SUSTAINABILITY & ENERGY STATEMENT

BUILDING ENERGY EXPERTS

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Prepared for:	Eastman Estates Ltd
Project:	20 Whiteladies Road
Report date:	11/07/2024
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Reviewed:	KG

Contents

1. Executive Summary

This Sustainability and Energy Statement demonstrates how the proposed redevelopment and conversion of an existing building into a house multiple occupation (HMO) at 20 Whiteladies Road, Bristol will comply with the following Bristol City Council (BCC) Policies:

- BCS13 – Climate Change
- BCS14 – Sustainable Energy (from the Development Framework Core Strategy)
- BCS15 – Sustainable Design and Construction
- BCS16 – Flood Risk and Water Management

The statements contain the results of energy modelling, showing how the proposed development will meet BCC policy requirements to reduce carbon emissions by at least 20% for this development over the building regulation requirements. The energy strategy in this statement has been produced in line with the Energy Hierarchy:

- Be "Lean" - reduce energy demand.
- Be "Clean" – supply energy efficiently.
- Be "Green"– use renewable energy.

SAP calculations have been completed in line with Part L (Volume 1, 2021) of the Building Regulations and the requirements of the BCC to demonstrate a 20% reduction in regulated carbon emissions using the above energy hierarchy.

Firstly, SAP calculations to achieve compliance with Part L (Volume 1, 2021) were modelled using SAP10 with the threshold values to provide 'baseline' energy demand, primary energy rate and emissions. Then, additional measures were applied to provide 'residual' energy demand, primary energy rate and emissions. Finally, appropriate decentralised renewables were included in the calculations to provide the final energy demand and emissions figures for comparison. More detail is provided in the following sections.

The baseline calculation uses a Gas Combi Boiler for heating and hot water in the baseline building, this is an appropriate selection for a baseline calculation as it represents a common heating method for domestic buildings in the area and is included in the notional building specification.

To summarise the results, the total reduction in carbon emissions for the proposed development is as follows:

Summary of total reduction in carbon emissions

	Before Renewables	After Renewables (PV)
Baseline Target Emission Rate (TER)	6,447.22	
Residual Building Emission Rate (DER)	5,560.59	1,042.35
Total CO_2 Saving on residual energy	13.75%	81.26%

2. Planning Policy Context

National Policy Context

National Planning Policy Framework – Encourages the adoption of sustainable development through encouraging local authorities to adopt strategies, policies and targets that mitigate and adapt to climate change. It also recommends the move to low carbon technologies by planning new development in ways to reduce greenhouse gas emissions and adhere to standards established in the Government's zero carbon buildings policy.

The government energy policy sets targets for the UK to cut carbon dioxide emissions and become net zero by 2050, as well as setting national targets for the generation of electricity from clean and renewable sources.

Regional & Local Policy Context

Local Policy requirements are set out in both Bristol City Council's Local Plan and Core Strategy.

Policy BCS13
Development should contribute to both mitigating and adapting to climate change, and to meeting targets to reduce carbon dioxide emissions.

Developments should mitigate climate change through measures including:

- High standards of energy efficiency, including optimal levels of thermal insulation, passive ventilation and cooling, passive solar design, and the efficient use of natural resources in new buildings.
- The use of decentralised, renewable, and low-carbon energy supply systems.
- Patterns of development which encourage walking, cycling and the use of public transport instead of journeys by private car.

Development should adapt to climate change through measures including:

- Site layouts and approaches to design and construction that provide resilience to climate change.
- Measures to conserve water supplies and minimise the risk and impact of flooding.
- The use of green infrastructure to minimise and mitigate the heating of the urban environment.
- Avoiding responses to climate impacts which lead to increases in energy use and carbon dioxide emissions.

These measures should be integrated into the design of new development.

The new development should demonstrate through this sustainability statement how it would contribute to mitigating and adapting to climate change, and to meeting targets to reduce carbon dioxide emissions by means of the above measures.

Policy BCS14

Proposals for the utilisation, distribution, and development of renewable and low carbon sources of energy, including large-scale freestanding installations, will be encouraged. In assessing such proposals, the environmental and economic benefits of the proposed development will be afforded significant weight, alongside considerations of public health and safety and impacts on biodiversity, landscape character, the historic environment, and the residential amenity of the surrounding area.

The development in Bristol should include measures to reduce carbon dioxide emissions arising from energy usage in accordance with the following energy hierarchy:

1. Minimising energy requirements.
2. Incorporating renewable energy sources.
3. Incorporating low-carbon energy sources.

Consistent with stage two of the above energy hierarchy, the development will be expected to use sufficient renewable energy sources to reduce carbon dioxide emissions arising from residual energy use by at least 20%. An exception will only be made in the case where a development is necessary, but where it is demonstrated that meeting the required standard would not be feasible.

The use of combined heat and power (CHP), combined cooling, heat, and power (CCHP), and district heating will be encouraged. Within heat priority areas, major developments will be expected to incorporate, where feasible, infrastructure for district heating, and will be expected to connect to existing systems where available.

The redevelopment will be expected to demonstrate that the heating and cooling systems have been selected according to the following heat hierarchy:

1. Connection to existing CHP/CCHP distribution networks
2. Site-wide renewable CHP/CCHP
3. Site-wide gas-fired CHP/CCHP
4. Site-wide renewable community heating/cooling
5. Site-wide gas-fired community heating

Policy BCS15

Sustainable design and construction will be integral to the new development in Bristol. In delivering sustainable design and construction, developments should address the following key issues:

- Maximising energy efficiency and integrating the use of renewable and low carbon energy
- Waste and recycling during construction and in operation
- Conserving water resources and minimising vulnerability to flooding
- The type, life cycle and source of materials used during construction
- Flexibility and adaptability, allowing future modification of use or layout to facilitate future refurbishment and retrofitting
- Opportunities to incorporate measures which enhance the biodiversity value of the development, such as green roofs.

The redevelopment will be required to demonstrate (as part of the sustainability statement submitted with the planning application) how the above issues have been addressed. For major developments and developments used in healthcare or education, the sustainability statement should include a BREEAM and/or Code for Sustainable Homes assessment. Additionally, in the case of a super-major development, a BREEAM for Communities assessment will be required.

From 2016, residential development will be expected to meet Level 6 of the Code for Sustainable Homes. For non-residential development, also from 2016, a BREEAM "Excellent" rating will be expected.

All new development will be required to provide satisfactory arrangements for the storage of refuse and recyclable materials as an integral part of its design. Major developments should include communal facilities for waste collection and recycling where appropriate.

New homes and workplaces should allow for high-speed broadband access and facilitate access to Next Generation broadband.

Developments in Bristol follow a sequential approach to flood risk management, giving priority to the development of sites with the lowest risk of flooding. The development of sites with a greater risk of flooding will be considered where essential for regeneration, or where necessary to meet the development requirements of the city.

Development in areas at risk of flooding will be expected to:

- Be resilient to flooding through design and layout, and/or;
- Incorporate sensitively designed mitigation measures, which may take the form of on-site flood defence works and a commitment to undertaking off-site measures (where they are necessary) to ensure that the development remains safe from flooding over its lifetime.

All developments will also be expected to incorporate water management measures to reduce surface water run-off and ensure that it does not increase flood risks elsewhere. This should include the use of sustainable drainage systems (SUDS).

3. Design Principles to Reduce Energy Consumption and Carbon Emissions

The energy strategy for the proposed development has been formulated in line with the energy hierarchy. It uses the following approaches to optimise energy usage, supply clean and renewable energy, and reduce embedded carbon emissions while meeting local requirements (Figure 1).

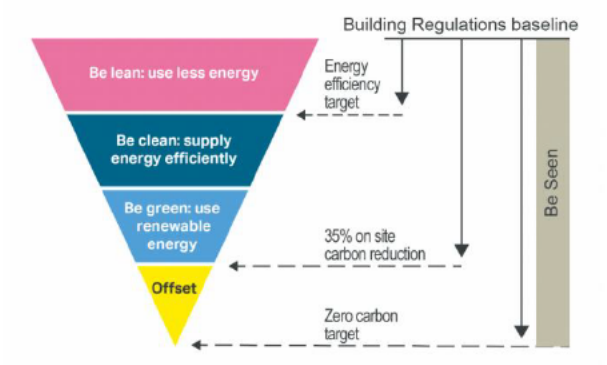


Figure 1: The Energy Hierarchy

Be "Lean" – Use less energy

The proposed redevelopment has been designed with the use of efficient fabric specifications, integrating efficiency into both the new and existing thermal envelope of the dwelling. The proposed thermal elements meet or go beyond the minimum requirements set out in Approved Document L Volume 1 (2021) for retained (where possible) and new fabric elements.

Target U-values have been specified to achieve or go beyond the U-values found in the national dwelling specification. When possible, the national dwelling values are much lower than the limiting factors (maximum allowed U-values) to create the target rates used in the SAP calculation.

The fabric elements and fenestration have been specified using calculated U-values for the intended construction specification for the building. This includes:

- Internally Insulated Ground Floor Retained External walls that achieve a U-value of at least 0.22 W/m^{2}k.
- Internally Insulated First Floor Retained External walls that achieve a U-value of at least 0.28 W/m^{2}k.
- New Cavity Walls that achieve a U-value of at least 0.18 W/m^{2}k.
- A Timber Exposed floor that achieves a U-value of at least 0.21 W/m^{2}k.
- A solid Exposed floor that achieves a U-value of at least 0.16 W/m^{2}k.
- A retained Flat Roof that achieves a U-value of at least 0.16 W/m^{2}k.
- A retained Sloping Ceiling that achieves a U-value of at least 0.16 W/m^{2}k.
- A new Flat Roof that achieves a U-value of at least 0.16 W/m^{2}k.
- A pitched roof with insulation at the flat ceiling plane that achieves a U-value of at least 0.13 W/m^{2}k.

Careful consideration will be given to the fenestration. Replacement timber sash windows with double glazing with low window U-values of 1.4W/m^2k will be utilised to limit heat loss through openings. The glazing design also allows for passive heating into the buildings. However, to minimise the risk of overheating, the glazing will be openable where practical as well as feature a low e-coating.

Good detailing will help to limit heat losses through the fabric of the proposed redevelopment. Where available, all non-repeating thermal bridges (e.g. between the external walls and the roofs) will be specified to enhanced construction details that represent the best practice for the proposed construction.

The dwellings will be naturally ventilated, with intermittent extractor fans in the bathrooms, and a cooker hood in the kitchens. This will reduce the energy demand of active ventilation systems. The proposed building layout has been determined by several factors, such as ownership and site boundaries, relationship to adjacent buildings and site access, as well as internal walls arrangements. The internal room layouts within the resultant footprint have been designed with consideration of recommended zoning and room orientations.

Although not a requirement for the building, voluntary air pressure will be conducted, and the dwellings will have designed air permeability of 5 $m^3/hr/m^2$. This is below the requirements of the building regulations 8 $m^3/hr/m^2$ and the below the default value of 15 $m^3/hr/m^2$.

The design of the dwellings optimises the use of natural lighting, and it is proposed that only energy efficient lighting is installed at the properties. This means that all light fittings should have bulbs with a luminous efficacy of greater than 80 lamp lumens per circuit-watt.

The proposed dwellings have been designed to allow for cross ventilation where possible, in order to minimise the need for additional mechanical methods of cooling. Windows have been sized and positioned to allow for good internal natural light and allow for solar gains during winter months. Windows will also have a large free opening area to help ensure that the risk of summer overheating is reduced.

Be “Clean” – Supply energy efficiently

The energy that is used in the redevelopment has been considered for its efficiency. Local policy supports the connection of proposed developments to heat networks. Local heat and power sources minimise distribution losses and achieve greater efficiency when compared to separate localised energy systems.

This section shows the consideration given to the connection of the dwellings to any existing or planned district heating networks in the proximity of the site. There are no existing district heating systems near the development site. The redevelopment is not major (under 100 dwellings), this means the use of district heating networks, or a CHP system, would not be selected due to the unnecessary added complexity. This project is also aiming to use very efficient fabric in order to reduce the heating demand and use efficient services to reduce water demand. Therefore, the expected demand for heating and hot water would potentially not be significant enough for CHP systems.

Be "Green" – Renewable energy

Low carbon energy generation and renewable technologies have been assessed for the proposed redevelopment, with some considered appropriate. See Section 6 for further details regarding the feasibility of each assessed technologies.

Based upon the feasibility matrix an air source heat pump (ASHP) will be used for the hot water and heating requirements and solar PV will be used to achieve the 20% reduction over Part L requirements.

4. Sustainable Design and Construction

Energy Efficiency

The proposed building fabric makes use of high-performance insulation materials. The U-values of the building fabric have been calculated and used in the assessment of the dwelling. The achieved U-values are lower than the limiting factors permitted by Part L and are substantially less or equal to the U-values used in the notional building.

The proposed dwellings would have the potential to achieve an 83.83% total reduction in CO_2 over the baseline Building Regulation measures if low carbon technologies and energy efficiency improvements are used.

Decentralised, Renewable, and Low-Carbon Energy Supply Systems

The proposal for the dwellings makes use of two low carbon systems, including an electric air source heat pump for heating and water heating. Solar PV is also proposed to be added to the building to provide onsite renewable generation. This reduces the associated carbon emissions of the development, with solar used to offset the increase in electricity consumption on site.

Avoiding Responses to Climate Impacts that Lead to Increases in Energy Use and CO_2 Emissions

There are no proposals to include artificial cooling. The proposed dwellings have been designed to allow for cross ventilation where possible. Windows have been sized and positioned to allow for good internal natural light and allow for solar gains during winter months. The buildings will also include appropriate internal shading, such as blinds and curtains, will be used to mitigate overheating from the sun. The design of the dwellings also includes some external features to provide shading.

Encouraging Greener Transport Use

The proposal will include provision for secure cycle storage. The nearest bus stops are located on Whiteladies Road (1-minute walk from the property) with buses towards the City Centre, Temple Meads, Long Ashton, Cribbs Causeway, and Southmead. The nearest train station is Clifton Down, a short 7-minute walk away.

The nearest supermarket and many more local services, shops, and restaurants can be found along Whiteladies Road. The area also has excellent leisure and exercise facilities nearby, with the Clifton Downs being a short walk from the proposed site.

Waste and Recycling - During Construction

A site waste management plan (SWMP) will be developed for this project. Waste groups to be monitored will be identified, and targets will be set to identify how waste can be reduced, reused, recycled, or diverted from landfills. Unavoidable waste will be disposed of responsibly.

Waste and Recycling - In Operation

Adequate waste and recycling storage will be provided within the curtilage of each dwelling to cater for the resident's waste and recycling needs. Both the internal and external provision will comply with Bristol City Council's recycling and waste collection requirements, ensuring that recyclables, and waste can be separated before collection.

Building Materials - Type, Life Cycle, and Source

Where feasible, the most local suppliers of materials will be selected to minimise the environmental impact of transportation. Materials used for the proposal will be purchased from sources that minimise carbon emissions and come from sustainable sources, in line with the developer's environmental policy.

Only suppliers with a certified chain of custody from the Forest Stewardship Council (FSC) or the Programme for the Endorsement of Forest Certification (PEFC) will be used to supply materials. 100% of the timber used will be legally sourced. Material will be sourced from suppliers with an EMS certificate or equivalent.

Pollution

An appropriate construction management plan will be prepared to address issues regarding water, waste, noise, vibration, dust, emissions, odours, and ground contamination. The redevelopment makes use of natural building materials for the structure of the dwelling. It will also include renewable technologies and nontoxic paints, producing limited impact on air pollution in the local area. The redevelopment will also incorporate lighting measures to prevent light pollution.

Summary

The energy strategy demonstrates how the dwellings will achieve a high fabric performance and proposes the installation of Solar PV, and ASHP to further offset the carbon dioxide emissions associated with the dwellings. There is minimal perceived flood risk, and the dwellings will be specified to achieve a water use target of less than 125 liters per person per day.

The proposed redevelopment is therefore judged to comply with all the relevant sustainability and climate change requirements.

5. Water Management

Water Conservation Measures

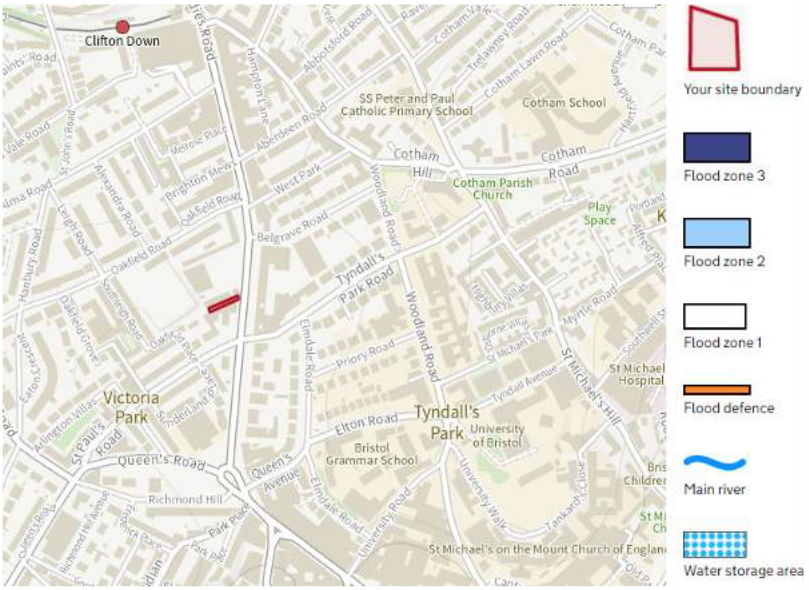
Internal portable water will be conserved by installing flow restrictors to taps, showers, and dual flush toilets. The following schedule provides a suggested specification which has been proven to exceed building regulations requirements for water conservation (Regulation 36 Compliance).

Table 1 - Water Consumption

Area	Flow Rate/Capacity
Toilet	Dual Flush 6 and 4 Liters
Basin Taps	6 Litres / Minute
Bath	180 Litres (Capacity to Overflow)
Shower	10 Litres / Minute
Kitchen Taps	8 Litres / Minute
Dishwasher	1.25 Litres / Place Setting
Washing Machine	8.17 Litres / KG dry load
Total Water Consumption Litres/person/day	125

Surface Water Management

The proposal site lies within Flood Zone 1, for this development, Surface water runoff will be managed through a sustainable urban drainage system (SUDs).



6. Selecting Renewables

Table 2 – Feasibility Matrix of Appropriate Renewables

Showing the considerations in choosing a renewable technology for this site.

Solar PV	Water Source Heat Pump
The orientation, shading and available roof space area make solar PV a suitable option that has been included in the proposal.	Not possible in this location.
Solar Thermal	**Biomass**
The hot water demand and installation area would make it possible to use solar thermal. However, to reach the 20% reduction in carbon emissions, a significant number of panels would be required. Therefore, it is more space efficient to use solar PV to reach the 20% reduction.	The proximity of residential dwellings could have an impact on the local air quality. There is not a suitable area for storage to the building.
Air Source Heat Pump	**Combined Heat & Power (CHP)**
An air source heat pump has been deemed appropriate based on the requirement for fabric, noise, space, and the space heating demand.	CHP requires a significant electricity demand, which this development does not provide. This makes CHP unviable, unless a site-wide community heating system is proposed.
Ground Source Heat Pump	**Wind**
The energy demand of the proposed scheme would make it possible to use ground source heat pumps. However, further investigation into external work and the geological setting would be required. The amount of space in the garden is limited and would require bore holes that would be considerably expensive.	The redevelopment is within proximity to residential properties, so wind is not suitable for this site.
District Heating	
The property is not within an existing district heat network, or in proximity to any planned heat network.	

Table 3 – Feasibility Matrix of Appropriate Renewables

Showing the considerations in choosing a renewable technology for this site.

Technology	Requirements	Requirements Met?	Appropriate?
Photovoltaic panels	Roof facing east to west (through south)	Yes	Yes- Selected
	Little/no or modest over shading	Yes	
	Flat roof or pitched roof not greater than 45°	Yes	
	Any size development	Yes	
Solar thermal	All requirements for photovoltaic panels	Yes	No – area used for solar PV
	Hot water tank	Yes	
Air source heat pumps	Suitable external wall or other location on-site for equipment	Yes	Yes – Selected
	Aesthetic considerations	Yes	
	Noise impact	Yes	
	Any size development	Yes	
Ground source heat pumps	External space for horizontal trench or vertical borehole	Yes	Would require further investigation
	Medium to large sized development	Yes	
	Archaeology	Unknown	
	Best suited to underfloor heating	No	
Biomass	Space needed for plant, fuel storage and deliveries	Yes	No - air pollution, storage size and delivery location insufficient
	Medium to large sized development	No	
	Minimal impact on residents (air quality, deliveries)	No	
Combined heat and power	Space need for plant access and servicing	Yes	No (redevelopment intended to have low heat demand)
	Large sized development (large heat demand)	No	
District heating	Available network	No	No
	Very large sized development (Substantial heat demand)	No	

Table 4 – The Heat Hierarchy

Showing how the heat hierarchy can be applied to this site.

Stage	Feasible	Notes
1. Connection to existing CHP/CCHP distribution networks	No	No network available
2. Site-wide renewable CHP/CCHP	No	No network available
3. Site-wide gas-fired CHP/CCHP	No	No network available
4. Site-wide renewable community heating/cooling	Yes	No network available
5. Site-wide gas-fired community heating/cooling	Yes	No network available
6. Individual building renewable heating	Yes	Air Source Heat Pumps

Table 5 – Proposed Renewables

Showing renewables added to the specification to further reduce carbon emissions. This includes the use of an air source heat pump and solar PV. The table below shows the array size of the proposed solar PV installation for the entire site.

Total Array Size	Direct/Landlord's Supply	Orientation	Inclination	Overshading
2kWp	Landlords Supply	South	30	None or little

Individual Type PV Proposal				
Type	Total Array Size	Direct/Landlord's Supply	Inclination	Overshading
Coach House	2 kWp	Landlords Supply	30	None or little

Feasibility of Appropriate Renewables – Conclusion

The location, size and type of development makes most renewable technologies appropriate for this site. Air Source Heat Pumps (ASHP) are proposed for this redevelopment. Solar thermal hot water heating is feasible however the roof space will be required for the solar PV. The number of photovoltaic panels required to reach the required 20% reduction in carbon emissions are shown in Table 10. The redevelopment is not in an area with a planned district heating system.

7. Baseline 'Threshold Values' & Proposed Fabric/Services Specification

Table 6 – Baseline Compliance & proposed building

Building Specification		
Category	Part L 2021 Limiting Factors	Proposed Building (Specified Values)
Building Fabric		
Air Permeability (m3/m2.h at 50Pa)	15 (Default)	5
Retained Ground Floor Wall U-value (W/m2K)	0.30	0.22
Retained Updated Floor Wall U-value (W/m2K)	0.30	0.28
New Wall U-value (W/m2K)	0.18	0.18
Retained Flat Roof U-value (W/m2K)	0.16	0.16
New Flat Roof U-value (W/m2K)	0.16	0.16
Retained Sloping Ceiling U-value (W/m2K)	0.16	0.16
Retained Flat Ceiling U-value (W/m2K)	0.16	0.13
Ground Floor U-value (W/m2K)	-	0.98
Exposed Floor U-value (W/m2K)	0.25	0.16
Exposed Floor U-value (W/m2K)	0.25	0.21
Fenestration		
Rooflights W/m2K)	2.2	1.3
Glazing U-value (W/m2K)	1.4	1.4
Doors U-value (W/m2K)	1.4	1.4
Thermal Bringing		
Thermal Bringing Details	-	-
Building Services & Systems		
Ventilation	Natural ventilation with intermittent extractor fans	
Heating	Gas boiler	Air Source Heat Pump
Heating Controls	Time and temperature zonal control	
Heating Systems	Gas boiler	Air source heat pump
Water Heating (From main heating)	From main heating	From main heating
Waste water heat recovery	Yes	No
Lighting	Efficacy of 75lm/W	15 Watts (power) with efficacy of 80lm/W
Renewables	Solar PV (40% of GA/6)	Solar PV

8. Conclusion

Table 7 – Summary Table Domestic

	Building Regulations Part L1b compliance ("Baseline" energy demand and emissions)	Be 'Clean' Proposed scheme after energy efficiency measures and CHP ("Residual" energy demand and emissions)/ASHP	Be 'Green' Proposed scheme after on-site renewables	Total savings on residual emissions
Energy demand (kWh pa)	22,898.54	19,545.15		
Energy saving achieved (%)		14.65%		
Regulated CO2 emissions (kg pa)	6,447.22	5,560.59	1,042.35	
Saving achieved on residual CO2 emissions (%)		13.75%	81.26%	83.83%
Dwelling Primary Energy Rate (kWh pa)	35,919.64	30,900.98	10,656.08	
Energy saving achieved (%)		13.97%	65.52%	

Summary

This report demonstrates that via a fabric first approach, the proposals will result in carbon emissions being reduced by up to 13.75% against Building Regulations Part L1(B), prior to taking account of the use of renewable energy generation sources. With the renewable energy generation sources proposed within this development (air source heat pumps and photovoltaic panels on every plot), the carbon emissions will be reduced by up to a further 81.26%, culminating in a carbon emission reduction against building regulations of up to 83.83% across the site in total.

BCC policy requires that all residential development will be required to reduce CO_2 emissions over and above building regulations requirements by at least 20% via the use of renewable and/or low carbon energy generation sources. As demonstrated, these proposals will achieve at least 20% in accordance with this policy.

Appendix A – SAP Outputs

Full SAP Calculation Printout

Property Reference	20 Whiteladies Rd	Issued on Date	12/07/2024
Assessment Reference	Gas Baseline	Prop Type Ref	
Property	20 Whiteladies Road, Clifton, BRISTOL, BS8 2LG		

SAP Rating	63 D	DER	31.05	TER	
Environmental	66 D	% DER < TER			N/A
CO_2 Emissions (t/year)	5.38	DFEE	110.28	TFEE	
Compliance Check	See BREL	% DFEE < TFEE			
% DPER < TPER		DPER	172.99	TPER	

Assessor Details	Mr. Richard Millard	Assessor ID	U367-0001
Client			

SAP 10 WORKSHEET FOR Conversion (As Built) (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	24.6800	(1b)	x 2.9300	(2b) =	72.3124	(1b) - (3b)
First floor	91.4800	(1c)	x 2.2500	(2c) =	205.8300	(1c) - (3c)
Second floor	91.4800	(1d)	x 3.7200	(2d) =	340.3056	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	207.6400					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		618.4480	(5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	10 * 10 =	100.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	100.0000 / (5) =	0.1617 (8)
Pressure test		No
Pressure Test Method		Blower Door
Measured/design AP50		15.0000 (17)
Infiltration rate		0.9117 (18)
Number of sides sheltered		2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.7749 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.9880	0.9687	0.9493	0.8524	0.8331	0.7362	0.7362	0.7168	0.7749	0.8331	0.8718	0.9106	(22b)
Effective ac	0.9881	0.9692	0.9506	0.8633	0.8470	0.7710	0.7710	0.7569	0.8003	0.8470	0.8800	0.9146	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Timber Sash Windows (Uw = 1.40)			16.9300	1.3258	22.4451			(27)
RF-01			0.8400	1.2357	1.0380			(27a)
RF-02			0.8400	1.2357	1.0380			(27a)
Ground Floor			24.6800	0.9800	24.1864	110.0000	2714.8000	(28a)
Exposed Floor Rear			30.4400	0.2500	7.6100			(28b)
Exposed Floor Front			36.3600	0.2500	9.0900	20.0000	727.2000	(28b)
Retained Ground Floor	48.0600	4.7500	43.3100	0.3000	12.9930	190.0000	8228.9000	(29a)
Retained Upper Floors	194.9900	12.1800	182.8100	0.3000	54.8430	190.0000	34733.9000	(29a)
New Cavity Wall	16.1500		16.1500	0.1800	2.9070	70.0000	1130.5000	(29a)
Retained Flat Roof	39.3800		39.3800	0.1600	6.3008	9.0000	354.4200	(30)
New Flat Roof	12.6000		12.6000	0.1600	2.0160	9.0000	113.4000	(30)
Retained Sloping Ceiling	27.2800	1.6800	25.6000	0.1600	4.0960	9.0000	230.4000	(30)
Retained Plane Ceiling	20.6500		20.6500	0.1600	3.3040	9.0000	185.8500	(30)
Total net area of external elements Aum(A, m2)			450.5900					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		210.4723			(33)
Party Wall 1			117.2100	0.5000	58.6050	180.0000	21097.8000	(32)
Internal Floor 1			24.6800			18.0000	444.2400	(32d)
Internal Floor 2			91.4800			18.0000	1646.6400	(32d)

Internal Ceiling 1	24.6800	9.0000	222.1200	(32e)
Internal Ceiling 2	91.4800	9.0000	823.3200	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	72653.4900	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		349.9012	(35)
Thermal bridges (Default value 0.200 * total exposed area)		90.1180	(36)
Point Thermal bridges	(36a) =	0.0000	
Total fabric heat loss	(33) + (36) + (36a) =	300.5903	(37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	201.6635	197.7951	194.0034	176.1937	172.8615	157.3498	157.3498	154.4773	163.3247	172.8615	179.6024	186.6497	(38)
Heat transfer coeff	502.2538	498.3854	494.5937	476.7840	473.4518	457.9401	457.9401	455.0676	463.9150	473.4518	480.1927	487.2400	(39)
Average = Sum(39)m / 12 =												476.7680	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	2.4189	2.4002	2.3820	2.2962	2.2802	2.2055	2.2055	2.1916	2.2342	2.2802	2.3126	2.3466	(40)
HLP (average)												2.2961	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy												3.0119 (42)
Hot water usage for mixer showers	132.0199	130.0359	127.1448	121.6133	117.5311	112.9787	110.3911	113.2603	116.4055	121.2934	126.9438	131.5141 (42a)
Hot water usage for baths	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (42b)
Hot water usage for other uses	45.4744	43.8208	42.1672	40.5136	38.8600	37.2064	37.2064	38.8600	40.5136	42.1672	43.8208	45.4744 (42c)
Average daily hot water use (litres/day)												163.0583 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	177.4943	173.8567	169.3120	162.1268	156.3911	150.1851	147.5975	152.1203	156.9191	163.4606	170.7646	176.9885	(44)
Energy conte	281.1076	247.5697	260.2263	221.9435	210.5324	184.6701	178.5064	188.3567	193.4970	221.8145	243.2855	277.1212	(45)
Energy content (annual)										Total = Sum(45)m =		2708.6309	
Distribution loss (46)m = 0.15 x (45)m	42.1661	37.1354	39.0339	33.2915	31.5799	27.7005	26.7760	28.2535	29.0245	33.2722	36.4928	41.5682	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	50.9589	46.0274	50.9589	49.3151	50.9589	49.3151	50.9589	50.9589	49.3151	50.9589	49.3151	50.9589	(61)
Total heat required for water heating calculated for each month	332.0665	293.5970	311.1852	271.2586	261.4914	233.9851	229.4653	239.3156	242.8120	272.7734	292.6005	328.0801	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	332.0665	293.5970	311.1852	271.2586	261.4914	233.9851	229.4653	239.3156	242.8120	272.7734	292.6005	328.0801	(64)
										Total per year (kWh/year) = Sum(64)m =		3308.6309	(64)
12Total per year (kWh/year)												3309	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month	106.2080	93.8238	99.2650	86.1250	82.7418	73.7316	72.0931	75.3683	76.6665	86.4930	93.2212	104.8825	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	224.4785	248.5298	224.4785	231.9612	224.4785	231.9612	224.4785	224.4785	231.9612	224.4785	231.9612	224.4785	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	378.2496	382.1747	372.2837	351.2269	324.6465	299.6647	282.9754	279.0503	288.9413	309.9981	336.5784	361.5602	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	(71)
Water heating gains (Table 5)	142.7527	139.6187	133.4206	119.6181	111.2120	102.4050	96.8993	101.3015	106.4813	116.2541	129.4739	140.9712	(72)
Total internal gains	816.6587	841.5010	801.3607	773.9840	731.5150	702.2087	672.5311	673.0083	695.5616	721.9086	769.1913	798.1878	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	6.1600	11.2829	0.6300	0.7000	0.7700	21.2410	(75)
Southwest	7.6400	36.7938	0.6300	0.7000	0.7700	85.9093	(79)
Northwest	3.1300	11.2829	0.6300	0.7000	0.7700	10.7929	(81)
Southeast	1.6800	40.0991	0.6300	0.7000	1.0000	26.7378	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	144.6810	260.5955	392.3466	543.1875	658.3638	675.0061	641.9127	553.0892	444.3244	297.8366	175.9149	122.0975	(83)
Total gains	961.3397	1102.0965	1193.7073	1317.1715	1389.8788	1377.2149	1314.4438	1226.0975	1139.8860	1019.7452	945.1063	920.2853	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	40.1819	40.4938	40.8043	42.3284	42.6264	44.0702	44.0702	44.3484	43.5026	42.6264	42.0280	41.4201	
alpha	3.6788	3.6996	3.7203	3.8219	3.8418	3.9380	3.9380	3.9566	3.9002	3.8418	3.8019	3.7613	
util living area	0.9997	0.9994	0.9989	0.9973	0.9918	0.9722	0.9264	0.9463	0.9884	0.9981	0.9995	0.9998	(86)
MIT	18.5216	18.6848	18.9960	19.4913	19.9739	20.4551	20.7271	20.6801	20.2924	19.6748	19.0636	18.5545	(87)
Th 2	19.0687	19.0799	19.0908	19.1432	19.1531	19.1999	19.1999	19.2086	19.1818	19.1531	19.1331	19.1123	(88)
util rest of house	0.9995	0.9991	0.9983	0.9951	0.9829	0.9260	0.7563	0.8145	0.9688	0.9963	0.9991	0.9996	(89)
MIT 2	16.3038	16.5195	16.9250	17.5907	18.2117	18.8348	19.1136	19.0857	18.6332	17.8325	17.0369	16.3715	(90)
Living area fraction										fLA = Living area / (4) =		0.1243	(91)
MIT	16.5796	16.7888	17.1826	17.8270	18.4308	19.0363	19.3142	19.2839	18.8395	18.0616	17.2889	16.6430	(92)
Temperature adjustment												0.0000	
adjusted MIT	16.5796	16.7888	17.1826	17.8270	18.4308	19.0363	19.3142	19.2839	18.8395	18.0616	17.2889	16.6430	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9991	0.9984	0.9969	0.9922	0.9763	0.9183	0.7746	0.8244	0.9613	0.9940	0.9984	0.9993	(94)
Useful gains	960.4693	1100.3161	1190.0542	1306.8552	1356.9489	1264.7483	1018.1669	1010.8482	1095.7810	1013.5997	943.6351	919.6354	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	6167.4675	5925.1905	5283.5263	4256.2727	3186.7119	2031.5402	1242.9396	1312.3868	2198.7229	3532.7080	4892.6314	6062.7159	(97)
Space heating kWh	3874.0067	3242.3156	3045.5432	2123.5806	1361.3437	0.0000	0.0000	0.0000	0.0000	1874.2166	2843.2773	3826.4519	(98a)
Space heating requirement - total per year (kWh/year)												22190.7355	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	3874.0067	3242.3156	3045.5432	2123.5806	1361.3437	0.0000	0.0000	0.0000	0.0000	1874.2166	2843.2773	3826.4519	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												22190.7355	
Space heating per m2											(98c) / (4) =	106.8712	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.1000 (201)
Fraction of space heat from main system(s) 0.9000 (202)
Efficiency of main space heating system 1 (in %) 79.0000 (206)
Efficiency of main space heating system 2 (in %) 0.0000 (207)
Efficiency of secondary/supplementary heating system, % 100.0000 (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	3874.0067	3242.3156	3045.5432	2123.5806	1361.3437	0.0000	0.0000	0.0000	0.0000	1874.2166	2843.2773	3826.4519	(98)
Space heating efficiency (main heating system 1)	79.0000	79.0000	79.0000	79.0000	79.0000	0.0000	0.0000	0.0000	0.0000	79.0000	79.0000	79.0000	(210)
Space heating fuel (main heating system)	4413.4253	3693.7772	3469.6062	2419.2690	1550.8979	0.0000	0.0000	0.0000	0.0000	2135.1834	3239.1767	4359.2490	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	387.4007	324.2316	304.5543	212.3581	136.1344	0.0000	0.0000	0.0000	0.0000	187.4217	284.3277	382.6452	(215)
Water heating													
Water heating requirement	332.0665	293.5970	311.1852	271.2586	261.4914	233.9851	229.4653	239.3156	242.8120	272.7734	292.6005	328.0801	(64)
Efficiency of water heater												75.0000	(216)
(217)m	83.1325	83.0885	82.9847	82.7656	82.2637	75.0000	75.0000	75.0000	75.0000	82.6199	82.9783	83.1323	(217)
Fuel for water heating, kWh/month	399.4425	353.3545	374.9910	327.7433	317.8696	311.9802	305.9537	319.0875	323.7494	330.1546	352.6231	394.6482	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	3.4822	3.1452	3.4822	3.3699	3.4822	3.3699	3.4822	3.4822	3.3699	3.4822	3.3699	3.4822	(231)
Lighting	46.6422	37.4181	33.6909	24.6834	19.0661	15.5772	17.3928	22.6078	29.3653	38.5288	43.5182	47.9385	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-39.4805	-60.0085	-92.3781	-109.5045	-120.1586	-101.9542	-100.5457	-92.8808	-80.0985	-69.6409	-44.5037	-33.6339	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year
Space heating fuel - main system 1 25280.5848 (211)
Space heating fuel - main system 2 0.0000 (213)
Space heating fuel - secondary 2219.0736 (215)
Efficiency of water heater 75.0000
Water heating fuel used 4111.5976 (219)
Space cooling fuel 0.0000 (221)

Electricity for pumps and fans:
central heating pump 41.0000 (230c)
Total electricity for the above, kWh/year 41.0000 (231)
Electricity for lighting (calculated in Appendix L) 376.4293 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation -944.7879 (233)
Wind generation 0.0000 (234)
Hydro-electric generation (Appendix N) 0.0000 (235a)
Electricity generated - Micro CHP (Appendix N) 0.0000 (235)
Appendix Q - special features

Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	31083.8973	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	25280.5848	0.2100	5308.9228	(261)
Total CO2 associated with community systems			0.0000	(373)
Space heating - secondary	2219.0736	0.1536	340.7511	(263)
Water heating (other fuel)	4111.5976	0.2100	863.4355	(264)
Space and water heating			6513.1094	(265)
Pumps, fans and electric keep-hot	41.0000	0.1387	5.6872	(267)
Energy for lighting	376.4293	0.1443	54.3304	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-944.7879	0.1344	-126.9339	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-126.9339	(269)
Total CO2, kg/year			6446.1931	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			31.0500	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	25280.5848	1.1300	28567.0608	(275)
Total CO2 associated with community systems			0.0000	(473)
Space heating - secondary	2219.0736	1.5685	3480.6252	(277)
Water heating (other fuel)	4111.5976	1.1300	4646.1053	(278)
Space and water heating			36693.7913	(279)
Pumps, fans and electric keep-hot	41.0000	1.5128	62.0248	(281)
Energy for lighting	376.4293	1.5338	577.3799	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-944.7879	1.4965	-1413.9221	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-1413.9221	(283)
Total Primary energy kWh/year			35919.2739	(286)
Dwelling Primary energy Rate (DPER)			172.9900	(287)

Full SAP Calculation Printout

Property Reference	20 Whiteladies Rd	Issued on Date	12/07/2024
Assessment Reference	Gas Residual	Prop Type Ref	
Property	20 Whiteladies Road, Clifton, BRISTOL, BS8 2LG		

SAP Rating	68 D	DER	26.78	TER	
Environmental	71 C	% DER < TER			N/A
CO_2 Emissions (t/year)	4.83	DFEE	94.13	TFEE	
Compliance Check	See BREL	% DFEE < TFEE			
% DPER < TPER		DPER	148.82	TPER	

Assessor Details	Mr. Richard Millard	Assessor ID	U367-0001
Client			

SAP 10 WORKSHEET FOR Conversion (As Built) (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	24.6800	(1b)	x 2.9300	(2b) =	72.3124	(1b) - (3b)
First floor	91.4800	(1c)	x 2.2500	(2c) =	205.8300	(1c) - (3c)
Second floor	91.4800	(1d)	x 3.7200	(2d) =	340.3056	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	207.6400					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		618.4480	(5)

2. Ventilation rate

	m3 per hour	
Number of open chimneys	0 * 80 =	0.0000 (6a)
Number of open flues	0 * 20 =	0.0000 (6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000 (6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000 (6d)
Number of flues attached to other heater	0 * 35 =	0.0000 (6e)
Number of blocked chimneys	0 * 20 =	0.0000 (6f)
Number of intermittent extract fans	10 * 10 =	100.0000 (7a)
Number of passive vents	0 * 10 =	0.0000 (7b)
Number of flueless gas fires	0 * 40 =	0.0000 (7c)

	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	100.0000 / (5) =	0.1617 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		5.0000 (17)
Infiltration rate		0.4117 (18)
Number of sides sheltered		2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3499 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.4462	0.4374	0.4287	0.3849	0.3762	0.3324	0.3324	0.3237	0.3499	0.3762	0.3937	0.4112	(22b)
Effective ac	0.5995	0.5957	0.5919	0.5741	0.5708	0.5553	0.5553	0.5524	0.5612	0.5708	0.5775	0.5845	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Timber Sash Windows (Uw = 1.40)			16.9300	1.3258	22.4451			(27)
RF-01			0.8400	1.2357	1.0380			(27a)
RF-02			0.8400	1.2357	1.0380			(27a)
Ground Floor			24.6800	0.9800	24.1864	110.0000	2714.8000	(28a)
Exposed Floor Rear			30.4400	0.1600	4.8704			(28b)
Exposed Floor Front			36.3600	0.2100	7.6356	20.0000	727.2000	(28b)
Retained Ground Floor	48.0600	4.7500	43.3100	0.2200	9.5282	190.0000	8228.9000	(29a)
Retained Upper Floors	194.9900	12.1800	182.8100	0.2800	51.1868	190.0000	34733.9000	(29a)
New Cavity Wall	16.1500		16.1500	0.1800	2.9070	70.0000	1130.5000	(29a)
Retained Flat Roof	39.3800		39.3800	0.1600	6.3008	9.0000	354.4200	(30)
New Flat Roof	12.6000		12.6000	0.1600	2.0160	9.0000	113.4000	(30)
Retained Sloping Ceiling	27.2800	1.6800	25.6000	0.1600	4.0960	9.0000	230.4000	(30)
Retained Plane Ceiling	20.6500		20.6500	0.1300	2.6845	9.0000	185.8500	(30)
Total net area of external elements Aum(A, m2)			450.5900					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	198.5378			(33)
Party Wall 1			117.2100	0.5000	58.6050	180.0000	21097.8000	(32)
Internal Floor 1			24.6800			18.0000	444.2400	(32d)
Internal Floor 2			91.4800			18.0000	1646.6400	(32d)

Internal Ceiling 1	24.6800	9.0000	222.1200	(32e)
Internal Ceiling 2	91.4800	9.0000	823.3200	(32e)
Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =		72653.4900	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K			349.9012	(35)
Thermal bridges (Default value 0.200 * total exposed area)			90.1180	(36)
Point Thermal bridges		(36a) =	0.0000	
Total fabric heat loss	(33) + (36) + (36a) =		288.6558	(37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	122.3580	121.5692	120.7960	117.1643	116.4848	113.3217	113.3217	112.7359	114.5401	116.4848	117.8594	119.2964	(38)
Heat transfer coeff	411.0138	410.2250	409.4518	405.8201	405.1406	401.9775	401.9775	401.3918	403.1959	405.1406	406.5152	407.9522	(39)
Average = Sum(39)m / 12 =												405.8168	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.9795	1.9757	1.9719	1.9544	1.9512	1.9359	1.9359	1.9331	1.9418	1.9512	1.9578	1.9647	(40)
HLP (average)												1.9544	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy											3.0119	(42)
Hot water usage for mixer showers	132.0199	130.0359	127.1448	121.6133	117.5311	112.9787	110.3911	113.2603	116.4055	121.2934	126.9438	131.5141	(42a)
Hot water usage for baths	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42b)
Hot water usage for other uses	45.4744	43.8208	42.1672	40.5136	38.8600	37.2064	37.2064	38.8600	40.5136	42.1672	43.8208	45.4744	(42c)
Average daily hot water use (litres/day)												163.0583	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	177.4943	173.8567	169.3120	162.1268	156.3911	150.1851	147.5975	152.1203	156.9191	163.4606	170.7646	176.9885	(44)
Energy conte	281.1076	247.5697	260.2263	221.9435	210.5324	184.6701	178.5064	188.3567	193.4970	221.8145	243.2855	277.1212	(45)
Energy content (annual)										Total = Sum(45)m =		2708.6309	
Distribution loss (46)m = 0.15 x (45)m	42.1661	37.1354	39.0339	33.2915	31.5799	27.7005	26.7760	28.2535	29.0245	33.2722	36.4928	41.5682	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	50.9589	46.0274	50.9589	49.3151	50.9589	49.3151	50.9589	50.9589	49.3151	50.9589	49.3151	50.9589	(61)
Total heat required for water heating calculated for each month	332.0665	293.5970	311.1852	271.2586	261.4914	233.9851	229.4653	239.3156	242.8120	272.7734	292.6005	328.0801	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	332.0665	293.5970	311.1852	271.2586	261.4914	233.9851	229.4653	239.3156	242.8120	272.7734	292.6005	328.0801	(64)
										Total per year (kWh/year) = Sum(64)m =		3308.6309	(64)
12Total per year (kWh/year)												3309	(64)
Electric shower(s)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		0.0000	(64a)
Heat gains from water heating, kWh/month	106.2080	93.8238	99.2650	86.1250	82.7418	73.7316	72.0931	75.3683	76.6665	86.4930	93.2212	104.8825	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	224.4785	248.5298	224.4785	231.9612	224.4785	231.9612	224.4785	224.4785	231.9612	224.4785	231.9612	224.4785	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	378.2496	382.1747	372.2837	351.2269	324.6465	299.6647	282.9754	279.0503	288.9413	309.9981	336.5784	361.5602	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	0.0000	0.0000	0.0000	0.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	(71)
Water heating gains (Table 5)	142.7527	139.6187	133.4206	119.6181	111.2120	102.4050	96.8993	101.3015	106.4813	116.2541	129.4739	140.9712	(72)
Total internal gains	816.6587	841.5010	801.3607	773.9840	731.5150	702.2087	672.5311	673.0083	695.5616	721.9086	769.1913	798.1878	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	6.1600	11.2829	0.6300	0.7000	0.7700	21.2410	(75)
Southwest	7.6400	36.7938	0.6300	0.7000	0.7700	85.9093	(79)
Northwest	3.1300	11.2829	0.6300	0.7000	0.7700	10.7929	(81)
Southeast	1.6800	40.0991	0.6300	0.7000	1.0000	26.7378	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	144.6810	260.5955	392.3466	543.1875	658.3638	675.0061	641.9127	553.0892	444.3244	297.8366	175.9149	122.0975	(83)
Total gains	961.3397	1102.0965	1193.7073	1317.1715	1389.8788	1377.2149	1314.4438	1226.0975	1139.8860	1019.7452	945.1063	920.2853	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	49.1018	49.1962	49.2891	49.7302	49.8136	50.2056	50.2056	50.2789	50.0539	49.8136	49.6452	49.4703	
alpha	4.2735	4.2797	4.2859	4.3153	4.3209	4.3470	4.3470	4.3519	4.3369	4.3209	4.3097	4.2980	
util living area													
	0.9998	0.9996	0.9992	0.9975	0.9915	0.9682	0.9112	0.9363	0.9876	0.9983	0.9996	0.9998	(86)
MIT	18.9227	19.0625	19.3288	19.7303	20.1560	20.5615	20.7979	20.7528	20.4144	19.8715	19.3395	18.9081	(87)
Th 2	19.3471	19.3496	19.3521	19.3639	19.3661	19.3764	19.3764	19.3783	19.3724	19.3661	19.3616	19.3570	(88)
util rest of house													
	0.9997	0.9994	0.9987	0.9956	0.9826	0.9197	0.7411	0.8027	0.9678	0.9967	0.9994	0.9998	(89)
MIT 2	16.9882	17.1692	17.5124	18.0343	18.5775	19.0797	19.3120	19.2823	18.9084	18.2173	17.5323	16.9758	(90)
Living area fraction										fLA = Living area / (4) =		0.1243	(91)
MIT	17.2288	17.4046	17.7382	18.2452	18.7738	19.2640	19.4968	19.4652	19.0957	18.4230	17.7570	17.2161	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.2288	17.4046	17.7382	18.2452	18.7738	19.2640	19.4968	19.4652	19.0957	18.4230	17.7570	17.2161	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9995	0.9989	0.9977	0.9932	0.9769	0.9140	0.7607	0.8146	0.9614	0.9949	0.9989	0.9996	(94)
Useful gains	960.8112	1100.8971	1190.9831	1308.1772	1357.8044	1258.8310	999.8784	998.7236	1095.8857	1014.5817	944.0614	919.8782	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	5313.9046	5129.7005	4601.5135	3792.4736	2865.8868	1874.8241	1164.4321	1230.3456	2014.2398	3169.4005	4332.2395	5309.9416	(97)
Space heating kWh	3238.7015	2707.3559	2537.4347	1788.6934	1122.0133	0.0000	0.0000	0.0000	0.0000	1603.1851	2439.4882	3266.2072	(98a)
Space heating requirement - total per year (kWh/year)												18703.0794	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	3238.7015	2707.3559	2537.4347	1788.6934	1122.0133	0.0000	0.0000	0.0000	0.0000	1603.1851	2439.4882	3266.2072	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												18703.0794	
Space heating per m2											(98c) / (4) =	90.0745	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)												0.1000	(201)
Fraction of space heat from main system(s)												0.9000	(202)
Efficiency of main space heating system 1 (in %)												79.0000	(206)
Efficiency of main space heating system 2 (in %)												0.0000	(207)
Efficiency of secondary/supplementary heating system, %												100.0000	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	3238.7015	2707.3559	2537.4347	1788.6934	1122.0133	0.0000	0.0000	0.0000	0.0000	1603.1851	2439.4882	3266.2072	(98)
Space heating efficiency (main heating system 1)	79.0000	79.0000	79.0000	79.0000	79.0000	0.0000	0.0000	0.0000	0.0000	79.0000	79.0000	79.0000	(210)
Space heating fuel (main heating system)	3689.6599	3084.3295	2890.7484	2037.7520	1278.2430	0.0000	0.0000	0.0000	0.0000	1826.4135	2779.1638	3720.9955	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	323.8702	270.7356	253.7435	178.8693	112.2013	0.0000	0.0000	0.0000	0.0000	160.3185	243.9488	326.6207	(215)
Water heating													
Water heating requirement	332.0665	293.5970	311.1852	271.2586	261.4914	233.9851	229.4653	239.3156	242.8120	272.7734	292.6005	328.0801	(64)
Efficiency of water heater												75.0000	(216)
(217)m	82.9816	82.9298	82.8083	82.5712	81.9766	75.0000	75.0000	75.0000	75.0000	82.4274	82.8311	83.0000	(217)
Fuel for water heating, kWh/month	400.1689	354.0306	375.7897	328.5150	318.9829	311.9802	305.9537	319.0875	323.7494	330.9258	353.2496	395.2773	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	3.4822	3.1452	3.4822	3.3699	3.4822	3.3699	3.4822	3.4822	3.3699	3.4822	3.3699	3.4822	(231)
Lighting	46.6422	37.4181	33.6909	24.6834	19.0661	15.5772	17.3928	22.6078	29.3653	38.5288	43.5182	47.9385	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-39.1139	-59.2631	-90.9786	-107.8143	-118.2695	-101.9542	-100.5457	-92.8808	-80.0985	-68.9228	-44.1156	-33.3739	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)
Annual totals kWh/year													
Space heating fuel - main system 1												21307.3056	(211)
Space heating fuel - main system 2												0.0000	(213)
Space heating fuel - secondary												1870.3079	(215)
Efficiency of water heater												75.0000	
Water heating fuel used												4117.7106	(219)
Space cooling fuel												0.0000	(221)
Electricity for pumps and fans:													
central heating pump												41.0000	(230c)
Total electricity for the above, kWh/year												41.0000	(231)
Electricity for lighting (calculated in Appendix L)												376.4293	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation												-937.3310	(233)
Wind generation												0.0000	(234)
Hydro-electric generation (Appendix N)												0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)												0.0000	(235)
Appendix Q - special features													

Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	26775.4224	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	21307.3056	0.2100	4474.5342	(261)
Total CO2 associated with community systems			0.0000	(373)
Space heating - secondary	1870.3079	0.1536	287.1989	(263)
Water heating (other fuel)	4117.7106	0.2100	864.7192	(264)
Space and water heating			5626.4523	(265)
Pumps, fans and electric keep-hot	41.0000	0.1387	5.6872	(267)
Energy for lighting	376.4293	0.1443	54.3304	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-937.3310	0.1343	-125.8511	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-125.8511	(269)
Total CO2, kg/year			5560.6189	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			26.7800	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	21307.3056	1.1300	24077.2553	(275)
Total CO2 associated with community systems			0.0000	(473)
Space heating - secondary	1870.3079	1.5685	2933.5959	(277)
Water heating (other fuel)	4117.7106	1.1300	4653.0130	(278)
Space and water heating			31663.8642	(279)
Pumps, fans and electric keep-hot	41.0000	1.5128	62.0248	(281)
Energy for lighting	376.4293	1.5338	577.3799	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-937.3310	1.4962	-1402.4563	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-1402.4563	(283)
Total Primary energy kWh/year			30900.8126	(286)
Dwelling Primary energy Rate (DPER)			148.8200	(287)

Full SAP Calculation Printout

Property Reference	20 Whiteladies Rd	Issued on Date	12/07/2024
Assessment Reference	Proposed PV	Prop Type Ref	
Property	20 Whiteladies Road, Clifton, BRISTOL, BS8 2LG		

SAP Rating	70 C	DER	5.02	TER	
Environmental	95 A	% DER < TER			N/A
CO_2 Emissions (t/year)	0.89	DFEE	94.13	TFEE	
Compliance Check	See BREL	% DFEE < TFEE			
% DPER < TPER		DPER	51.32	TPER	

Assessor Details	Mr. Richard Millard	Assessor ID	U367-0001
Client			

SAP 10 WORKSHEET FOR Conversion (As Built) (Version 10.2, February 2022)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

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1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	24.6800	(1b)	x 2.9300	(2b) =	72.3124	(1b) - (3b)
First floor	91.4800	(1c)	x 2.2500	(2c) =	205.8300	(1c) - (3c)
Second floor	91.4800	(1d)	x 3.7200	(2d) =	340.3056	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	207.6400					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		618.4480	(5)

2. Ventilation rate

		m3 per hour	
Number of open chimneys	0 * 80 =	0.0000	(6a)
Number of open flues	0 * 20 =	0.0000	(6b)
Number of chimneys / flues attached to closed fire	0 * 10 =	0.0000	(6c)
Number of flues attached to solid fuel boiler	0 * 20 =	0.0000	(6d)
Number of flues attached to other heater	0 * 35 =	0.0000	(6e)
Number of blocked chimneys	0 * 20 =	0.0000	(6f)
Number of intermittent extract fans	10 * 10 =	100.0000	(7a)
Number of passive vents	0 * 10 =	0.0000	(7b)
Number of flueless gas fires	0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	100.0000 / (5) =	0.1617	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4117	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3499	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.4462	0.4374	0.4287	0.3849	0.3762	0.3324	0.3324	0.3237	0.3499	0.3762	0.3937	0.4112	(22b)
Effective ac	0.5995	0.5957	0.5919	0.5741	0.5708	0.5553	0.5553	0.5524	0.5612	0.5708	0.5775	0.5845	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Timber Sash Windows (Uw = 1.40)			16.9300	1.3258	22.4451			(27)
RF-01			0.8400	1.2357	1.0380			(27a)
RF-02			0.8400	1.2357	1.0380			(27a)
Ground Floor			24.6800	0.9800	24.1864	110.0000	2714.8000	(28a)
Exposed Floor Rear			30.4400	0.1600	4.8704			(28b)
Exposed Floor Front			36.3600	0.2100	7.6356	20.0000	727.2000	(28b)
Retained Ground Floor	48.0600	4.7500	43.3100	0.2200	9.5282	190.0000	8228.9000	(29a)
Retained Upper Floors	194.9900	12.1800	182.8100	0.2800	51.1868	190.0000	34733.9000	(29a)
New Cavity Wall	16.1500		16.1500	0.1800	2.9070	70.0000	1130.5000	(29a)
Retained Flat Roof	39.3800		39.3800	0.1600	6.3008	9.0000	354.4200	(30)
New Flat Roof	12.6000		12.6000	0.1600	2.0160	9.0000	113.4000	(30)
Retained Sloping Ceiling	27.2800	1.6800	25.6000	0.1600	4.0960	9.0000	230.4000	(30)
Retained Plane Ceiling	20.6500		20.6500	0.1300	2.6845	9.0000	185.8500	(30)
Total net area of external elements Aum(A, m2)			450.5900					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		198.5378			(33)
Party Wall 1			117.2100	0.5000	58.6050	180.0000	21097.8000	(32)
Internal Floor 1			24.6800			18.0000	444.2400	(32d)
Internal Floor 2			91.4800			18.0000	1646.6400	(32d)

Internal Ceiling 1	24.6800	9.0000	222.1200 (32e)
Internal Ceiling 2	91.4800	9.0000	823.3200 (32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	72653.4900 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		349.9012 (35)
Thermal bridges (Default value 0.200 * total exposed area)		90.1180 (36)
Point Thermal bridges	(36a) =	0.0000
Total fabric heat loss	(33) + (36) + (36a) =	288.6558 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	122.3580	121.5692	120.7960	117.1643	116.4848	113.3217	113.3217	112.7359	114.5401	116.4848	117.8594	119.2964	(38)
Heat transfer coeff	411.0138	410.2250	409.4518	405.8201	405.1406	401.9775	401.9775	401.3918	403.1959	405.1406	406.5152	407.9522	(39)
Average = Sum(39)m / 12 =												405.8168	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.9795	1.9757	1.9719	1.9544	1.9512	1.9359	1.9359	1.9331	1.9418	1.9512	1.9578	1.9647	(40)
HLP (average)												1.9544	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

4. Water heating energy requirements (kWh/year)

Assumed occupancy												3.0119	(42)
Hot water usage for mixer showers	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42a)
Hot water usage for baths	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(42b)
Hot water usage for other uses	45.4744	43.8208	42.1672	40.5136	38.8600	37.2064	37.2064	38.8600	40.5136	42.1672	43.8208	45.4744	(42c)
Average daily hot water use (litres/day)												41.3404	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	45.4744	43.8208	42.1672	40.5136	38.8600	37.2064	37.2064	38.8600	40.5136	42.1672	43.8208	45.4744	(44)
Energy conte	72.0204	62.4003	64.8094	55.4611	52.3130	45.7496	44.9979	48.1168	49.9573	57.2205	62.4308	71.2020	(45)
Energy content (annual)										Total = Sum(45)m =		686.6790	
Distribution loss (46)m = 0.15 x (45)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(46)
Water storage loss:													
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month	61.2173	53.0402	55.0880	47.1419	44.4660	38.8871	38.2482	40.8993	42.4637	48.6374	53.0662	60.5217	(62)
WWHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63a)
PV diverter	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	(63b)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63c)
FGHRS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63d)
Output from w/h	61.2173	53.0402	55.0880	47.1419	44.4660	38.8871	38.2482	40.8993	42.4637	48.6374	53.0662	60.5217	(64)
										Total per year (kWh/year) = Sum(64)m =		583.6771	(64)
12Total per year (kWh/year)												584	(64)
Electric shower(s)	76.8916	68.5110	74.8114	71.3916	72.7313	69.3786	71.6912	72.7313	71.3916	74.8114	73.4047	76.8916	(64a)
										Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =		874.6373	(64a)
Heat gains from water heating, kWh/month	34.5272	30.3878	32.4749	29.6334	29.2993	27.0664	27.4848	28.4076	28.4638	30.8622	31.6177	34.3533	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	150.5929	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	224.4785	248.5298	224.4785	231.9612	224.4785	231.9612	224.4785	224.4785	231.9612	224.4785	231.9612	224.4785	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	378.2496	382.1747	372.2837	351.2269	324.6465	299.6647	282.9754	279.0503	288.9413	309.9981	336.5784	361.5602	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	38.0593	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	-120.4743	(71)
Water heating gains (Table 5)	46.4076	45.2200	43.6490	41.1575	39.3808	37.5923	36.9420	38.1823	39.5331	41.4815	43.9135	46.1738	(72)
Total internal gains	717.3136	744.1023	708.5891	692.5234	656.6838	637.3960	612.5738	609.8890	628.6135	644.1360	680.6310	700.3905	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Northeast	6.1600	11.2829	0.6300	0.7000	0.7700	21.2410	(75)
Southwest	7.6400	36.7938	0.6300	0.7000	0.7700	85.9093	(79)
Northwest	3.1300	11.2829	0.6300	0.7000	0.7700	10.7929	(81)
Southeast	1.6800	40.0991	0.6300	0.7000	1.0000	26.7378	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	144.6810	260.5955	392.3466	543.1875	658.3638	675.0061	641.9127	553.0892	444.3244	297.8366	175.9149	122.0975	(83)
Total gains	861.9946	1004.6978	1100.9357	1235.7109	1315.0476	1312.4022	1254.4865	1162.9782	1072.9379	941.9726	856.5459	822.4880	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	49.1018	49.1962	49.2891	49.7302	49.8136	50.2056	50.2056	50.2789	50.0539	49.8136	49.6452	49.4703	
alpha	4.2735	4.2797	4.2859	4.3153	4.3209	4.3470	4.3470	4.3519	4.3369	4.3209	4.3097	4.2980	
util living area	0.9999	0.9997	0.9994	0.9981	0.9931	0.9730	0.9223	0.9459	0.9901	0.9988	0.9998	0.9999	(86)
Living	18.8877	19.0282	19.2962	19.7019	20.1306	20.5415	20.7836	20.7358	20.3919	19.8442	19.3082	18.8736	
Non living	16.9434	17.1253	17.4707	17.9981	18.5461	19.0590	19.3040	19.2707	18.8820	18.1825	17.4923	16.9316	
24 / 16	0	0	0	0	0	0	0	0	0	0	0	0	
24 / 9	31	28	31	30	31	30	31	31	30	31	30	31	
16 / 9	0	0	0	0	0	0	0	0	0	0	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	(87)
Th 2	19.3471	19.3496	19.3521	19.3639	19.3661	19.3764	19.3764	19.3783	19.3724	19.3661	19.3616	19.3570	(88)
util rest of house	0.9998	0.9996	0.9990	0.9966	0.9858	0.9304	0.7626	0.8242	0.9738	0.9976	0.9996	0.9999	(89)
MIT 2	19.3471	19.3496	19.3521	19.3639	19.3661	19.3764	19.3764	19.3783	19.3724	19.3661	19.3616	19.3570	(90)
Living area fraction									fLA = Living area / (4) =			0.1243	(91)
MIT	19.5526	19.5548	19.5570	19.5673	19.5693	19.5783	19.5783	19.5800	19.5748	19.5693	19.5654	19.5613	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.5526	19.5548	19.5570	19.5673	19.5693	19.5783	19.5783	19.5800	19.5748	19.5693	19.5654	19.5613	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9998	0.9996	0.9991	0.9968	0.9871	0.9386	0.7935	0.8489	0.9770	0.9978	0.9996	0.9999	(94)
Useful gains	861.8401	1004.3020	1099.9349	1231.7580	1298.0624	1231.7736	995.4377	987.2706	1048.2761	939.9280	856.2108	822.3722	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	6269.0324	6011.7807	5346.2226	4329.0170	3188.1581	2001.1573	1197.2023	1276.4079	2207.4185	3633.8128	5067.3560	6266.6668	(97)
Space heating kWh	4022.9511	3365.0257	3159.2381	2230.0265	1406.2312	0.0000	0.0000	0.0000	0.0000	2004.2503	3032.0246	4050.5551	(98a)
Space heating requirement - total per year (kWh/year)												23270.3025	
Solar heating kWh	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(98b)
Solar heating contribution - total per year (kWh/year)												0.0000	
Space heating kWh	4022.9511	3365.0257	3159.2381	2230.0265	1406.2312	0.0000	0.0000	0.0000	0.0000	2004.2503	3032.0246	4050.5551	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												23270.3025	
Space heating per m2											(98c) / (4) =	112.0704	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (201)
Fraction of space heat from main system(s) 1.0000 (202)
Efficiency of main space heating system 1 (in %) 386.6586 (206)
Efficiency of main space heating system 2 (in %) 0.0000 (207)
Efficiency of secondary/supplementary heating system, % 100.0000 (208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	4022.9511	3365.0257	3159.2381	2230.0265	1406.2312	0.0000	0.0000	0.0000	0.0000	2004.2503	3032.0246	4050.5551	(98)
Space heating efficiency (main heating system 1)	386.6586	386.6586	386.6586	386.6586	386.6586	0.0000	0.0000	0.0000	0.0000	386.6586	386.6586	386.6586	(210)
Space heating fuel (main heating system)	1040.4400	870.2833	817.0613	576.7430	363.6880	0.0000	0.0000	0.0000	0.0000	518.3514	784.1606	1047.5791	(211)
Space heating efficiency (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(212)
Space heating fuel (main heating system 2)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(213)
Space heating fuel (secondary)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement	61.2173	53.0402	55.0880	47.1419	44.4660	38.8871	38.2482	40.8993	42.4637	48.6374	53.0662	60.5217	(64)
Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month	61.2173	53.0402	55.0880	47.1419	44.4660	38.8871	38.2482	40.8993	42.4637	48.6374	53.0662	60.5217	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(231)
Lighting	46.6422	37.4181	33.6909	24.6834	19.0661	15.5772	17.3928	22.6078	29.3653	38.5288	43.5182	47.9385	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-42.1942	-65.6986	-103.5815	-125.7753	-139.5398	-112.7598	-111.4866	-102.5280	-87.2307	-77.5428	-48.1823	-35.8214	(233a)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234a)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235a)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235a)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235c)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235c)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(233b)
Electricity generated by wind turbines (Appendix M) (negative quantity)													
(234b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(234b)
Electricity generated by hydro-electric generators (Appendix M) (negative quantity)													
(235b)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235b)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)													
(235d)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(235d)

Annual totals kWh/year
Space heating fuel - main system 1 6018.3067 (211)
Space heating fuel - main system 2 0.0000 (213)
Space heating fuel - secondary 0.0000 (215)
Efficiency of water heater 100.0000
Water heating fuel used 583.6771 (219)
Space cooling fuel 0.0000 (221)

Electricity for pumps and fans:
Total electricity for the above, kWh/year 0.0000 (231)
Electricity for lighting (calculated in Appendix L) 376.4293 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV generation -1052.3411 (233)

Wind generation	0.0000	(234)
Hydro-electric generation (Appendix N)	0.0000	(235a)
Electricity generated - Micro CHP (Appendix N)	0.0000	(235)
Appendix Q - special features		
Energy saved or generated	-0.0000	(236)
Energy used	0.0000	(237)
Total delivered energy for all uses	6800.7094	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	6018.3067	0.1535	923.9879	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	583.6771	0.1416	82.6702	(264)
Energy for instantaneous electric shower(s)	874.6373	0.1391	121.6814	(264a)
Space and water heating			1006.6581	(265)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(267)
Energy for lighting	376.4293	0.1443	54.3304	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1052.3411	0.1343	-141.3342	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-141.3342	(269)
Total CO2, kg/year			1041.3356	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			5.0200	(273)

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

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	6018.3067	1.5684	9439.1587	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	583.6771	1.5238	889.3809	(278)
Energy for instantaneous electric shower(s)	874.6373	1.5143	1324.4932	(278a)
Space and water heating			10328.5396	(279)
Pumps, fans and electric keep-hot	0.0000	0.0000	0.0000	(281)
Energy for lighting	376.4293	1.5338	577.3799	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-1052.3411	1.4964	-1574.7030	
PV Unit electricity exported	0.0000	0.0000	0.0000	
Total			-1574.7030	(283)
Total Primary energy kWh/year			10655.7096	(286)
Dwelling Primary energy Rate (DPER)			51.3200	(287)

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