The PES

Energy & Sustainability Statement

8th December 2023

40 Stratford Road Watford WD17 4NZ

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Version Control

V1	08-12- 23	

1.0 Executive Summary



The proposed development project at 40 Stratford Road involves the development of a 3 x new build detached dwellings

The residential development project has been designed to achieve the highest of environmental performance standards following the Energy Hierarchy in order to comply with national policies and the Local Plan Policies of Watford Borough Council.

'Lean, Clean, Green' approach has been adopted and the development achieves an overall improvement (DER/TER) in regulated emissions at over **84%** above Part L 2021 standard, through the adoption of very high standards of insulation, with heat pump driven heating and hot water systems.



2.0 The Site & Proposal

The development site is located on the corner of Stratford Road and Langley Road.

The proposed development project for the demolition of the existing dwelling on site and the erection of 3×10^{-10} km build dwellings.

2.1 Local Planning Context

The site sits within the administrative boundaries of Watford Borough

Watford Borough Council adopted the Watford Local Plan 2021-2038 on 17 October 2022.

Policy CC8.1: Mitigating Climate Change and Reducing Carbon Emissions

The Council will support proposals that help combat climate change and ensure the borough becomes more resilient, sustainable and adaptable to climate change. New development will need to demonstrate how it is contributing positively towards:

A carbon neutral Watford

Developments are expected to contribute towards the borough becoming carbon neutral and reducing the overall environmental impact.

Sustainable construction

Proposals need to consider how they will affect the environment from start to finish including the construction process and how occupants will use the building and surrounding area.

New buildings

New buildings will need to be high quality, use resources efficiently, reduce pollution, be safe to live in and encourage healthy lifestyles.

Cumulative development

New development should consider opportunities associated with cumulative development. This includes materials used in construction, the layout of the scheme and measures that will create a comfortable micro-climate such as light, shading and landscaping.

Low carbon and renewable energy

On site low carbon and renewable energy technologies will be encouraged, particularly where the scale of growth can support community energy networks.



Policy CC8.3: Sustainable Construction and Resource Management

Energy efficiency

To minimise the impact of new homes on the environment, residential developments should:

a) Be designed so they can be adapted to be carbon neutral;

b) Avoid overheating and use passive ventilation when possible; and
c) Achieve a 19% improvement for carbon emissions over the target emission rate (TER) as set out in National Building Regulations Part L (2013), or any updated government standards, whichever results in a higher target.

Proposals that do not meet the energy efficiency target will only be supported if it is unfeasible and a financial contribution is made towards the Carbon Offset Fund to provide equivalent carbon savings off site.

Water efficiency

All residential developments should meet the technical standard for water efficiency of 110 litres per person, per day.

In new, non-residential developments, that are unable to achieve BREEAM 'excellent' standard, water conservation measures should be incorporated to reduce water consumption to a standard equivalent to BREEAM 'very good' for the appropriate building typology.

Materials and waste management

Development proposals should reduce construction waste through the re-use and recycling of materials. Practices undertaken should reflect the Hertfordshire Waste Hierarchy. As part of an application, applicants should set out how waste management of the site is in accordance with the Hertfordshire Waste Local Plan.

2.2 The Energy Hierarchy

In order to assess the overall efficiency of the proposed retirement village, this report will utilise the principles of the energy hierarchy as set out below; the 3 stages being:-

- Be lean: use less energy and manage demand during construction and operation.
- Be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly.
- Be green: generate, store and use renewable energy on-site.



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3.0 Baseline energy results

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

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

3.1 New Build Dwellings

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

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/(m ² K)
Party walls	u-0
Roors	U = 0.13 W/ (m ² K)
Roofs	U = 0.11 W/ (m ² K)
Opaque door (less than 30% glazed area)	U = 10 W/(m ² K)
Semi-glazed door (30-60% glazed area)	U = 10 W/ (m ² K)
Windows and glazed doors with greater than 60% glazed area	U = 1.2 W/[m ² K] Frame factor = 0.7
Roof windows	$U = 1.2 W/[m^2 \kappa]$ when in vertical position (for correction due to angle, see specification in SAP 10 Appendix R)
Rooflights	U = 17 W/(m ² 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 m ³ /(hm ²) at 50 Pa
Main heating fuel (space and water)	Mains gas
Heating system	Boiler and radiators Central heating pump 2013 or later, in heated space Design flow temperature = 55 °C
Boiler	Efficiency, SEDBux 2009 = 89.5%
Heating system controls	Boiler interlock, ErP Class V Either:
	total floor area: programmer and room thermostat - any other dwelling: time and temperature zone control, thermostatic register values:
Hot water system	Heated by boiler (regular or combi as above) Separate time control for space and water heating
Wastewater heat recovery (WWHR)	All showers connected to WWHR, including showers over baths Instantaneous WWHR with 36% recovery efficiency utilisation of 0.98
Hot water cylinder	If cylinder, declared loss factor = 0.85 x (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 x total floor area Efficacy of all fixed lighting = 80 lm/ W
Air conditioning	None
Photovoltaic (PV) system	For houses kWp = 40% of ground floor area, including unheated spaces / 6.5 For flats kWp = 40% of dwelling floor area / (6.5 x number of storeys in block)
	System Facing south-east or south-west



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

For the Stratford Road project, a single dwelling has been selected to inform the energy strategy and inform the projected energy and CO₂ reductions.

3.2 Baseline Results

The baseline building results – the Target Emission Rate have been calculated in line with Part L2021/SAP10.2 emission standards and are presented in Table 2 below. The SAP outputs (which summarise the key data) are attached at **Appendix A**.

Unit	Target Emission	Total baseline
	Rate	emissions
	(regulated	
	energy use)	Kg
	Kg/sqm/annum	
Unit 1	25.46	4,277
Total		4,277

Table 2 – Baseline energy consumption and CO2 emissions



4.0 Design for energy efficiency

The first step in the 'Energy Hierarchy' as laid out under 2.2 above, requires that buildings be designed to use improved energy efficiency measures – Be Lean. This will reduce demand for heating, cooling, and lighting, and therefore reduce operational costs while also minimizing associated carbon dioxide emissions.

This section sets out the measures included within the design of the development, to reduce the demand for energy, both gas and electricity (not including energy from renewable sources). The table at the end of this section details the amount of energy used and CO₂ produced by the building after the energy efficiency measures have been included. From these figures the overall reduction in CO₂ emissions, as a result of passive design measures, can be calculated. To achieve reductions in energy demand the following measures have been included within the design and specification of the building:

4.1 Passive Design

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

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

The project at 40 Stratford Road has had been designed to ensure the building is not vulnerable to overheating; to instigate consideration of the risk of overheating within the proposed development, the design team have followed the guidance within the Cooling Hierarchy:-

1. minimise internal heat generation through energy efficient design

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

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



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

The Stratford Road site is located on a corner plot with an south east/north east aspect in a low rise suburban context – with very little benefit from topographical shading.

The houses are orientated to the aspects as above, with the main livings areas having dual aspects; the lack of a truly southern aspect will limit the levels of excessive midsummer solar gains, yet large glazed area are able to harvest useful solar gain.

All other areas – bedrooms and bathrooms – have reduced glazing areas to limit heat losses.

Glazing specification has been considered as part of the overheating risk and the specified new glazing will achieve a g-value of 0.57 or better in order to assist in further reducing overheating risk from excessive solar gain.

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

The new build structures will be of a brick/block construction offering significant thermal mass able to absorb heat during the summer months, which can then be ventilated during the evening or overnight via the above ventilation strategy.

4. passive ventilation

All glazing across the scheme is designed to have opening areas to introduce high levels of natural levels of "purge" ventilation to further assist in the reduction of overheating risks in appropriate areas.

All the properties are able to fully cross – ventilate and as all bedrooms are at first floor level, there will be no opening restrictions associated with AD Part O.

5. mechanical ventilation

Given the passive design strategy highlighted above, combined with the project location, a natural ventilation strategy is to be employed.

4.2 Heating System

The "notional" heating system considered under the "be lean – use less energy" section of the Energy Hierarchy, will assume the use of gas fired LTHW systems, assuming the Part L minimum efficiency at 92% whilst also providing the domestic hot water (DHW)



4.3 Fabric heat loss

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

- New wall constructions will target a U-Value of 0.15W/m²k or better.
- New pitched roof constructions are to be of a warm-roof type, achieving a U-Value of 0.11W/m²k.
- The newly laid floors will achieve a minimum u value of 0.12W/m²k subject to perimeter/area ratios

Glazing

• The new glazing for windows and doors will be triple glazed with an area weighted average U-Value of 1.0W/m²K or better.

Air Tightness

• The project be tested to 4m³/hr/m² in line with best practice for naturally ventilated buildings.

Construction Details

 Heat loss via non-repeating thermal bridging within the new build elements will be minimised by the use of approved construction details. An overall Y-Value <0.05 is targeted.

The above passive design measures and fabric standards achieve an improvement in dwelling fabric efficiency at **35%** over the Part L2021 minimum standard.

4.4 Ventilation

As noted above, the project will assume a natural ventilation – using trickle vents and opening windows, with wet room extraction.

4.5 Lighting and appliances

The development will incorporate high efficiency light fittings utilising LED lamps.

The use of LED lighting will also minimise the internal gains commonly associated with tungsten and fluorescent lighting systems and thereby further reduce the potential for the residential units to overheat.

External lighting will utilise daylight controls to ensure lights are not active during the day.



5.0 Supplying Energy Efficiently

5.1 Community Heating/Combined Heat and Power (CHP)

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

This report must consider the availability – now or in the future – of heat networks in the Stratford Road area.

At time of writing, there is no proposed heat network for this location, nor is there any awareness of likelihood of same, given the location remote from central Watford and the low rise housing density.

Clearly there is very little to no potential for the project site to connect to a DEN in the future, however, consideration should be given to the potential for an on-site solution.

5.2 On-site CHP/District Heating

A community heating network comprises a series of insulated pipes used to deliver heat, in the form of hot water or steam, to a number of different locations or dwellings. They range from small, providing heat to a house and a couple of holiday cottages for example, to large scale systems supplying housing estates or blocks of flats.

The heat production facility for a DH scheme is generally considered to include heat only boilers (HOB) and/or the production of both electricity and heat i.e. CHP.

CHP systems are essentially biomass or fossil fuel fired electricity generators that use the heat by-product to provide space and water heating. The electricity generated can be used directly within the host buildings or sold to electricity suppliers on the national grid.

CHP is, as a rule of thumb, is only operated as a base load as, depending on the technology, it may be difficult and/or inefficient to operate according to daily variations in demand. In a well-designed district heating network heat from CHP will provide between 60% and 80% of the annual baseline heat (heating and hot water) requirement with heat-only boiler plants providing the peak load and back-up. To maximise efficiency of the engine it needs to run for at least 17 hours a day; therefore, the heat load needs to be present for this period.

Clearly, as a small scale residential development, with only the limited year round DHW demand to support a CHP installation (approx. 2-4 hours per day in the May – October period), the economy of scale, in terms of year-round demand, simply isn't present and as such the potential use of on-site CHP is very limited.



6.0 Renewable Energy Options

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

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

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

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

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

6.1 Government incentives

6.1.1 Smart Export Guarantee (SEG)

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

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

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

Payment are made against metered exports only.

6.1.1 Renewable Heat Incentive

The Renewable Heat Incentive (RHI) was formally withdrawn for all new projects in March 2022.



6.2 Wind turbines

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

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

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

The availability and consistency of wind in urban environments is largely dependent upon the proximity, scale and orientation of surrounding obstructions. The site has a relatively open aspect, but does have dwellings on the boundaries.

However, the visual impact of large scale wind turbines would be considered unacceptable when proposed in an ad-hoc manner and it is inconceivable that any wind turbines of this size would be considered acceptable in this location.

6.3 Solar Energy

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

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

6.3.1 Solar water heating

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

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

Solar hot water systems are of course, displacing heat pumps for DHW provision (as noted below), and due to the efficiency as a source of energy, solar thermal systems tend to have a very poor pay back model unless there is a reliable and consultant demand for hot water; a medium size residential led scheme simply does not provide this.



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

6.3.2 Photovoltaics (PV)

A 1kWp (1 kilowatt peak) system in the UK could be expected to produce between 790-800kWh of electricity per year based upon a south east orientation according to SAP2005 methodology used by the Microgeneration Certification Scheme (MCS). The figure given in the London Renewables Toolkit is 783 kWh per year for a development in London.

Despite the withdrawal of the Feed in Tariff, the returns on PV installations are still able to achieve 6-7% returns via the reduction in (ever more expensive) electricity consumption.

Accordingly, the design team are proposing a 4 panel PV for each dwelling – the total array generating some 4,000kWh/annum.

6.4 Biomass heating

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

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

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

6.5 Ground source heat pump

All heat pump technologies utilise electricity as the primary fuel source – in this case displacing gas, as such, the overall reduction in emissions when using this technology can be less effective when opposed to a technology that is actually displacing electricity.



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

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

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

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

The new dwellings at Stratford Road do not have the available external space to install low level ground collectors and deep bore solutions are highly expensive given the heat load required for this small residential scheme.

Accordingly, ground source heating would be considered inappropriate, particularly in light of the more flexible option offered by air source heating:-

6.6 Air source heat pump

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

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

Assuming a seasonal system efficiency of 320% (Coefficient of Performance of 3.2) and that the air source heat pump will replace 100% of the space heating/hot water demand, then the system would reduce the overall CO_2 emissions by approximately 70%. The table below demonstrates, on the assumption of a demand of 1000Kwh/year for heating and hot water.

Type of Array	Energy Consumption (kWh/yr.)	Emission factor (kgCO ₂ /h)	Total CO₂ emissions (kg/annum)
90% efficient gas boiler	11111	0.210	2333
320% efficient ASHP	2813	0.136	383
100% efficient	1000	0.136	136
immersion (back-up)			

Table 4 – Air Source Heat Pump Performance

A theoretical carbon saving of 77%



With the above data in mind, clearly an ASHP could be an option and the "be green" proposals include the use of air source heat pumps to provide the heat source for the dwellings' LTHW heating and DHW systems.

Overall system efficiency has been advised at 350% and this figure has been used for the communal heating systems within the final energy calculations.

6.7 Final Emissions Calculation

Given the outcome of the feasibility study above, the developer is proposing the use the above noted air source heat pump system to deliver the heating and hot water demands to the development, as well as 4 panel PV arrays to each dwelling.

The final table – Table 2 – summarises the final outputs from the SAP models; attached at **Appendix C.**

Unit	Emission Rate	Total "be green
	(regulated	"emissions
	energy use)	
	Kg/sqm/annum	Kg
Unit 1	3.99	670
Total		670

Table 2 – "Be Green" emission levels

The data at Table 2 confirms that overall emissions have been reduced by **84%** over and above the baseline building regulations compliant model.



7.0 Sustainable Design & Construction

The Sustainability credentials of the proposed residential development at Stratford Road are set out below; based on the assessment criteria developed by the Building Research Establishment

Materials

New build construction techniques will be considered against the BRE Green Guide to ensure that, where practical, the most environmentally friendly construction techniques are deployed.

Construction materials will be sourced from suppliers capable of demonstrating a culture of responsible sourcing via environmental management certification, such as BES6001

Insulation materials will be selected that demonstrate the use of blowing agents with a low global warming potential, specifically, a rating of 5 or less. Additionally, all insulants used will demonstrate responsible sourcing of material and key processes.

The principle contractor with be required to produce a site waste management plan and sustainable procure plan, in line with BREEAM standards. The procurement plan will follow the waste hierarchy Reduce; Reuse & Recycle.

The Site Waste Management Plan (SWMP) will be developed prior to commencement of development stage will inform the adoption of good practice waste minimisation in design. This will set targets to minimise the generation of non-hazardous construction waste using the sustainable procurement plan to avoid over-ordering and to use just-in-time delivery policies.

Operational waste and recycling – appropriate internal and external storage space will be provided to ensure that residents can sort, store and dispose of waste and recyclable materials in line with local collection policies.

Pollution

The contractor will also monitor the use of energy and water use during the construction phase and incorporate best site practices to reduce the potential for air (dust) and ground water pollution.

The completed development will use zero emission heat pump systems for heating and hot water.

The main contractor will be required to register the site with the Considerate Constructors Scheme and achieve a best practice score of 33 or more.

To avoid the issue of noise pollution, the development will comply with Building Regulations Part E, providing a good level of sound insulation between the proposed development and surrounding buildings.



Energy

The development will incorporate renewables technologies as noted in the main report above; air source heat pumps and PV arrays.

The completed residential units will be supplied with a Home User Guide offering practical advice on how to use the home economically and efficiently, including specific advise on how to reduce unregulated energy uses.

This will be further enhanced by the installation of smart energy metering, enabling occupants to accurately assess their energy usage and thereby, manage it.

Water

The development minimise water use as far as practicable by incorporating appropriate water efficiency and water recycling measures. The development will utilise low flow taps, dual flush toilets and minimum use urinals to minimise internal water use.

Current proposals are for:-

- Basin Taps 5l/min
- Kitchen taps 7l/min
- Showers 8l/min
- Baths Capacity 1451
- Toilets Dual Flush 5/2.51

An overall target of 105l/person/day will be achieved.

Ecology and Biodiversity

Clearly, the existing site has significant landscaped areas, so the applicants will seek an improvement on this situation to increase biodiversity.

The development would employ an ecologist to consider the landscaping and planting regime and any other opportunities to achieve an overall improvement in the levels of fauna and flora utilising indigenous species where possible and appropriate.

It is expected to achieve an uplift in net biodiversity.

Sustainable Urban Drainage

The existing site is currently made up of building and permeable surfaces. Accordingly, the introduction of new planted areas and gardens will help to control the levels of surface water run-off.

The design team have considered the requirements of Watford policies in regard to the need to actively reduce surface water run-off rates where possible and this matter is covered under a separate report.

8.0 Conclusions



The baseline results have shown that if the sample house was built to a standard to meet only the minimum requirements of current building regulations, the total amount of CO_2 emissions would be **4,277Kg/year**.

Following the introduction of passive energy efficiency measures into the development, as detailed in section 4, the total amount of CO₂ emissions would be considerably reduced via a **35%** improvement in fabric energy efficiency

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

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

The results of the assessment of suitable technologies relative to the nature, locations and type of development suggest that the most suitable solution to meeting reduction in CO₂ emissions would be via the use of heat pump driven heating and hot water systems as well as 4 panel roof mounted PV arrays.

This has been used in the SAP models (reproduced at **Appendix A**) for the development which have also been detailed above in Table 2, which show a final gross emission level of **670Kg/year**, representing a total reduction in emission over the baseline model, taking into account unregulated energy, of **84%**.

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Appendix A

SAP Outputs – DER/TER "as designed"

Property Referen	ce	Un	it 1						ls	sued on Dat	te	06/12/2023	
Assessment Refe	erence	Un	it 1					Prop Type R	et				
Flopenty													
SAP Rating					80 C		DER	3.9	9	TER		25.46	
Environmental					96 A		% DER < TER					84.33	
CO ₂ Emissions (t/	/year)				0.58		DFEE	74.	60	TFEE		115.24	
Compliance Chec	ck				See BREL		% DFEE < TFE	E				35.27	
	ar 🔊 🕅	пегду			68.18		DPER	43.	11	TPER		135.50	
D Coloulotion Drinte	sut Nel	mpriter Geor	ge Farr							Asses	sor ID	T355-000	1
SAP 10 WORKSHEE CALCULATION OF 1	T FOR New E DWELLING EM	Build (As D MISSIONS FO	esigned) (R REGULATION	Version 10 IS COMPLIAN	.2, February CE	7 2022)							
Ground floor First floor	ling charac	teristics						Area (m2) 56.5000 57.8800 54.0300	Store: (1b) x (1c) x (1d) x	y height (m) 2.6700 (3.0000 (2.8600 (2b) = 2c) = 2d) =	Volume (m3) 150.8550 173.6400 154.5258	(1b) - (3) (1c) - (3) (1d) - (3)
Dwelling volume	a TFA = (18 rate)+(Id)+(Ie).	(IN)					3a)+(3b)+(3c)+	(3d)+(3e).	(3n) =	479.0208	(4)
Number of open (Number of open : Number of chimm, Number of flues Number of flues Number of block Number of inter Number of passi Number of fluet	chimneys flues eys / flues attached t ed chimneys mittent ext ve vents ess gas fir	s attached f to solid fu to other he s tract fans tres	to closed fi el boiler ater	re							0 * 80 = 0 * 20 = 0 * 10 = 0 * 20 = 0 * 35 = 0 * 20 = 5 * 10 = 0 * 10 = 0 * 40 =	n3 per hour 0.0000 0.0000 0.0000 0.0000 0.0000 50.0000 0.0000 0.0000	(6a) (6b) (6c) (6d) (6f) (7a) (7b) (7c)
Infiltration due Pressure test Pressure Test Me Measured/design Infiltration rations Number of sides	e to chimne ethod AP50 te sheltered	eys, flues .	and fans =	= (6a)+(6b)	+(6c)+(6d)+((6e)+(6f)+	(6g)+(7a)+(*	7b)+(7c) =		50.0000	Air change / (5) = H	es per hour 0.1044 Yes Blower Door 4.0000 0.3044 1	<pre>(8) (17) (18) (19)</pre>
Shelter factor Infiltration rat	te adjusted	l to includ	e shelter fa	ctor					(20) = 1 - (21)	[0.075 x) = (18) x	(19)] = (20) =	0.9250 0.2816	(20) (21)
Wind speed Wind factor Adj infilt rate	Jan 5.1000 1.2750	Feb 5.0000 1.2500	Mar 4.9000 1.2250	Apr 4.4000 1.1000	May 4.3000 1.0750	Jun 3.8000 0.9500	Jul 3.8000 0.9500	Aug 3.7000 0.9250	Sep 4.0000 1.0000	Oct 4.3000 1.0750	Nov 4.5000 1.1250	Dec 4.7000 1.1750	(22) (22a)
Effective ac	0.3590 0.5644	0.3519 0.5619	0.3449 0.5595	0.3097 0.5480	0.3027 0.5458	0.2675 0.5358	0.2675 0.5358	0.2604 0.5339	0.2816 0.5396	0.3027 0.5458	0.3167 0.5502	0.3308 0.5547	(22b) (25)
3. Heat losses a	and heat lo	oss paramet	er										
Element DOOR G (Uw = 1.00)				Gross m2	Openings m2	Net 2 32	tArea m2 .5100 .9600	U-value W/m2K 1.1000 0.9615	A x U W/K 2.7610 31.6923	K- k	value J/m2K	A x K kJ/K	(26) (27)
GF EF EW PR Total net area o Fabric heat loss	of external s, W/K = Su	elements I im (A x U)	24 7 Aum(A, m2)	6.1100 6.4100	35.4700	56 1 210 76 380	.5400 .3500 .6400 .4100 .4100 (26)(3	0.1200 0.2200 0.1500 0.1100 30) + (32)	6.7848 0.2970 31.5960 8.4051 = 81.5362	110 20 60 9	.0000	6219.4000 27.0000 12638.4000 687.6900	(28a) (28b) (29a) (30) (31) (33) (32c)
IF IF						293 110 110	.5700 .5700			9 18 9	.0000	∠642.7600 1990.2600 995.1300	(320) (32d) (32e)

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Heat capacity Cm = Sum(A x k) Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K List of Thermal Bridges Kl Element E2 Other lintels (including other steel lintels) E3 Sill (28)...(30) + (32) + (32a)...(32e) = 25200.6400 (34) 149.6386 (35) Length Psi-value Total 16.0500 0.0540 0.8667 16.0500 0.0400 0.6420

E4 Jamb E14 Flat roof E16 Corner (normal) E17 Corner (inverted - inte E18 Party wall between dwel E11 Eaves (insulation at ra E13 Gable (insulation at ra E6 Intermediate floor withi E5 Ground floor (normal) E20 Exposed floor (normal) Thermal bridges (Sum(L x Psi) calcu Point Thermal bridges Total fabric heat loss	rnal area great lings fter level) fter level) n a dwelling lated using App	er than exte endix K)	ernal a	cea)		355 0 3175 2 0 21 14 63 32 2	0.0400 0.0000 0.0000 0.0000 0.0000 0.2100 0.22100 0.2200 0.2000 0.8000	0.0490 0.0800 0.0400 -0.0680 0.0180 0.0360 0.0370 0.0380 0.0620 33) + (36)	1.71 0.00 127.00 -0.18 0.00 0.38 0.51 2.34 1.22 0.17 (36a) = + (36a) =	70 00 00 72 16 63 36 134.6848 0.0000 216.2210	(36) (37)
Ventilation heat loss calculated mo	nthly (38)m = 0 Mar	.33 x (25)m Apr M	x (5) 4ay	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
SAP Calculation Printout	88.4405 8	6.6196 86	5.2790	84.6930	84.6930	84.3993	85.3039	86.2790	86.9682	87.6887	(38)
305.4447 305.0492 Average = Sum(39)m / 12 =	304.6615 30	2.8406 302	2.5000	300.9140	300.9140	300.6203	301.5249	302.5000	303.1892	303.9097 302.8390	(39)
Jan Feb HLP 1.8137 1.8113	Mar 1.8090	Apr 1	4ay L.7962	Jun 1.7868	Jul 1.7868	Aug 1.7851	Sep 1.7904	Oct 1.7962	Nov 1.8003	Dec 1.8046	(40)
HLP (average) Days in mont 31 28	31	30	31	30	31	31	30	31	30	1.7982 31	
4. Water heating energy requirement	s (kWh/year)										
Assumed occupancy										2.9604	(42)
Hot water usage for mixer snowers 73.8567 72.7468	71.1294 6	8.0348 65	5.7511	63.2044	61.7568	63.3619	65.1214	67.8559	71.0169	73.5737	(42a)
31.8840 31.4105 Hot water usage for other uses	30.7437 2	9.5142 28	3.5935	27.5727	27.0213	27.6835	28.4044	29.4968	30.7516	31.7762	(42b)
44.9479 43.3134 Average daily hot water use (litres	41.6789 4 /day)	0.0445 38	3.4100	36.7755	36.7755	38.4100	40.0445	41.6789	43.3134	44.9479 138.5166	(42c) (43)
Jan Feb	Mar	Apr N	lay	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
150.6886 147.4706 Energy conte 238.6538 209.9962 Energy content (annual)	143.5520 13 220.6341 18	7.5935 132 8.3586 178	2.7547 3.7133	127.5526 156.8408	125.5536 151.8462	129.4554 160.2928	133.5703 164.7056	139.0316 188.6645 Total = S	145.0819 206.6957 um(45)m =	150.2978 235.3300 2300.7317	(44) (45)
Distribution loss (46)m = 0.15 x (35.7981 31.4994	45)m 33.0951 2	8.2538 20	5.8070	23.5261	22.7769	24.0439	24.7058	28.2997	31.0044	35.2995	(46)
Water storage loss: Store volume a) If manufacturer declared loss f Temperature factor from Table 2b Enter (49) or (54) in (55)	actor is known	(kWh/day):								150.0000 1.6800 0.5400 0.9072	(47) (48) (49) (55)
Total storage loss 28.1232 25.4016	28.1232 2	7.2160 28	3.1232	27.2160	28.1232	28.1232	27.2160	28.1232	27.2160	28.1232	(56)
28.1232 25.4016 Primary loss 23.2624 21.0112	28.1232 2 23.2624 2	7.2160 28 2.5120 23	3.1232 3.2624	27.2160 22.5120	28.1232 23.2624	28.1232 23.2624	27.2160 22.5120	28.1232 23.2624	27.2160 22.5120	28.1232 23.2624	(57) (59)
Combi loss 0.0000 0.0000 Total heat required for water heati	0.0000 ng calculated f	0.0000 (or each mont).0000 :h	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
290.0394 256.4090 WWHRS -65.8099 -58.2028 DV divertor 0.0000	272.0197 23 -60.9467 -5	8.0866 230 0.4662 -4	0.0989 7.0327	206.5688	203.2318	211.6784	214.4336	240.0501	256.4237	286.7156	(62) (63a)
FV diverter -0.0000 -0.0000 Solar input 0.0000 0.0000 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	(63c) (63d)
Output from w/h 224.2295 198.2062	211.0730 18	7.6203 183	3.0662	166.3226	165.5074	171.5622	172.7933	190.9608	200.8115	222.1244	(64)
12Total per year (kWh/year)						Total p	er year (kW	h/year) = S	um(64)m =	2294.2773 2294	(64) (64)
0.0000 0.0000	0.0000	0.0000 (Total Er	0.0000 hergy us	0.0000 sed by inst	0.0000 antaneous e	0.0000 lectric sho	0.0000 wer(s) (kWh	0.0000 /year) = Su	0.0000 m(64a)m =	0.0000	(64a) (64a)
Heat gains from water heating, kWh/ 120.4609 106.9540	month 114.4693 10	2.4116 100	0.5307	91.9320	91.5973	94.4058	94.5470	103.8394	108.5087	119.3557	(65)
5. Internal gains (see Table 5 and	5a)										
Metabolic gains (Table 5), Watts Jan Feb	Mar	Apr N	lay	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m 148.0220 148.0220 Lighting gains (calculated in Appen	148.0220 14 dix L, equation	8.0220 148 L9 or L9a),	3.0220 , also s	148.0220 see Table 5	148.0220	148.0220	148.0220	148.0220	148.0220	148.0220	(66)
1/6.5986 195.5199 Appliances gains (calculated in App 339 9246 343 4510	1/0.5986 18 endix L, equati 334 5631 21	2.4852 176 on L13 or L3 5.6399 201	0.5986 13a), al 1 7527	182.4852 Lso see Tab 269 3021	1/6.5986 le 5 254 3037	1/6.5986 250 7764	182.4852	1/6.5986	182.4852	1/6.5986	(67)
Cooking gains (calculated in Append 37.8022 37.8022	lix L, equation 37.8022 3	L15 or L15a) 7.8022 3	, also	see Table 37.8022	5 37.8022	37.8022	37.8022	37.8022	37.8022	37.8022	(69)
Pumps, fans 0.0000 0.0000 Losses e.g. evaporation (negative v	0.0000 alues) (Table 5	0.0000 (0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
-118.4176 -118.4176 Water heating gains (Table 5)	-118.4176 -11	8.4176 -118	3.4176	-118.4176	-118.4176	-118.4176	-118.4176	-118.4176	-118.4176	-118.4176	(71)
161.9098 159.1577 Total internal gains	153.8566 14	2.2384 135	5.1218	127.6833	123.1147	126.8896	131.3153	139.5691	150.7066	160.4243	(72)
(40.000 /00.0362	/32.4249 /0	1.11U1 0/(040.8//2	021.423/	021.0/12	040.8/23	002.1028	/03.0/40	129.3338	(73)
6. Solar gains											
[Jan]	Area	Sola	ar flux		a		FF	Acce	ss	Gains	
	m2	Ta	able 6a W/m2	Speci or	fic data Table 6b	Specific or Tab	data de 6c	fact Table	or 6d	W	
North	18.8100		L0.6334		0.5700	0	.7000	0.77	00	55.3053	(74)
Sourn West 	1.9400		10./521 L9.6403		0.5700	0 0 	.7000	0.77	00	10.5355	(78)

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Solar gains 223.6828 384.8055 542.8254 710.1453 837.0913 851.3397 812.1883 713.0720 599.3879 429.0881 268.4593 191.1591 (83) Total gains 969.5224 1150.3416 1275.2503 1417.9153 1507.9711 1498.2170 1433.6119 1334.7432 1240.2602 1091.2509 971.5334 920.5149 (84)

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Full

7. Mean internal temper	ature (heati	ing season)										
Temperature during heat	ing periods	in the livi	.ng area fro	m Table 9,	Thl (C)						21.0000	(85)
tau 22.9180 alpha 2.5279	Feb 22.9477 2.5298	Mar 22.9769 2.5318	Apr 23.1151 2.5410	May 23.1411 2.5427	Jun 23.2630 2.5509	Jul 23.2630 2.5509	Aug 23.2858 2.5524	Sep 23.2159 2.5477	Oct 23.1411 2.5427	Nov 23.0885 2.5392	Dec 23.0337 2.5356	
util living area 0.9878	0.9804	0.9690	0.9431	0.8932	0.8017	0.6893	0.7311	0.8714	0.9547	0.9814	0.9893	(86)
SAP Calculation Printout	elmhurst 301	18.9868	19.4922	20.0051	20.4468	20.6793	20.6368	20.2828	19.6246	18.9363	18.3819	
24 / 16 0 24 / 9 31	28	17.2294 0 31	17.8/15 0 30	18.5041 0 31	19.0164 0 30	19.2380 0 31	19.2090 0 31	18.8466 0 30	18.0468 0 31	17.1723 0 30	10.4014 0 31	
16 / 9 0 MIT 21.0000	0 21.0000	0 21.0000	0 21.0000	0 21.0000	0 21.0000	0 21.0000	0 21.0000	0 21.0000	0 21.0000	0 21.0000	21.0000	(87)
Th 2 19.4604 util rest of house	19.4621	19.4637	19.4712	19.4727	19.4793	19.4793	19.4805	19.4767	19.4727	19.4698	19.4668	(88)
MIT 2 19.4604	19.4621	19.4637	19.4712	19.4727	19.4793	19.4793	19.4805	0.8064 19.4767 fLA =	0.9372 19.4727 Living are	0.9758 19.4698 a / (4) =	19.4668 0.2524	(89) (90) (91)
MIT 19.8490 Temperature adjustment	19.8502	19.8514	19.8570	19.8581	19.8630	19.8630	19.8639	19.8611	19.8581	19.8560	19.8537 0.0000	(92)
adjusted MIT 19.8490	19.8502	19.8514	19.8570	19.8581	19.8630	19.8630	19.8639	19.8611	19.8581	19.8560	19.8537	(93)
8. Space heating requir	ement											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation 0.9856 Useful gains 955.5723 Ext temp. 4.3000	0.9769 1123.7567 4.9000	0.9630 1228.0304 6.5000	0.9306 1319.4637 8.9000	0.8653 1304.8793 11.7000	0.7380 1105.7074 14.6000	0.5737 822.4977 16.6000	0.6249 834.0240 16.4000	0.8262 1024.6477 14.1000	0.9424 1028.3892 10.6000	0.9774 949.5730 7.1000	0.9874 908.9475 4.2000	(94) (95) (96)
Heat loss rate W 4749.3462	4560.5407	4067.6526	3318.2357	2467.8234	1583.7205	981.8925	1041.3335	1737.1241	2800.5733	3867.4665	4757.3155	(97)
Space heating kWh 2822.5677 Space heating requirement	2309.5189	2112.6789 Der vear (kW	1439.1159 Nh/vear)	865.2304	0.0000	0.0000	0.0000	0.0000	1318.5050	2100.8833	2863.1858	(98a)
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)
Space heating kWh 2822.5677	2309.5189	2112.6789	1439.1159	865.2304	0.0000	0.0000	0.0000	0.0000	1318.5050	2100.8833	2863.1858	(98c)
Space heating requireme Space heating per m2	nt after sol	lar contribu	ition - tota	l per year	(kWh/year)				(98c) / (4) =	15831.6859 94.0068	(99)
		l bosting s	vstems, inc									
9a. Energy requirements Fraction of space heat Fraction of space heat Efficiency of main space	from seconda from main sy e heating sy	ary/suppleme /stem(s) /stem 1 (in	<pre>syste %) %)</pre>	m (Table 11	L)						0.0000 1.0000 394.2166	(201) (202) (206)
9a. Energy requirements Fraction of space heat Fraction of space heat Efficiency of main space Efficiency of main space Efficiency of secondary	from seconda from main sy e heating sy /supplementa	ary/suppleme ystem(s) ystem 1 (in ystem 2 (in ary heating	<pre>%) %) %) system, %</pre>	m (Table 11	L)						0.0000 1.0000 394.2166 0.0000 0.0000	(201) (202) (206) (207) (208)
9a. Energy requirements Fraction of space heat Fraction of space heat Efficiency of main space Efficiency of secondary Jan Space heating requirements	from seconda from main sy he heating sy he heating sy hypplementa Feb	ary/suppleme ystem(s) ystem 1 (in ystem 2 (in ary heating Mar	<pre>system, % Apr</pre>	May	Jun	Jul	Aug	Sep	Oct	Nov	0.0000 1.0000 394.2166 0.0000 0.0000 Dec	(201) (202) (206) (207) (208)
9a. Energy requirements 	from seconda from main sy the heating sy the heating sy the second sy the second second Feb nt 2309.5189 ty (main heat 240 2166	ary/suppleme /stem(s) /stem 1 (in /stem 2 (in ary heating Mar 2112.6789 cing system 3042126	<pre>system, % %) %) system, % Apr 1439.1159 1) 394.2166</pre>	May 865.2304	Jun 0.0000	Jul 0.0000	Aug 0.0000	Sep 0.0000	Oct 1318.5050	Nov 2100.8833	0.0000 1.0000 394.2166 0.0000 0.0000 Dec 2863.1858	(201) (202) (206) (207) (208) (98)
9a. Energy requirements 	from second from main sy the heating sy supplementa Feb (main heat 394.2166 n heating sy 585.8503	ary/suppleme stem(s) ystem 1 (in ystem 2 (in ary heating Mar 2112.6789 cing system 394.2166 ystem) 535.9183	<pre>system, % %) %) system, % Apr 1439.1159 1) 394.2166 365.0572</pre>	May 865.2304 394.2166 219.4810	Jun 0.0000 0.0000	Jul 0.0000 0.0000 0.0000	Aug 0.0000 0.0000 0.0000	Sep 0.0000 0.0000 0.0000	Oct 1318.5050 394.2166 334.4621	Nov 2100.8833 394.2166 532.9262	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976	(201) (202) (206) (207) (208) (98) (210) (211)
9a. Energy requirements 	<pre>- Individue from seconda from main sy e heating sy /supplements</pre>	rry/suppleme rry/suppleme (stem (s) /stem 1 (in /stem 2 (in rry heating Mar 2112.6789 Cing system 394.2166 /stem) 535.9183 Sing system 0.0000	<pre>system, % %) system, % Apr 1439.1159 1) 394.2166 365.0572 2) 0.0000</pre>	May 865.2304 394.2166 219.4810 0.0000	Jun 0.0000 0.0000 0.0000 0.0000	Jul 0.0000 0.0000 0.0000 0.0000	Aug 0.0000 0.0000 0.0000 0.0000	Sep 0.0000 0.0000 0.0000 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000	(201) (202) (206) (207) (208) (98) (210) (211) (212)
9a. Energy requirements 	<pre>- Individue from seconde from main sy e heating sy /supplements 2309.5189 y (main heat 334.2166 n heating sy 585.8503 y (main heat 0.0000</pre>	ry/suppleme ry/suppleme /stem() /stem() /stem 2 (in ary heating Mar 2112.6789 ting system 394.2166 (stem) 535.9183 ting system 0.0000 /stem 2) 0.0000	<pre>(10000) 100 (10000) 1000 (10000) 1000 (10000) 1000 (10000) 1000 (10000) 1000 (10000) 1000 (10000) 1000 (10000) 1000 (10000) 10000 (10000) 10000000 (10000) 10000000000000000000000000000000</pre>	May 865.2304 394.2166 219.4810 0.0000 0.0000	Jun 0.0000 0.0000 0.0000 0.0000 0.0000	Jul 0.0000 0.0000 0.0000 0.0000 0.0000	Aug 0.0000 0.0000 0.0000 0.0000 0.0000	Sep 0.0000 0.0000 0.0000 0.0000 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000	(201) (202) (206) (207) (208) (98) (210) (211) (212) (213)
9a. Energy requirements 	<pre>- Individue from seconde from seconde se heating sy /supplements 2309.5189 y (main heat 394.2166 n heating sy 585.6503 y (main heat 0.0000 n heating sy 0.0000 ondary) 0.0000</pre>	ry/suppleme ry/suppleme ystem(s) ystem 1 (in ystem 2 (in ry heating 2112.6789 cing system 394.2166 ystem) 535.9183 cing system 0.0000 ystem 2) 0.0000 0.0000	(), (), (), (), (), (), (), (), (), (),	May 865.2304 394.2166 219.4810 0.0000 0.0000	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	Jul 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	Aug 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	Sep 0.0000 0.0000 0.0000 0.0000 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 0.0000	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000	(201) (202) (206) (207) (208) (210) (211) (211) (212) (213) (215)
9a. Energy requirements 	rom second from second from main sy e heating sy /supplementa set as a second rom second Feb nt 2309.5189 y (main heat 394.2166 n heating sy 585.8503 y (main heat 0.0000 n heating sy 0.0000 nodary) 0.0000	ry/suppleme rry/suppleme rry/suppleme (stem(s) ystem 1 (in ystem 2 (in ary heating 2112.6789 ing system 394.2166 ystem) 535.5183 ing system 0.0000 0.0000 0.0000 211.0730	<pre>ntary syste %) %) system, % Apr 1439.1159 1) 394.2166 365.0572 2) 0.0000 0.0000 0.0000 187.6203</pre>	May 865.2304 394.2166 219.4810 0.0000 0.0000	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	Jul 0.0000 0.0000 0.0000 0.0000 0.0000	Aug 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	Sep 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 0.0000	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000	(201) (202) (206) (207) (208) (210) (210) (211) (212) (213) (215)
9a. Energy requirements 	<pre>- Individue from seconde from seconde from main sy e heating sy /supplements 2309.5189 y (main heat 394.2166 n heating sy 585.8503 y (main heat 0.0000 n heating sy 0.0000 ondary) 198.2062 ter 188.9550</pre>	ry/suppleme ry/suppleme ystem(s) /stem 1 (in /stem 2 (in ary heating 2112.6789 cing system 394.2166 /stem) 535.9183 cing system 0.0000 /stem 2) 0.0000 211.0730 188.9550	<pre>system, % Apr 1439.1159 1) 394.2166 365.0572 0.0000 0.0000 187.6203 188.9550</pre>	May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550	Jul 0.0000 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550	Aug 0.0000 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550	Sep 0.0000 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 200.8115 188.9550	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 222.1244 188.9550	(201) (202) (206) (207) (208) (210) (211) (212) (213) (215) (64) (217)
9a. Energy requirements 	<pre>- Individue from seconde from main sy e heating sy /supplementa replementa sy (main heat 394.2166 n heating sy 0.0000 ondary) 0.0000 nt 198.2062 ter 198.2062 kWh/month 104.8960</pre>	ry/suppleme ry/suppleme ry/suppleme (stem(s) /stem 1 (in /stem 2 (in ary heating 2112.6789 ting system 394.2166 /stem) 535.9183 ting system 0.0000 0.0000 0.0000 211.0730 188.9550 111.7054	ntary syste %) %) system, % Apr 1439.1159 1) 394.2166 365.0572 2) 0.0000 0.0000 0.0000 187.6203 188.9550 99.2937	May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550 96.8835	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550 88.0223	Jul 0.0000 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550 87.5909	Aug 0.0000 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550 90.7953	Sep 0.0000 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550 91.4468	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550 101.0615	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 0.0000 200.8115 188.9550 106.2748	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 222.1244 188.9550 188.9550 117.5541	(201) (202) (206) (207) (208) (210) (211) (211) (212) (213) (215) (64) (216) (217) (219)
9a. Energy requirements 	rindividue from seconde from main sy e heating sy /supplements 2309.5189 y (main heat 394.2166 n heating sy 558.8503 y (main heat 0.0000 n heating sy 0.0000 n heating sy 0.0000 nt 198.2062 ter 188.9550 kWh/month 104.8960 j:rement 0.0000	ry/suppleme ry/suppleme ry/suppleme (stem (s) /stem 1 (in /stem 2 (in mar 2112.6789 2112.6789 2112.6789 334.2166 /stem 0.0000 /stem 2) 0.0000 0.0000 211.0730 188.9550 111.7054 0.0000 0.0000	<pre>system, % Apr 1439.1159 1) 394.2166 365.0572 2) 0.0000 0.0000 187.6203 188.9550 99.2937 0.0000</pre>	May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550 96.8835 0.0000	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550 88.0223 0.0000	Jul 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550 87.5909 0.0000	Aug 0.0000 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550 90.7953 0.0000	Sep 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550 91.4468 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550 101.0615 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 200.8115 188.9550 106.2748 0.0000	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 222.1244 188.9550 188.9550 117.5541 0.0000	(201) (202) (206) (207) (208) (210) (211) (212) (213) (213) (215) (64) (217) (216) (217) (219) (221)
9a. Energy requirements 	<pre>- Individue from seconde from main sy the heating sy /supplementa sy (supplementa 394.2166 n heating sy 555.8503 y (main heat 0.0000 ondary) 0.0000 nt 198.2062 ter 198.2062 ter 198.2062 ter 198.2062 ter 104.8960 iriement 0.0000 31.6479 y FVs (Apper</pre>	ry/suppleme rry/suppleme rry/suppleme (stem (s) /stem 1 (in /stem 2 (in ary heating 0 and 394.2166 /stem) 535.9183 ting system 0.0000 0.0000 0.0000 211.0730 188.9550 111.7054 0.0000 0.8.4954 ddix M) (neg	ntary syste %) %) system, % Apr 1439.1159 1) 394.2166 365.0572 2) 0.0000 0.0000 187.6203 188.9550 99.2937 0.0000 0.0000 20.8769 yative quant	May (Table 11 May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550 96.8835 0.0000 16.1259 ity)	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550 88.0223 0.0000 0.0000 13.1750	Jul 0.0000 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550 87.5909 0.0000 0.0000 14.7106	Aug 0.0000 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550 90.7953 0.0000 0.0000 19.1214	Sep 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550 91.4468 0.0000 24.8368	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550 101.0615 0.0000 0.0000 32.5873	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 200.8115 188.9550 106.2748 0.0000 0.0000 36.8073	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 222.1244 188.9550 188.9550 117.5541 0.0000 0.0000 40.5459	(201) (202) (206) (207) (208) (210) (211) (211) (212) (213) (215) (215) (64) (216) (217) (219) (221) (221) (231) (232)
<pre>9a. Energy requirements </pre>	<pre>- Individue from seconde from main sy e heating sy /supplements 394.2166 n heating sy 0.0000 n heating sy 0.00000 n heating sy 0.00000 n heating sy 0.00000 n heating sy 0.0000000000 n heating sy 0.00000000000000000000000000000000000</pre>	ry/suppleme ry/suppleme ry/suppleme (stem (s) /stem 1 (in /stem 2 (in mar 2112.6789 2112.6789 2394.2166 /stem 0.0000 /stem 2) 0.0000 211.0730 188.9550 111.7054 0.0000 28.4954 diix M) (neg -71.9638 ines (Append	ntary syste *) *) *) *) *) *) *) *) *) *)	May (Table 11 May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550 96.8835 0.0000 16.1259 ity) -110.7241 tive quanti	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550 88.0223 0.0000 0.0000 0.3.1750 -94.9757	Jul 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550 87.5909 0.0000 0.0000 0.0000 14.7106	Aug 0.0000 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550 90.7953 0.0000 0.0000 19.1214 -82.9707	Sep 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550 91.4468 0.0000 24.8368 -66.0607	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550 101.0615 0.0000 0.2.5873 -50.8111	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 200.8115 188.9550 106.2748 0.0000 0.0000 0.68073 -28.3401	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 222.1244 188.9550 188.9550 117.5541 0.0000 0.0000 40.5459 -19.9090	(201) (202) (206) (207) (208) (210) (211) (211) (212) (213) (215) (213) (215) (215) (217) (219) (221) (231) (232) (233a)
<pre>9a. Energy requirements </pre>	- Individue from seconde from main sy the heating sy (supplements Feb int 2309.5189 y (main heat 334.2166 n heating sy 585.8503 y (main heat 0.0000 int 198.2062 ter 188.9550 kWh/month 104.8960 intement 0.0000 31.6479 y Vis (Apper -41.0409 y wind turbi 0.0000 y hydro-elec 0.0000	ry/suppleme rry/suppleme rry/suppleme rsystem(s) /stem 1 (in /stem 2 (in rry heating Mar 2112.6789 cing system 334.2166 /stem) 535.9183 cing system 0.0000 /stem 2) 0.0000 211.0730 188.9550 111.7054 0.0000 28.4954 ddix M) (neg -71.9638 ines (Append 0.0000	<pre>system, % %) system, % Apr 1439.1159 1) 394.2166 365.0572 2) 0.0000 0.0000 0.0000 187.6203 188.9550 99.2937 0.0000 20.8769 99.2937 0.0000 20.8769 99.2937 0.0000 20.8769 99.2937 0.0000 20.8769 99.2937</pre>	May (Table 11 May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550 96.8835 0.0000 16.1259 ity) -110.7241 tive quanti 0.0000 dix M) (neq	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550 88.0223 0.0000 13.1750 -94.9757 0.0000 jative quant	Jul 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550 87.5909 0.0000 14.7106 -93.1646 0.0000	Aug 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550 90.7953 0.0000 19.1214 -82.9707 0.0000	Sep 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550 91.4468 0.0000 24.8368 -66.0607 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550 101.0615 0.0000 32.5873 -50.8111 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 200.8115 188.9550 106.2748 0.0000 36.8073 -28.3401 0.0000	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 2222.1244 188.9550 188.9550 188.9550 117.5541 0.0000 0.0000 40.5459 -19.9090 0.0000	(201) (202) (206) (207) (208) (210) (211) (212) (213) (212) (213) (215) (215) (217) (217) (217) (219) (221) (231) (232) (233a) (234a)
<pre>9a. Energy requirements </pre>	- Individue from seconde from main sy the heating sy /supplementa Second Second (supplementa 394.2166 n heating sy 585.8503 y (main heat 394.2166 n heating sy 585.8503 y (main heat 0.0000 n heating sy 0.0000 n heating sy 0.0000 198.2062 ter 198.2062 ter 198.2062 ter 104.8960 irement 0.0000 0.1.6479 y Vs (Apper -41.0409 y wind turbi 0.0000 y hydro-elec 0.0000 electricity 0.0000	ry/suppleme rry/suppleme rry/suppleme (stem (s) /stem 1 (in /stem 2 (in nry heating 2112.6789 2112.6789 2112.6789 394.2166 /stem) 535.9183 535.9183 535.9183 535.9183 535.9183 0.0000 /stem 2) 0.0000 0.0000 211.0730 111.7054 0.0000 28.4954 111.7054 0.0000 28.4954 dix M) (neg -71.9638 Lnes (Append 0.0000 ctric generated 0.0000	<pre>system, % Apr 1439.1159 1) 394.2166 365.0572 2) 0.0000 0.0000 187.6203 188.9550 99.2937 0.0000 0.0000 0.0000 0.8769 yative quant -95.1571 ix M) (nega 0.0000 tors (Appen 0.0000 by micro-CH</pre>	May (Table 11 May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550 96.8835 0.0000 16.1259 ity) -110.7241 tive quanti 0.0000 dix M) (nec 0.0000 P (Appendix) 0.0000	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550 88.0223 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 ()0.0000 0.00000 0.0000 0.0000 0.00000 0.0000 0.0000 0.00000 0.00000	Jul 0.0000 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550 87.5909 0.0000 14.7106 -93.1646 0.0000 ity) 0.0000 ve if net g 0.0000	Aug 0.0000 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550 90.7953 0.0000 19.1214 -82.9707 0.0000 0.0000 eneration)	Sep 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550 91.4468 0.0000 24.8368 -66.0607 0.0000 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550 101.0615 0.0000 32.5873 -50.8111 0.0000 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 200.8115 188.9550 106.2748 0.0000 36.8073 -28.3401 0.0000 0.0000	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 222.1244 188.9550 188.9550 188.9550 117.5541 0.0000 0.0000 40.5459 -19.9090 0.0000 0.0000	(201) (202) (206) (207) (208) (210) (211) (211) (212) (213) (213) (215) (213) (215) (216) (217) (219) (221) (231) (232) (233a) (235a) (235c)
<pre>9a. Energy requirements </pre>	<pre>- Individue from seconde from seconde from main sy e heating sy /supplements 2309.5189 y (main heat 394.2166 n heating sy 555.8503 y (main heat 0.0000 n heating sy 0.0000 n heating sy 0.0000 n heating sy 0.0000 n heating sy 0.0000 nt 188.9550 kWh/month 104.8960 .0000 31.6479 y FVS (Apper -41.0409 y wind turbi 0.0000 y hydro-elec 0.0000 y FVS (Apper -9.8559</pre>	ry/suppleme rry/suppleme rry/suppleme rsy/suppleme (stem (s) /stem 1 (in /stem 2 (in mary heating 394.2166 /stem) 535.9183 535.9183 535.9183 535.9183 535.9183 535.9183 0.0000 0.0000 211.0730 188.9550 111.7054 0.0000 28.4954 ddix M) (neg -71.9638 lnes (Append 0.0000 ctric generated 0.0000 ctric generated 0.00000 ctric generated 0.0000 ctric generated 0.0000 ctric ge	ntary syste *) *) system, * Apr 1439.1159 1) 394.2166 365.0572 2) 0.0000 0.0000 187.6203 188.9550 99.2937 0.0000 0.0000 20.8769 181.95571 0.0000 0.0000 10.0000 10.0000 0.00000 0.00000 0.0000 0.000	May (Table 11 May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550 96.8835 0.0000 16.1259 ity) -110.7241 tive quanti 0.0000 dix M) (nec 0.0000 0.0000 dix M) (nec 0.0000 -78.5831	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550 88.0223 0.0000 13.1750 -94.9757 1ty) 0.0000 pative quant 0.0000 (N) (negati 0.0000 -95.3303	Jul 0.0000 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550 87.5909 0.0000 14.7106 -93.1646 0.0000 14.7106 -93.1646 0.0000 ve if net g 0.0000 -92.8781	Aug 0.0000 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550 90.7953 0.0000 19.1214 -82.9707 0.0000 0.0000 eneration) 0.0000 0.0000	Sep 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550 91.4468 0.0000 24.8368 -66.0607 0.0000 0.0000 0.0000 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550 101.0615 0.0000 32.5873 -50.8111 0.0000 0.0000 0.0000 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 200.8115 188.9550 106.2748 0.0000 36.8073 -28.3401 0.0000 0.0000 0.0000 0.0000 -5.6090	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 2222.1244 188.9550 188.9550 117.5541 0.0000 0.0000 40.5459 -19.9090 0.0000 0.0000 0.0000 0.0000	(201) (202) (206) (207) (208) (210) (211) (212) (213) (212) (213) (215) (215) (215) (217) (219) (221) (231) (231) (233a) (233a) (235a) (235c) (233b)
<pre>9a. Energy requirements </pre>	- Individue from seconde from seconde from main sy the heating sy /supplementa Second Second (supplementa 394.2166 n heating sy 585.8503 y (main heat 394.2166 n heating sy 585.8503 y (main heat 0.0000 n heating sy 0.0000 n heating sy 0.0000 198.2062 ter 198.2062 ter 198.2062 ter 198.2062 ter 198.2062 ter 198.2062 ter 198.2062 ter 198.2062 ter 104.8960 0.0000 0.0000 0.16479 y Vis (Apper -41.0409 y wind turbi 0.0000 y PVs (Apper -9.8559 y wind turbi 0.0000 y PVs (Apper -9.8559 y wind turbi 0.0000	ry/suppleme rry/suppleme ry/suppleme (stem (s) /stem 1 (in /stem 2 (in mar 2112.6789 ing system 394.2166 /stem) 535.9183 ing system 0.0000 /stem 2) 0.0000 /stem 2) 0.0000 /211.0730 188.9550 111.7054 0.0000 28.4954 dix M) (neg -71.9638 lines (Append 0.0000 /generated 0.0000 dix M) (neg -25.4022 lines (Append 0.0000 dix M) (neg -25.4022 lines (Append 0.0000 dix M) (neg	<pre>ntary syste %) %) system, % Apr 1439.1159 1) 394.2166 365.0572 2) 0.0000 0.0000 0.0000 0.0000 187.6203 188.9550 99.2937 0.0000 20.8769 99.2937 0.0000 20.8769 99.2937 0.0000 tors (Appen 0.0000 tors (Appen 0.0000 tors (Appen 0.0000 tors(Appen 0.0000 tors(Appen 0.0000 tor</pre>	May m (Table 11 May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550 96.8835 0.0000 16.1259 ity) -110.7241 tive quanti 0.0000 dix M) (neq 0.0000 regeneration of the second seco	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550 88.0223 0.0000 0.0000 13.1750 -94.9757 ity) 0.0000 colored 0.0000 -95.3303 ity) 0.0000 -95.3303 ity)	Jul 0.0000 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550 87.5909 0.0000 14.7106 -93.1646 0.0000 14.7106 -93.1646 0.0000 ve if net g 0.0000 -92.8781 0.0000	Aug 0.0000 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550 90.7953 0.0000 19.1214 -82.9707 0.0000 eneration) 0.0000 -72.5187 0.0000	Sep 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550 91.4468 0.0000 24.8368 -66.0607 0.0000 0.0000 0.0000 0.0000 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550 101.0615 0.0000 32.5873 -50.8111 0.0000 0.0000 0.0000 0.0000 -17.2508 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 2200.8115 188.9550 106.2748 0.0000 36.8073 -28.3401 0.0000 0.0000 0.0000 0.0000 0.0000	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 2222.1244 188.9550 188.9550 117.5541 0.0000 0.0000 40.5459 -19.9090 0.0000 0.0000 0.0000 0.0000 0.0000	(201) (202) (206) (207) (208) (210) (211) (211) (212) (213) (213) (215) (213) (215) (217) (219) (217) (219) (221) (232) (233a) (233a) (235c) (233b) (234b)
<pre>9a. Energy requirements </pre>	- Individue - Individue from seconde from main sy the heating sy - Supplements - State	ry/suppleme rry/suppleme ry/suppleme ry/suppleme (stem (s) /stem 1 (in /stem 2 (in ary heating 394.2166 /stem) 535.9183 535.9183 535.9183 535.9183 535.9183 535.9183 (o.0000 0.0000 0.0000 211.0730 188.9550 111.7054 0.0000 28.4954 111.7054 0.0000 29.4954 111.7054 0.0000 20.00000 20.0000 20.00000 20.00000 20.00000 20.0000000 20.00000000	ntary syste ************************************	May (Table 11 May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550 96.8835 0.0000 16.1259 ity) -110.7241 tive quanti 0.0000 P (Appendix 0.0000 P (Appendix 0.0000 D (Dave 1) -78.5831 tive quanti 0.0000 dix M) (neg 0.0000 D (Dave 1) -78.5831 tive quanti 0.0000 D (Dave 1) -78.5831 D (Dave 1) D (Dave	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550 88.0223 0.00000 0.00000 0.00000 0.00000 0.0000 0.0000 0.00000 0.00000	Jul 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550 87.5909 0.0000 0.0000 14.7106 -93.1646 0.0000 ity) 0.0000 ve if net g 0.0000 -92.8781 0.0000 ity) 0.0000 ity) 0.0000 ity) 0.00000 0.0000 0.0000 0.00000 0.00000 0.00000 0.00000 0.000	Aug 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550 90.7953 0.0000 19.1214 -82.9707 0.0000 eneration) 0.0000 -72.5187 0.0000 0.0000	Sep 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550 91.4468 0.0000 24.8368 -66.0607 0.0000 0.0000 0.0000 0.0000 -45.7937 0.0000 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550 101.0615 0.0000 32.5873 -50.8111 0.0000 0.0000 0.0000 -17.2508 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 200.8115 188.9550 106.2748 0.0000 0.6000 36.8073 -28.3401 0.0000 0.0000 0.0000 -5.6090 0.0000	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 2222.1244 188.9550 117.5541 0.0000 40.5459 -19.9090 0.0000 0.0000 0.0000 0.0000 -2.8034 0.0000 0.0000	(201) (202) (206) (207) (208) (210) (211) (212) (213) (213) (215) (213) (215) (217) (219) (221) (231) (231) (233a) (233a) (233a) (235c) (233b) (235b)
<pre>9a. Energy requirements </pre>	- Individue from seconde from seconde from main sy e heating sy /supplements 2309.5189 y (main heat 394.2166 n heating sy 555.8503 y (main heat 0.0000 n heating sy 0.0000 n heating sy 0.0000 n heating sy 0.0000 nt 198.2062 ter 188.9550 kWh/month 104.8960 0.0000 0.16479 y FVS (Apper -1.0409 y wind turbi 0.0000 y hydro-elec 0.0000 y PVS (Apper -9.8559 y wind turbi 0.0000 y hydro-elec 0.0000 y hydro-elec 0.0000 y hydro-elec 0.0000	ry/suppleme rry/suppleme rry/suppleme rsy/suppleme (stem(s) /stem 1 (in ry heating Mar 2112.6789 2112.6789 2112.6789 2112.6789 2112.6789 2112.6789 0.0000 211.0730 188.9550 111.7054 0.0000 28.4954 dix M) (neg -71.9638 Lines (Append 0.0000 dix M) (neg -2.5.4022 Lines (Append 0.0000	<pre>intary syste intary syste % % Apr 1439.1159 1) 394.2166 365.0572 2) 0.0000 0.0000 0.0000 187.6203 188.9550 99.2937 0.0000 20.8769 gative quant -95.1571 lix M) (nega 0.0000 by micro-CH 0.0000</pre>	May (Table 11 May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550 96.8835 0.0000 16.1259 ity) -110.7241 tive quanti 0.0000 dix M) (nec 0.0000 ity) -78.5831 tive quanti 0.0000 Q(Appendix) 0.0000 P(Appendix) 0.0000 P(Appendix) 0.0000 P(Appendix) 0.0000 P(Appendix) 0.0000 P(Appendix) 0.0000 P(Appendix) 0.0000	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550 88.0223 0.0000 13.1750 -94.9757 0.0000 13.1750 -94.9757 0.0000 yative quant 0.0000 -95.3303 ity) 0.0000 (N) (negati 0.0000 (N) (N) (negati 0.0000 (N) (N) (negati 0.0000 (N) (N) (N) (N) (N) (N) (N) (N) (N) (N)	Jul 0.0000 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550 87.5909 0.0000 14.7106 -93.1646 0.0000 14.7106 -93.1646 0.0000 ve if net g 0.0000 ve if net g 0.0000 ve if net g 0.0000	Aug 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550 90.7953 0.0000 19.1214 -82.9707 0.0000 eneration) 0.0000 -72.5187 0.0000 eneration) 0.0000	Sep 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550 91.4468 0.0000 24.8368 -66.0607 0.0000 0.0000 0.0000 0.0000 -45.7937 0.0000 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550 101.0615 0.0000 32.5873 -50.8111 0.0000 0.0000 0.0000 -17.2508 0.0000 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 200.8115 188.9550 106.2748 0.0000 36.8073 -28.3401 0.0000 0.0000 0.0000 -5.6090 0.0000 0.0000 0.0000	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 2222.1244 188.9550 188.9550 188.9550 117.5541 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	(201) (202) (206) (207) (208) (210) (211) (212) (213) (212) (213) (215) (215) (215) (217) (219) (231) (231) (232) (233a) (233a) (235a) (235b) (235b) (235b)
<pre>9a. Energy requirements </pre>	- Individue from seconde from main sy the heating sy /supplementa Second Second (supplementa 394.2166 n heating sy 585.8503 y (main heat 394.2166 n heating sy 585.8503 y (main heat 0.0000 n heating sy 0.0000 n heating sy 0.0000 n heating sy 0.0000 (supplemental system 1 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 y Wind turbi 0.0000 y HVS (Apper -41.0409 y wind turbi 0.0000 y hydro-elec 0.0000 y hydro-electricity 0.0000 y hydro-electricity 0.0000 y hydro-electricity 0.0000 y hydro-electricity 0.0000 y hydro-electricity 0.0000 in system 1 in system 1	ry/suppleme ry/suppleme ry/suppleme (stem (s) /stem 1 (in /stem 2 (in /ry heating 2112.6789 2112.6789 2112.6789 394.2166 /stem) 535.9183 535.9183 535.9183 535.9183 535.9183 (o.0000 /stem 2) 0.0000 (stem 2) 0.0000 211.0730 188.9550 111.7054 0.0000 28.4954 111.7054 0.0000 28.4954 111.7054 0.0000 28.4954 0.0000 ctric generated 0.0000 ctric generated 0.0000 ctric generated 0.0000	<pre>ntary syste %) %) system, % Apr 1439.1159 1) 394.2166 365.0572 2) 0.0000 0.0000 187.6203 188.9550 99.2937 0.0000 20.8769 99.2937 0.0000 20.8769 99.1971 ix M) (nega 0.0000 ttors (Appen 0.0000 by micro-CH 0.0000 by micro-CH 0.0000 by micro-CH 0.0000</pre>	May (Table 11 May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550 96.8835 0.0000 16.1259 ity) -110.7241 tive quanti 0.0000 dix M) (nec 0.0000 r4.5831 tive quanti 0.0000 dix M) (nec 0.0000 P (Appendix 0.0000 P (Appendix 0.0000 P (Appendix 0.0000 P (Appendix 0.0000 P (Appendix 0.0000 P (Appendix	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550 88.0223 0.0000 0.0000 13.1750 -94.9757 0.0000 (N) (negati 0.0000 -95.3303 ity) 0.0000 (N) (negati 0.0000 (N) (N) (negati 0.00000 (N) (N) (negati 0.0000 (N) (N) (negati 0.	Jul 0.0000 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550 87.5909 0.0000 14.7106 -93.1646 0.0000 14.7106 0.0000 ve if net g 0.0000 ve if net g 0.0000 ve if net g 0.0000 ve if net g 0.0000	Aug 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550 90.7953 0.0000 19.1214 -82.9707 0.0000 0.0000 eneration) 0.0000 -72.5187 0.0000 eneration) 0.0000	Sep 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550 91.4468 0.0000 24.8368 -66.0607 0.0000 0.0000 0.0000 0.0000 -45.7937 0.0000 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550 101.0615 0.0000 32.5873 -50.8111 0.0000 0.0000 0.0000 -17.2508 0.0000 0.0000 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 200.8115 188.9550 106.2748 0.0000 36.8073 -28.3401 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 222.1244 188.9550 117.5541 0.0000 40.5459 -19.9090 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000 0.000000 0.00000000	(201) (202) (206) (207) (208) (210) (211) (212) (213) (212) (213) (215) (213) (221) (231) (231) (233a) (233a) (235a) (235b) (235b) (235b) (235d) (211) (211)
<pre>9a. Energy requirements </pre>	- Individue from seconde from main sy e heating sy /supplements 2309.5189 y (main heat 394.2166 n heating sy 558.8503 y (main heat .0.0000 n heating sy 0.0000 n heating sy 0.0000 n heating sy 0.0000 nt 198.2062 ter 188.9550 kWh/month 104.8960 0.0000 0.16479 y FVS (Apper -1.0409 y wind turbi 0.0000 y hydro-elec 0.0000 y PVS (Apper -9.8559 y wind turbi 0.0000 y hydro-elec 0.0000 y hydro-elec 0.0000 y hydro-elec 0.0000 y hydro-elec 0.0000 y hydro-elec 0.0000 y hydro-elec 0.0000 in system 1 in system 2 condary ter	ry/suppleme rry/suppleme rry/suppleme rry/suppleme (stem (s) /stem 1 (in /stem 2 (in /stem 2 (in /stem) 535.9183 535.9183 535.9183 535.9183 535.9183 535.9183 535.9183 535.9183 0.0000 0.0000 211.0730 188.9550 111.7054 0.0000 28.4954 ddix M) (neg -21.9638 Lines (Append 0.0000 ddix M) (neg -2.5.4022 Lines (Append 0.0000	<pre>intary syste intary syste % % Apr 1439.1159 1) 394.2166 365.0572 2) 0.0000 0.0000 0.0000 187.6203 188.9550 99.2937 0.0000 20.8769 grative quant -95.1571 lix M) (nega 0.0000 vaite quant -92.436 0.0000 vaite quant -49.2436 0.0000 by micro-CH 0.0000 by micro-CH 0.0000 </pre>	May (Table 11 May 865.2304 394.2166 219.4810 0.0000 0.0000 183.0662 188.9550 96.8835 0.0000 16.1259 ity) -110.7241 tive quanti 0.0000 dix M) (nec 0.0000 dix M) (nec 0.0000 dix M) (nec 0.0000 dix M) (nec 0.0000 C) (Appendix 0.0000 P (Appendix 0.00000 P (Appendix 0.00000 P	Jun 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 166.3226 188.9550 88.0223 0.0000 13.1750 -94.9757 0.0000 13.1750 -94.9757 0.0000 (N) (negati 0.0000 -95.3303 ity) 0.0000 (N) (negati 0.0000 (N) (N) (negati 0.0000 (N) (N) (N) (N) (N) (N) (N) (N) (N) (N)	Jul 0.0000 0.0000 0.0000 0.0000 0.0000 165.5074 188.9550 87.5909 0.0000 14.7106 -93.1646 0.0000 14.7106 -93.1646 0.0000 0.0000 -92.8781 0.0000 -92.8781 0.0000 ve if net g 0.0000 ve if net g 0.0000 ve if net g 0.0000	Aug 0.0000 0.0000 0.0000 0.0000 171.5622 188.9550 90.7953 0.0000 19.1214 -82.9707 0.0000 eneration) 0.0000 -72.5187 0.0000 eneration) 0.0000	Sep 0.0000 0.0000 0.0000 0.0000 172.7933 188.9550 91.4468 0.0000 24.8368 -66.0607 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	Oct 1318.5050 394.2166 334.4621 0.0000 0.0000 190.9608 188.9550 101.0615 0.0000 32.5873 -50.8111 0.0000 0.0000 0.0000 -17.2508 0.0000 0.0000 0.0000	Nov 2100.8833 394.2166 532.9262 0.0000 0.0000 200.8115 188.9550 106.2748 0.0000 36.8073 -28.3401 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	0.0000 1.0000 394.2166 0.0000 Dec 2863.1858 394.2166 726.2976 0.0000 0.0000 0.0000 2222.1244 188.9550 188.9550 188.9550 117.5541 0.0000 0.0000 40.5459 -19.9090 0.00000 0.00000 0.00000 0.000000	(201) (202) (206) (207) (208) (210) (211) (212) (213) (213) (215) (213) (215) (217) (219) (221) (231) (232) (233a) (233a) (235a) (235b) (235b) (235b) (235b) (235b) (211) (211) (212)

Space cooling fuel				0.0000	(221)	
Electricity for pumps and fans: Total electricity for the above, kWh/year Electricity for lighting (calculated in Appendix L)				0.0000 318.3800	(231) (232)	
Energy saving/generation technologies (Appendices M ,N and Q) PV generation Wind generation Hydro-electric generation (Appendix N)				-1278.2588 0.0000 0.0000	(233) (234) (235a)	
Electricity generated - Micro CHP (Appendix N) Appendix Q - special features Energy saved or generated				-0.0000	(235)	
Energy used Total delivered energy for all uses				0.0000 4270.3005	(237) (238)	
SAP Calculation Printout						
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP		-				
Space beating - main system 1	Energy kWh/year 4015 9868	Emission factor kg CO2/kW	r h 9	Emissions kg CO2/year 617 9585	(261)	
Total CO2 associated with community systems Water heating (other fuel)	1214.1924	0.140	6	0.0000	(373) (264)	
Space and water heating Pumps, fans and electric keep-hot Energy for lighting	0.0000 318.3800	0.0000	0 3	788.7273 0.0000 45.9521	(265) (267) (268)	
Energy saving/generation technologies PV Unit electricity used in dwelling	-779.2064	0.132	5	-103.2518		
PV Unit electricity exported Total	-499.0523	0.1183	3	-59.0432	(269)	
TOTAI CO2, Kg/year EPC Dwelling Carbon Dioxide Emission Rate (DER)				672.3844 3.9900	(272) (273)	
13a. Primary energy - Individual heating systems including micro-CHP 	Energy	V Primary energy factor	r F	rimary energy		
Space heating - main system 1	kWh/year 4015.9868	kg CO2/kWl 1.569	л 7	kWh/year 6303.8191	(275)	
Water heating (other fuel) Space and water heating	1214.1924	1.5200	C	1845.6177 8149.4369	(473) (278) (279)	
Pumps, fans and electric keep-hot Energy for lighting	0.0000 318.3800	0.0000) B	0.0000 488.3419	(281) (282)	
Energy saving/generation technologies PV Unit electricity used in dwelling PV Unit electricity exported	-779.2064	1.489 0.433	6	-1160.7339		
Total Total Primary energy kWh/year				-1377.1799 7260.5989	(283) (286)	
SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022) CALCULATION OF TARGET EMISSIONS						
1. Overall dwelling characteristics						
Ground floor	Area (m2) 56.5000	Storey height (m) (1b) x 2.6700	c) 0 (2b)	Volume (m3) = 150.8550	(1b) - (3)	b)
First floor Second floor Total floor 2002 TEA = (12)+(14)+(12)+(14)+(10) (12) (12) 168 4100	57.8800 54.0300	0 (1c) x 3.0000 0 (1d) x 2.8600) (2c)) (2d)	= 173.6400 = 154.5258	(1c) - (3) (1d) - (3)	2) d)
Dwelling volume	((3a)+(3b)+(3c)+(3d)+(3e	e)(3n)	= 479.0208	(5)	
2. Ventilation rate						
Number of open chimneys			0 * 80	= 0.0000	(6a)	
Number of open flues Number of chimneys / flues attached to closed fire Number of flues attached to solid fuel boiler			0 * 20 0 * 10 0 * 20	= 0.0000 = 0.0000 = 0.0000	(6b) (6c) (6d)	
Number of flues attached to other heater Number of blocked chimneys			0 * 35 0 * 20 4 * 10	= 0.0000 = 0.0000	(6e) (6f) (7a)	
Number of passive vents Number of flueless gas fires			0 * 10 0 * 40	= 0.0000 = 0.0000	(7a) (7b) (7c)	
Infiltration due to chimneys, flues and fans = $(6a) + (6b) + (6c) + (6d) + (6e) + (6f) + (6g) + (6$	(7a)+(7b)+(7c) =	= 40.000	Air cha 00 / (5) =	nges per hour = 0.0835	(8)	
Pressure test Pressure Test Method				Yes Blower Door	(17)	
Number of sides sheltered				0.3335 1	(18) (19)	
Shelter factor Infiltration rate adjusted to include shelter factor		(20) = 1 - [0.075] (21) = (18)	x (19)]) x (20)	= 0.9250 = 0.3085	(20) (21)	

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	Jan 5.1000 1.2750	Feb 5.0000 1.2500	Mar 4.9000 1.2250	Apr 4.4000	May 4.3000	Jun 3.8000 0.9500	Jul 3.8000	Aug 3.7000 0.9250	Sep 4.0000	Oct 4.3000 1.0750	Nov 4.5000 1.1250	Dec 4.7000 1.1750	(22
infilt rate	0.3933	0.3856	0.3779	0.3393	0.3316	0.2931	0.2931	0.2854	0.3085	0.3316	0.3471	0.3625	(22
fective ac	0.5774	0.5743	0.5714	0.5576	0.5550	0.5429	0.5429	0.5407	0.5476	0.5550	0.5602	0.5657	(25
Heat losses a	nd heat 1	.oss paramet	ter										
ement		പപട്ടു		Gross m2	Openings m2	Net	m2	U-value W/m2K	A x W/	U K K	-value kJ/m2K	A x K kJ/K	
Calculation Printo	ut 🔊	elmhurst	2 2	246.1100 76.4100	35.4700	2. 32. 56. 1. 210. 76.	5100 9600 5400 3500 6400 4100	1.0000 1.1450 0.1300 0.1300 0.1800 0.1100	2.510 37.740 7.350 0.175 37.915 8.405	0 5 2 5 2 1			(26 (27 (28 (28 (29 (30)
bric heat loss	W/K = S	um (A x U)	Aum (A, m2)			500.	(26)(3	30) + (32) =	94.096	5			(33
ermal mass par st of Thermal	ameter (1 Bridges	'MP = Cm / 1	ſFA) in kJ∕n	12K								149.6386	(35
E2 Other E3 Sill E4 Jamb E14 Flat E16 Corr E17 Corr E18 Part E11 Eave E13 Gabl E6 Inter E20 Expc ermal bridges int Thermal br	: lintels : roof ter (norma- ter (inver y wall be : (insula- te	(including tted - inter ttween dwell ttion at rai tloor withir normal) c (normal) Psi) calcu:	other steel rnal area gr lings fter level) fter level) n a dwelling lated using	. lintels) :eater than g Appendix K	external ar	eā)		16. 16. 355. 2. 0. 21. 14 63. 32. 2.	0500 0500 0400 0000 6700 0000 5100 2100 3000 2700 8000	0.0500 0.0500 0.0500 0.0800 0.0900 0.0600 0.0600 0.0400 0.0800 0.0000 0.1600 0.3200 3) + (36)	0.802 0.802 1.752 0.0000 285.750 0.2403 0.0000 0.8604 1.1366 0.0000 5.1632 0.8960 (36a) =	296.9231 0.0000	(36
tal fabric hea ntilation heat	loss cal	culated mor	nthly (38)m	= 0.33 x (2	25)m x (5)				(3	3) + (36)	+ (36a) =	391.0190	(3)
8)m at transfer co	Jan 91.2661	Feb 90.7913	Mar 90.3259	Apr 88.1398	May 87.7308	Jun 85.8269	Jul 85.8269	Aug 85.4743	Sep 86.5603	Oct 87.7308	Nov 88.5582	Dec 89.4232	(38
erage = Sum(39	82.2857)m / 12 =	481.8108	481.3454	479.1594	478.7504	476.8464	476.8464	476.4938	477.5798	478.7504	479.5778	480.4428 479.1574	(3
P	Jan 2.8638	Feb 2.8609	Mar 2.8582	Apr 2.8452	May 2.8428	Jun 2.8315	Jul 2.8315	Aug 2.8294	Sep 2.8358	Oct 2.8428	Nov 2.8477	Dec 2.8528	(4)
P (average) ys in mont	31	28	31	30	31	30	31	31	30	31	30	2.8452 31	
Water heating sumed occupanc t water usage t water usage	y for mixer 73.8567 for baths 31.8840	equirements showers 72.7468 31.4105	3 (kWh/year) 71.1294 30.7437	68.0348 29.5142	65.7511 28.5935	63.2044 27.5727	61.7568 27.0213	63.3619 27.6835	65.1214 28.4044	67.8559 29.4968	71.0169 30.7516	2.9604 73.5737 31.7762	(42 (42 (42
: water usage erage daily ho	for other 44.9479 t water u	uses 43.3134 use (litres,	41.6789 /day)	40.0445	38.4100	36.7755	36.7755	38.4100	40.0445	41.6789	43.3134	44.9479 138.5166	(4) (4)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1 1 / / / / / / / / / / / / / / / / /	50.6886	147.4706	142 5500					100 4554	100 5700	139.0316	145.0819	150.2978	(4
ergy conte 2 ergy conte 2 ergy content (38.6538 annual)	209.9962	220.6341	137.5935 188.3586	132.7547 178.7133	127.5526 156.8408	125.5536 151.8462	129.4554 160.2928	164.7056	188.6645 Total = S	206.6957 um(45)m = 2	235.3300	(4
ergy conte 2 ergy conte (stribution los	38.6538 annual) s (46)m 35.7981 ss:	209.9962 = 0.15 x (4 31.4994	143.5520 220.6341 45)m 33.0951	137.5935 188.3586 28.2538	132.7547 178.7133 26.8070	127.5526 156.8408 23.5261	125.5536 151.8462 22.7769	129.4554 160.2928 24.0439	24.7058	188.6645 Total = S 28.2997	206.6957 um(45)m = 2 31.0044	235.3300 300.7317 35.2995	(4
11y not water 1 ergy conte 2 ergy content (stribution los ter storage lo ore volume If manufactu Temperature fa ter (49) or (5	38.6538 annual) s (46)m 35.7981 ss: erer decla ctor from 4) in (55	209.9962 = 0.15 x (4 31.4994 ared loss fa Table 2b)	220.6341 45)m 33.0951 actor is kno	137.5935 188.3586 28.2538 wn (kWh/da	132.7547 178.7133 26.8070 Ay):	127.5526 156.8408 23.5261	125.5536 151.8462 22.7769	129.4554 160.2928 24.0439	24.7058	188.6645 Total = S 28.2997	206.6957 um(45)m = 2 31.0044	235.3300 300.7317 35.2995 150.0000 1.3938 0.5400 0.7527	(4 (4 (4 (4 (5
Ily not water 1 argy conte 2 rrgy content (stribution los ter storage lc ore volume If manufactu Remperature fa cal storage lc cylinder cont	38.6538 annual) s (46)m 35.7981 ss: urer decla ctor from (4) in (55 ss 23.3325 ains dedi	209.9962 = 0.15 x (' 31.4994 ared loss fa Table 2b 21.0745 cated solar	220.6341 45)m 33.0951 actor is kno 23.3325 c storage	137.5935 188.3586 28.2538 wwn (kWh/da 22.5798	132.7547 178.7133 26.8070 Ay): 23.3325	127.5526 156.8408 23.5261 22.5798	125.5536 151.8462 22.7769 23.3325	24.0439 23.3325	24.7058 22.5798	188.6645 Total = S 28.2997 23.3325	206.6957 um(45)m = 2 31.0044 22.5798	235.3300 300.7317 35.2995 150.0000 1.3938 0.5400 0.7527 23.3325	(4 (4 (4 (5 (5
Ily not water 1 rrgy conte 2 ergy content (stribution loss er storage lc ore volume If manufactu "emperature fa er (49) or (5 cal storage lc cylinder cont imary loss ubi loss cal heat regui	38.6538 annual) ss (46)m 35.7981 ss: erer decla ctor from 4) in (55 ss 23.3325 23.3325 23.2624 0.0000 red for w	209.9962 = 0.15 x (* 31.4994 irred loss fr Table 2b) 21.0745 .cated solar 21.0745 21.0145 21.0120 0.0000 ater heatin	220.6341 45)m 33.0951 actor is kno 23.3325 r storage 23.3325 23.2624 0.0000 ig calculate	137.5935 188.3586 28.2538 wm (kWh/da 22.5798 22.5798 22.5798 22.5798 0.0000 d for each	132.7547 178.7133 26.8070 ay): 23.3325 23.3325 23.2624 0.0000 month	127.5526 156.8408 23.5261 22.5798 22.5798 22.5798 22.5120 0.0000	125.5536 151.8462 22.7769 23.3325 23.3325 23.2624 0.0000	129.4554 160.2928 24.0439 23.3325 23.3325 23.2624 0.0000	24.7058 22.5798 22.5798 22.5120 0.0000	188.6645 Total = S 28.2997 23.3325 23.3325 23.2624 0.0000	206.6957 um(45)m = 2 31.0044 22.5798 22.5798 22.5120 0.0000	235.3300 300.7317 35.2995 150.0000 1.3938 0.5400 0.7527 23.3325 23.3325 23.2624 0.0000	(4 (4 (4 (4 (5 (5 (5 (5 (5)(6))))))))))))))))))))))
Ily not water 1 argy conte 2 ergy content (ergy content (tribution los ter storage lc core volume If manufactu remperature fa ter (49) or (5 cal storage lc cylinder cont imary loss mbi loss cal heat requi 2 RS -	38.6538 annual) ss (46)m 35.7981 ss: rer decla cctor from (4) in (55 ss 23.3325 ains dedi 23.3325 23.2624 0.0000 red for w 85.2487 33.7642	209.9962 = 0.15 x (31.4994 ired loss fa 1 Table 2b) 21.0745 cated solar 21.0745 21.0112 0.0000 rater heatir 252.0819 -29.8613	143.3320 220.6341 45)m 33.0951 actor is kno 23.3325 r storage 23.3325 r storage 23.3325 23.2624 0.0000 rg calculate 267.2290 -31.2691	137.5935 188.3586 28.2538 wwn (kWh/da 22.5798 22.5798 22.5798 22.5798 22.5790 0.0000 d for each 233.4504 -25.8920	132.7547 178.7133 26.8070 ay): 23.3325 23.2624 0.0000 month 225.3082 -24.1304	127.5526 156.8408 23.5261 22.5798 22.5798 22.5120 0.0000 201.9326 -20.6486	125.5536 151.8462 22.7769 23.3325 23.3325 23.325 23.2624 0.0000 198.4411 -19.3548	129.4554 160.2928 24.0439 23.3325 23.3325 23.3325 23.2624 0.0000 206.8877 -20.5818	22.5798 22.5798 22.5798 22.5798 22.5120 0.0000 209.7974 -21.3638	188.6645 Total = S 28.2997 23.3325 23.3325 23.2624 0.0000 235.2594 -25.1856	206.6957 um(45)m = 2 31.0044 22.5798 22.5798 22.5798 22.5120 0.0000 251.7876 -28.5322	235.3300 300.7317 35.2995 150.0000 1.3938 0.5400 0.7527 23.3325 23.3325 23.2624 0.0000 281.9249 -33.1389	(4) (4) (4) (4) (4) (5) (5) (5) (6)
Ily not water 1 rrgy conte 2 rrgy content (tribution los er storage lo re volume If manufactu 'emperature fa er (49) or (5 cal storage lo cylinder cont mary loss bi loss cal heat requi 2 IRS - diverter ar input IRS	38.6538 annual) ss (46)m 35.7981 ss: rer decla ctor fron 4) in (55 ss ains dedi 23.3325 23.2624 0.0000 0.0000 0.0000 0.0000	209.9962 = 0.15 x (' 31.4994 ired loss ff 1 Table 2b ') 21.0745 21.0745 21.0112 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0000 0.0000 0.0000	220.6341 220.6341 45)m 33.0951 actor is kno 23.3325 r storage 23.3325 23.2624 0.0000 r aclculate 267.2290 -31.2691 -0.0000 0.0000	137.5935 188.3586 28.2538 28.2538 22.5798 22.5798 22.5798 22.5798 22.5798 22.5798 22.5798 22.5798 23.4504 -25.8920 -0.0000 0.0000	132.7547 178.7133 26.8070 ay): 23.3325 23.3325 23.32624 0.0000 month 225.3082 -24.1304 -0.0000 0.0000	127.5526 156.8408 23.5261 22.5798 22.5798 22.5120 0.0000 201.9326 -20.6486 -0.0000 0.0000	125.5536 151.8462 22.7769 23.3325 23.3325 23.2624 0.0000 198.4411 -19.3548 -0.0000 0.0000	129.4554 160.2928 24.0439 23.3325 23.3325 23.2624 0.0000 206.8877 -20.5818 -0.0000 0.0000	22.5798 22.5798 22.5798 22.5798 22.5120 0.0000 209.7974 -21.3638 -0.0000 0.0000	188.6645 Total = S 28.2997 23.3325 23.3325 23.2624 0.0000 235.2594 -25.1856 -0.0000 0.0000	206.6957 um(45)m = 2 31.0044 22.5798 22.5798 22.5120 0.0000 251.7876 -28.5322 -0.0000 0.0000	235.3300 300.7317 35.2995 150.0000 1.3938 0.5400 0.7527 23.3325 23.325 23.2624 0.0000 281.9249 -3.31389 -0.0000 0.0000	(4) (4) (4) (4) (4) (4) (5) (5) (5) (6)
Ily not water 1 rrgy conte 2 rrgy content (tribution los er storage lo pre volume If manufactu emperature fa er (49) or (5 cal storage lo cylinder cont mary loss bi loss al heat requi diverter ar input RS - diverter ar input RS - 2 diverter w/h 2 2 2 2 2 2 2 2 2 2 2 2 2	38.6538 annual) s (46)m 35.7981 ss: rer decla cctor from 4) in (55 ss 23.3325 23.3325 23.3325 23.3325 23.32624 0.0000 v85.2487 33.7642 -0.0000 0.0000 51.4845	209.9962 = 0.15 x (* 31.4994 ired loss fr a Table 2b * 21.0745 c.ated solar 21.0745 21.0145 21.0145 21.0145 21.0120 0.0000 rater heatir 252.0819 -29.8613 -0.0000 0.0000 0.0000 222.2206	220.6341 220.6341 45)m 33.0951 actor is kno 23.3325 r storage 23.3325 23.2624 0.0000 rg calculate 267.2290 -31.2691 -0.0000 0.0000 0.0000 235.9599	137.5935 188.3586 28.2538 28.2538 22.5798 22.5788 2	132.7547 178.7133 26.8070 ay): 23.3325 23.3325 23.2624 0.0000 month 225.3082 -24.1304 -0.0000 0.0000 0.0000 201.1778	127.5526 156.8408 23.5261 22.5798 22.5798 22.5798 22.5120 0.0000 201.9326 -0.06486 0.0000 0.0000 181.2841	125.5536 151.8462 22.7769 23.3325 23.325 23.2624 0.0000 198.4411 -19.3548 -0.0000 0.0000 0.0000 179.0864	129.4554 160.2928 24.0439 23.3325 23.3325 23.2624 0.0000 206.8877 -20.5818 -0.0000 0.0000 0.0000 186.3059 Total pe	13703 164.7056 24.7058 22.5798 22.5798 22.5798 22.5120 0.0000 209.7974 -21.3638 -0.0000 0.0000 0.0000 188.4336 er year (kWH	188.6645 Total = S 28.2997 23.3325 23.3325 23.2624 0.0000 235.2594 -25.1856 -0.0000 0.0000 0.0000 210.0739 /year) = S	206.6957 um(45)m = 2 31.0044 22.5798 22.5798 22.5120 0.0000 251.7876 -28.5322 -0.0000 0.0000 0.0000 223.2554 um(64)m = 2	235.3300 3300.7317 35.2995 150.0000 1.3938 0.5400 0.7527 23.3325 23.325 23.2624 0.0000 281.9249 -3.139 -0.0000 0.0000 0.0000 0.0000 248.7860	(4) (4) (4) (4) (4) (5) (5) (5) (6)
11y hot water 1 prgy conte 2 prgy conte 2 srgy content (stribution los ter storage lc ore volume If manufactu Pemperature fa ter (49) or (5 cal storage lc cylinder cont imary loss tal heat requi diverter diverter diverter tar input HRS cput from w/h 2 Cotal per year ectric shower(38.6538 annual) ss (46)m 35.7981 ss: rer decla cctor from 4) in (55 ss 23.3325 23.3325 23.2624 0.0000 red for w 85.2487 -0.0000 0.0000 51.4845 (kWh/yee s) 0.0000	209.9962 = 0.15 x (* 31.4994 ared loss fr 1 Table 2b * 21.0745 .cated solar 21.0745 21.0112 0.0000 rater heatir -29.8613 -0.0000 0.0000 222.2206 x) 0.0002	220.6341 220.6341 45)m 33.0951 actor is kno 23.3325 r storage 23.3325 r storage 23.2624 0.0000 rg calculate 267.2290 -31.2691 -0.0000 0.0000 235.9599	137.5935 188.3586 28.2538 28.2538 22.5798 23.4504 -25.8920 0.0000 0.0000 0.0000 207.5584	132.7547 178.7133 26.8070 ay): 23.3325 23.2624 0.0000 month 225.3082 -24.1304 -0.0000 0.0000 201.1778	127.5526 156.8408 23.5261 22.5798 22.5798 22.5798 22.5120 0.0000 201.9326 -20.6486 -0.0000 0.0000 181.2841	125.5536 151.8462 22.7769 23.3325 23.3325 23.325 23.2624 0.0000 198.4411 -19.3548 -0.0000 0.0000 179.0864	129.4554 160.2928 24.0439 23.3325 23.2624 0.0000 206.8877 -20.5818 -0.0000 0.0000 0.0000 186.3059 Total pe	13703 164.7056 24.7058 22.5798 22.5798 22.5798 22.5120 0.0000 209.7974 -21.3638 -0.0000 0.0000 0.0000 188.4336 er year (kwf	188.6645 Total = S 28.2997 23.3325 23.3325 23.2624 0.0000 235.2594 -25.1856 -0.0000 0.0000 210.0739 /year) = S	206.6957 um(45)m = 2 31.0044 22.5798 22.5798 22.5798 22.5120 0.0000 251.7876 -28.5322 -0.0000 0.0000 223.2554 um(64)m = 2	235.3300 300.7317 35.2995 150.0000 1.3938 0.5400 0.7527 23.3325 23.2624 0.0000 281.9249 -33.1389 -0.0000 0.0000 0.0000 248.7860 2535.6263 2536	(4) (4) (4) (4) (4) (5) (5) (5) (5) (5) (5) (6) (6) (6) (6) (6) (6) (6) (6) (6) (6
Ily not water 1 rrgy conte 2 grgy content (stribution los cer storage lc pre volume If manufactu emperature fa cer (49) or (5 cal storage lc cylinder cont imary loss abi loss cal heat requi diverter lar input HS 2 Cotal per year ectric shower(at gains from	38.6538 annual) s (46)m 35.7981 ss: rer decla ctor from 4) in (55 ss 23.3325 23.3325 23.3325 23.3325 23.3325 23.3262 0.0000 v85.2487 33.7642 -0.0000 0.0000 0.511.4845 c (kWh/yeas 0.0000 water bes	209.9962 = 0.15 x (' 31.4994 ared loss fr 1 Table 2b ') 21.0745 .cated solar 21.0745 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0145 21.0045 22.20819 -29.8613 -0.0000 0.0000 0.0000 222.2206 r) 0.0000 ting. kWh/m	143.3220 220.6341 45)m 33.0951 actor is kno 23.3325 r storage 23.3325 23.2624 0.0000 ng calculate 267.2290 -31.2691 -0.0000 0.0000 235.9599 0.0000 nonth	137.5935 188.3586 28.2538 28.2538 22.5798 23.4504 -5.8920 0.0000 0.0000 20.75584 0.0000 Tota	132.7547 178.7133 26.8070 ay): 23.3325 23.2624 0.0000 month 225.3082 -24.1304 -0.0000 0.0000 201.1778 0.0000 al Energy us	127.5526 156.8408 23.5261 22.5798 22.5798 22.5798 22.5798 22.5120 0.0000 201.9326 -20.6486 0.0000 0.0000 181.2841 0.0000 ed by insta	125.5536 151.8462 22.7769 23.3325 23.252 23.2624 0.0000 198.4411 -19.3548 -0.0000 0.0000 179.0864 0.0000 antaneous el	129.4554 160.2928 24.0439 23.3325 23.3325 23.2624 0.0000 206.8877 -20.5818 -0.0000 0.0000 186.3059 Total per 0.0000 lectric show	13703 164.7056 24.7058 22.5798 22.5798 22.5798 22.5120 0.0000 209.7974 -21.3638 -0.0000 0.0000 0.0000 188.4336 err year (kWh/ 0.0000 ver(s) (kWh/	188.6645 Total = S 28.2997 23.3325 23.3325 23.2624 0.0000 235.2594 -25.1856 -0.0000 0.0000 210.0739 /year) = S 0.0000 year) = Su	206.6957 um(45)m = 2 31.0044 22.5798 22.5798 22.5120 0.0000 251.7876 -28.5322 -0.0000 0.0000 0.0000 223.2554 um(64)m = 2 0.0000 m(64a)m =	235.3300 3300.7317 35.2995 150.0000 1.3938 0.5400 0.7527 23.3325 23.2624 0.0000 281.9249 -3.139 -0.0000 0.0000 0.535.6263 2536 0.0000 0.0000	(4) (4) (4) (4) (4) (5) (5) (5) (6)
11y not water 1 prgy conte 2 rrgy conte 2 srgy content (stribution los er storage lc rre volume 1f manufactu Nemperature fa er (49) or (5 cal storage lc cylinder cont .mary loss .al heat requi .al heat requi	38.6538 annual) ss (46)m 35.7981 ss: rer decla cctor from 4) in (55 ss 23.3325 23.3325 23.2624 0.0000 v85.2487 v85.2487 0.0000 0.0000 0.0000 51.4845 (kWh/yea s) 0.0000 water hea 16.6283	209.9962 = 0.15 x (* 31.4994 ared loss ff ar Table 2b * 21.0745 .cated solar 21.0745 21.0112 0.0000 rater heatin 252.0819 -29.8613 -0.0000 0.0000 222.2206 .r) 0.0000 .ting, kWh/m 103.4923	14.5.520 220.6341 45)m 33.0951 actor is kno 23.3325 r storage 23.3325 r storage 23.2624 0.0000 ng calculate 267.2290 -31.2691 -0.0000 0.0000 235.9599 0.0000 nonth 110.6367	137.5935 188.3586 28.2538 28.2538 22.5798 23.4504 -25.8920 0.0000 0.0000 207.5584 0.0000 Tota 98.7027	132.7547 178.7133 26.8070 ay): 23.3325 23.2624 0.0000 month 225.3082 -24.1304 -0.0000 0.0000 201.1778 0.0000 al Energy us 96.6981	127.5526 156.8408 23.5261 22.5798 22.5798 22.5798 22.5120 0.0000 201.9326 -20.6486 -0.0000 0.0000 181.2841 0.0000 ed by insta 88.2230	125.5536 151.8462 22.7769 23.3325 23.3325 23.2624 0.0000 198.4411 -19.3548 -0.0000 0.0000 179.0864 0.0000 179.0864 87.7648	129.4554 160.2928 24.0439 23.3325 23.3325 23.2624 0.0000 206.8877 -20.5818 -0.0000 0.0000 186.3059 Total pe 0.0000 lectric show 90.5733	13703 164.7056 24.7058 22.5798 22.5798 22.5798 22.5120 0.0000 209.7974 -21.3638 22.5120 0.0000 0.0000 0.0000 188.4336 er year (kWH 0.0000 ver(s) (kWh/ 90.8381	188.6645 Total = S 28.2997 23.3325 23.2524 -25.1856 -0.0000 0.0000 210.0739 //year) = S 0.0000 year) = Su 100.0069	206.6957 um(45)m = 2 31.0044 22.5798 22.5798 22.5798 22.5120 0.0000 251.7876 -28.5322 -0.0000 0.0000 223.2554 um(64)m = 2 0.0000 m(64a)m = 104.7998	235.3300 300.7317 35.2995 150.0000 1.3938 0.5400 0.7527 23.3325 23.325 23.22624 0.0000 281.9249 -3.1392 -0.0000 0.0000 0.0000 248.7860 0.0000 0.0000 0.0000 115.5232	(4) (4) (4) (4) (4) (4) (5) (5) (6)

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(66)m	148.0220	148.0220	148.0220	148.0220	148.0220	148.0220	148.0220	148.0220	148.0220	148.0220	148.0220	148.0220	(66)
Lighting gains	(calculat	ed in Appen	dix L, equa	tion L9 or	L9a), also	see Table 5							
	173.0767	191.6207	173.0767	178.8460	173.0767	178.8460	173.0767	173.0767	178.8460	173.0767	178.8460	173.0767	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	339.9246	343.4519	334.5631	315.6399	291.7527	269.3021	254.3037	250.7764	259.6652	278.5884	302.4756	324.9262	(68)
Cooking gains	(calculate	d in Append	ix L, equat	ion L15 or	L15a), also	see Table	5						
	37.8022	37.8022	37.8022	37.8022	37.8022	37.8022	37.8022	37.8022	37.8022	37.8022	37.8022	37.8022	(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. ev	aporation	(negative v	alues) (Tab	le 5)									
	-118.4176	-118.4176	-118.4176	-118.4176	-118.4176	-118.4176	-118.4176	-118.4176	-118.4176	-118.4176	-118.4176	-118.4176	(71)
Water heating	gains (Tab	le 5)											
	156.7585	154.0064	148.7053	137.0871	129.9706	122.5320	117.9634	121.7383	126.1640	134.4178	145.5553	155.2731	(72)
Total internal	gains												
	740.1664	759.4856	726.7518	701.9795	665.2066	638.0867	612.7505	612.9980	632.0818	656.4896	697.2835	723.6826	(73)

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SAP Calculation PI	rintout	elmhurst											
6. Solar gair	15												
[Jan]		Area m2		Solar flux Table 6a W/m2	a Speci 2 or	g Specific data or Table 6b		FF data ble 6c	FF Access ta factor 6c Table 6d		Gains W		
North South West			18.8 12.2 1.9	100 100 400	10.6334 46.7521 19.6403	l 	0.6300 0.6300 0.6300	((().7000).7000).7000	0.77 0.77 0.77	700 700 700	61.1269 174.4570 11.6445	(74) (78) (80)
Solar gains Total gains	247.2284 987.3948	425.3113 1184.7970	599.9649 1326.7167	784.8974 1486.8769	925.2062 1590.4128	940.9545 1579.0411	897.6818 1510.4323	788.1322 1401.1302	662.4814 1294.5631	474.2553 1130.7449	296.7182 994.0017	211.2811 934.9638	(83) (84)
7. Mean inter	nal tempera	ture (heati	ing season)										
Temperature o	during heati	ng periods	in the livi	ng area fro	om Table 9,	Th1 (C)						21.0000	(85)
tau alpha	Jan 14.5146 1.9676	Feb 14.5289 1.9686	Mar 14.5429 1.9695	Apr 14.6093 1.9740	May 14.6218 1.9748	Jun 14.6802 1.9787	Jul 14.6802 1.9787	Aug 14.6910 1.9794	Sep 14.6576 1.9772	Oct 14.6218 1.9748	Nov 14.5965 1.9731	Dec 14.5703 1.9714	
util living a	area 0.9859	0.9790	0.9690	0.9484	0.9117	0.8476	0.7658	0.7980	0.8980	0.9581	0.9800	0.9874	(86)
MIT Th 2	16.4748 18.8197	16.7815 18.8211	17.3572 18.8226	18.1860 18.8294	19.0735 18.8307	19.8982 18.8366	20.3947 18.8366	20.3092 18.8377	19.6296 18.8343	18.5004 18.8307	17.3511 18.8281	16.4221 18.8254	(87) (88)
MIT 2 Living area f	nouse 0.9817 13.9350	0.9727 14.3210	0.9589 15.0458	0.9285 16.0843	0.8682 17.1773	0.7421 18.1449	0.5446 18.6377	0.6005 18.5766	0.8248 17.8624 fLA =	0.9379 16.4885 Living are	0.9729 15.0443	0.9837 13.8694 0.2524	(89) (90) (91)
MIT Temperature a	14.5759 adjustment	14.9420	15.6291	16.6147	17.6558	18.5874	19.0811	19.0139	18.3084	16.9962	15.6264	14.5136 0.0000	(92)
8. Space heat	ing require	ment											
Utilisation Useful gains Ext temp.	Jan 0.9662 954.0496 4.3000	Feb 0.9519 1127.8503 4.9000	Mar 0.9321 1236.5814 6.5000	Apr 0.8939 1329.1100 8.9000	May 0.8305 1320.8930 11.7000	Jun 0.7238 1142.8697 14.6000	Jul 0.5808 877.1952 16.6000	Aug 0.6246 875.1296 16.4000	Sep 0.7957 1030.1065 14.1000	Oct 0.9070 1025.5942 10.6000	Nov 0.9528 947.1198 7.1000	Dec 0.9695 906.4347 4.2000	(94) (95) (96)
Reat loss rat	4955.9328	4838.3228	4394.2517	3696.5536	2851.3594	1901.3622	1183.1079	1245.4925	2009.8373	3062.1898	4089.0875	4955.1064	(97)
Space heating	2977.4011 g requiremen	2493.4375 nt - total p	2349.3067 Der year (kW	1704.5594 Mh/year)	1138.6670	0.0000	0.0000	0.0000	0.0000	1515.2271	2262.2168	3012.2118 17453.0274	(98a)
Solar heating	0.0000 g contributi g kWh	0.0000 .on - total	0.0000 per year ()	0.0000 Wh/year)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 0.0000	(98b)
Space heating Space heating	2977.4011 g requiremen g per m2	2493.4375 at after sol	2349.3067 Lar contribu	1704.5594 ution - tota	1138.6670 al per year	0.0000 (kWh/year)	0.0000	0.0000	0.0000	1515.2271 (98c	2262.2168 c) / (4) =	3012.2118 17453.0274 103.6342	(98c) (99)
9a. Energy re Fraction of s Fraction of s Efficiency of Efficiency of	equirements space heat f space heat f main space main space	- Individua from seconda from main sy heating sy heating sy	al heating s ary/suppleme ystem(s) ystem 1 (in ystem 2 (in	<pre>systems, inc entary syste %) %)</pre>	cluding micr							0.0000 1.0000 92.3000 0.0000	(201) (202) (206) (207)
LIIICICHCy OI	Jan	Feb	Mar	Apr	Mav	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(200
Space heating	g requiremen 2977.4011	2493.4375	2349.3067	1704.5594	1138.6670	0.0000	0.0000	0.0000	0.0000	1515.2271	2262.2168	3012.2118	(98)
Space heating	g efficiency 92.3000	(main heat 92.3000	ing system 92.3000	1) 92.3000	92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	(210)
Space heating	g fuel (main 3225.7867	heating sy 2701.4491	/stem) 2545.2943	1846.7599	1233.6587	0.0000	0.0000	0.0000	0.0000	1641.6329	2450.9391	3263.5014	(211)

 Space heating efficiency (main heating system 2)
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(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 35	.9619 28	.8500	25.9762	19.0313	14.7003	12.0103	13.4101	17.4310	22.6411	29.7064	33.5533	36.9614	(232)
Electricity genera	ted by PVs	(Appendi	.x M) (nega	tive quanti	ty)								
(233a)m -53	.4106 -75	.5870 -	109.0240	-122.9513	-132.7851	-123.8828	-122.2180	-115.2042	-102.9806	-86.4588	-58.7684	-46.1317	(233a)
Electricity genera	ted by wind	turbine	s (Appendi	x M) (negat	ive guanti	tv)							
(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 genera	ted by hvdr	o-electr	ic generat	ors (Append	ix M) (neg	ative quant	itv)						
(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 o	r net elect	ricity o	enerated b	v micro-CHP	(Appendix	N) (negati	ve if net o	eneration)					(=====,
(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 genera	ted by PVs	(Appendi	v M) (nega	tive quanti	±v)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(2000)
(233b)m _20	3166 -61	7671 -	122 0971	_105 0001	-245 1629	-246 6064	-243 8382	-206 3914	-151 0765	-99 6164	-30 2227	-23 1970	(233h)
(255b)m -25	tod by wind	.7071 -	122.9071	-103.0004 . M) (nogot	-245.1025	-240.0004	-243.0392	-200.3014	-131.0703	-00.0104	-39.2227	-23.1070	(2550)
(224b)m 0	Ced by willa	CUIDING	o oooo	A M) (negac		0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	0 0000	(2246)
(234D)III 0	.0000 0	.0000	0.0000	(].0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234D)
	A GUGIDA	0-electr	ic generat	ors (Append	ix M) (neg	ative quant	.1ty)	0 0000	0 0000	0 0000	0 0000	0 0000	(0.251.)
SAP Calculation Printout	🖏 elmhur:	4 000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
LICCULLULY USER O	1 1100 01000	incity g	generated b	y micro-CHP	(Appendix	N) (negati	ve if net g	eneration)					
(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 sys	tem 1										18909.0221	(211)
Space heating fuel	- main sys	tem 2										0.0000	(213)
Space heating fuel	- secondar	У										0.0000	(215)
Efficiency of wate	r heater											79.8000	
Water heating fuel	used											2971.2356	(219)
Space cooling fuel												0.0000	(221)
Electricity for pu	mps and fan	s:											
Total electricity	for the abo	ve, kWh/	vear									86.0000	(231)
Electricity for li	ghting (cal	culated	in Appendi	x L)								290.2334	(232)
	5 . 5		11	,									,
Energy saving/gene	ration tech	nologies	(Appendic	es M. Nand	0)								
PV generation				,	3C /							-2792 6541	(233)
Wind generation												0 0000	(234)
Hudro-oloctric con	oration (An	nondix N	1)									0.0000	(2355)
Electricity gen	ted Miana	CUD (Am	() mondir N)									0.0000	(2354)
And a state of the	-l fastures	СПР (Ар	pendix N)									0.0000	(233)
Appendix Q - Speci	ar reatures											0 0000	(226)
Energy saved of ge	nerated											-0.0000	(220)
Energy used		1										10462 0270	(237)
TOTAL GELIVERED en	ergy for al	⊥ uses										19403.83/0	(∠38)

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

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Energy	Emission factor	Emissions
kWh/year	kg CO2/kWh	kg CO2/year
Space heating - main system 1 18909.0221	0.2100	3970.8946 (261)
Total CO2 associated with community systems		0.0000 (373)
Water heating (other fuel) 2971.2356	0.2100	623.9595 (264)
Space and water heating		4594.8541 (265)
Pumps, fans and electric keep-hot 86.0000	0.1387	11.9293 (267)
Energy for lighting 290.2334	0.1443	41.8896 (268)
Energy saving/generation technologies		
PV Unit electricity used in dwelling -1149.4024	0.1345	-154.6407
PV Unit electricity exported -1643.2517	0.1258	-206.7600
Total		-361.4007 (269)
Total CO2, kg/year		4287.2723 (272)
EPC Target Carbon Dioxide Emission Rate (TER)		25.4600 (273)

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

	Energy	Primary energy factor	Primary energy
	kWh/year	kg CO2/kWh	kWh/year
Space heating - main system 1	18909.0221	1.1300	21367.1950 (275)
Total CO2 associated with community systems			0.0000 (473)
Water heating (other fuel)	2971.2356	1.1300	3357.4962 (278)
Space and water heating			24724.6912 (279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008 (281)
Energy for lighting	290.2334	1.5338	445.1696 (282)
Energy saving/generation technologies			
PV Unit electricity used in dwelling	-1149.4024	1.4972	-1720.9256
PV Unit electricity exported	-1643.2517	0.4619	-758.9439
Total			-2479.8695 (283)
Total Primary energy kWh/year			22820.0922 (286)
Target Primary Energy Rate (TPER)			135.5000 (287)