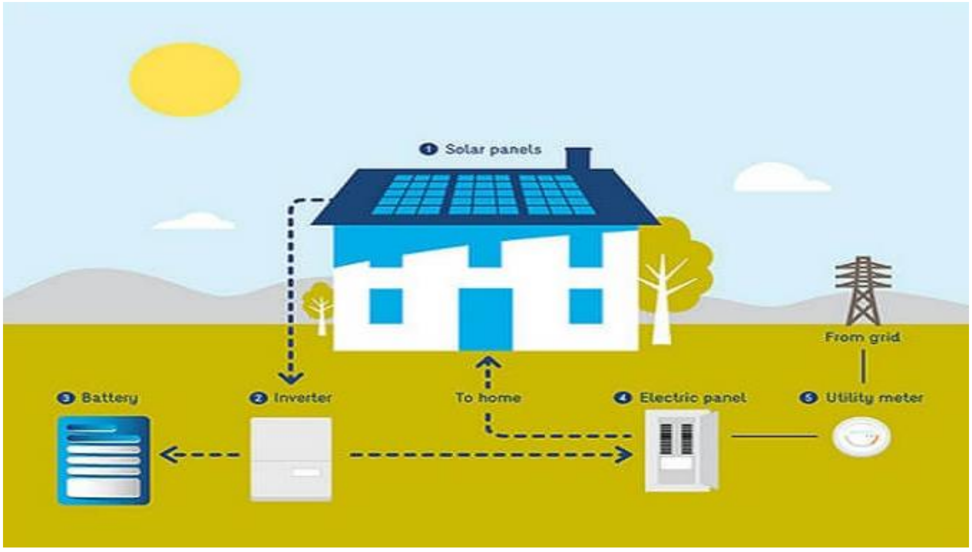
## 6 On-site Renewables

Due to the urban setting of the project, renewable energy sources are limited to solar PV, solar thermal, and wind turbines.

### 6.1 Photovoltaic Panels

Photovoltaic (PV) cells convert sunlight directly to DC electricity. The DC electricity can be utilised to directly power motors or charge batteries. Typically, the DC electricity generated by the PV is converted to AC through the use of an inverter. This AC power can then be distributed to the property or fed back into the grid. Solar PV can either be roof mounted or ground mounted depending on the property.

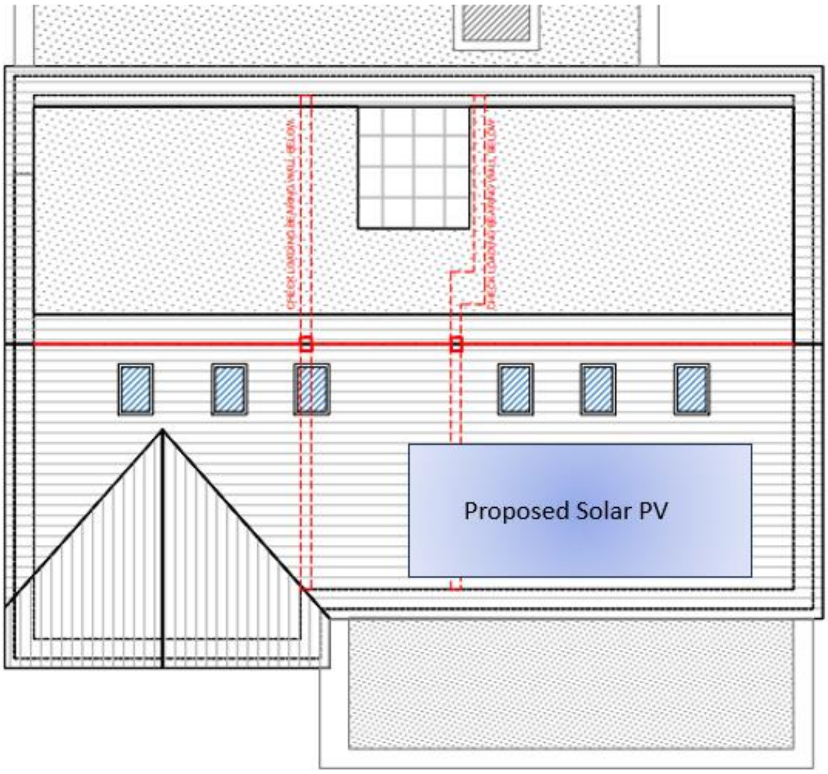
PV panels can be used in conjunction with battery storage to provide electricity to the property during periods of no solar generation. A charge controller regulates the charging and discharging of the battery.




Solar PV & Battery Storage Arrangement

6.1.1 Recommendation

Solar PV is a viable option to provide on-site energy generation. There is sufficient space on the southernly side of the dwelling to install up to 3 kW of solar PV. Solar PV is recommended for the property.




Proposed Solar PV Location

## 6.2 Solar Thermal Panels

Solar thermal water heating systems utilise energy from the sun to heat water. The system incorporates a heat collector that is usually roof mounted. The fluid contained in the heat collector is heated by the sun, the heat from this fluid is then transferred to water in the domestic water system via a coil in the hot water cylinder.

The required surface area of the solar collectors will be dependent on the hot water demand profile. If the property has a large hot water demand, the required solar collector area may not be feasible.

Solar thermal technology could be sized to handle the base heat load of the property. It could be combined with boilers to bring the water up to operating temperature.

### 6.2.1 Recommendation

Solar thermal panels will not be efficient during periods of low solar radiation. During these periods, traditional forms of heating will need to be relied upon to produce hot water for the property. As a result, solar thermal panels are not recommended.

## 6.1 Wind Turbines

Wind turbines harness the power of wind to generate electricity. The blades of the wind turbine capture the energy of the wind and spin the axis of a generator. This generator produces DC electricity which is converted AC electricity for household consumption.

Residential wind turbines can be either pole or building mounted. Pole mounted wind turbines are free standing and are mounted in an exposed position.
They can generate around 6 kW of electricity.

Building mounted wind turbines are smaller and less intrusive than pole mounted wind turbines. However, they will generate less electricity than the pole mounted version.

### 6.1.1 Recommendation

Wind turbines are not recommended for the property. A building mounted wind turbine will not generate a significant enough amount of energy to offset the property’s electricity consumption. A pole mounted wind turbine will likely be too intrusive for the property. There are structures and trees around the property that may affect electricity generation.

## 7 SAP Results

The below table highlights the improvements to the baseline SAP results if the recommended building fabric improvements and heating option are implemented.

| | |
|---|---|
| **Baseline Emission Rate** | 8.4 kgCO2/yr/$m^2$ |
| **Dwelling Emission Rate** | 3.4 kgCO2/yr/$m^2$ |
| **Reduction From Baseline** | 59.1 % |
| | |
| **Baseline Primary Energy Rate** | 44.9 kWh/$m^2$/yr |
| **Dwelling Primary Energy Rate** | 34.8 kWh/$m^2$/yr |
| **Reduction From Baseline** | 22.5 % |
| | |
| **Baseline Fabric Energy Efficiency** | 44.4 kWh/$m^2$/yr |
| **Dwelling Fabric Energy Efficiency** | 44.1 kWh/$m^2$/yr |
| **Reduction From Baseline** | 0.75 % |

The recommended improvements to the building fabric, the use of an ASHP, and the installation of 3 kW of solar PV results in a 59.1% reduction in the dwelling's carbon emissions. Furthermore, the dwelling's primary energy usage could be reduced to 22.5 % when compared to baseline conditions (SAP calculations attached in Appendix A).

## 8 Water Efficiency

If the property is to reduce water consumption, water efficient fittings will need to be installed on the property. Grey water recycling and rain water harvesting could also be investigated.

### 8.1 Water Efficient Fixtures

Installing water efficient fittings on the property will drastically reduce on-site water consumption. As a general guide, building regulations Part G allows for a 110 litres per person per day target.

The following figures demonstrate the maximum allowable water consumption for fittings to attain the target of 110 litres per person per day.

- Showers Limited to 8 litres / m with flow restrictor.
- WCs 4 / 2.6 litre dual flush.
- Basin Taps Limited to 5 litres / m with flow restrictor.
- Kitchen Taps Limited to 6 litres / m with flow restrictor.
- Baths Max. 170 litres to overflow.
- Washing Machine Max. 8.17 litres / kg dry load.
- Dishwasher Max. 1.25 litres / place setting.

### 8.2 Grey Water

Grey water is water that has been used by the washing machine, bath tub, shower or bathroom sinks. Grey water is deemed to not be toxic and fit for repurpose.

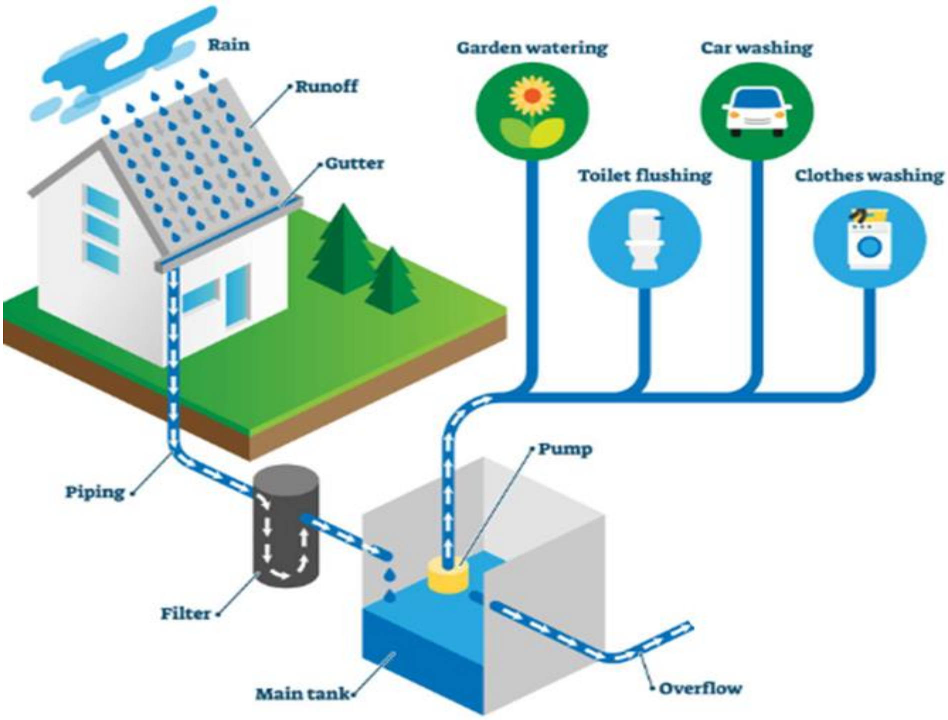
Grey water can be diverted from the main plumbing system, filtered, and stored in storage tanks. The water can then be reused for toiler flushing or irrigation systems.

Grey water systems do incur ongoing maintenance costs and are not cost effective if the available grey water does not match demand. A grey water system is not recommended.

8.3 <u>Rain Water Harvesting</u>

Capturing rainwater provides a cost effective and efficient means of meeting the non-potable water demand on properties.

The amount of rain water captured will be dependent on the surface area of the roof and annual rainfall. Storage tanks for the rain water harvesting may be located above or below ground.




Rainwater Harvesting Schematic

The stored water is pumped out of the storage tank, filtered and can be supplied to toilets, washing machines and irrigation systems.

With a proper filtration and sterilisation system, the water can be cleaned and used for potable (drinking) water supply to the property. The filtration process does however require a reasonable amount of electricity to run.

Onsite rain water storage will be limited due to space restrictions on the property. The system will be further limited by the amount of rain fall in the area. Due to the high installation cost and possible limited use, the system is not recommended.

# 9 Drainage

The following preliminary drainage scheme is for consideration. The final scheme may change pending a detailed investigation.

- Any existing redundant drainage will be removed.
- The foul water drainage system will connect to existing outgoing drain connection to the local water authority sewer network.
- The surface water run -off will be reduced by 50% in line with the Stockport core strategy.
- The feasibility of a soakaway will be considered as the preferred method of surface water disposal by infiltration.
- If a soakaway is not feasible then attenuation will be provided in the form of a buried attenuation tank with controlled flow outlet to the local water authority sewer connection.
- The use of permeable surfaces for the driveways are to be considered, along with water butts at the rainwater downpipes.
- Rodding access will be provided at all of the drain points and manholes/ inspection chambers provided at changes of direction and where required to maintain the below ground systems.
- All rainwater pipes will be trapped before connection to the below ground system.

# 10 Appendix A – SAP Calculations

# Full SAP Calculation Printout

elmhurst energy

| Property Reference | Baseline | Issued on Date | 08/01/2024 |
|---|---|---|---|
| Assessment Reference | 00001 | Prop Type Ref | Baseline |
| Property | | | |

| SAP Rating | 82 B | DER | 3.44 | TER | 8.42 |
|---|---|---|---|---|---|
| Environmental | 96 A | % DER < TER | | | 59.14 |
| $CO_2$ Emissions (t/year) | 1.09 | DFEE | 44.09 | TFEE | 44.43 |
| Compliance Check | See BREL | % DFEE < TFEE | | | 0.75 |
| % DPER < TPER | 22.52 | DPER | 34.76 | TPER | 44.86 |

| Assessor Details | Mr. Theolan Govender | Assessor ID | CM44-0001 |
|---|---|---|---|
| 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 (m2) | | | Storey height (m) | | | Volume (m3) | |
|---|---|---|---|---|---|---|---|---|
| Ground floor | 150.0000 | (1b) | x | 2.7000 | (2b) | = | 405.0000 | (1b) - (3b) |
| First floor | 90.0000 | (1c) | x | 2.3000 | (2c) | = | 207.0000 | (1c) - (3c) |
| Second floor | 60.0000 | (1d) | x | 2.4000 | (2d) | = | 144.0000 | (1d) - (3d) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 300.0000 | | | | | | | | (4) |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | | = | 756.0000 | (5) |

## 2. Ventilation rate

| | | m3 per hour | |
|---|---|---|---|
| Number of open chimneys | 0 * 80 = | 0.0000 | (6a) |
| Number of open flues | 0 * 20 = | 0.0000 | (6b) |
| Number of chimneys / flues attached to closed fire | 0 * 10 = | 0.0000 | (6c) |
| Number of flues attached to solid fuel boiler | 0 * 20 = | 0.0000 | (6d) |
| Number of flues attached to other heater | 0 * 35 = | 0.0000 | (6e) |
| Number of blocked chimneys | 0 * 20 = | 0.0000 | (6f) |
| Number of intermittent extract fans | 5 * 10 = | 50.0000 | (7a) |
| Number of passive vents | 0 * 10 = | 0.0000 | (7b) |
| Number of flueless gas fires | 0 * 40 = | 0.0000 | (7c) |

| | | Air changes per hour | |
|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = | 50.0000 / (5) = | 0.0661 | (8) |
| Pressure test | | Yes | |
| Pressure Test Method | | Blower Door | |
| Measured/design AP50 | | 3.0000 | (17) |
| Infiltration rate | | 0.2161 | (18) |
| Number of sides sheltered | | 0 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 1.0000 | (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) = | 0.2161 | (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 | 0.2756 | 0.2702 | 0.2648 | 0.2378 | 0.2323 | 0.2053 | 0.2053 | 0.1999 | 0.2161 | 0.2323 | 0.2432 | 0.2540 | (22b) |
| Effective ac | 0.5380 | 0.5365 | 0.5351 | 0.5283 | 0.5270 | 0.5211 | 0.5211 | 0.5200 | 0.5234 | 0.5270 | 0.5296 | 0.5322 | (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 | |
|---|---|---|---|---|---|---|---|---|
| Opening Type 1 (Uw = 1.20) | | | 85.4000 | 1.1450 | 97.7863 | | | (27) |
| Opening Type 3 | | | 2.2500 | 1.0000 | 2.2500 | | | (26) |
| Opening | | | 6.6000 | 1.1450 | 7.5573 | | | (27a) |
| Opening | | | 1.4000 | 1.1450 | 1.6031 | | | (27a) |
| Heatloss Floor 1 | | | 150.0000 | 0.1100 | 16.5000 | 110.0000 | 16500.0000 | (28a) |
| External Wall - GF | 143.5000 | 28.5500 | 114.9500 | 0.1400 | 16.0930 | 190.0000 | 21840.5000 | (29a) |
| External Wall - 1ST | 91.2000 | 36.5000 | 54.7000 | 0.1400 | 7.6580 | 190.0000 | 10393.0000 | (29a) |
| External Wall - 2ND | 54.3000 | 22.6000 | 31.7000 | 0.1400 | 4.4380 | 190.0000 | 6023.0000 | (29a) |
| External Roof 1 | 60.0000 | 1.4000 | 58.6000 | 0.1100 | 6.4460 | 9.0000 | 527.4000 | (30) |
| External Roof 2 | 42.5000 | 6.6000 | 35.9000 | 0.1100 | 3.9490 | 9.0000 | 323.1000 | (30) |
| Total net area of external elements Aum(A, m2) | | | 541.5000 | | | | | (31) |
| Fabric heat loss, W/K = Sum (A x U) | | | | (26)...(30) + (32) = | 164.2806 | | | (33) |
| Internal Wall - gf | | | 200.0000 | | | 100.0000 | 20000.0000 | (32c) |
| Internal Wall - 1st | | | 162.0000 | | | 100.0000 | 16200.0000 | (32c) |
| Internal Wall - 2nd | | | 123.8000 | | | 100.0000 | 12380.0000 | (32c) |
| Internal Ceiling 1 | | | 60.0000 | | | 9.0000 | 540.0000 | (32e) |
| Internal Ceiling 2 | | | 90.0000 | | | 9.0000 | 810.0000 | (32e) |

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 105537.0000 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 351.7900 (35)
Thermal bridges (User defined value 0.095 * total exposed area) 51.4425 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 215.7231 (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 | 134.2130 | 133.8451 | 133.4846 | 131.7910 | 131.4742 | 129.9991 | 129.9991 | 129.7260 | 130.5673 | 131.4742 | 132.1152 | 132.7853 | (38) |
| Heat transfer coeff | 349.9360 | 349.5682 | 349.2076 | 347.5141 | 347.1972 | 345.7222 | 345.7222 | 345.4490 | 346.2903 | 347.1972 | 347.8382 | 348.5084 | (39) |
| Average = Sum(39)m / 12 = | | | | | | | | | | | | 347.5126 | |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HLP | 1.1665 | 1.1652 | 1.1640 | 1.1584 | 1.1573 | 1.1524 | 1.1524 | 1.1515 | 1.1543 | 1.1573 | 1.1595 | 1.1617 | (40) |
| HLP (average) | | | | | | | | | | | | 1.1584 | |
| Days in mont | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |

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4. Water heating energy requirements (kWh/year)

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Assumed occupancy 3.1319 (42)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage for mixer showers | 76.7321 | 75.5789 | 73.8986 | 70.6836 | 68.3109 | 65.6650 | 64.1611 | 65.8287 | 67.6567 | 70.4977 | 73.7817 | 76.4381 | (42a) |
| Hot water usage for baths | 33.1205 | 32.6286 | 31.9360 | 30.6588 | 29.7024 | 28.6420 | 28.0692 | 28.7571 | 29.5060 | 30.6407 | 31.9442 | 33.0086 | (42b) |
| Hot water usage for other uses | 46.7041 | 45.0058 | 43.3074 | 41.6091 | 39.9108 | 38.2124 | 38.2124 | 39.9108 | 41.6091 | 43.3074 | 45.0058 | 46.7041 | (42c) |
| Average daily hot water use (litres/day) | | | | | | | | | | | | 143.9106 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily hot water use | 156.5567 | 153.2133 | 149.1420 | 142.9514 | 137.9242 | 132.5195 | 130.4428 | 134.4966 | 138.7718 | 144.4458 | 150.7317 | 156.1507 | (44) |
| Energy conte | 247.9475 | 218.1737 | 229.2257 | 195.6934 | 185.6724 | 162.9482 | 157.7592 | 166.5348 | 171.1196 | 196.0116 | 214.7449 | 244.4943 | (45) |
| Energy content (annual) | | | | | | | | | | Total = Sum(45)m = | | 2390.3253 | |
| Distribution loss (46)m = 0.15 x (45)m | 37.1921 | 32.7261 | 34.3839 | 29.3540 | 27.8509 | 24.4422 | 23.6639 | 24.9802 | 25.6679 | 29.4017 | 32.2117 | 36.6741 | (46) |

Water storage loss:
Store volume 200.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day): 2.0900 (48)
Temperature factor from Table 2b 0.5400 (49)
Enter (49) or (54) in (55) 1.1286 (55)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total storage loss | 34.9866 | 31.6008 | 34.9866 | 33.8580 | 34.9866 | 33.8580 | 34.9866 | 34.9866 | 33.8580 | 34.9866 | 33.8580 | 34.9866 | (56) |
| If cylinder contains dedicated solar storage | 34.9866 | 31.6008 | 34.9866 | 33.8580 | 34.9866 | 33.8580 | 34.9866 | 34.9866 | 33.8580 | 34.9866 | 33.8580 | 34.9866 | (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 | 306.1965 | 270.7857 | 287.4747 | 252.0634 | 243.9214 | 219.3182 | 216.0082 | 224.7838 | 227.4896 | 254.2606 | 271.1149 | 302.7433 | (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 | 306.1965 | 270.7857 | 287.4747 | 252.0634 | 243.9214 | 219.3182 | 216.0082 | 224.7838 | 227.4896 | 254.2606 | 271.1149 | 302.7433 | (64) |

Total per year (kWh/year) = Sum(64)m = 3076.1603 (64)
12Total per year (kWh/year) 3076 (64)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat gains from water heating, kWh/month | 129.0418 | 114.6324 | 122.8167 | 110.1640 | 108.3353 | 99.2763 | 99.0541 | 101.9720 | 101.9933 | 111.7730 | 116.4987 | 127.8936 | (65) |

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

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Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 231.1418 | 255.9070 | 231.1418 | 238.8465 | 231.1418 | 238.8465 | 231.1418 | 231.1418 | 238.8465 | 231.1418 | 238.8465 | 231.1418 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 458.2645 | 463.0199 | 451.0365 | 425.5254 | 393.3223 | 363.0558 | 342.8360 | 338.0806 | 350.0640 | 375.5750 | 407.7782 | 438.0447 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | (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) | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | (71) |
| Water heating gains (Table 5) | 173.4432 | 170.5839 | 165.0763 | 153.0056 | 145.6119 | 137.8837 | 133.1373 | 137.0592 | 141.6573 | 150.2326 | 161.8037 | 171.8999 | (72) |
| Total internal gains | 932.8285 | 959.4897 | 917.2336 | 887.3566 | 840.0550 | 809.7650 | 777.0940 | 776.2606 | 800.5467 | 826.9284 | 878.4074 | 911.0654 | (73) |

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6. Solar gains

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| [Jan] | Area m2 | Solar flux Table 6a W/m2 | g Specific data or Table 6b | FF Specific data or Table 6c | Access factor Table 6d | Gains W | |
|---|---|---|---|---|---|---|---|
| Southeast | 26.8000 | 36.7938 | 0.7200 | 0.7000 | 0.7700 | 344.4083 | (77) |
| Northwest | 58.6000 | 11.2829 | 0.7200 | 0.7000 | 0.7700 | 230.9318 | (81) |
| Northeast | 8.0000 | 26.0000 | 0.7200 | 0.7000 | 1.0000 | 94.3488 | (82) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains | 669.6889 | 1252.6783 | 1997.9650 | 2929.7631 | 3680.3377 | 3824.9044 | 3616.6893 | 3033.3477 | 2318.4293 | 1462.3400 | 822.8441 | 559.5370 | (83) |
| Total gains | 1602.5174 | 2212.1680 | 2915.1986 | 3817.1196 | 4520.3927 | 4634.6694 | 4393.7833 | 3809.6083 | 3118.9761 | 2289.2684 | 1701.2515 | 1470.6024 | (84) |

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7. Mean internal temperature (heating season)

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

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tau | 83.7748 | 83.8630 | 83.9496 | 84.3587 | 84.4357 | 84.7959 | 84.7959 | 84.8630 | 84.6568 | 84.4357 | 84.2801 | 84.1180 | |
| alpha | 6.5850 | 6.5909 | 6.5966 | 6.6239 | 6.6290 | 6.6531 | 6.6531 | 6.6575 | 6.6438 | 6.6290 | 6.6187 | 6.6079 | |
| util living area | 0.9999 | 0.9987 | 0.9887 | 0.9069 | 0.6905 | 0.4756 | 0.3460 | 0.4164 | 0.7310 | 0.9816 | 0.9994 | 0.9999 | (86) |
| Living | 20.0948 | 20.2612 | 20.5115 | 20.8026 | 20.9314 | 20.9516 | 20.9531 | 20.9528 | 20.9310 | 20.6769 | 20.3183 | 20.0655 | |
| Non living | 18.8810 | 19.0950 | 19.4132 | 19.7596 | 19.8804 | 19.8977 | 19.8983 | 19.8990 | 19.8857 | 19.6265 | 19.1724 | 18.8466 | |
| 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 | 20.5369 | 20.2612 | 20.5115 | 20.8026 | 20.9314 | 20.9516 | 20.9531 | 20.9528 | 20.9310 | 20.6769 | 20.3183 | 20.1962 | (87) |
| Th 2 | 19.9469 | 19.9479 | 19.9489 | 19.9534 | 19.9543 | 19.9583 | 19.9583 | 19.9590 | 19.9567 | 19.9543 | 19.9526 | 19.9508 | (88) |
| util rest of house | 0.9998 | 0.9981 | 0.9832 | 0.8716 | 0.6223 | 0.3992 | 0.2642 | 0.3226 | 0.6367 | 0.9688 | 0.9990 | 0.9999 | (89) |
| MIT 2 | 19.5220 | 19.0950 | 19.4132 | 19.7596 | 19.8804 | 19.8977 | 19.8983 | 19.8990 | 19.8857 | 19.6265 | 19.1724 | 19.0456 | (90) |
| Living area fraction | | | | | | | | | fLA = Living area / (4) = | | | 0.2833 | (91) |
| MIT | 19.8096 | 19.4254 | 19.7244 | 20.0551 | 20.1782 | 20.1963 | 20.1972 | 20.1976 | 20.1819 | 19.9241 | 19.4970 | 19.3716 | (92) |
| Temperature adjustment | | | | | | | | | | | | 0.0000 | |
| adjusted MIT | 19.8096 | 19.4254 | 19.7244 | 20.0551 | 20.1782 | 20.1963 | 20.1972 | 20.1976 | 20.1819 | 19.9241 | 19.4970 | 19.3716 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation | 0.9998 | 0.9976 | 0.9817 | 0.8754 | 0.6374 | 0.4167 | 0.2830 | 0.3442 | 0.6583 | 0.9683 | 0.9987 | 0.9998 | (94) |
| Useful gains | 1602.1507 | 2206.9335 | 2861.8874 | 3341.6872 | 2881.4760 | 1931.3819 | 1243.4163 | 1311.1495 | 2053.1158 | 2216.6924 | 1699.0649 | 1470.3767 | (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 | 5427.3555 | 5077.6295 | 4618.0719 | 3876.5510 | 2943.6045 | 1934.7577 | 1243.6174 | 1311.8612 | 2106.1054 | 3237.2987 | 4312.1677 | 5287.4270 | (97) |
| Space heating kWh | 2845.9523 | 1929.1077 | 1306.6013 | 385.1019 | 46.2236 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 759.3311 | 1881.4340 | 2839.8855 | (98a) |
| Space heating requirement - total per year (kWh/year) | | | | | | | | | | | | 11993.6375 | |
| 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 | 2845.9523 | 1929.1077 | 1306.6013 | 385.1019 | 46.2236 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 759.3311 | 1881.4340 | 2839.8855 | (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) | | | | | | | | | | | | 11993.6375 | |
| Space heating per m2 | | | | | | | | | | | (98c) / (4) = | 39.9788 | (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 %) | 215.7552 | (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 | 2845.9523 | 1929.1077 | 1306.6013 | 385.1019 | 46.2236 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 759.3311 | 1881.4340 | 2839.8855 | (98) |
| Space heating efficiency (main heating system 1) | 215.7552 | 215.7552 | 215.7552 | 215.7552 | 215.7552 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 215.7552 | 215.7552 | 215.7552 | (210) |
| Space heating fuel (main heating system) | 1319.0652 | 894.1186 | 605.5942 | 178.4902 | 21.4241 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 351.9410 | 872.0224 | 1316.2533 | (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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water heating requirement | 306.1965 | 270.7857 | 287.4747 | 252.0634 | 243.9214 | 219.3182 | 216.0082 | 224.7838 | 227.4896 | 254.2606 | 271.1149 | 302.7433 | (64) |
| Efficiency of water heater | | | | | | | | | | | | 167.9071 | (216) |
| (217)m | 167.9071 | 167.9071 | 167.9071 | 167.9071 | 167.9071 | 167.9071 | 167.9071 | 167.9071 | 167.9071 | 167.9071 | 167.9071 | 167.9071 | (217) |
| Fuel for water heating, kWh/month | 182.3607 | 161.2712 | 171.2105 | 150.1207 | 145.2717 | 130.6188 | 128.6475 | 133.8739 | 135.4854 | 151.4293 | 161.4672 | 180.3040 | (219) |
| Space cooling fuel requirement (221)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (221) |
| Pumps and Fa | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (231) |
| Lighting | 47.0465 | 37.7424 | 33.9829 | 24.8973 | 19.2314 | 15.7122 | 17.5435 | 22.8037 | 29.6198 | 38.8628 | 43.8954 | 48.3540 | (232) |
| Electricity generated by PVs (Appendix M) (negative quantity) (233a)m | -45.1912 | -71.4145 | -112.8671 | -130.7235 | -141.6490 | -133.5178 | -131.4415 | -120.0038 | -100.4146 | -82.9786 | -51.7096 | -38.0217 | (233a) |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (234a) |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (235a) |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (235c) |
| Electricity generated by PVs (Appendix M) (negative quantity) (233b)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (233b) |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (234b) |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (235b) |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235d)m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (235d) |

Annual totals kWh/year

| | | |
|---|---|---|
| Space heating fuel - main system 1 | 5558.9089 | (211) |
| Space heating fuel - main system 2 | 0.0000 | (213) |
| Space heating fuel - secondary | 0.0000 | (215) |
| Efficiency of water heater | 167.9071 | |
| Water heating fuel used | 1832.0608 | (219) |
| Space cooling fuel | 0.0000 | (221) |

Electricity for pumps and fans:

| | | |
|---|---|---|
| Total electricity for the above, kWh/year | 0.0000 | (231) |
| Electricity for lighting (calculated in Appendix L) | 379.6920 | (232) |

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

| | | |
|---|---|---|
| PV generation | -1159.9329 | (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 | 6610.7289 | (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 | 5558.9089 | 0.1571 | 873.1632 | (261) |
| Total CO2 associated with community systems | | | 0.0000 | (373) |
| Water heating (other fuel) | 1832.0608 | 0.1409 | 258.2092 | (264) |
| Space and water heating | | | 1131.3724 | (265) |
| Pumps, fans and electric keep-hot | 0.0000 | 0.0000 | 0.0000 | (267) |
| Energy for lighting | 379.6920 | 0.1443 | 54.8013 | (268) |
| Energy saving/generation technologies | | | | |
| PV Unit electricity used in dwelling | -1159.9329 | 0.1337 | -155.0462 | |
| PV Unit electricity exported | 0.0000 | 0.0000 | 0.0000 | |
| Total | | | -155.0462 | (269) |
| Total CO2, kg/year | | | 1031.1275 | (272) |
| EPC Dwelling Carbon Dioxide Emission Rate (DER) | | | 3.4400 | (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 | 5558.9089 | 1.5815 | 8791.1931 | (275) |
| Total CO2 associated with community systems | | | 0.0000 | (473) |
| Water heating (other fuel) | 1832.0608 | 1.5211 | 2786.8285 | (278) |
| Space and water heating | | | 11578.0216 | (279) |
| Pumps, fans and electric keep-hot | 0.0000 | 0.0000 | 0.0000 | (281) |
| Energy for lighting | 379.6920 | 1.5338 | 582.3843 | (282) |
| Energy saving/generation technologies | | | | |
| PV Unit electricity used in dwelling | -1159.9329 | 1.4940 | -1732.9222 | |
| PV Unit electricity exported | 0.0000 | 0.0000 | 0.0000 | |
| Total | | | -1732.9222 | (283) |
| Total Primary energy kWh/year | | | 10427.4837 | (286) |
| Dwelling Primary energy Rate (DPER) | | | 34.7600 | (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 | 150.0000 | (1b) | x | 2.7000 | (2b) | = | 405.0000 | (1b) - (3b) |
| First floor | 90.0000 | (1c) | x | 2.3000 | (2c) | = | 207.0000 | (1c) - (3c) |
| Second floor | 60.0000 | (1d) | x | 2.4000 | (2d) | = | 144.0000 | (1d) - (3d) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 300.0000 | | | | | | | | (4) |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | | = | 756.0000 | (5) |

## 2. Ventilation rate

| | | m3 per hour | |
|---|---|---|---|
| Number of open chimneys | 0 * 80 = | 0.0000 | (6a) |
| Number of open flues | 0 * 20 = | 0.0000 | (6b) |
| Number of chimneys / flues attached to closed fire | 0 * 10 = | 0.0000 | (6c) |
| Number of flues attached to solid fuel boiler | 0 * 20 = | 0.0000 | (6d) |
| Number of flues attached to other heater | 0 * 35 = | 0.0000 | (6e) |
| Number of blocked chimneys | 0 * 20 = | 0.0000 | (6f) |
| Number of intermittent extract fans | 4 * 10 = | 40.0000 | (7a) |
| Number of passive vents | 0 * 10 = | 0.0000 | (7b) |
| Number of flueless gas fires | 0 * 40 = | 0.0000 | (7c) |

| | | Air changes per hour | |
|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = | 40.0000 / (5) = | 0.0529 | (8) |
| Pressure test | | Yes | |
| Pressure Test Method | | Blower Door | |
| Measured/design AP50 | | 5.0000 | (17) |
| Infiltration rate | | 0.3029 | (18) |
| Number of sides sheltered | | 0 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 1.0000 | (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) = | 0.3029 | (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 | 0.3862 | 0.3786 | 0.3711 | 0.3332 | 0.3256 | 0.2878 | 0.2878 | 0.2802 | 0.3029 | 0.3256 | 0.3408 | 0.3559 | (22b) |
| Effective ac | 0.5746 | 0.5717 | 0.5688 | 0.5555 | 0.5530 | 0.5414 | 0.5414 | 0.5393 | 0.5459 | 0.5530 | 0.5581 | 0.5633 | (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 | | | 2.2500 | 1.0000 | 2.2500 | | | (26) |
| TER Opening Type (Uw = 1.20) | | | 66.5200 | 1.1450 | 76.1679 | | | (27) |
| Opening | | | 5.1400 | 1.5918 | 8.1816 | | | (27a) |
| Opening | | | 1.0900 | 1.5918 | 1.7350 | | | (27a) |
| Heatloss Floor 1 | | | 150.0000 | 0.1300 | 19.5000 | | | (28a) |
| External Wall - GF | 143.5000 | 22.7400 | 120.7600 | 0.1800 | 21.7368 | | | (29a) |
| External Wall - 1ST | 91.2000 | 28.4300 | 62.7700 | 0.1800 | 11.2986 | | | (29a) |
| External Wall - 2ND | 54.3000 | 17.6000 | 36.7000 | 0.1800 | 6.6060 | | | (29a) |
| External Roof 1 | 60.0000 | 1.0900 | 58.9100 | 0.1100 | 6.4801 | | | (30) |
| External Roof 2 | 42.5000 | 5.1400 | 37.3600 | 0.1100 | 4.1096 | | | (30) |
| Total net area of external elements Aum(A, m2) | | | 541.5000 | | | | | (31) |
| Fabric heat loss, W/K = Sum (A x U) | | | | (26)...(30) + (32) = | 158.0657 | | | (33) |

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 351.7900 (35)

List of Thermal Bridges

| K1 Element | Length | Psi-value | Total |
|---|---|---|---|
| E1 Steel lintel with perforated steel base plate | 37.8000 | 0.0500 | 1.8900 |
| E3 Sill | 37.8000 | 0.0500 | 1.8900 |
| E4 Jamb | 34.0000 | 0.0500 | 1.7000 |
| E5 Ground floor (normal) | 53.2000 | 0.1600 | 8.5120 |
| E6 Intermediate floor within a dwelling | 73.0000 | 0.0000 | 0.0000 |
| E11 Eaves (insulation at rafter level) | 23.0000 | 0.0400 | 0.9200 |
| E13 Gable (insulation at rafter level) | 20.0000 | 0.0800 | 1.6000 |
| E14 Flat roof | 20.0000 | 0.0800 | 1.6000 |
| E16 Corner (normal) | 30.1000 | 0.0900 | 2.7090 |
| E17 Corner (inverted - internal area greater than external area) | 7.7000 | -0.0900 | -0.6930 |
| E24 Eaves (insulation at ceiling level - inverted) | 10.0000 | 0.2400 | 2.4000 |
| R2 Sill of roof window | 13.4000 | 0.0600 | 0.8040 |
| R3 Jamb of roof window | 15.8000 | 0.0800 | 1.2640 |
| R4 Ridge (vaulted ceiling) | 12.0000 | 0.0800 | 0.9600 |
| R7 Flat ceiling (inverted) | 11.8000 | 0.0400 | 0.4720 |
| R9 Roof to wall (flat ceiling) | 17.3000 | 0.0400 | 0.6920 |
| E12 Gable (insulation at ceiling level) | 5.6000 | 0.0600 | 0.3360 |
| E10 Eaves (insulation at ceiling level) | 5.0000 | 0.0600 | 0.3000 |

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 27.3560 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 185.4217 (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 | 143.3460 | 142.6235 | 141.9153 | 138.5890 | 137.9667 | 135.0695 | 135.0695 | 134.5330 | 136.1855 | 137.9667 | 139.2257 | 140.5419 | (38) |
| Heat transfer coeff | 328.7677 | 328.0452 | 327.3370 | 324.0107 | 323.3884 | 320.4912 | 320.4912 | 319.9547 | 321.6072 | 323.3884 | 324.6474 | 325.9636 | (39) |
| Average = Sum(39)m / 12 = | | | | | | | | | | | | 324.0077 | |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HLP | 1.0959 | 1.0935 | 1.0911 | 1.0800 | 1.0780 | 1.0683 | 1.0683 | 1.0665 | 1.0720 | 1.0780 | 1.0822 | 1.0865 | (40) |
| HLP (average) | | | | | | | | | | | | 1.0800 | |
| Days in mont | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |

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

Assumed occupancy 3.1319 (42)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage for mixer showers | 76.7321 | 75.5789 | 73.8986 | 70.6836 | 68.3109 | 65.6650 | 64.1611 | 65.8287 | 67.6567 | 70.4977 | 73.7817 | 76.4381 | (42a) |
| Hot water usage for baths | 33.1205 | 32.6286 | 31.9360 | 30.6588 | 29.7024 | 28.6420 | 28.0692 | 28.7571 | 29.5060 | 30.6407 | 31.9442 | 33.0086 | (42b) |
| Hot water usage for other uses | 46.7041 | 45.0058 | 43.3074 | 41.6091 | 39.9108 | 38.2124 | 38.2124 | 39.9108 | 41.6091 | 43.3074 | 45.0058 | 46.7041 | (42c) |

Average daily hot water use (litres/day) 143.9106 (43)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily hot water use | 156.5567 | 153.2133 | 149.1420 | 142.9514 | 137.9242 | 132.5195 | 130.4428 | 134.4966 | 138.7718 | 144.4458 | 150.7317 | 156.1507 | (44) |
| Energy conte | 247.9475 | 218.1737 | 229.2257 | 195.6934 | 185.6724 | 162.9482 | 157.7592 | 166.5348 | 171.1196 | 196.0116 | 214.7449 | 244.4943 | (45) |

Energy content (annual) Total = Sum(45)m = 2390.3253

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 37.1921 | 32.7261 | 34.3839 | 29.3540 | 27.8509 | 24.4422 | 23.6639 | 24.9802 | 25.6679 | 29.4017 | 32.2117 | 36.6741 | (46) |

Water storage loss:
Store volume 200.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day): 1.6525 (48)
Temperature factor from Table 2b 0.5400 (49)
Enter (49) or (54) in (55) 0.8924 (55)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total storage loss | 27.6637 | 24.9865 | 27.6637 | 26.7713 | 27.6637 | 26.7713 | 27.6637 | 27.6637 | 26.7713 | 27.6637 | 26.7713 | 27.6637 | (56) |
| If cylinder contains dedicated solar storage | 27.6637 | 24.9865 | 27.6637 | 26.7713 | 27.6637 | 26.7713 | 27.6637 | 27.6637 | 26.7713 | 27.6637 | 26.7713 | 27.6637 | (57) |
| Primary loss | 23.2624 | 21.0112 | 23.2624 | 22.5120 | 23.2624 | 22.5120 | 23.2624 | 23.2624 | 22.5120 | 23.2624 | 22.5120 | 23.2624 | (59) |
| Combi loss | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (61) |
| Total heat required for water heating calculated for each month | 298.8736 | 264.1715 | 280.1517 | 244.9767 | 236.5985 | 212.2315 | 208.6853 | 217.4609 | 220.4029 | 246.9376 | 264.0282 | 295.4204 | (62) |
| WWHRS | -35.0787 | -31.0239 | -32.4864 | -26.9000 | -25.0699 | -21.4525 | -20.1083 | -21.3831 | -22.1956 | -26.1661 | -29.6430 | -34.4291 | (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 | 263.7949 | 233.1476 | 247.6653 | 218.0766 | 211.5286 | 190.7790 | 188.5770 | 196.0778 | 198.2073 | 220.7715 | 234.3852 | 260.9913 | (64) |

Total per year (kWh/year) = Sum(64)m = 2664.0022 (64)
12Total per year (kWh/year) 2664 (64)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat gains from water heating, kWh/month | 123.1834 | 109.3410 | 116.9584 | 104.4947 | 102.4769 | 93.6069 | 93.1958 | 96.1137 | 96.3239 | 105.9147 | 110.8293 | 122.0352 | (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 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 231.1418 | 255.9070 | 231.1418 | 238.8465 | 231.1418 | 238.8465 | 231.1418 | 231.1418 | 238.8465 | 231.1418 | 238.8465 | 231.1418 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 458.2645 | 463.0199 | 451.0365 | 425.5254 | 393.3223 | 363.0558 | 342.8360 | 338.0806 | 350.0640 | 375.5750 | 407.7782 | 438.0447 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | (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) | | | | | | | | | | | | | |
| | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 165.5691 | 162.7098 | 157.2021 | 145.1315 | 137.7378 | 130.0096 | 125.2632 | 129.1851 | 133.7832 | 142.3585 | 153.9296 | 164.0258 | (72) |
| Total internal gains | | | | | | | | | | | | | |
| | 927.9544 | 954.6156 | 912.3594 | 882.4824 | 835.1809 | 801.8909 | 769.2199 | 768.3865 | 792.6726 | 822.0543 | 873.5333 | 906.1913 | (73) |

## 6. Solar gains

| [Jan] | Area m2 | Solar flux Table 6a W/m2 | g Specific data or Table 6b | FF Specific data or Table 6c | Access factor Table 6d | Gains W | |
|---|---|---|---|---|---|---|---|
| Southeast | 20.8800 | 36.7938 | 0.6300 | 0.7000 | 0.7700 | 234.7888 | (77) |
| Northwest | 45.6400 | 11.2829 | 0.6300 | 0.7000 | 0.7700 | 157.3765 | (81) |
| Northeast | 6.2300 | 26.0000 | 0.6300 | 0.7000 | 1.0000 | 64.2899 | (82) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains | 456.4551 | 853.8016 | 1361.7412 | 1996.7764 | 2508.2972 | 2606.8130 | 2464.9116 | 2067.3617 | 1580.1427 | 996.6938 | 560.8418 | 381.3782 | (83) |
| Total gains | 1384.4095 | 1808.4172 | 2274.1007 | 2879.2588 | 3343.4781 | 3408.7039 | 3234.1315 | 2835.7482 | 2372.8153 | 1818.7480 | 1434.3752 | 1287.5695 | (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 | 89.1688 | 89.3652 | 89.5586 | 90.4780 | 90.6521 | 91.4716 | 91.4716 | 91.6249 | 91.1542 | 90.6521 | 90.3005 | 89.9359 | |
| alpha | 6.9446 | 6.9577 | 6.9706 | 7.0319 | 7.0435 | 7.0981 | 7.0981 | 7.1083 | 7.0769 | 7.0435 | 7.0200 | 6.9957 | |
| util living area | | | | | | | | | | | | | |
| | 0.9999 | 0.9996 | 0.9969 | 0.9669 | 0.8247 | 0.5951 | 0.4353 | 0.5166 | 0.8449 | 0.9939 | 0.9998 | 1.0000 | (86) |
| MIT | 19.8817 | 20.0536 | 20.3243 | 20.6898 | 20.9317 | 20.9938 | 20.9994 | 20.9982 | 20.9415 | 20.5753 | 20.1600 | 19.8578 | (87) |
| Th 2 | 20.0042 | 20.0062 | 20.0081 | 20.0172 | 20.0189 | 20.0268 | 20.0268 | 20.0283 | 20.0237 | 20.0189 | 20.0154 | 20.0118 | (88) |
| util rest of house | | | | | | | | | | | | | |
| | 0.9999 | 0.9994 | 0.9953 | 0.9502 | 0.7635 | 0.5081 | 0.3395 | 0.4090 | 0.7626 | 0.9892 | 0.9996 | 1.0000 | (89) |
| MIT 2 | 18.6836 | 18.9056 | 19.2533 | 19.7138 | 19.9707 | 20.0243 | 20.0267 | 20.0279 | 19.9902 | 19.5820 | 19.0494 | 18.6588 | (90) |
| Living area fraction | | | | | | | | | fLA = Living area / (4) = | | | 0.2833 | (91) |
| MIT | 19.0231 | 19.2309 | 19.5568 | 19.9903 | 20.2430 | 20.2990 | 20.3023 | 20.3028 | 20.2597 | 19.8635 | 19.3640 | 18.9985 | (92) |
| Temperature adjustment | | | | | | | | | | | | 0.0000 | |
| adjusted MIT | 19.0231 | 19.2309 | 19.5568 | 19.9903 | 20.2430 | 20.2990 | 20.3023 | 20.3028 | 20.2597 | 19.8635 | 19.3640 | 18.9985 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation | 0.9999 | 0.9992 | 0.9942 | 0.9497 | 0.7786 | 0.5328 | 0.3667 | 0.4396 | 0.7848 | 0.9881 | 0.9995 | 0.9999 | (94) |
| Useful gains | 1384.2436 | 1806.9724 | 2260.9257 | 2734.3244 | 2603.1428 | 1816.2952 | 1185.9407 | 1246.6550 | 1862.1341 | 1797.0983 | 1433.6669 | 1287.4779 | (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 | | | | | | | | | | | | | |
| | 4840.4779 | 4701.1769 | 4273.9602 | 3593.3889 | 2762.6942 | 1826.4732 | 1186.5501 | 1248.7105 | 1981.0138 | 2995.6926 | 3981.4878 | 4823.7798 | (97) |
| Space heating kWh | | | | | | | | | | | | | |
| | 2571.4383 | 1944.9054 | 1497.6977 | 618.5264 | 118.7063 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 891.7541 | 1834.4311 | 2631.0086 | (98a) |
| Space heating requirement - total per year (kWh/year) | | | | | | | | | | | | 12108.4680 | |
| 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 | | | | | | | | | | | | | |
| | 2571.4383 | 1944.9054 | 1497.6977 | 618.5264 | 118.7063 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 891.7541 | 1834.4311 | 2631.0086 | (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) | | | | | | | | | | | | 12108.4680 | |
| Space heating per m2 | | | | | | | | | | | (98c) / (4) = | 40.3616 | (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 | | | | | | | | | | | | | |
| | 2571.4383 | 1944.9054 | 1497.6977 | 618.5264 | 118.7063 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 891.7541 | 1834.4311 | 2631.0086 | (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) | | | | | | | | | | | | | |
| | 2785.9570 | 2107.1565 | 1622.6410 | 670.1261 | 128.6092 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 966.1475 | 1987.4660 | 2850.4969 | (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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water heating requirement | | | | | | | | | | | | | |
| | 263.7949 | 233.1476 | 247.6653 | 218.0766 | 211.5286 | 190.7790 | 188.5770 | 196.0778 | 198.2073 | 220.7715 | 234.3852 | 260.9913 | (64) |
| Efficiency of water heater | | | | | | | | | | | | 79.8000 | (216) |
| (217)m | 87.8779 | 87.7407 | 87.4013 | 86.2639 | 82.8172 | 79.8000 | 79.8000 | 79.8000 | 79.8000 | 86.8561 | 87.6797 | 87.9053 | (217) |

Fuel for water heating, kWh/month

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 300.1836 | 265.7233 | 283.3658 | 252.8016 | 255.4164 | 239.0714 | 236.3121 | 245.7115 | 248.3801 | 254.1808 | 267.3199 | 296.9005 | (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 | 48.0267 | 38.5288 | 34.6909 | 25.4161 | 19.6321 | 16.0396 | 17.9090 | 23.2789 | 30.2369 | 39.6725 | 44.8100 | 49.3615 | (232) |
| Electricity generated by PVs (Appendix M) (negative quantity) | | | | | | | | | | | | | |
| (233a)m | -117.7331 | -155.6847 | -209.9239 | -220.7221 | -225.5350 | -205.7843 | -202.7278 | -196.9351 | -185.7165 | -169.7969 | -125.4687 | -102.9892 | (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 | -101.8965 | -208.9721 | -406.0347 | -597.0824 | -777.8667 | -777.8156 | -769.1054 | -656.8320 | -488.7712 | -295.0045 | -134.6848 | -81.0428 | (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 | 13118.6002 | (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 | 3145.3670 | (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) | 387.6030 | (232) |
| Energy saving/generation technologies (Appendices M ,N and Q) | | |
| PV generation | -7414.1258 | (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 | 9323.4444 | (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 | 13118.6002 | 0.2100 | 2754.9060 | (261) |
| Total CO2 associated with community systems | | | 0.0000 | (373) |
| Water heating (other fuel) | 3145.3670 | 0.2100 | 660.5271 | (264) |
| Space and water heating | | | 3415.4331 | (265) |
| Pumps, fans and electric keep-hot | 86.0000 | 0.1387 | 11.9293 | (267) |
| Energy for lighting | 387.6030 | 0.1443 | 55.9431 | (268) |
| Energy saving/generation technologies | | | | |
| PV Unit electricity used in dwelling | -2119.0173 | 0.1360 | -288.2887 | |
| PV Unit electricity exported | -5295.1085 | 0.1265 | -669.9250 | |
| Total | | | -958.2137 | (269) |
| Total CO2, kg/year | | | 2525.0917 | (272) |
| EPC Target Carbon Dioxide Emission Rate (TER) | | | 8.4200 | (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 | 13118.6002 | 1.1300 | 14824.0182 | (275) |
| Total CO2 associated with community systems | | | 0.0000 | (473) |
| Water heating (other fuel) | 3145.3670 | 1.1300 | 3554.2647 | (278) |
| Space and water heating | | | 18378.2829 | (279) |
| Pumps, fans and electric keep-hot | 86.0000 | 1.5128 | 130.1008 | (281) |
| Energy for lighting | 387.6030 | 1.5338 | 594.5185 | (282) |
| Energy saving/generation technologies | | | | |
| PV Unit electricity used in dwelling | -2119.0173 | 1.5029 | -3184.6535 | |
| PV Unit electricity exported | -5295.1085 | 0.4644 | -2459.2254 | |
| Total | | | -5643.8790 | (283) |
| Total Primary energy kWh/year | | | 13459.0232 | (286) |
| Target Primary Energy Rate (TPER) | | | 44.8600 | (287) |

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

1. Overall dwelling characteristics

| | Area (m2) | | | Storey height (m) | | | Volume (m3) | |
|---|---|---|---|---|---|---|---|---|
| Ground floor | 150.0000 | (1b) | x | 2.7000 | (2b) | = | 405.0000 | (1b) - (3b) |
| First floor | 90.0000 | (1c) | x | 2.3000 | (2c) | = | 207.0000 | (1c) - (3c) |
| Second floor | 60.0000 | (1d) | x | 2.4000 | (2d) | = | 144.0000 | (1d) - (3d) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 300.0000 | | | | | | | | (4) |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = | | | 756.0000 | (5) |

## 2. Ventilation rate

| | | m3 per hour | |
|---|---|---|---|
| Number of open chimneys | 0 * 80 = | 0.0000 | (6a) |
| Number of open flues | 0 * 20 = | 0.0000 | (6b) |
| Number of chimneys / flues attached to closed fire | 0 * 10 = | 0.0000 | (6c) |
| Number of flues attached to solid fuel boiler | 0 * 20 = | 0.0000 | (6d) |
| Number of flues attached to other heater | 0 * 35 = | 0.0000 | (6e) |
| Number of blocked chimneys | 0 * 20 = | 0.0000 | (6f) |
| Number of intermittent extract fans | 4 * 10 = | 40.0000 | (7a) |
| Number of passive vents | 0 * 10 = | 0.0000 | (7b) |
| Number of flueless gas fires | 0 * 40 = | 0.0000 | (7c) |

| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans | = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = | 40.0000 / (5) = | 0.0529 | (8) |
| Pressure test | | | Yes | |
| Pressure Test Method | | | Blower Door | |
| Measured/design AP50 | | | 3.0000 | (17) |
| Infiltration rate | | | 0.2029 | (18) |
| Number of sides sheltered | | | 0 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | | 1.0000 | (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) = | | 0.2029 | (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 | 0.2587 | 0.2536 | 0.2486 | 0.2232 | 0.2181 | 0.1928 | 0.1928 | 0.1877 | 0.2029 | 0.2181 | 0.2283 | 0.2384 | (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)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Effective ac | 0.5335 | 0.5322 | 0.5309 | 0.5249 | 0.5238 | 0.5186 | 0.5186 | 0.5176 | 0.5206 | 0.5238 | 0.5261 | 0.5284 | (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 | |
|---|---|---|---|---|---|---|---|---|
| Opening Type 1 (Uw = 1.20) | | | 85.4000 | 1.1450 | 97.7863 | | | (27) |
| Opening Type 3 | | | 2.2500 | 1.0000 | 2.2500 | | | (26) |
| Opening | | | 6.6000 | 1.1450 | 7.5573 | | | (27a) |
| Opening | | | 1.4000 | 1.1450 | 1.6031 | | | (27a) |
| Heatloss Floor 1 | | | 150.0000 | 0.1100 | 16.5000 | 110.0000 | 16500.0000 | (28a) |
| External Wall - GF | 143.5000 | 28.5500 | 114.9500 | 0.1400 | 16.0930 | 190.0000 | 21840.5000 | (29a) |
| External Wall - 1ST | 91.2000 | 36.5000 | 54.7000 | 0.1400 | 7.6580 | 190.0000 | 10393.0000 | (29a) |
| External Wall - 2ND | 54.3000 | 22.6000 | 31.7000 | 0.1400 | 4.4380 | 190.0000 | 6023.0000 | (29a) |
| External Roof 1 | 60.0000 | 1.4000 | 58.6000 | 0.1100 | 6.4460 | 9.0000 | 527.4000 | (30) |
| External Roof 2 | 42.5000 | 6.6000 | 35.9000 | 0.1100 | 3.9490 | 9.0000 | 323.1000 | (30) |
| Total net area of external elements Aum(A, m2) | | | 541.5000 | | | | | (31) |
| Fabric heat loss, W/K = Sum (A x U) | | | | (26)...(30) + (32) = | 164.2806 | | | (33) |
| Internal Wall - gf | | | 200.0000 | | | 100.0000 | 20000.0000 | (32c) |
| Internal Wall - 1st | | | 162.0000 | | | 100.0000 | 16200.0000 | (32c) |
| Internal Wall - 2nd | | | 123.8000 | | | 100.0000 | 12380.0000 | (32c) |
| Internal Ceiling 1 | | | 60.0000 | | | 9.0000 | 540.0000 | (32e) |
| Internal Ceiling 2 | | | 90.0000 | | | 9.0000 | 810.0000 | (32e) |

| | | | |
|---|---|---|---|
| Heat capacity Cm = Sum(A x k) | (28)...(30) + (32) + (32a)...(32e) = | 105537.0000 | (34) |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K | | 351.7900 | (35) |
| Thermal bridges (User defined value 0.095 * total exposed area) | | 51.4425 | (36) |
| Point Thermal bridges | (36a) = | 0.0000 | |
| Total fabric heat loss | (33) + (36) + (36a) = | 215.7231 | (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 | 133.0890 | 132.7648 | 132.4470 | 130.9544 | 130.6751 | 129.3751 | 129.3751 | 129.1344 | 129.8759 | 130.6751 | 131.2401 | 131.8307 | (38) |
| Heat transfer coeff | 348.8120 | 348.4878 | 348.1701 | 346.6775 | 346.3982 | 345.0982 | 345.0982 | 344.8574 | 345.5989 | 346.3982 | 346.9631 | 347.5538 | (39) |
| Average = Sum(39)m / 12 = | | | | | | | | | | | | 346.6761 | |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HLP | 1.1627 | 1.1616 | 1.1606 | 1.1556 | 1.1547 | 1.1503 | 1.1503 | 1.1495 | 1.1520 | 1.1547 | 1.1565 | 1.1585 | (40) |
| HLP (average) | | | | | | | | | | | | 1.1556 | |
| Days in mont | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |

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

Assumed occupancy 3.1319 (42)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 33.1205 | 32.6286 | 31.9360 | 30.6588 | 29.7024 | 28.6420 | 28.0692 | 28.7571 | 29.5060 | 30.6407 | 31.9442 | 33.0086 | (42b) |
| Hot water usage for other uses | 46.7041 | 45.0058 | 43.3074 | 41.6091 | 39.9108 | 38.2124 | 38.2124 | 39.9108 | 41.6091 | 43.3074 | 45.0058 | 46.7041 | (42c) |
| Average daily hot water use (litres/day) | | | | | | | | | | | | 73.1662 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily hot water use | 79.8246 | 77.6344 | 75.2434 | 72.2679 | 69.6132 | 66.8545 | 66.2817 | 68.6678 | 71.1151 | 73.9481 | 76.9499 | 79.7126 | (44) |
| Energy conte | 126.4227 | 110.5503 | 115.6463 | 98.9311 | 93.7128 | 82.2054 | 80.1619 | 85.0251 | 87.6920 | 100.3469 | 109.6293 | 124.8107 | (45) |
| Energy content (annual) | | | | | | | | | | | Total = Sum(45)m = | 1215.1346 | |
| 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 | 107.4593 | 93.9678 | 98.2993 | 84.0915 | 79.6559 | 69.8746 | 68.1377 | 72.2714 | 74.5382 | 85.2949 | 93.1849 | 106.0891 | (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 | 107.4593 | 93.9678 | 98.2993 | 84.0915 | 79.6559 | 69.8746 | 68.1377 | 72.2714 | 74.5382 | 85.2949 | 93.1849 | 106.0891 | (64) |

Total per year (kWh/year) = Sum(64)m = 1032.8644 (64)

12Total per year (kWh/year) 1033 (64)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Electric shower(s) | 61.4496 | 54.7521 | 59.7872 | 57.0542 | 58.1248 | 55.4454 | 57.2936 | 58.1248 | 57.0542 | 59.7872 | 58.6630 | 61.4496 | (64a) |

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 698.9856 (64a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat gains from water heating, kWh/month | 42.2272 | 37.1800 | 39.5216 | 35.2864 | 34.4452 | 31.3300 | 31.3578 | 32.5990 | 32.8981 | 36.2705 | 37.9620 | 41.8847 | (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 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 231.1418 | 255.9070 | 231.1418 | 238.8465 | 231.1418 | 238.8465 | 231.1418 | 231.1418 | 238.8465 | 231.1418 | 238.8465 | 231.1418 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 458.2645 | 463.0199 | 451.0365 | 425.5254 | 393.3223 | 363.0558 | 342.8360 | 338.0806 | 350.0640 | 375.5750 | 407.7782 | 438.0447 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | (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) | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | (71) |
| Water heating gains (Table 5) | 56.7570 | 55.3273 | 53.1205 | 49.0089 | 46.2973 | 43.5139 | 42.1476 | 43.8159 | 45.6918 | 48.7507 | 52.7249 | 56.2966 | (72) |
| Total internal gains | 816.1423 | 844.2332 | 805.2778 | 783.3598 | 740.7403 | 715.3952 | 686.1043 | 683.0173 | 704.5813 | 725.4465 | 769.3287 | 795.4621 | (73) |

## 6. Solar gains

| [Jan] | Area m2 | Solar flux Table 6a W/m2 | g Specific data or Table 6b | FF Specific data or Table 6c | Access factor Table 6d | Gains W | |
|---|---|---|---|---|---|---|---|
| Southeast | 26.8000 | 36.7938 | 0.7200 | 0.7000 | 0.7700 | 344.4083 | (77) |
| Northwest | 58.6000 | 11.2829 | 0.7200 | 0.7000 | 0.7700 | 230.9318 | (81) |
| Northeast | 8.0000 | 26.0000 | 0.7200 | 0.7000 | 1.0000 | 94.3488 | (82) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains | 669.6889 | 1252.6783 | 1997.9650 | 2929.7631 | 3680.3377 | 3824.9044 | 3616.6893 | 3033.3477 | 2318.4293 | 1462.3400 | 822.8441 | 559.5370 | (83) |
| Total gains | 1485.8312 | 2096.9115 | 2803.2428 | 3713.1229 | 4421.0780 | 4540.2996 | 4302.7936 | 3716.3650 | 3023.0106 | 2187.7865 | 1592.1728 | 1354.9991 | (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 | 84.0448 | 84.1230 | 84.1998 | 84.5623 | 84.6304 | 84.9493 | 84.9493 | 85.0086 | 84.8262 | 84.6304 | 84.4926 | 84.3491 | |
| alpha | 6.6030 | 6.6082 | 6.6133 | 6.6375 | 6.6420 | 6.6633 | 6.6633 | 6.6672 | 6.6551 | 6.6420 | 6.6328 | 6.6233 | |
| util living area | 0.9999 | 0.9991 | 0.9908 | 0.9157 | 0.7022 | 0.4844 | 0.3527 | 0.4260 | 0.7478 | 0.9854 | 0.9996 | 1.0000 | (86) |
| MIT | 19.8290 | 20.0512 | 20.3870 | 20.7853 | 20.9683 | 20.9975 | 20.9997 | 20.9992 | 20.9665 | 20.6092 | 20.1273 | 19.7893 | (87) |
| Th 2 | 19.9500 | 19.9508 | 19.9517 | 19.9557 | 19.9564 | 19.9599 | 19.9599 | 19.9606 | 19.9586 | 19.9564 | 19.9549 | 19.9533 | (88) |
| util rest of house | 0.9999 | 0.9986 | 0.9863 | 0.8824 | 0.6338 | 0.4068 | 0.2694 | 0.3303 | 0.6537 | 0.9749 | 0.9993 | 0.9999 | (89) |
| MIT 2 | 18.8778 | 19.1004 | 19.4338 | 19.8055 | 19.9408 | 19.9592 | 19.9599 | 19.9605 | 19.9454 | 19.6571 | 19.1801 | 18.8409 | (90) |

Living area fraction fLA = Living area / (4) = 0.2833 (91)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIT | 19.1473 | 19.3698 | 19.7038 | 20.0831 | 20.2319 | 20.2534 | 20.2545 | 20.2548 | 20.2347 | 19.9268 | 19.4484 | 19.1096 | (92) |
| Temperature adjustment | | | | | | | | | | | | 0.0000 | |
| adjusted MIT | 19.1473 | 19.3698 | 19.7038 | 20.0831 | 20.2319 | 20.2534 | 20.2545 | 20.2548 | 20.2347 | 19.9268 | 19.4484 | 19.1096 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation | 0.9998 | 0.9982 | 0.9848 | 0.8870 | 0.6525 | 0.4288 | 0.2930 | 0.3575 | 0.6802 | 0.9745 | 0.9991 | 0.9999 | (94) |
| Useful gains | 1485.5528 | 2093.1920 | 2760.7417 | 3293.7142 | 2884.6649 | 1946.9632 | 1260.9202 | 1328.4393 | 2056.1965 | 2131.9244 | 1590.7637 | 1354.8604 | (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 | 5178.9203 | 5042.5447 | 4597.1833 | 3876.9248 | 2955.4381 | 1950.9691 | 1261.1707 | 1329.3403 | 2120.1571 | 3230.7942 | 4284.4553 | 5181.8895 | (97) |
| Space heating kWh | 2747.8654 | 1981.9650 | 1366.3126 | 419.9117 | 52.6552 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 817.5591 | 1939.4580 | 2847.3096 | (98a) |

Space heating requirement - total per year (kWh/year) 12173.0366

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 2747.8654 | 1981.9650 | 1366.3126 | 419.9117 | 52.6552 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 817.5591 | 1939.4580 | 2847.3096 | (98c) |

Space heating requirement after solar contribution - total per year (kWh/year) 12173.0366

Space heating per m2 (98c) / (4) = 40.5768 (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 | 3243.9228 | 2553.7265 | 2620.9165 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (100) |
| Utilisation | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.9811 | 0.9930 | 0.9822 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (101) |
| Useful loss | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 3182.5076 | 2535.8923 | 2574.2030 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (102) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total gains | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 5073.3109 | 4806.7654 | 4145.6656 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (103) |
| Space cooling kWh | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1361.3784 | 1689.5296 | 1169.1681 | 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 | 340.3446 | 422.3824 | 292.2920 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (107) |
| Space cooling requirement | | | | | | | | | | | | 1055.0190 | (107) |
| Energy for space heating | | | | | | | | | | | | 40.5768 | (99) |
| Energy for space cooling | | | | | | | | | | | | 3.5167 | (108) |
| Total | | | | | | | | | | | | 44.0935 | (109) |
| Fabric Energy Efficiency (DFEE) | | | | | | | | | | | | 44.1 | (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 | 150.0000 | (1b) | x | 2.7000 | (2b) | = | 405.0000 | (1b) - (3b) |
| First floor | 90.0000 | (1c) | x | 2.3000 | (2c) | = | 207.0000 | (1c) - (3c) |
| Second floor | 60.0000 | (1d) | x | 2.4000 | (2d) | = | 144.0000 | (1d) - (3d) |

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 300.0000 (4)
Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 756.0000 (5)

## 2. Ventilation rate

| | | m3 per hour | |
|---|---|---|---|
| Number of open chimneys | 0 * 80 = | 0.0000 | (6a) |
| Number of open flues | 0 * 20 = | 0.0000 | (6b) |
| Number of chimneys / flues attached to closed fire | 0 * 10 = | 0.0000 | (6c) |
| Number of flues attached to solid fuel boiler | 0 * 20 = | 0.0000 | (6d) |
| Number of flues attached to other heater | 0 * 35 = | 0.0000 | (6e) |
| Number of blocked chimneys | 0 * 20 = | 0.0000 | (6f) |
| Number of intermittent extract fans | 4 * 10 = | 40.0000 | (7a) |
| Number of passive vents | 0 * 10 = | 0.0000 | (7b) |
| Number of flueless gas fires | 0 * 40 = | 0.0000 | (7c) |

| | | Air changes per hour | |
|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = | 40.0000 / (5) = | 0.0529 | (8) |
| Pressure test | | Yes | |
| Pressure Test Method | | Blower Door | |
| Measured/design AP50 | | 5.0000 | (17) |
| Infiltration rate | | 0.3029 | (18) |
| Number of sides sheltered | | 0 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 1.0000 | (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) = | 0.3029 | (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 | 0.3862 | 0.3786 | 0.3711 | 0.3332 | 0.3256 | 0.2878 | 0.2878 | 0.2802 | 0.3029 | 0.3256 | 0.3408 | 0.3559 | (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 | 0.5746 | 0.5717 | 0.5688 | 0.5555 | 0.5530 | 0.5414 | 0.5414 | 0.5393 | 0.5459 | 0.5530 | 0.5581 | 0.5633 | (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 | | | 2.2500 | 1.0000 | 2.2500 | | | (26) |
| TER Opening Type (Uw = 1.20) | | | 66.5200 | 1.1450 | 76.1679 | | | (27) |
| Opening | | | 5.1400 | 1.5918 | 8.1816 | | | (27a) |
| Opening | | | 1.0900 | 1.5918 | 1.7350 | | | (27a) |
| Heatloss Floor 1 | | | 150.0000 | 0.1300 | 19.5000 | | | (28a) |
| External Wall - GF | 143.5000 | 22.7400 | 120.7600 | 0.1800 | 21.7368 | | | (29a) |
| External Wall - 1ST | 91.2000 | 28.4300 | 62.7700 | 0.1800 | 11.2986 | | | (29a) |
| External Wall - 2ND | 54.3000 | 17.6000 | 36.7000 | 0.1800 | 6.6060 | | | (29a) |
| External Roof 1 | 60.0000 | 1.0900 | 58.9100 | 0.1100 | 6.4801 | | | (30) |
| External Roof 2 | 42.5000 | 5.1400 | 37.3600 | 0.1100 | 4.1096 | | | (30) |
| Total net area of external elements Aum(A, m2) | | | 541.5000 | | | | | (31) |
| Fabric heat loss, W/K = Sum (A x U) | | | | (26)...(30) + (32) = | 158.0657 | | | (33) |

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 351.7900 (35)

List of Thermal Bridges

| K1 Element | Length | Psi-value | Total |
|---|---|---|---|
| E1 Steel lintel with perforated steel base plate | 37.8000 | 0.0500 | 1.8900 |
| E3 Sill | 37.8000 | 0.0500 | 1.8900 |
| E4 Jamb | 34.0000 | 0.0500 | 1.7000 |
| E5 Ground floor (normal) | 53.2000 | 0.1600 | 8.5120 |
| E6 Intermediate floor within a dwelling | 73.0000 | 0.0000 | 0.0000 |
| E11 Eaves (insulation at rafter level) | 23.0000 | 0.0400 | 0.9200 |
| E13 Gable (insulation at rafter level) | 20.0000 | 0.0800 | 1.6000 |
| E14 Flat roof | 20.0000 | 0.0800 | 1.6000 |
| E16 Corner (normal) | 30.1000 | 0.0900 | 2.7090 |
| E17 Corner (inverted - internal area greater than external area) | 7.7000 | -0.0900 | -0.6930 |

| | | | |
|---|---|---|---|
| E24 Eaves (insulation at ceiling level - inverted) | 10.0000 | 0.2400 | 2.4000 |
| R2 Sill of roof window | 13.4000 | 0.0600 | 0.8040 |
| R3 Jamb of roof window | 15.8000 | 0.0800 | 1.2640 |
| R4 Ridge (vaulted ceiling) | 12.0000 | 0.0800 | 0.9600 |
| R7 Flat ceiling (inverted) | 11.8000 | 0.0400 | 0.4720 |
| R9 Roof to wall (flat ceiling) | 17.3000 | 0.0400 | 0.6920 |
| E12 Gable (insulation at ceiling level) | 5.6000 | 0.0600 | 0.3360 |
| E10 Eaves (insulation at ceiling level) | 5.0000 | 0.0600 | 0.3000 |

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 27.3560 (36)
Point Thermal bridges (36a) = 0.0000
Total fabric heat loss (33) + (36) + (36a) = 185.4217 (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 | 143.3460 | 142.6235 | 141.9153 | 138.5890 | 137.9667 | 135.0695 | 135.0695 | 134.5330 | 136.1855 | 137.9667 | 139.2257 | 140.5419 | (38) |
| Heat transfer coeff | 328.7677 | 328.0452 | 327.3370 | 324.0107 | 323.3884 | 320.4912 | 320.4912 | 319.9547 | 321.6072 | 323.3884 | 324.6474 | 325.9636 | (39) |
| Average = Sum(39)m / 12 = | | | | | | | | | | | | 324.0077 | |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HLP | 1.0959 | 1.0935 | 1.0911 | 1.0800 | 1.0780 | 1.0683 | 1.0683 | 1.0665 | 1.0720 | 1.0780 | 1.0822 | 1.0865 | (40) |
| HLP (average) | | | | | | | | | | | | 1.0800 | |
| Days in mont | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | |

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

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Assumed occupancy 3.1319 (42)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 33.1205 | 32.6286 | 31.9360 | 30.6588 | 29.7024 | 28.6420 | 28.0692 | 28.7571 | 29.5060 | 30.6407 | 31.9442 | 33.0086 | (42b) |
| Hot water usage for other uses | 46.7041 | 45.0058 | 43.3074 | 41.6091 | 39.9108 | 38.2124 | 38.2124 | 39.9108 | 41.6091 | 43.3074 | 45.0058 | 46.7041 | (42c) |
| Average daily hot water use (litres/day) | | | | | | | | | | | | 73.1662 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily hot water use | 79.8246 | 77.6344 | 75.2434 | 72.2679 | 69.6132 | 66.8545 | 66.2817 | 68.6678 | 71.1151 | 73.9481 | 76.9499 | 79.7126 | (44) |
| Energy conte | 126.4227 | 110.5503 | 115.6463 | 98.9311 | 93.7128 | 82.2054 | 80.1619 | 85.0251 | 87.6920 | 100.3469 | 109.6293 | 124.8107 | (45) |
| Energy content (annual) | | | | | | | | | | Total = Sum(45)m = | | 1215.1346 | |
| 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 | 107.4593 | 93.9678 | 98.2993 | 84.0915 | 79.6559 | 69.8746 | 68.1377 | 72.2714 | 74.5382 | 85.2949 | 93.1849 | 106.0891 | (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 | 107.4593 | 93.9678 | 98.2993 | 84.0915 | 79.6559 | 69.8746 | 68.1377 | 72.2714 | 74.5382 | 85.2949 | 93.1849 | 106.0891 | (64) |

Total per year (kWh/year) = Sum(64)m = 1032.8644 (64)
12Total per year (kWh/year) 1033 (64)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Electric shower(s) | 61.4496 | 54.7521 | 59.7872 | 57.0542 | 58.1248 | 55.4454 | 57.2936 | 58.1248 | 57.0542 | 59.7872 | 58.6630 | 61.4496 | (64a) |

Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 698.9856 (64a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat gains from water heating, kWh/month | 42.2272 | 37.1800 | 39.5216 | 35.2864 | 34.4452 | 31.3300 | 31.3578 | 32.5990 | 32.8981 | 36.2705 | 37.9620 | 41.8847 | (65) |

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

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Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | 156.5965 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 231.1418 | 255.9070 | 231.1418 | 238.8465 | 231.1418 | 238.8465 | 231.1418 | 231.1418 | 238.8465 | 231.1418 | 238.8465 | 231.1418 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 458.2645 | 463.0199 | 451.0365 | 425.5254 | 393.3223 | 363.0558 | 342.8360 | 338.0806 | 350.0640 | 375.5750 | 407.7782 | 438.0447 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | 38.6596 | (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) | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | -125.2772 | (71) |
| Water heating gains (Table 5) | 56.7570 | 55.3273 | 53.1205 | 49.0089 | 46.2973 | 43.5139 | 42.1476 | 43.8159 | 45.6918 | 48.7507 | 52.7249 | 56.2966 | (72) |
| Total internal gains | 816.1423 | 844.2332 | 805.2778 | 783.3598 | 740.7403 | 715.3952 | 686.1043 | 683.0173 | 704.5813 | 725.4465 | 769.3287 | 795.4621 | (73) |

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## 6. Solar gains

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| [Jan] | Area m2 | Solar flux Table 6a W/m2 | g Specific data or Table 6b | FF Specific data or Table 6c | Access factor Table 6d | Gains W | |
|---|---|---|---|---|---|---|---|
| Southeast | 20.8800 | 36.7938 | 0.6300 | 0.7000 | 0.7700 | 234.7888 | (77) |
| Northwest | 45.6400 | 11.2829 | 0.6300 | 0.7000 | 0.7700 | 157.3765 | (81) |
| Northeast | 6.2300 | 26.0000 | 0.6300 | 0.7000 | 1.0000 | 64.2899 | (82) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains | 456.4551 | 853.8016 | 1361.7412 | 1996.7764 | 2508.2972 | 2606.8130 | 2464.9116 | 2067.3617 | 1580.1427 | 996.6938 | 560.8418 | 381.3782 | (83) |
| Total gains | 1272.5974 | 1698.0348 | 2167.0190 | 2780.1362 | 3249.0375 | 3322.2082 | 3151.0159 | 2750.3790 | 2284.7240 | 1722.1403 | 1330.1705 | 1176.8403 | (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 | 89.1688 | 89.3652 | 89.5586 | 90.4780 | 90.6521 | 91.4716 | 91.4716 | 91.6249 | 91.1542 | 90.6521 | 90.3005 | 89.9359 | |
| alpha | 6.9446 | 6.9577 | 6.9706 | 7.0319 | 7.0435 | 7.0981 | 7.0981 | 7.1083 | 7.0769 | 7.0435 | 7.0200 | 6.9957 | |
| util living area | 1.0000 | 0.9997 | 0.9977 | 0.9723 | 0.8394 | 0.6095 | 0.4467 | 0.5322 | 0.8631 | 0.9956 | 0.9999 | 1.0000 | (86) |
| MIT | 19.8513 | 20.0236 | 20.2957 | 20.6677 | 20.9234 | 20.9929 | 20.9993 | 20.9978 | 20.9324 | 20.5499 | 20.1316 | 19.8276 | (87) |
| Th 2 | 20.0042 | 20.0062 | 20.0081 | 20.0172 | 20.0189 | 20.0268 | 20.0268 | 20.0283 | 20.0237 | 20.0189 | 20.0154 | 20.0118 | (88) |
| util rest of house | 1.0000 | 0.9996 | 0.9965 | 0.9578 | 0.7797 | 0.5210 | 0.3484 | 0.4216 | 0.7841 | 0.9921 | 0.9998 | 1.0000 | (89) |
| MIT 2 | 18.9446 | 19.1185 | 19.3915 | 19.7608 | 19.9761 | 20.0245 | 20.0267 | 20.0279 | 19.9927 | 19.6537 | 19.2342 | 18.9272 | (90) |
| Living area fraction | | | | | | | | | fLA = Living area / (4) = | | | 0.2833 | (91) |
| MIT | 19.2015 | 19.3750 | 19.6477 | 20.0178 | 20.2445 | 20.2989 | 20.3023 | 20.3027 | 20.2589 | 19.9076 | 19.4885 | 19.1823 | (92) |
| Temperature adjustment | | | | | | | | | | | | 0.0000 | |
| adjusted MIT | 19.2015 | 19.3750 | 19.6477 | 20.0178 | 20.2445 | 20.2989 | 20.3023 | 20.3027 | 20.2589 | 19.9076 | 19.4885 | 19.1823 | (93) |

8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation | 0.9999 | 0.9995 | 0.9958 | 0.9578 | 0.7947 | 0.5462 | 0.3763 | 0.4531 | 0.8056 | 0.9915 | 0.9997 | 1.0000 | (94) |
| Useful gains | 1272.5164 | 1697.1826 | 2157.9723 | 2662.8674 | 2581.8797 | 1814.5729 | 1185.8205 | 1246.1893 | 1840.5556 | 1707.5436 | 1329.7936 | 1176.7979 | (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 | 4899.1371 | 4748.4435 | 4303.7333 | 3602.2750 | 2763.1866 | 1826.4369 | 1186.5424 | 1248.6817 | 1980.7602 | 3009.9786 | 4021.8781 | 4883.6934 | (97) |
| Space heating kWh | 2698.2058 | 2050.4474 | 1596.4462 | 676.3735 | 134.8923 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 969.0117 | 1938.3009 | 2757.9302 | (98a) |
| Space heating requirement - total per year (kWh/year) | | | | | | | | | | | | 12821.6080 | |
| 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 | 2698.2058 | 2050.4474 | 1596.4462 | 676.3735 | 134.8923 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 969.0117 | 1938.3009 | 2757.9302 | (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) | | | | | | | | | | | | 12821.6080 | |
| Space heating per m2 | | | | | | | | | | (98c) / (4) = | | 42.7387 | (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 | 3012.6176 | 2371.6351 | 2431.6559 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (100) |
| Utilisation | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.9460 | 0.9787 | 0.9516 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (101) |
| Useful loss | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 2849.8050 | 2321.0049 | 2314.0059 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (102) |
| Total gains | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 3688.6053 | 3497.4222 | 3047.2355 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (103) |
| Space cooling kWh | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 603.9363 | 875.2545 | 545.5229 | 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 | 150.9841 | 218.8136 | 136.3807 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | (107) |
| Space cooling requirement | | | | | | | | | | | | 506.1784 | (107) |
| Energy for space heating | | | | | | | | | | | | 42.7387 | (99) |
| Energy for space cooling | | | | | | | | | | | | 1.6873 | (108) |
| Total | | | | | | | | | | | | 44.4260 | (109) |
| Fabric Energy Efficiency (TFEE) | | | | | | | | | | | | 44.4 | (109) |