John Street, Cardiff

Energy Statement

Grainger Residential Limited

JSCX-ACM-XX-XX-RP-ZZ-040003

June 2025

Delivering a better world

Quality information

Prepared by	Checked by	Verified by	Approved by
RM Sustainability Consultant	LH Principal Sustainability Consultant	BS Regional Director	AF Project Director

Revision History

Revision	Revision date	Details	Authorized	Position
P01	06/06/2025	Draft Issue for approval	AF	Project Director
P02	13/06/2025	Issue for approval	AF	Project Director

Prepared for:

Grainger Residential Limited

Prepared by:

AECOM Limited

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1. Executive Summary

This Energy Statement has been prepared by AECOM on behalf of Grainger Residential Limited ("the Applicant") to support a full planning application relating to proposals for the residential-led, mixed-use development of the John Street site (hereafter the 'Proposed Development') located in Cardiff within the administrative authority of Cardiff Council.

The existing site is located in the town centre of Cardiff, bounded by John Street to the Southeast, Bute Street to the Southwest and railway tracks to the North and East.

The Proposed Development is a Build to Rent (BtR) residential and mixed-use scheme located in the heart of Cardiff. The project comprises two tower blocks, rising to 28 and 18 storeys respectively, connected by a six-storey link building. The development will feature a ground floor commercial unit, which will be leased by the landlord, alongside a variety of resident amenity spaces. These include a reception area, gym, co-working facilities, lounge, and bookable private function rooms located on the upper levels.

Externally, the scheme will offer a publicly accessible landscaped area at the front of the site, a private garden at ground level, and a rooftop garden situated above the link building, exclusively for residents. In addition to the main structure, the developer has secured a long-term lease for five arches within the adjacent railway viaduct. Of these, two arches will be sublet as commercial units, while the remaining three will serve as resident amenities, providing additional communal space and secure cycle storage.

1.1 Energy Strategy

The Proposed Development demonstrate **75.8% emissions saving and 53.9% Primary Energy saving** compared to the Part L1 2022 baseline.

All residential unit's modelled are predicted to achieve a **SAP rating of 81-B as a minimum**.

. Residential CO_2 Emissions Savings

	Regulated CO_2 Emissions (tCO_2/yr)	CO_2 Emissions Savings
Baseline (Part L 2022)	312.1	-
Proposed Development	75.5	**75.8%**

Table 1. Residential Primary Energy Savings

	Regulated Primary Energy (kWh/m²/yr)	Primary Energy Savings
Baseline (Part L 2022)	75.6	-
Proposed Development	34.9	**53.9%**

The Proposed Development follows national regulation and policy guidance and has adopted an energy hierarchy approach by implementing the measures outlined below:

<table>
<tr><td>Energy Reduction (Lean)</td><td colspan="4">

The building form is simple, reducing the floor area to building envelope ratio and therefore reducing the heating demand.
The glazing ratios have been designed to balance limiting the solar gains in the summer with beneficial gains in the winter months.

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<tr><td rowspan="10">Energy Efficiency (Lean)</td><td colspan="4">

Enhanced U-values for the building fabric.
Improved level of air tightness.
Good Practice Thermal Bridging
High efficiency lighting and ventilations systems including heat recovery.

The fabric and energy efficiency specification for the dwellings exceed Part L1 Notional Specification
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<tr><td>Element</td><td>Unit</td><td>Part L Notional Specification</td><td>Proposed Specification</td></tr>
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<tr><td>Windows g-value</td><td>-</td><td>0.63</td><td>0.40</td></tr>
<tr><td>Windows frame factor</td><td>-</td><td>0.70</td><td>0.70</td></tr>
<tr><td>Doors U-value</td><td>W/m²K</td><td>1.90</td><td>N/A</td></tr>
<tr><td>Air Permeability</td><td>m³/m²h@50Pa</td><td>3.00</td><td>2.50</td></tr>
<tr><td>Renewable Energy (Green)</td><td colspan="4">
The technical and financial feasibility was assessed for each option, and it was determined that a decentralised Hot Water Cylinder Air Source Heat Pumps combined with efficient electric space heating provided high carbon emission savings and had several other benefits over a communal system, including:

Removes the requirement for communal pipework and therefore the associated distribution losses and pumping energy.
Reduced overheating in corridors compared to a communal heating strategy.
Lower embodied carbon.
Provides an element of thermal storage in each dwelling.

</td></tr>
</table>

2. Introduction

2.1 Background

This Energy Statement has been prepared by AECOM on behalf of Grainger Residential Limited("the Applicant") to support a full planning application relating to proposals for the residential-led development of the John Street site (hereafter the 'Proposed Development') located in Cardiff within the administrative authority of Cardiff Council.

2.2 The Site

The existing site is located in the town centre of Cardiff, bounded by John Street to the Southeast, Bute Street to the Southwest and railway tracks to the North and East.

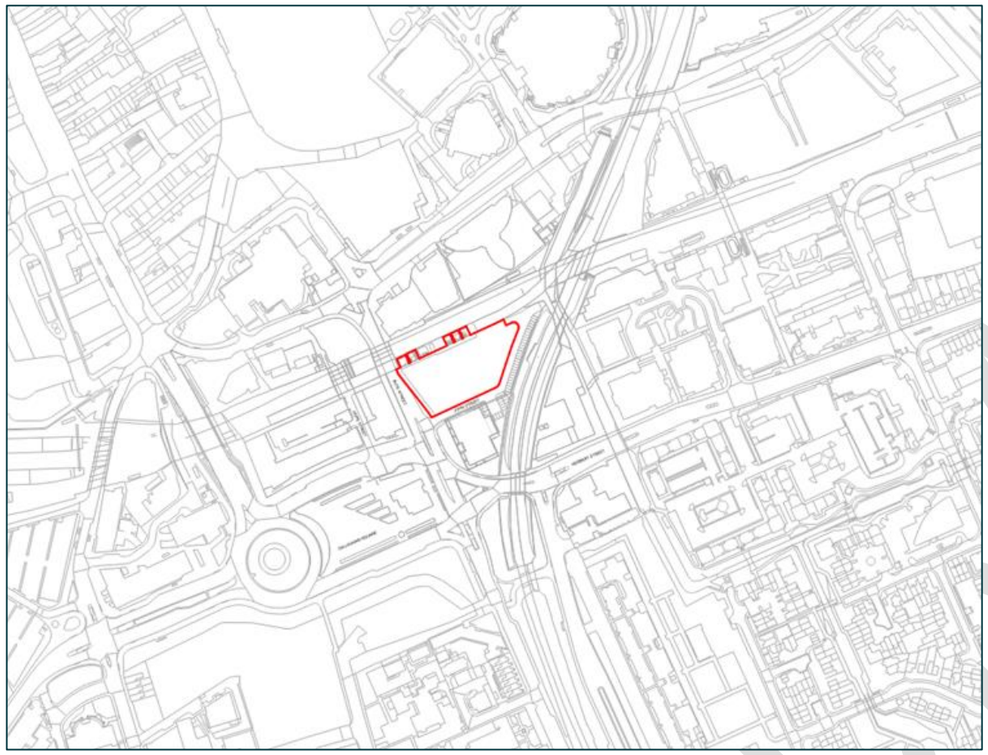


Figure 1 Site Location Plan (Credit: Chapman Taylor)

2.3 The Proposed Development

The Proposed Development is a Build to Rent (BtR) residential and mixed-use scheme located in the heart of Cardiff. The project comprises two tower blocks, rising to 28 and 18 storeys respectively, connected by a six-storey link building. The development will feature a ground floor commercial unit, which will be leased by the landlord, alongside a variety of resident amenity spaces. These include a reception area, gym, co-working facilities, lounge, and bookable private function rooms located on the upper levels. Externally, the scheme will offer a publicly accessible landscaped area at the front of the site, a private garden at ground level, and a rooftop garden situated above the link building, exclusively for residents. In addition to the main structure, the developer has secured a long-term lease for five arches within the adjacent railway viaduct. Of these, two arches will be sublet as commercial units, while the remaining three will serve as resident amenities, providing additional communal space and secure cycle storage.

2.4 The Energy Statement

AECOM has been commissioned by the Applicant to prepare this Energy Statement to accompany the planning application for the John Street development.

This Energy Statement sets out the proposed strategy for reducing the energy use of the Proposed Development and utilising low carbon and renewable energy sources. It also identifies how the scheme is aligned with the energy policies set out in the National and Local Planning Policies. The Overheating Modelling is provided as a separate report.

Figure 2 Typical Mid Floor Plan (Credit: Chapman Taylor)

3. Policy and Drivers

3.1 Introduction

The Energy Statement for the Proposed Development has been developed in response to international, national, regional and local policy drivers that aim to reduce carbon emissions from new development whilst protecting local air quality and indoor comfort for building occupiers. The main policies of relevance are summarised below.

Table 2. Main Policies of Relevance

Policy Level	Document Name
International Drivers	- The United Nations Framework Convention on Climate Change - European Energy Performance of Buildings (EPBD)
National Drivers	- UK Climate Act - Future Wales: the national plan 2040 - Energy White Paper - Net Zero Strategy and Heat and Buildings Strategy
Building Regulations	- Approved Document L 2022 - Approved Document O 2022
Regional Planning Policies	- Planning Policy Wales (2024) - Welsh Government Technical Advice Note (TAN) 12
Local Planning Policies	- Cardiff Local Development Plan (2006-2026) - Cardiff Planning Obligations SPG

3.2 Policy Review Summary

The key policy drivers and targets that have been identified as applicable to the Proposed Development within the adopted policy can be summarised as follows:

- Reduce energy demand through the energy hierarchy and 'fabric first' approach.
- Meet the target fabric performance by adopting the minimum energy efficiency standards for building fabric.
- Achieve a minimum SAP rating of 81.
- Follow the energy hierarchy used in national policy (TAN12):
    1. Energy Reduction
    2. Energy Efficiency
    3. Renewable Energy
    4. Minimise carbon impact of other energy generation
- Investigate the technical feasibility of incorporating Low or Zero Carbon (LZC) technologies and opportunities to minimise carbon emissions associated with heating, cooling and power systems beyond the standards set out in Building Regulation Part L.

3.3 International Drivers

The need to reduce the growth of greenhouse gas emissions is a key focus for the international political agenda. The **United Nations Framework Convention on Climate Change** is a main channel for international cooperation on climate change mitigation alongside related international agreements including the Kyoto Protocol, Paris Agreement and Glasgow Climate Pact.

The need to deliver highly energy efficient buildings is widely recognised, the European Energy Performance of Buildings Directive (EPBD) requires that all new buildings should be 'nearly zero-energy buildings.' Typically, EPBD requirements are met through transposition into national legislation. At present there is no official position on whether future requirements of the EPBD will be implemented now that the UK has left the EU.

3.4 National Drivers

In 2019, the UK parliament declared a 'Climate Emergency' becoming the first country to do so. A subsequent amendment was made to **the UK Climate Change Act** (Originally 2008, 2050 Target Amendment Order (2019)), which legally commits the UK government to reducing greenhouse gas emissions by 100% by the year 2050, compared with a 1990 baseline.

The Future Wales: the National Plan 2040 outlines the framework for the development in Wales to 2040. It is a strategic plan for addressing key national priorities through the planning system, aiming to develop a vibrant economy, decarbonise, and enhance climate resilience. The document outlines a framework for local plan development and illustrates national-scale policy objectives.
Building Regulations Part L 2022

Approved Document L (ADL) of the Building Regulations in Wales is the key mechanism that prescribes standards for the energy performance of new and the refurbishment of existing buildings in Wales.

As of 23rd November 2022, ADL edition 2022 came into effect, with further amendments made in 2024, and is the version with which development must comply at the time of writing. The Applicant is aware of emerging future regulations and will continue to appraise proposed changes and transitional arrangements.

Building Regulations requires residential areas of buildings to the assessed under Volume 1 of ADL, and non-residential area of buildings to be assessed under Volume 2 of ADL.

ADL 2022 assesses dwellings/buildings against the following key compliance metrics, for which the dwelling/building rated must not exceed the target rates:

- CO2 Emission Rate
- Primary Energy Rate
- Target Fabric Performance (dwellings only)
- Minimum Energy Efficiency Rating (dwellings only)

The CO2 emission and primary energy rate are evaluated by comparing the actual building/dwelling with a notional building/dwelling with the same size and shape as the actual but with standardised fabric and services.

The target fabric performance is met by adopting the minimum energy efficiency standards for building fabric shown in the table below.

Table 3 maximum u-values for new buildings, Building Regulations Part L

Element	Unit	ADL1 2022 Maximum U-values in new dwellings	ADL2 2022 Maximum U-values in new buildings
External Wall – Flats U-value	W/m^2K	0.21	0.26
Party wall	W/m^2K	0.20	-
Floor U-value	W/m^2K	0.15	0.22
Roof U-value	W/m^2K	0.13	0.2
Windows U-value	W/m^2K	1.4	1.6
Door	W/m^2K	1.4	1.8

The minimum energy efficiency rating can be met by achieving a minimum SAP rating of 81.

3.4.1 Welsh Government Technical Advice Note (TAN) 12

The purpose of TAN 12[1] is to instruct all those involved in the design of developments about sustainability through good design, aspiring that in the future all new buildings achieve a zero carbon and nearly zero energy standard for regulated emissions. An energy hierarchy is promoted to prioritise design solutions aiming at reducing the energy demand and address the design development to reduce the carbon emissions.

3.4.2 Planning Policy Wales (2024)

The Welsh Government planning policy[2] uses the energy hierarchy to achieve mitigation against climate change in planning policies. Buildings are asked to be very highly energy efficient, support decarbonisation, incorporate adaptation measures to climate change while tackling its causes. All those aspects play part simultaneously in meeting the decarbonisation and renewable energy targets. Consequently, developers are asked to take into account future requirements for carbon reduction in buildings as result of changes to Building Regulation in Wales.

3.5 Local Planning Policies

3.5.1 Cardiff Local Development Plan (2006-2026)

The Cardiff Local Development Plan[3] contains the framework of local planning policy shaping one of the fastest growing cities in the UK making provisions for new homes and jobs. The site falls into one of the key strategic sites, the Cardiff Central Enterprise Zone providing an opportunity to provide accommodation capable of satisfying the high housing demand while accomplishing sustainable development strategies responding to the climate change. The key relevant policies are outlined below:

KP5: Good Quality and Sustainable Design

- All new development is required to be of high quality, sustainable design whilst also maximising renewable energy solutions.

KP6: New Infrastructure

- Ensure that new developments make appropriate provision for infrastructure. District heating and sustainable energy infrastructure.

KP15: Green Infrastructure

- All sustainable developments should take into account the KP15 policy which aims at:
  - Reducing carbon emissions;
  - Adapting to the implications of climate change at both a strategic and detailed design level;
  - Promoting energy efficiency and increasing the supply renewable energy; and
- A reduction in carbon emissions should be achieved in the first instance through controlling the energy demand associated with the development through maximising energy efficiency of the development. Secondly, sustainable sources of energy should be incorporated, without reliance on fossil fuels.
- The development should be designed to be flexible not only to climatic change, including increased temperature ranges, but also to accommodate a variety of uses over its lifetime.
- The development is also required to have high standards of energy efficiency

EN12: Renewable Energy and Low Carbon Technologies

- Submit an independent energy assessment investigating the technical feasibility of utilising renewable and low carbon technologies in major developments, as outlined in the SPG.
- Follow the energy hierarchy used in national policy (TAN12). The policy also refers to the Cardiff Planning Obligations SPG for further specifications.

3.5.2 Cardiff Planning Obligations SPG

The Cardiff Planning Obligations SPG[4] provides additional information to supplement the Cardiff Local Development Plan. Policy 14 of the document targets major developments:

Table 4 Development Specific Type Provision/Mitigation Sought

Development Type	Provision / Mitigation Sought
LDP-Strategic Sites	▪ To provide a Renewable Energy Assessment and propose an associated scheme of mitigation measures.
Developments containing 100 or more dwellings	
Commercial developments of 1000sqm or more	

Developments containing 100 or more dwellings are required "*to prepare an Independent Energy Assessment which investigates the technical feasibility and financial viability of incorporating Low or Zero Carbon (LZC) technologies and opportunities to minimise carbon emissions associated with heating, cooling and power systems beyond the standards set out in Building Regulation Part L".* Consistent with the Technical Advice Note 12, the principles of the energy hierarchy to reduce energy demand and carbon emissions is to be followed:

- ***Energy Reduction*** *– Reduce the amount of energy used ('smart' heating and lighting, behavioural changes), use of passive design measures.*
- ***Energy Efficiency*** *– Using energy efficient systems (better insulation, efficient appliances and lighting).*
- ***Renewable Energy*** *– Generate heat and electricity from renewable sources (solar PV and thermal, wind, biomass, hydro, geothermal).*
- ***Minimise carbon impact of other energy generation*** *– Using low carbon technologies to reduce residual CO2 emissions (heat pumps, CHP and CCHP systems)*

The energy assessment should contain a non-technical executive summary detailing:

- *Carbon footprint: Anticipated total energy demand / carbon dioxide emissions associated with the development (both regulated and unregulated loads should be identified),*
- *Assessment of options to reduce energy demand and emissions at each stage of the energy hierarchy*
- *Measures of mitigation and proposed CO2 reductions at each stage of the energy hierarchy, expressed in relation to compliance with Part L of the Building Regulations as the benchmark*

[1] 27918 TAN 12 (gov.wales)
[2] https://www.gov.wales/sites/default/files/publications/2024-07/planning-policy-wales-edition-12.pdf
[3] https://www.cardiffldp.co.uk/wp-content/uploads/Final-Adopted-Local-Development-Plan-English.pdf
[4] Planning Obligations SPG - Edition 1A (26th January 2017) (cardiff.gov.uk)

4. Approach to Energy

4.1 Introduction

The Proposed Development will be evaluated under Welsh Part L Volume 1 (L1) 2022 as per Building Regulation requirements. Part L1 will be used to model the residential areas. The non-domestic areas make up a smaller component of the overall scheme and associated carbon emissions of the scheme and due to end uses being unknown at this stage the spaces have yet to undergo energy modelling, but this will be undertaken at the next stage of design as the uses of these spaces becomes clearer.

The drawings used for the modelling, created by Chapman Taylor, were issued in the design freeze with drawings dated 9th May 2025 for the GA plans, elevations and sections.

The use type for the Proposed Development under this application is as follows:

- 417 units of residential accommodation

4.2 The Energy Hierarchy

The energy hierarchy is a widely adopted method to identify opportunities to reduce energy demand and decrease the related carbon dioxide (CO_2) emissions. The Energy Strategy has been developed using a 'fabric first' approach through the energy hierarchy to reduce energy use through passive design measures in the first instance, before seeking opportunities to deliver energy efficiently and increase the provision of low and zero carbon technologies.

4.3 Energy Modelling

4.3.1 Residential SAP Modelling

The Elmhurst Design SAP 10 software was used to model the energy demands of a representative sample of dwellings against Part L 2022.

The modelling exercise provided the Target Emission Rate (TER) for each sample unit modelled as well as the projected demands for heating and hot water.

The representative sample models include 41 units. Results have been applied with a multiplier ratio, to ensure the entire development is represented within the results.

Design SAP 10 model Dwelling Emission Rate (DER) and TER outputs example worksheets are provided in Appendix B.

The emissions for representative sample units have been used to calculate the overall baseline Part L 2022 regulated carbon emissions for all the dwellings on the site.

5. Energy Reduction and Energy Efficiency (Lean)

Passive design measures form the basis for the reduction in overall energy demand and carbon emissions for the Application. This Energy Strategy aims to reduce the energy demand initially by optimising the building form and glazing design.

5.1 Passive Design Features

The following passive design measures are proposed to reduce the need for energy:

- The building form is simple, reducing the floor area to building envelope ratio and therefore reducing the heating demand.
- The glazing ratios have been designed to balance limiting the solar gains in the summer with gaining beneficial gains in the winter months.

5.2 Fabric and Energy Efficiency Approach

Consideration has been given to passive design, fabric, and services of the building, including the following key measures:

- Enhanced U-values for the building fabric.
- Improved levels of air tightness.
- Good Practice Thermal Bridging
- High efficiency lighting and ventilations systems including heat recovery.

Table 5 shows the proposed fabric and energy efficiency specification and Table 6 shows the good practice psi-values used for the dwellings, all of which will undergo further refinements as the design progresses at later RIBA stages.

Table 5. Fabric and energy efficiency specification for the dwellings

Element	Unit	Part L Notional Specification	Proposed Specification
External Wall U-value	W/m^2K	0.18	0.15 (External Wall) 0.18 (Sheltered Wall)
Wall to Corridor/Core U-value	W/m^2K	0.18	0.25 (Core and Riser Walls)
Floor U-value	W/m^2K	0.13	0.12
Roof U-value	W/m^2K	0.11	0.10
Windows U-value	W/m^2K	1.20	1.20
Windows g-value	-	0.63	0.40
Windows frame factor	-	0.70	0.70
Doors U-value	W/m^2K	1.90	N/A
Air Permeability	$m^3/m^2h@50Pa$	3.00	2.50

Table 6. Psi-values for the dwellings

Junction Reference	SAP Description	Good Practice Psi-Values*
Junctions with External Wall		
E2	Other lintels (including other steel lintels)	0.03
E3	Sill	0.03
E4	Jamb	0.04
E5	Ground floor (normal)	0.18
E20	Exposed floor (normal)	0.16 0.23 (Corridor) 0.227 (Core and Riser) 0.301 (Sheltered Wall)
E21	Exposed floor (inverted)	0.32
E6	Intermediate floor within a dwelling	0.14
E7	Party floor between dwellings (block of flats)	0.05 0.199 (Core and Riser) 0.263 (Sheltered Wall)
E14	Flat roof	0.125
E15	Flat roof with parapet	0.15
E24	Eaves (Inverted)	0.15
E16	Corner (normal)	0.10
E17	Corner (inverted)	-0.07
E18	Party wall between dwellings	0.05
E25	Staggered party wall between dwellings (corner)	0.05
Junctions with Party Wall		
P3	Intermediate floor between dwellings (block of flats)	0.00
P4	Roof (insulation at ceiling level)	0.03
P7	Exposed floor (normal)	0.04

*Any psi-values not listed have been modelled as default.

5.2.1 Energy Efficiency Proposals

Energy efficiency has also been imbedded into the design of the Proposed Development through the following measures:

- All dwellings are proposed to incorporate highly efficient mechanical ventilation systems with heat recovery (MVHR) to provide sufficient background air change rates. During the heating season, the MVHR will reduce space heating demand by recovering heat from the background ventilation exhaust air.
- 100% low energy fixed lighting is proposed for use within the dwellings.
- The Proposed Development will also look to ensure the provision or purchase of energy efficient white goods where these are to be supplied by the developer.

6. Renewable Energy (Green)

This section assesses the opportunities for reducing carbon emissions using renewable energy technologies.

6.1 Options Appraisal

The following options for delivering renewable energy generation on-site at the Proposed Development were considered:

- Heat Pumps
- Biomass
- Photovoltaics
- Solar Water Heating
- Wind Turbines

6.1.1 Heat Pumps

A heat pump works by extracting heat from an external (or internal) source (air, ground and water) and transferring it to the heating system of the building using electricity and a refrigerant. Heat pumps are more efficient than other heating systems because the amount of heat they produce is more than the amount of electricity they use. The efficiency of heat pumps can reduce carbon emissions in comparison to traditional gas boilers and further carbon savings could be made as the national grid decarbonises.

Decentralised and Centralised Heat Pumps were considered for the development. The technical and financial feasibility was assessed for several options, and it was determined that a decentralised Hot Water Cylinder Air Source Heat Pumps combined with efficient electric space heating provided very good carbon emission savings and had several other benefits over a communal system, including:

- Removes the requirement for communal pipework and therefore the associated distribution losses and pumping energy.
- Reduced overheating in corridors compared to a communal heating strategy.
- Lower embodied carbon
- Provides an element of thermal storage in each dwelling.

The hot water cylinder heat pump consists of a ducted system to supply external air to an air source heat pump mounted on a water cylinder. The heat pump collects energy from the air and converts this into heat, which is transferred to the cylinder to create hot water efficiently.

The hot water heat pump cylinder will be complemented by direct electric heating to provide space heating which has been reduced through efficient fabric as outlined in the earlier sections. The electric heating system will be suitably sized for the dwelling and will consider suitable systems such as infrared radiant heaters, modern High Heat Retention Storage Heaters and smart electric panels. Technological advancements in electrical heating, including Artificial Intelligence (AI), is changing home heating by introducing smarter, more efficient systems. These systems can learn a household's heating preferences and automatically adjust settings and results in enhanced comfort and energy savings. The use of smart heating devices and thermostats will be considered during detailed design.

6.1.2 Biomass

Biomass is a renewable energy source, generated from burning wood, plants and other organic matter. It releases CO_2 when burned but considerably less than fossil fuels.

The development should minimise the local emissions generated by the development to not negatively impact on the local air quality. Biomass heat relies on the combustion of organic material resulting in high levels of emissions containing particulate matter (PM), nitrogen oxides (NOx), carbon monoxide (CO), sulphur dioxide (SO_2), and other hazardous air pollutants (HAPs). Therefore, biomass will not be considered further.

6.1.3 Photovoltaics (PV)

PV panels harness energy from sunlight and convert this into useful energy in the form of electricity. A PV system requires viable roof space for the system array to be installed and function effectively. PV panels are relatively straightforward to install and can be placed on available roof space that is not shaded.

The development has three rooftops, tower A, tower B and a link block. The link block roof will provide an outdoor landscaping area. Due to the high-rise nature of the development, the remaining two roofs are only a small portion of the development floor area and as a result will house plant and other specialist rooftop equipment.

Due to a lack of viable roof space, PV panels are not proposed at this stage.

6.1.4 Solar Water Heating

Solar thermal technology converts solar energy into thermal energy that can offset the demand on hot water generation systems.

As outlined above, the remaining roof space is limited which would result in limit hot water generation. On this basis, solar thermal panels are not proposed.

6.1.5 Wind Turbines

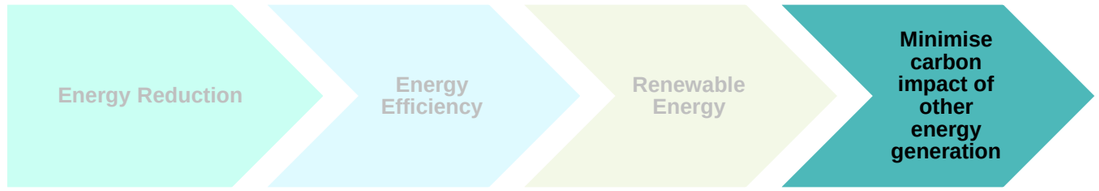
Wind power is the use of wind turbines to generate electricity. Kinetic energy created by air in motion is transformed into electrical energy using wind turbines or wind energy conversion systems.

Based on the impact of wind energy generation to residents in the surrounding area and the relatively low and disrupted wind speeds typically found in built-up areas, wind power will not be considered further.

6.2 ‘Be Green’ Strategy

The final proposed heating and hot water energy strategy for the development is to use a decentralised approach. Each residential unit will incorporate a compact hot water heat pump cylinder to provide domestic hot water and electric panel heaters to provide space heating.

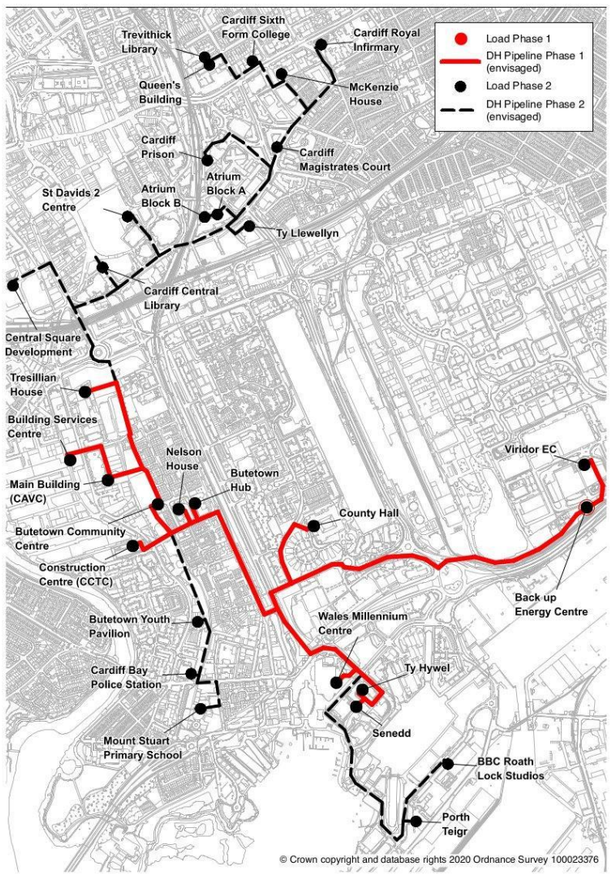
Minimise carbon impact other than generation



The potential to connect to the proposed low-carbon district heat network in Cardiff has been assessed. We understand Phase 1 of the network is nearing completion and a connection to Phase 1 would require an extension of approximately 350m making the connection economically unviable in isolation, given the relatively low heat demand of the building.

Phase 2 of the heat network is expected to run beneath the railway line at St Mary Street and then parallel to the railway line along Custom House Street, the opportunity to connect along Callaghan Square or Bute Street would reduce extension to the network to around 100m of additional pipework, which is still considered not to be economically viable in isolation, given the relatively low heat demand of the building.

For this reason, low carbon technologies are proposed for the development in the form of decentralised hot water cylinder air heat pumps in each apartment.



7. Results

Table 7 & 8 outlines the CO_2 emissions and Primary Energy and resulting savings for the Proposed Development against a Part L 2022 baseline.

The results demonstrate **75.8% emissions, and 53.9% Primary Energy saving** compared to the baseline.

In addition, all modelled units are predicting a **SAP rating of 81-B as a minimum**.

Table 7. Residential CO_2 Emissions Savings

	Regulated CO_2 Emissions (tCO_2/yr)	CO_2 Emissions Savings
Baseline (Part L 2022)	312.1	-
Proposed Development	75.5	75.8%

Table 8. Residential Primary Energy Savings

	Regulated Primary Energy ($kWh/m^2/yr$)	Primary Energy Savings
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8. Conclusion

The Proposed Development demonstrate **75.8% emissions saving and 53.9% Primary Energy saving** compared to the Part L1 2022 baseline and all residential unit's modelled are predicted to achieve a **SAP rating of 81-B as a minimum**.

The Proposed Development follows national regulation and policy guidance and has adopted an energy hierarchy approach by implementing the measures outlined below:

Energy Reduction (Lean)

- The building form is simple, reducing the floor area to building envelope ratio and therefore reducing the heating demand.
- The glazing ratios have been designed to balance limiting the solar gains in the summer with beneficial gains in the winter months.

Energy Efficiency (Lean)

- Enhanced U-values for the building fabric.
- Improved level of air tightness.
- Good Practice Thermal Bridging
- High efficiency lighting and ventilations systems including heat recovery.

The fabric and energy efficiency specification for the dwellings exceed Part L1 Notional Specification

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Windows U-value	W/m^{2}K	1.20	1.20
Windows g-value	-	0.63	0.40
Windows frame factor	-	0.70	0.70
Doors U-value	W/m^{2}K	1.90	N/A
Air Permeability	m^3/m^{2}h@50Pa	3.00	2.50

Renewable Energy (Green)

The technical and financial feasibility was assessed for each option, and it was determined that a decentralised Hot Water Cylinder Air Source Heat Pumps combined with efficient electric space heating provided high carbon emission savings and had several other benefits over a communal system, including:

- Removes the requirement for communal pipework and therefore the associated distribution losses and pumping energy.
- Reduced overheating in corridors compared to a communal heating strategy.
- Lower embodied carbon.
- Provides an element of thermal storage in each dwelling.

Appendix A Full Sample Results Table

Sample Unit	Type	Total Floor Area (m^2)	Multiplier	Total Floor Area (m^2)	DER	TER	% DER < TER	DPER	TPER	% DPER < TPER	SAP Rating
01 1Bed Exp	Exposed	49.19	2	98.38	6.01	18.6	67.69%	62.41	102.3	39.00%	81
02 Studio Exp	Exposed	39.9	5	199.5	3.91	16.9	76.86%	41.09	91.44	55.06%	89
03 Studio Exp	Exposed	39.9	10	399	3.69	16.32	77.39%	38.84	88.29	56.01%	89
04 2Bed Exp	Exposed	67.36	2	134.72	4.43	14.74	69.95%	46.1	80.67	42.85%	84
05 1Bed Exp	Exposed	50.62	4	202.48	4.35	16.18	73.11%	45.39	88.89	48.94%	86
06 2Bed Exp	Exposed	67.66	1	67.66	4.68	15.22	69.25%	48.61	83.27	41.62%	83
07 1Bed Exp	Exposed	51.4	3	154.2	4.23	15.92	73.43%	44.21	87.92	49.72%	86
08 2Bed Mid	Mid	67.18	24	1612.32	3.27	12.74	74.33%	34.22	70.39	51.39%	88
09 Studio Mid	Mid	39.67	25	991.75	2.76	15.03	81.64%	29.43	83.58	64.79%	92
10 Studio Mid	Mid	39.67	25	991.75	3.67	16.25	77.42%	38.63	90.18	57.16%	89
11 2Bed Mid	Mid	73.97	25	1849.25	3.55	12.72	72.09%	36.99	70.18	47.29%	87
12 2Bed Mid	Mid	67.46	24	1619.04	3.13	12.38	74.72%	32.76	68.43	52.13%	89
13 1Bed Mid	Mid	47.24	3	141.72	3.56	14.05	74.66%	37.34	75.72	50.69%	89
14 Studio Mid	Mid	39.9	3	119.7	2.75	14.13	80.54%	29.33	76.52	61.67%	92
15 1Bed Mid	Mid	47.24	3	141.72	2.76	13.05	78.85%	29.31	70.37	58.35%	91
16 Studio Mid	Mid	39.72	3	119.16	2.76	14.17	80.52%	29.39	76.74	61.70%	92
17 Studio Mid	Mid	38.89	3	116.67	4.48	16.72	73.21%	46.9	90.38	48.11%	87
18 Studio Mid	Mid	44.66	3	133.98	2.88	13.26	78.28%	30.57	71.7	57.36%	91
19 Studio Mid	Mid	39.72	3	119.16	2.64	13.63	80.63%	28.23	73.81	61.75%	92
20 1Bed Mid	Mid	47.24	3	141.72	2.58	12.37	79.14%	27.42	66.71	58.90%	92
21 Studio Mid	Mid	39.72	3	119.16	2.72	13.78	80.26%	28.99	74.62	61.15%	92
22 Studio Mid	Mid	38.84	3	116.52	3.13	14.52	78.44%	33.2	78.66	57.79%	91
23 2Bed Mid	Mid	66.59	19	1265.21	3.07	12.28	75.00%	32.2	67.52	52.31%	89
24 3Bed Mid	Mid	80.5	15	1207.5	3.6	12.48	71.15%	37.44	68.3	45.18%	86
25 2Bed Mid	Mid	67.66	18	1217.88	3.42	12.95	73.59%	35.71	71.08	49.76%	88
26 1Bed Mid	Mid	47.15	15	707.25	2.7	13.5	80.00%	28.69	74.54	61.51%	91
27 1Bed Mid	Mid	50.62	15	759.3	3.13	13.68	77.12%	32.94	75.44	56.34%	90
28 1Bed Mid	Mid	47.22	15	708.3	2.82	13.67	79.37%	29.88	75.43	60.39%	91
29 2Bed Mid	Mid	67.36	18	1212.48	3.25	12.49	73.98%	33.95	68.56	50.48%	88
30 1Bed Mid	Mid	47.42	25	1185.5	2.63	13.28	80.20%	27.96	73.77	62.10%	91
31 1Bed Mid	Mid	51.4	24	1233.6	3	13.37	77.56%	31.66	74.16	57.31%	90
32 1Bed Mid	Mid	46.86	24	1124.64	2.64	13.41	80.31%	28.09	74.49	62.29%	91
33 1Bed Mid	Mid	49.19	24	1180.56	4.19	15.78	73.45%	43.75	87.1	49.77%	87
34 3Bed Top	Top	80.5	2	161	4.59	14.96	69.32%	47.65	81.68	41.66%	82
35 2Bed Top	Top	67.66	2	135.32	4.51	15.69	71.26%	46.9	85.8	45.34%	83
36 1Bed Top	Top	50.62	4	202.48	4.05	16.1	74.84%	42.38	88.46	52.09%	87
37 1Bed Top	Top	51.4	1	51.4	3.92	15.77	75.14%	40.97	87.07	52.95%	87
38 1Bed Top	Top	46.86	2	93.72	3.44	15.71	78.10%	36.19	86.89	58.35%	89
39 Studio Top	Top	39.67	4	158.68	3.71	17.86	79.23%	39.04	98.82	60.49%	89
40 2Bed Top	Top	67.49	5	337.45	5.04	16.22	68.93%	52.34	89.1	41.26%	81
41 Studio Top	Top	39.72	5	198.6	3.66	16.96	78.42%	38.54	91.73	57.99%	89
			Area Weighted:	**22730.43**	**3.32**	**13.73**	**75.82%**	**34.85**	**75.64**	**53.92%**	**88.69**

Appendix B SAP Worksheets

B.1 Sample TER and DER Worksheets

Full SAP Calculation Printout

elmhurst energy

Property Reference	01 1Bed Exp	Issued on Date	04/06/2025
Assessment Reference	01 1Bed Exp	Prop Type Ref	1B2P
Property			

SAP Rating	81 B	DER	6.01	TER	18.60
Environmental	96 A	% DER < TER			67.69
CO_2 Emissions (t/year)	0.28	DPER	62.41	TPER	102.31
Compliance Check	See BRWL	% DPER < TPER			39.00

Assessor Details	Mr. Liam Holden	Assessor ID	P624-0001
Client			

SAP 10 WORKSHEET FOR New Build (As Designed) (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)	
Main dwelling						
Ground floor	49.1900 (1b)	x	2.5000 (2b)	=	122.9750 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	49.1900				(4)	
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	122.9750 (5)	

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2. Ventilation rate

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m3 per hour

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

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000 (8)
Pressure test		Yes
Pressure Test Method		Blower Door
Measured/design AP50		2.5000 (17)
Infiltration rate		0.1250 (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) =	0.1062 (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													
	0.1355	0.1328	0.1302	0.1169	0.1142	0.1009	0.1009	0.0983	0.1062	0.1142	0.1195	0.1248	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation	0.5000 (23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a)	0.5000 (23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	80.1000 (23c)

Effective ac	0.2350	0.2323	0.2297	0.2164	0.2137	0.2004	0.2004	0.1978	0.2057	0.2137	0.2190	0.2243	(25)

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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	
Main dwelling								
Window			10.6100	1.1450	12.1489			(27)
Exposed			49.1900	0.1165	5.7309	0.0000	0.0000	(28b)
External Wall	39.8800	10.6100	29.2700	0.1500	4.3905	14.0000	409.7800	(29a)
Sheltered Wall	10.6200		10.6200	0.1700	1.8054	9.0000	95.5800	(29a)
Core and Riser	4.7900		4.7900	0.1500	0.7185	9.0000	43.1100	(29a)
Total net area of external elements Aum(A, m2)			104.4800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	24.7941			(33)
Main dwelling								
Party Wall			20.5700	0.0000	0.0000	20.0000	411.4000	(32)
Corridor			3.6600	0.0000	0.0000	20.0000	73.2000	(32)
Party Ceiling 1			49.1900			30.0000	1475.7000	(32b)
Internal Wall 1			99.9500			9.0000	899.5500	(32c)
Heat capacity Cm = Sum(A x k)					(28)...(30) + (32) + (32a)...(32e) =		3408.3200	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							69.2889	(35)

List of Thermal Bridges

	Length	Psi-value	Total	
K1 Element				
E2 Other lintels (including other steel lintels)	5.5000	0.0300	0.1650	
E4 Jamb	18.3600	0.0400	0.7344	
E7 Party floor between dwellings (in blocks of flats)	14.5000	0.0500	0.7250	
E7 Party floor between dwellings (in blocks of flats)	0.0000	0.0000	0.0000	
E7 Party floor between dwellings (in blocks of flats)	1.7400	0.1990	0.3463	
E16 Corner (normal)	8.2500	0.1000	0.8250	
E17 Corner (inverted - internal area greater than external area)	2.7500	-0.0700	-0.1925	
E18 Party wall between dwellings	5.5000	0.0500	0.2750	
E25 Staggered party wall between dwellings	0.0000	0.0500	0.0000	
P3 Party wall - Intermediate floor between dwellings (in blocks of flats)	8.8100	0.0000	0.0000	
E20 Exposed floor (normal)	14.5000	0.1200	1.7400	
E20 Exposed floor (normal)	0.0000	0.0000	0.0000	
E20 Exposed floor (normal)	1.7400	0.2270	0.3950	
E20 Exposed floor (normal)	3.8600	0.3010	1.1619	
E7 Party floor between dwellings (in blocks of flats)	3.8600	0.2630	1.0152	
P7 Party Wall - Exposed floor (normal)	8.8100	0.0400	0.3524	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)				7.5426 (36)
Point Thermal bridges			(36a) =	3.2600 (36a)
Total fabric heat loss			(33) + (36) + (36a) =	35.5967 (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	9.5354	9.4276	9.3199	8.7809	8.6731	8.1341	8.1341	8.0263	8.3497	8.6731	8.8887	9.1043	(38)
Heat transfer coeff													
	45.1322	45.0244	44.9166	44.3776	44.2698	43.7308	43.7308	43.6230	43.9464	44.2698	44.4854	44.7010	(39)
Average = Sum(39)m / 12 =												44.3506	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9175	0.9153	0.9131	0.9022	0.9000	0.8890	0.8890	0.8868	0.8934	0.9000	0.9044	0.9087	(40)
HLP (average)												0.9016	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy												1.6663	(42)
Hot water usage for mixer showers	50.8398	50.0614	48.9143	47.1497	45.5687	43.3568	41.6074	43.6526	44.6812	46.8720	49.1535	50.7939	(42a)
Hot water usage for baths	22.0499	21.7171	21.2435	20.5344	19.8953	19.0155	18.3481	19.1643	19.5926	20.4643	21.3707	22.0324	(42b)
Hot water usage for other uses	31.6944	30.5418	29.3893	28.2368	27.0843	25.9318	25.9318	27.0843	28.2368	29.3893	30.5418	31.6944	(42c)
Average daily hot water use (litres/day)												96.1289	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	104.5840	102.3203	99.5472	95.9209	92.5483	88.3041	85.8872	89.9011	92.5106	96.7256	101.0660	104.5207	(44)
Energy conte	153.9658	135.3905	142.2509	125.2967	119.2578	102.1208	94.9079	105.8153	107.3077	124.6408	136.5940	153.4963	(45)
Energy content (annual)											Total = Sum(45)m =	1501.0445	
Distribution loss (46)m = 0.15 x (45)m													
	23.0949	20.3086	21.3376	18.7945	17.8887	15.3181	14.2362	15.8723	16.0962	18.6961	20.4891	23.0245	(46)
Water storage loss:													
Store volume												201.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.6100	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.8694	(55)
Total storage loss													
	26.9514	24.3432	26.9514	26.0820	26.9514	26.0820	26.9514	26.9514	26.0820	26.9514	26.0820	26.9514	(56)
If cylinder contains dedicated solar storage													
	26.9514	24.3432	26.9514	26.0820	26.9514	26.0820	26.9514	26.9514	26.0820	26.9514	26.0820	26.9514	(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													
	180.9172	159.7337	169.2023	151.3787	146.2092	128.2028	121.8593	132.7667	133.3897	151.5922	162.6760	180.4477	(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													
	180.9172	159.7337	169.2023	151.3787	146.2092	128.2028	121.8593	132.7667	133.3897	151.5922	162.6760	180.4477	(64)
											Total per year (kWh/year) = Sum(64)m =	1818.3755	(64)
12Total per year (kWh/year)												1818	(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													
	51.1936	45.0173	47.2984	41.6612	39.6532	33.9552	31.5569	35.1836	35.6798	41.4431	45.4175	51.0375	(65)

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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	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	74.2389	82.1931	74.2389	76.7135	74.2389	76.7135	74.2389	74.2389	76.7135	74.2389	76.7135	74.2389	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	145.1303	146.6363	142.8413	134.7620	124.5634	114.9782	108.5746	107.0686	110.8637	118.9429	129.1415	138.7268	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	(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)													
	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	(71)
Water heating gains (Table 5)													
	68.8086	66.9901	63.5731	57.8627	53.2973	47.1599	42.4152	47.2898	49.5553	55.7030	63.0799	68.5988	(72)
Total internal gains													
	336.1721	343.8137	328.6475	317.3325	300.0939	286.8458	273.2229	276.5915	285.1267	296.8791	316.9292	329.5587	(73)

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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

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Northeast				5.5500	11.2829	0.4000	0.7000	0.7700				12.1508	(75)
Northwest				5.0600	11.2829	0.4000	0.7000	0.7700				11.0781	(81)
Solar gains	23.2289	47.2831	85.1892	139.9051	188.0599	200.4917	187.5559	149.5218	103.8043	57.7837	29.2280	18.9699	(83)
Total gains	359.4010	391.0968	413.8367	457.2376	488.1538	487.3376	460.7788	426.1132	388.9311	354.6628	346.1572	348.5286	(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	20.9774	21.0276	21.0781	21.3341	21.3860	21.6496	21.6496	21.7031	21.5434	21.3860	21.2824	21.1798	
alpha	2.3985	2.4018	2.4052	2.4223	2.4257	2.4433	2.4433	2.4469	2.4362	2.4257	2.4188	2.4120	
util living area	0.9037	0.8808	0.8443	0.7622	0.6457	0.5003	0.3873	0.4283	0.6167	0.7936	0.8745	0.9093	(86)
MIT	18.5798	18.8513	19.2930	19.9289	20.4510	20.7937	20.9202	20.8960	20.6382	19.9819	19.2080	18.5406	(87)
Th 2	20.1526	20.1545	20.1564	20.1657	20.1675	20.1768	20.1768	20.1787	20.1731	20.1675	20.1638	20.1601	(88)
util rest of house	0.8944	0.8694	0.8290	0.7387	0.6101	0.4497	0.3231	0.3627	0.5677	0.7679	0.8609	0.9005	(89)
MIT 2	17.2997	17.6410	18.1949	18.9828	19.6053	19.9954	20.1214	20.1032	19.8355	19.0636	18.1008	17.2549	(90)
Living area fraction									fLA = Living area / (4) =			0.6424	(91)
MIT	18.1220	18.4185	18.9003	19.5906	20.1486	20.5082	20.6345	20.6125	20.3512	19.6535	18.8121	18.0808	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.1220	18.4185	18.9003	19.5906	20.1486	20.5082	20.6345	20.6125	20.3512	19.6535	18.8121	18.0808	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.8666	0.8412	0.8023	0.7207	0.6093	0.4706	0.3594	0.3981	0.5788	0.7500	0.8342	0.8732	(94)
Useful gains	311.4497	328.9818	332.0330	329.5476	297.4263	229.3529	165.6056	169.6348	225.1098	265.9993	288.7656	304.3521	(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	623.8180	608.6604	556.9793	474.4228	374.0162	258.3707	176.4329	183.7602	274.7169	400.7987	521.0167	620.4860	(97)
Space heating kWh	232.4020	187.9441	167.3600	104.3101	56.9828	0.0000	0.0000	0.0000	0.0000	100.2907	167.2208	235.2036	(98a)
Space heating requirement - total per year (kWh/year)												1251.7142	
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	232.4020	187.9441	167.3600	104.3101	56.9828	0.0000	0.0000	0.0000	0.0000	100.2907	167.2208	235.2036	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1251.7142	
Space heating per m2											(98c) / (4) =	25.4465	(99)
Energy for space heating												25.4465	(99)
Energy for space cooling												0.0000	(108)
Total												0.0000	(109)
Fabric Energy Efficiency (FEE)												62.4	(109)

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)
Fraction of main heating from main system 2												0.0000	(203)
Fraction of total heating from main system 1												1.0000	(204)
Fraction of total heating from main system 2												0.0000	(205)
Efficiency of main space heating system 1 (in %)												100.0000	(206)
Efficiency of main space heating system 2 (in %)												0.0000	(207)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	232.4020	187.9441	167.3600	104.3101	56.9828	0.0000	0.0000	0.0000	0.0000	100.2907	167.2208	235.2036	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	232.4020	187.9441	167.3600	104.3101	56.9828	0.0000	0.0000	0.0000	0.0000	100.2907	167.2208	235.2036	(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)
Space heating fuel used, main system 2												0.0000	(213)
Water heating													
Water heating requirement	180.9172	159.7337	169.2023	151.3787	146.2092	128.2028	121.8593	132.7667	133.3897	151.5922	162.6760	180.4477	(64)
Efficiency of water heater												349.4100	(216)
(217)m	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	349.4100	(217)
Fuel for water heating, kWh/month	51.7779	45.7153	48.4251	43.3241	41.8446	36.6912	34.8757	37.9974	38.1757	43.3852	46.5573	51.6436	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.4861	6.7616	7.4861	7.2446	7.4861	7.2446	7.4861	7.4861	7.2446	7.4861	7.2446	7.4861	(231)
Lighting	14.3534	11.5148	10.3678	7.5959	5.8673	4.7936	5.3524	6.9572	9.0367	11.8566	13.3920	14.7523	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)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	(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)

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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												1251.7142	(211)
Space heating fuel - main system 2												0.0000	(213)
Space heating fuel - secondary												0.0000	(215)
Efficiency of water heater												349.4100	
Water heating fuel used												520.4131	(219)
Space cooling fuel												0.0000	(221)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.5875)													
mechanical ventilation fans (SFP = 0.5875)												88.1423	(230a)
Total electricity for the above, kWh/year												88.1423	(231)
Electricity for lighting (calculated in Appendix L)												115.8402	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation												0.0000	(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												1976.1098	(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	1251.7142	0.1544	193.2248	(261)
Space heating - main system 2	0.0000	0.0000	0.0000	(262)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	520.4131	0.1411	73.4179	(264)
Space and water heating			266.6427	(265)
Pumps, fans and electric keep-hot	88.1423	0.1387	12.2264	(267)
Energy for lighting	115.8402	0.1443	16.7193	(268)
Total CO2, kg/year			295.5884	(272)
EPC Dwelling Carbon Dioxide Emission Rate (DER)			6.0100	(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	1251.7142	1.5715	1967.0852	(275)
Space heating - main system 2	0.0000	0.0000	0.0000	(276)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	520.4131	1.5217	791.8897	(278)
Space and water heating			2758.9749	(279)
Pumps, fans and electric keep-hot	88.1423	1.5128	133.3417	(281)
Energy for lighting	115.8402	1.5338	177.6796	(282)
Total Primary energy kWh/year			3069.9961	(286)
Dwelling Primary energy Rate (DPER)			62.4100	(287)

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

1. Overall dwelling characteristics

	Area (m2)		Storey height (m)		Volume (m3)	
Main dwelling						
Ground floor	49.1900 (1b)	x	2.5000 (2b)	=	122.9750 (1b) - (3b)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	49.1900				(4)	
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	122.9750 (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	2 * 10 =	20.0000	(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) =	20.0000 / (5) =	0.1626	(8)
Pressure test		Yes	
Pressure Test Method		Blower Door	
Measured/design AP50		5.0000	(17)
Infiltration rate		0.4126	(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) =	0.3507	(21)

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	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													
	0.4472	0.4384	0.4297	0.3858	0.3770	0.3332	0.3332	0.3244	0.3507	0.3770	0.3946	0.4121	(22b)
Effective ac	0.6000	0.5961	0.5923	0.5744	0.5711	0.5555	0.5555	0.5526	0.5615	0.5711	0.5778	0.5849	(25)

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3. Heat losses and heat loss parameter

Element	Gross	Openings	NetArea	U-value	A x U	K-value	A x K	
Main dwelling	m2	m2	m2	W/m2K	W/K	kJ/m2K	kJ/K	
TER Opening Type			10.6100	1.2357	13.1112			(27)
Exposed			49.1900	0.1100	5.4109			(28b)
External Wall	39.8800	10.6100	29.2700	0.1300	3.8051			(29a)
Sheltered Wall	10.6200		10.6200	0.1300	1.3806			(29a)
Core and Riser	4.7900		4.7900	0.1800	0.8622			(29a)
Total net area of external elements Aum(A, m2)			104.4800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	24.5700			(33)
Main dwelling								
Party Wall			20.5700	0.0000	0.0000			(32)
Corridor			3.6600	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 69.2889 (35)

List of Thermal Bridges

	Length	Psi-value	Total	
K1 Element				
E2 Other lintels (including other steel lintels)	5.5000	0.0500	0.2750	
E4 Jamb	18.3600	0.0500	0.9180	
E7 Party floor between dwellings (in blocks of flats)	14.5000	0.0700	1.0150	
E7 Party floor between dwellings (in blocks of flats)	0.0000	0.0700	0.0000	
E7 Party floor between dwellings (in blocks of flats)	1.7400	0.0700	0.1218	
E16 Corner (normal)	8.2500	0.0900	0.7425	
E17 Corner (inverted - internal area greater than external area)	2.7500	-0.0900	-0.2475	
E18 Party wall between dwellings	5.5000	0.0600	0.3300	
E25 Staggered party wall between dwellings	0.0000	0.0600	0.0000	
P3 Party wall - Intermediate floor between dwellings (in blocks of flats)	8.8100	0.0000	0.0000	
E20 Exposed floor (normal)	14.5000	0.3200	4.6400	
E20 Exposed floor (normal)	0.0000	0.3200	0.0000	
E20 Exposed floor (normal)	1.7400	0.3200	0.5568	
E20 Exposed floor (normal)	3.8600	0.3200	1.2352	
E7 Party floor between dwellings (in blocks of flats)	3.8600	0.0700	0.2702	
P7 Party Wall - Exposed floor (normal)	8.8100	0.1600	1.4096	
Thermal bridges (Sum(L x Psi) calculated using Appendix K)				11.2666 (36)
Point Thermal bridges			(36a) =	3.2600 (36a)
Total fabric heat loss			(33) + (36) + (36a) =	39.0966 (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	24.3487	24.1911	24.0367	23.3112	23.1755	22.5436	22.5436	22.4266	22.7870	23.1755	23.4501	23.7371	(38)
Heat transfer coeff													
	63.4453	63.2877	63.1333	62.4078	62.2721	61.6403	61.6403	61.5233	61.8836	62.2721	62.5467	62.8337	(39)
Average = Sum(39)m / 12 =												62.4072	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2898	1.2866	1.2835	1.2687	1.2660	1.2531	1.2531	1.2507	1.2581	1.2660	1.2715	1.2774	(40)
HLP (average)												1.2687	
Days in mont	31	28	31	30	31	30	31	31	30	31	30	31	

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4. Water heating energy requirements (kWh/year)

Assumed occupancy 1.6663 (42)

Hot water usage for mixer showers

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
52.1575	51.3737	50.2315	48.0461	46.4334	44.6349	43.6126	44.7461	45.9887	47.9198	50.1521	51.9577	(42a)

Hot water usage for baths

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
23.7397	23.3871	22.8906	21.9752	21.2897	20.5296	20.1191	20.6121	21.1489	21.9622	22.8965	23.6594	(42b)

Hot water usage for other uses

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
33.3625	32.1493	30.9361	29.7230	28.5098	27.2966	27.2966	28.5098	29.7230	30.9361	32.1493	33.3625	(42c)

Average daily hot water use (litres/day) 100.4274 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	109.2597	106.9101	104.0582	99.7442	96.2328	92.4611	91.0282	93.8680	96.8605	100.8181	105.1979	108.9796	(44)
Energy conte	173.0406	152.2385	159.9336	136.5449	129.5479	113.6917	110.0908	116.2282	119.4387	136.8092	149.8736	170.6357	(45)
Energy content (annual)										Total = Sum(45)m =		1668.0733	
Distribution loss (46)m = 0.15 x (45)m													
	25.9561	22.8358	23.9900	20.4817	19.4322	17.0537	16.5136	17.4342	17.9158	20.5214	22.4810	25.5954	(46)
Water storage loss:													
Store volume												150.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.3938	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												0.7527	(55)
Total storage loss													
	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(56)
If cylinder contains dedicated solar storage													
	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Combi loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(61)
Total heat required for water heating calculated for each month													
	219.6355	194.3243	206.5285	181.6367	176.1428	158.7835	156.6857	162.8231	164.5306	183.4041	194.9655	217.2306	(62)
WWHRS	-36.4287	-32.2178	-33.7367	-27.9353	-26.0347	-22.2781	-20.8821	-22.2061	-23.0497	-27.1731	-30.7838	-35.7541	(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													
	183.2068	162.1064	172.7919	153.7014	150.1081	136.5054	135.8035	140.6170	141.4808	156.2310	164.1817	181.4765	(64)
									Total per year (kWh/year) = Sum(64)m =			1878.2105	(64)
12Total per year (kWh/year)												1878	(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													
	94.8119	84.2879	90.4539	81.4746	80.3506	73.8760	73.8811	75.9218	75.7868	82.7650	85.9065	94.0123	(65)

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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	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	83.3140	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	73.2853	81.1373	73.2853	75.7282	73.2853	75.7282	73.2853	73.2853	75.7282	73.2853	75.7282	73.2853	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	145.1303	146.6363	142.8413	134.7620	124.5634	114.9782	108.5746	107.0686	110.8637	118.9429	129.1415	138.7268	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	31.3314	(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)													
	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	-66.6512	(71)
Water heating gains (Table 5)													
	127.4354	125.4284	121.5778	113.1592	107.9981	102.6055	99.3026	102.0454	105.2595	111.2432	119.3145	126.3606	(72)
Total internal gains													
	396.8452	404.1962	388.6985	374.6436	356.8410	341.3060	329.1567	330.3935	339.8456	354.4657	375.1784	389.3669	(73)

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6. Solar gains

[Jan]	Area	Solar flux	g	FF	Access	Gains	
	m2	Table 6a W/m2	Specific data or Table 6b	Specific data or Table 6c	factor Table 6d	W	
Northeast	5.5500	11.2829	0.6300	0.7000	0.7700	19.1376	(75)
Northwest	5.0600	11.2829	0.6300	0.7000	0.7700	17.4480	(81)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	36.5855	74.4709	134.1729	220.3505	296.1943	315.7745	295.4006	235.4968	163.4918	91.0094	46.0341	29.8776	(83)
Total gains	433.4308	478.6672	522.8715	594.9941	653.0354	657.0805	624.5573	565.8903	503.3374	445.4751	421.2125	419.2445	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	14.9224	14.9595	14.9961	15.1705	15.2035	15.3594	15.3594	15.3886	15.2990	15.2035	15.1368	15.0676	
alpha	1.9948	1.9973	1.9997	2.0114	2.0136	2.0240	2.0240	2.0259	2.0199	2.0136	2.0091	2.0045	
util living area													
	0.8933	0.8692	0.8280	0.7436	0.6273	0.4917	0.3849	0.4301	0.6126	0.7827	0.8645	0.8990	(86)
MIT	17.7749	18.1042	18.6796	19.4869	20.1790	20.6523	20.8498	20.8068	20.4232	19.5517	18.5579	17.7276	(87)
Th 2	19.8488	19.8513	19.8538	19.8654	19.8676	19.8778	19.8778	19.8796	19.8738	19.8676	19.8632	19.8586	(88)
util rest of house													
	0.8812	0.8544	0.8081	0.7134	0.5821	0.4267	0.3004	0.3437	0.5500	0.7500	0.8469	0.8875	(89)
MIT 2	16.1685	16.5760	17.2863	18.2680	19.0766	19.5994	19.7886	19.7581	19.3767	18.3718	17.1523	16.1128	(90)
Living area fraction											fLA = Living area / (4) =		0.6424	(91)
MIT	17.2005	17.5577	18.1813	19.0510	19.7848	20.2758	20.4703	20.4318	20.0490	19.1298	18.0553	17.1501	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.2005	17.5577	18.1813	19.0510	19.7848	20.2758	20.4703	20.4318	20.0490	19.1298	18.0553	17.1501	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.8445	0.8170	0.7727	0.6886	0.5785	0.4508	0.3464	0.3879	0.5605	0.7249	0.8115	0.8514	(94)
Useful gains	366.0169	391.0749	404.0153	409.7333	377.7678	296.1996	216.3348	219.4927	282.1315	322.9284	341.7937	356.9606	(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													
	818.4760	801.0795	737.4813	633.5044	503.4585	349.8553	238.5681	248.0499	368.1461	531.1669	685.2151	813.7055	(97)
Space heating kWh													
	336.6295	275.5231	248.0987	161.1152	93.5139	0.0000	0.0000	0.0000	0.0000	154.9294	247.2634	339.8182	(98a)
Space heating requirement - total per year (kWh/year)												1856.8914	
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													
	336.6295	275.5231	248.0987	161.1152	93.5139	0.0000	0.0000	0.0000	0.0000	154.9294	247.2634	339.8182	(98c)
Space heating requirement after solar contribution - total per year (kWh/year)												1856.8914	
Space heating per m2											(98c) / (4) =	37.7494	(99)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	92.3000 (206)
Efficiency of main space heating system 2 (in %)	0.0000 (207)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)

[Jan]	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement												
336.6295	275.5231	248.0987	161.1152	93.5139	0.0000	0.0000	0.0000	0.0000	154.9294	247.2634	339.8182	(98)
Space heating efficiency (main heating system 1)												
92.3000	92.3000	92.3000	92.3000	92.3000	0.0000	0.0000	0.0000	0.0000	92.3000	92.3000	92.3000	(210)
Space heating fuel (main heating system)												
364.7124	298.5082	268.7960	174.5560	101.3151	0.0000	0.0000	0.0000	0.0000	167.8542	267.8910	368.1671	(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

183.2068	162.1064	172.7919	153.7014	150.1081	136.5054	135.8035	140.6170	141.4808	156.2310	164.1817	181.4765	(64)

Full SAP Calculation Printout

Efficiency of water heater												79.8000	(216)
(217)m	85.4053	85.2390	84.8704	84.1656	83.0302	79.8000	79.8000	79.8000	79.8000	84.0410	84.9757	85.4452	(217)
Fuel for water heating, kWh/month													
	214.5145	190.1787	203.5950	182.6179	180.7874	171.0595	170.1799	176.2118	177.2943	185.8985	193.2100	212.3893	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(221)
Pumps and Fa	7.3041	6.5973	7.3041	7.0685	7.3041	7.0685	7.3041	7.3041	7.0685	7.3041	7.0685	7.3041	(231)
Lighting	15.2272	12.2159	10.9990	8.0584	6.2245	5.0855	5.6782	7.3807	9.5869	12.5785	14.2074	15.6505	(232)
Electricity generated by PVs (Appendix M) (negative quantity)													
(233a)m	-2.3015	-3.6692	-5.9553	-7.5898	-9.0231	-8.7423	-8.6389	-7.7248	-6.2924	-4.5549	-2.6767	-1.9436	(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	-0.2708	-0.6016	-1.2587	-1.9882	-2.7286	-2.7776	-2.7431	-2.2744	-1.6071	-0.8888	-0.3702	-0.2117	(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												2011.8000	(211)
Space heating fuel - main system 2												0.0000	(213)
Space heating fuel - secondary												0.0000	(215)
Efficiency of water heater												79.8000	
Water heating fuel used												2257.9367	(219)
Space cooling fuel												0.0000	(221)
Electricity for pumps and fans:													
Total electricity for the above, kWh/year												86.0000	(231)
Electricity for lighting (calculated in Appendix L)												122.8926	(232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV generation												-86.8335	(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												4391.7957	(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	2011.8000	0.2100	422.4780	(261)
Total CO2 associated with community systems			0.0000	(373)
Water heating (other fuel)	2257.9367	0.2100	474.1667	(264)
Space and water heating			896.6447	(265)
Pumps, fans and electric keep-hot	86.0000	0.1387	11.9293	(267)
Energy for lighting	122.8926	0.1443	17.7372	(268)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-69.1126	0.1321	-9.1311	
PV Unit electricity exported	-17.7209	0.1245	-2.2059	
Total			-11.3369	(269)
Total CO2, kg/year			914.9742	(272)
EPC Target Carbon Dioxide Emission Rate (TER)			18.6000	(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	2011.8000	1.1300	2273.3341	(275)
Total CO2 associated with community systems			0.0000	(473)
Water heating (other fuel)	2257.9367	1.1300	2551.4685	(278)
Space and water heating			4824.8025	(279)
Pumps, fans and electric keep-hot	86.0000	1.5128	130.1008	(281)
Energy for lighting	122.8926	1.5338	188.4967	(282)
Energy saving/generation technologies				
PV Unit electricity used in dwelling	-69.1126	1.4881	-102.8497	
PV Unit electricity exported	-17.7209	0.4568	-8.0958	
Total			-110.9454	(283)
Total Primary energy kWh/year			5032.4546	(286)
Target Primary Energy Rate (TPER)			102.3100	(287)

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