

Planning Statement

Energy Assessment

Antill Road

Document information

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Executive Summary

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About the Scheme:

The project consists of converting a parking lot in the London Borough of Haringey into a new build three-bedroom house of type 3B5P. The development spans over two floors, with a total GIA of 97 m².

Planning policy

The methodology followed in this report follows the guidance set out by the Greater London Authority (GLA) for developing energy strategies as detailed in the document "ENERGY PLANNING: Greater London Authority guidance on preparing energy assessments" dated Oct 2018.

- In accordance with the Sustainable, Design and Construction SPG, the scheme is required to demonstrate compliance with The London Plan (2016) Policy 5.2 and Draft New London Plan 'Intend to Publish' version 2019 Policy SI2.

Building Regulations

The scheme complies with the 2013 Building Regulations Part L and the minimum energy efficiency targets in the following documents have been followed:

- New build (Part L1A) – The actual dwelling CO₂ emissions rate (DER) is no greater than the notional CO₂ target emissions rate.

Local Policy and Employer's Requirements

Haringey's Local Plan – Strategic Policies (2013 with alterations adopted July 2017) and Development Management DPD (adopted July 2017) have been followed while developing the scheme. As per Haringey's policy SP4 'Working towards a Low Carbon Haringey'; all new residential development will aim to achieve a 100% reduction in total (regulated) CO₂ emissions and achieve a reduction in predicted carbon dioxide emissions of 20% from on-site renewable energy regeneration, which can include connections to local sources of decentralised renewable energy.

As per Haringey's 'Consolidated Employer's Requirements' published in Oct 2019, the following requirements have been met for '12.13 Energy Power & Water'.

- Maximum space Heating Demand of 15.7 kWh/m² per Year has been achieved
- 59% reduction in CO₂ emission (over Building Regulations Part L 2013) using SAP 10 carbon factors is achieved, and a fabric first approach adopted
- Various renewable energy options have been considered and the feasibility study is incorporated in this report.

The developments has achieves a 50.9% reduction in CO₂ emissions using SAP 10 from onsite renewable energy (air source heat pumps and solar PVs) –

Emission factors

The GLA Guidance on Energy Assessments, published in October 2018 highlights a critical development regarding carbon emission factors. Grid electricity has significantly decarbonised since the last update of Part L in April 2014 and in July 2018 the Government published updated carbon emission factors (SAP 10) demonstrating this. Although SAP 10 is not in use yet, the GLA Guidance encourages the use of SAP 10 carbon emission factors from January 2019. Any applicants proposing to use SAP 2012 emissions factors would be required to provide adequate justification. The dwelling will demonstrate compliance with the draft SAP 10 carbon factors. The revised factors are below:

Fuel Type	Carbon Factor (kg CO ₂ /kWh)	
	SAP 2012	SAP10
Natural Gas	0.216	0.210
Grid Electricity	0.519	0.233

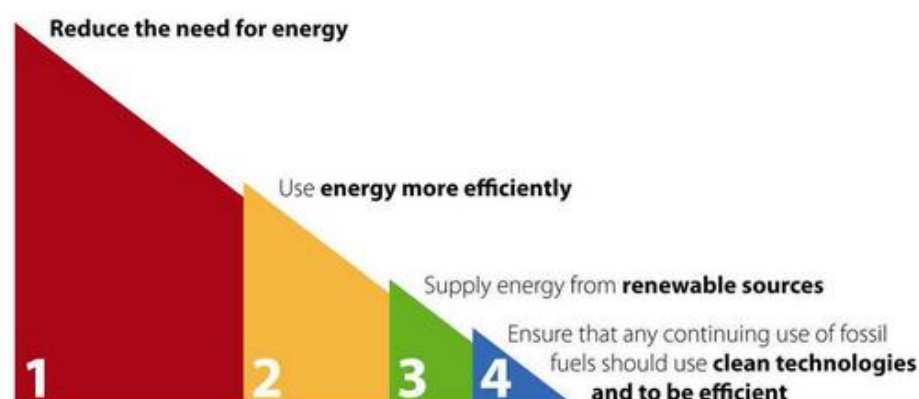
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The Energy Hierarchy

The proposed scheme has followed the energy hierarchy that is illustrated below:



GLA's Energy Hierarchy: Regulated carbon emissions
Calculated using draft SAP 10 carbon dioxide emission factors

	Baseline:	Be lean:	Be clean:	Be green:
CO ₂ emissions (tCO ₂ /yr)	1.90	1.74	–	0.78
CO ₂ emissions saving (tCO ₂ /yr)	–	0.15	–	0.97
Saving from each stage (%)	–	8.1	–	50.9
Total CO ₂ emissions saving (tCO ₂ /yr)		1.12		
59.0% total carbon emissions savings over 2013 Building Regulations Part L achieved (using draft SAP 10)				

Executive Summary

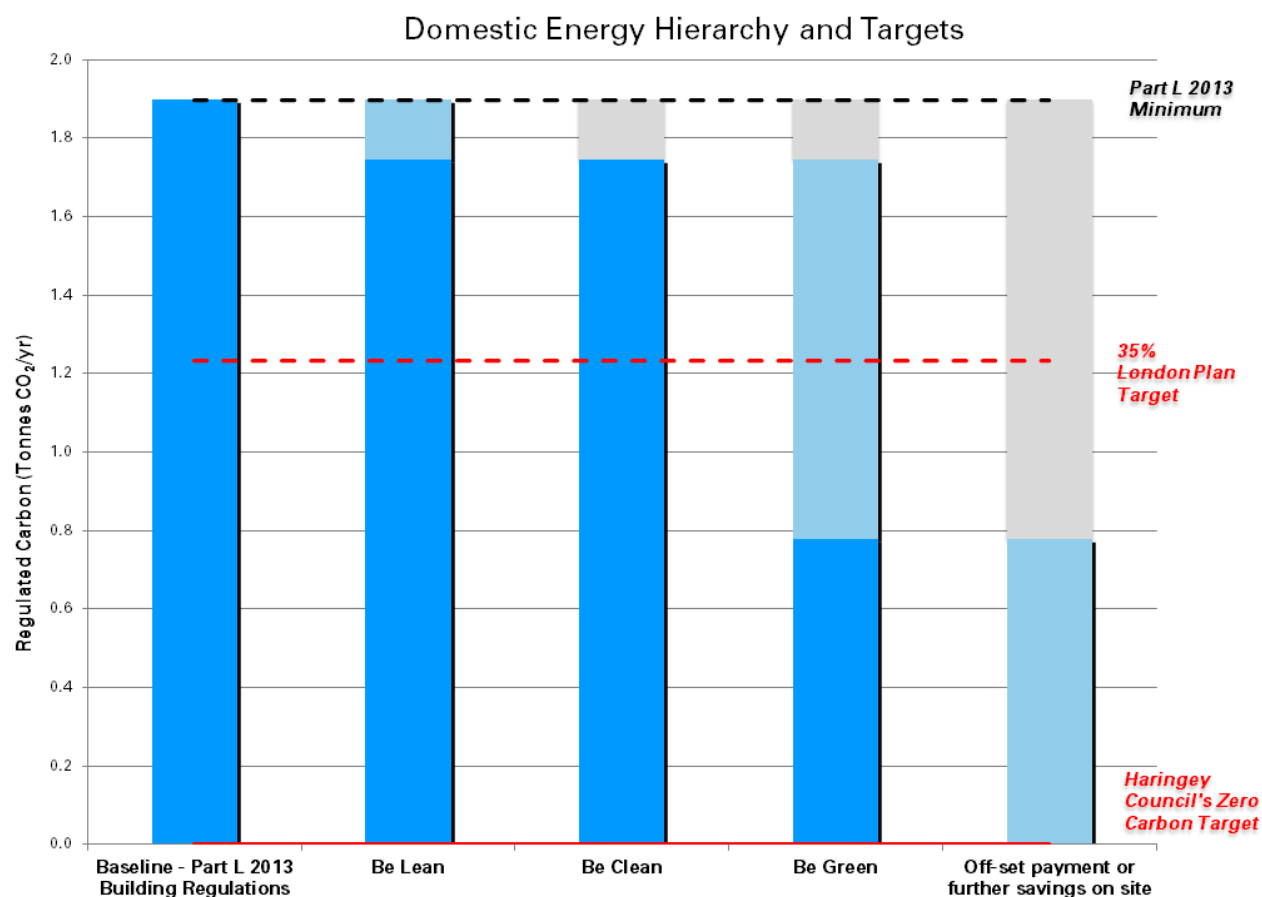
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GLA's Energy Hierarchy: Regulated carbon emissions

A graphical illustration of how the dwelling performs in relation to Building Regulations and the Energy Hierarchy is shown below. Carbon dioxide emission factors for draft SAP 10 have been used for the calculation.

Figure



Summary (draft SAP 10 factors):

As demonstrated above, the development will reduce carbon emissions by 8.1% from the fabric energy efficiency measures described in the 'Be Lean' section and will reduce total carbon emissions by 59% over Building Regulations (using SAP 10 carbon factors) with the further inclusion of low and zero carbon technologies (air source heat pumps).

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Aim of this study

The purpose of an energy assessment is to demonstrate that climate change mitigation measures comply with London Plan (2016) and Draft New London Plan 'Intend to Publish' version 2019 energy policies, including the energy hierarchy. It also ensures energy remains an integral part of the development's design and evolution.

Methodology

The methodology followed in this report follows the guidance set out by the Greater London Authority (GLA) for developing energy strategies as detailed in the document "ENERGY PLANNING: Greater London Authority guidance on preparing energy assessments".

Under the GLA's guidance (October 2018), applications for major developments should be accompanied by an energy statement. However, *Policy DM21:Sustainable Design,Layout and Construction* of Haringey's Development Management DPD states that all new development must be accompanied by an energy statement. The energy statement should provide information demonstrating how the energy hierarchy has been followed i.e. 'Lean, Clean, Green', including consideration of passive design and decentralised energy options such as CHP/Community CHP.

This report has followed these documents and comprises the following components:

- **BASELINE:** A calculation of the Part L 2013 Building Regulations compliant CO2 emission baseline using approved software. The baseline assumes a gas boiler would provide heating and any active cooling would be electrically powered.
- **LEAN:** A calculation of the impact of demand reduction measures. For example, passive design measures, including optimising orientation and site layout, natural ventilation and lighting, thermal mass and solar shading, and active design measures such as high efficacy lighting and efficient mechanical ventilation with heat recovery.
- **COOLING HIERARCHY:** In accordance with Policy 5.9 of London Plan and Draft New London Plan 'Intend to Publish' version 2019 Policy SI4, measures that are proposed to reduce the demand for cooling have been set out such as minimisation of solar and internal gains and night cooling strategies.
- **CLEAN:** In accordance with Policy 5.6 of London Plan and Draft New London Plan 'Intend to Publish' version 2019 SI3, this report has demonstrated how the scheme has selected heating, cooling and power systems to minimise carbon emissions. This comprises an evaluation of the feasibility of connecting to existing low carbon heat networks, planned networks, site-wide and communal heat networks and CHP.
- **GREEN:** In accordance with Policy 5.7 of London Plan and Draft New London Plan 'Intend to Publish' version 2019 SI2, this report has conducted a feasibility assessment of renewable energy technologies. This comprised a site-specific analysis of the technologies and, if applicable, how they would be integrated into the heating and cooling strategy for the scheme.

Please note that these findings are currently subject to a detailed analysis from a building services design engineer and qualified quantity surveyor.

Establishing Emissions: The Carbon Profile

Energy Assessment

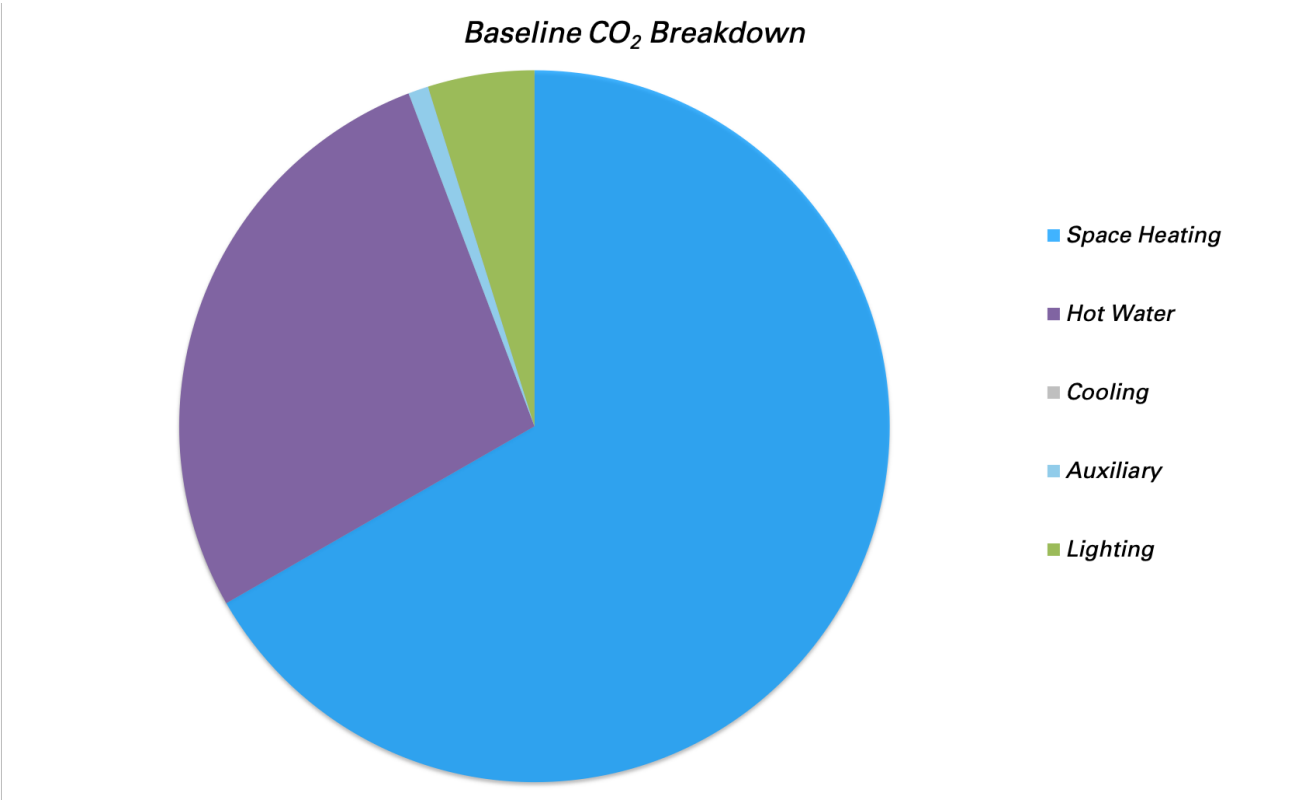
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Building regulations Part L 2013
Minimum compliance:

The total baseline carbon emissions for the dwelling is 1.90 tonnes CO₂/yr (using SAP 10 factors).

The pie chart below provides a breakdown of the specific carbon emissions by system over the course of one year.

Carbon Emissions in tonnes CO ₂ /yr.	Heating	Hot Water	Cooling	Auxiliary	Lighting
	1.27	0.52	0.00	0.02	0.09



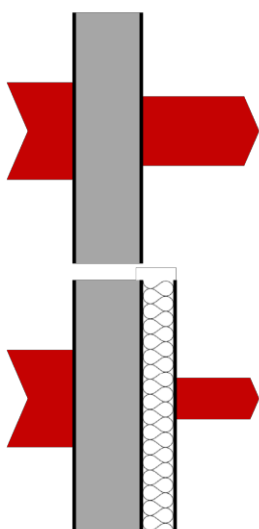
Overview

The chart above shows that space heating is the primary source of carbon dioxide emissions, and hot water is the second largest, across the scheme.

'Be Lean': Demand Reduction Measures Energy Assessment Antill Road

Be Lean: summary

Building fabric: passive design measures



Graphic illustrations of the heat flow through a wall and how it is minimized with low u-value (consequence of the additional insulation).

Demand reduction measures have reduced the scheme's carbon emissions by 8.1% (using SAP 10 figures) over the minimum Part L 2013 Building Regulations baseline.

Proposed U Values for the scheme are shown in the table below:

Element	Minimum Building Regulations U-value W/m ² K	Proposed U-value W/m ² K
Exposed / External Floors	0.25	0.12
External Walls	0.30	0.14
Roofs	0.20	0.12
Windows g-value 0.50	2.00	1.30
Doors	2.00	1.00
Air Permeability in m ³ /hour/m ² at 50Pa.		
Whole Building	10	3

This will require careful attention to two key areas:

- Structural leakage
- Services leakage

Structural leakage occurs at joints in the building fabric and around window and door openings, loft hatches and access openings. There will also be some diffusion through materials such as cracks in masonry walls typically caused by poor perpend in blockwork inner leafs. Structural leakage is hard to remedy retrospectively therefore good detailing at the design stage is essential.

Services leakage occurs at penetrations from pipes and cables entering the building. These can be sewerage pipes, water pipes and heating pipes. As well as electricity cables there may also be telecommunication cables. Attention, therefore, needs to be paid to sealing all penetrations during construction.

Thermal Bridging:

The scheme will be designed in line with the accredited construction details (ACD) and therefore it has been indicatively modelled with the accredited thermal bridge Psi-values for the following junctions:

- Lintels (E2)
- Sill (E3)
- Jambs (E4),
- Ground floor (E5)
- Party floor within a dwelling (E6)
- Corners (E16)
- Inverted corner (E17)
- Party wall between dwellings (E18)

The default psi-value has been used for the remaining junctions.

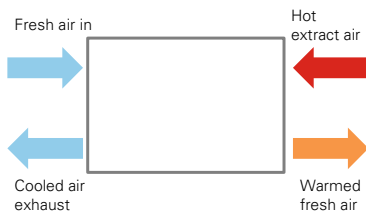
Thermal Mass:

Thermal mass of the scheme has been indicatively modelled as 250 kJ/m²K (medium).

'Be Lean': Demand Reduction Measures Energy Assessment Antill Road

Energy efficient services

Active design measures:



Graphic illustration of a heat recovery unit, which exploits the extract hot air of the room to heat the cold supply air.

Heating:

For the 'Be Lean' scenario, the dwelling has been modelled with a gas boiler with an efficiency of 89.5%.

For the 'Be Green' final scenario, an air source heat pump (Mitsubishi Ecodan PUHZ-HW50-140VHA2-YHA2-BS with 5KW capacity) been specified. The distribution of heat will be done using radiators and is controlled using time and temperature zone controls with suitable arrangement of plumbing and services.

Hot Water:

The hot water will be provided by the main heating system in both scenarios. The hot water storage cylinder has been modelled to be 150 litres with a specified loss factor of 1.26 kWh/day. The cylinder will be located in a heated space and primary pipework will be fully insulated.

Ventilation:

Mechanical ventilation with heat recovery has been specified for the dwelling which has two wet rooms and has been modelled with a SFP of 0.54 W/l/s and a heat recovery efficiency of 90%.

Cooling:

No cooling has been specified for the dwelling.

Lighting:

High efficiency lighting has been specified for the development with a minimum efficacy of 75 lumens/W.

Controls:

The proposed scheme sets out to address demand side response to energy efficiency, including smart meters, to provide more consumption data to inform control which will allow the running of some equipment at a lower capacity during times of peak demand. The design team will also explore the possibility of energy storage, smart controls, to optimise heating and power systems at a later stage of the project.

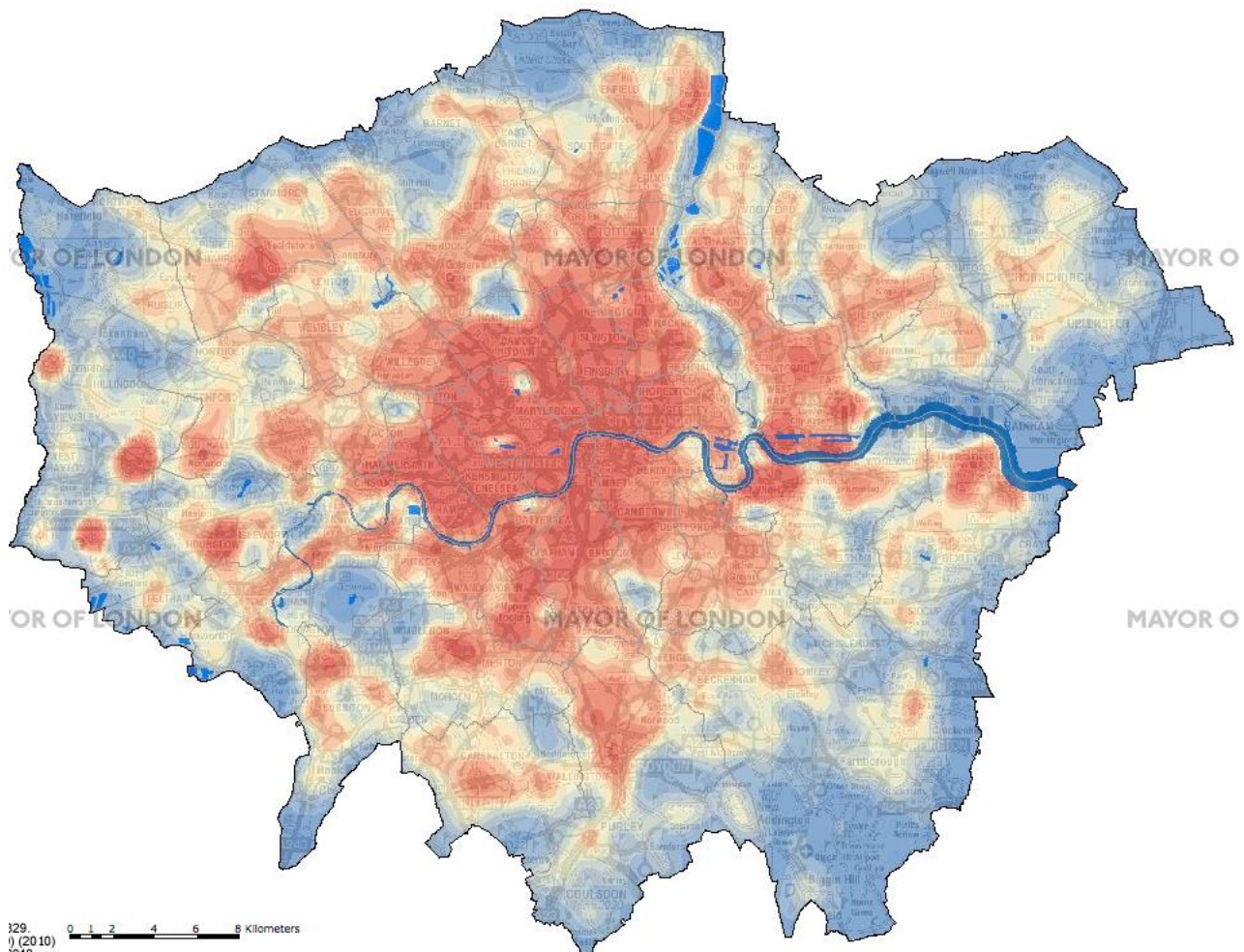
‘Be Lean’: Heating Infrastructure & CHP Energy Assessment Antill Road

Heating infrastructure including CHP:

Once demand for energy has been minimised, schemes must demonstrate how their energy systems have been selected in accordance with the order of preference in Policy 5.6b of the London Plan and Draft New London Plan ‘Intend to Publish’ version 2019 Policy SI3. This has involved a systematic appraisal of the potential to connect to existing or planned heating networks and on site communal and CHP systems.

Heating infrastructure:

The London Heat Map (shown below) has been consulted to establish the possibility of connecting to heating infrastructure.



Source: <http://www.londonheatmap.org.uk/Mapping>

‘Be Lean’: Existing and Planned Networks

Energy Assessment

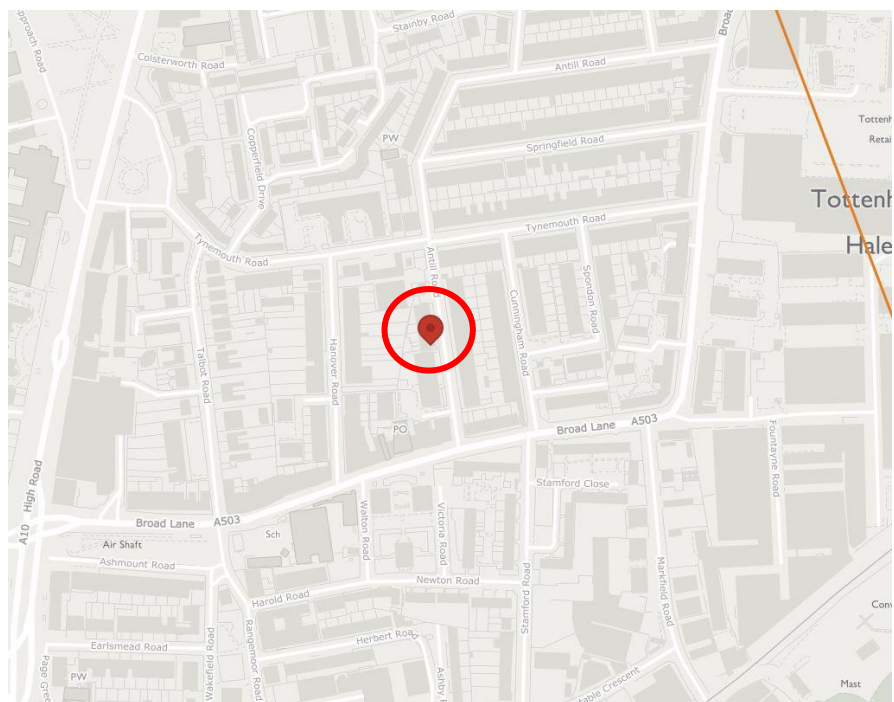
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Existing and planned networks:

Existing networks:

A review of the London Heat Map demonstrates that there are no existing networks present within connectable range of the scheme. A map of the existing and potential networks in the scheme’s location is shown below.

- Existing DH Networks
- Potential DH Networks



There are no existing or potential networks within the vicinity of the scheme, therefore a connection is not possible.

‘Be Clean’: Site Wide Networks and CHP Energy Assessment Antill Road

Combined Heat and Power (CHP)

In accordance with section 8.3 of the GLA guidance for Energy Planning where connection to an area wide heat network will not be available in the foreseeable future i.e. 5 years following completion, or the development is of such a scale that it could be the catalyst for an area wide heat network, applicants should evaluate the feasibility of on-site CHP

GLA guidance stipulates that small, or purely residential developments of less than 350 dwellings will not be expected to include on-site CHP. CHP systems are best utilised where there is a consistent and high demand for heat. Because of the small electricity supplies and demand of this scheme, a CHP installed to meet the base heat load would typically require the export of electricity to the grid. The administrative burden of managing CHP electricity sales at a small scale without an active energy service companies (ESCOs) is prohibitive for smaller operators of residential developments.

The heat demand profile of this single dwelling scheme is not suitable to CHP. The implemented fabric improvements from the ‘Be Lean’ scenario have also reduced the energy demand from space heating to hot water. For CHP systems to be economically viable they need to run for at least 5,000 hours per year. Therefore, a CHP system would most likely be oversized, and as a result less efficient and economic.

'Be Clean': Cooling Energy Assessment Antill Road

Overheating and cooling:

The aim of this section is to reduce the impact of the urban heat island effect in London and encourage the design of spaces to avoid overheating and excessive heat generation, and to mitigate overheating due to the impact of climate change.

Where design measures and the use of natural and/or mechanical ventilation are not enough to guarantee the occupant's comfort, in line with the cooling hierarchy the development's cooling strategy must include details of the active cooling plant being proposed, including efficiencies, and the ability to take advantage of free cooling and/or renewable cooling sources.

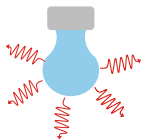
Where appropriate, the cooling strategy should investigate the opportunities to improve cooling efficiencies through the use of locally available sources such as ground cooling and river/dock water-cooling.

The cooling hierarchy:

All new developments should reduce potential overheating and reliance on air conditioning systems and demonstrate this with the Cooling Hierarchy:

- 1) Minimise internal heat generation through energy efficient design
- 2) Reduce the amount of heat entering the building in summer (e.g. shading and fenestration)
- 3) Manage the heat within the building through thermal mass, room height and green roofs
- 4) Passive ventilation
- 5) Mechanical ventilation
- 6) Active cooling systems (ensuring the lowest carbon option)

Avoiding overheating Measures taken:



LED bulbs can emit 80% less heat compared to an incandescent bulb and their life span is up to 41 times more.

The following measures have been taken in accordance with the cooling hierarchy to reduce overheating and the need for cooling:

- 1) Minimise internal heat generation through energy efficient design

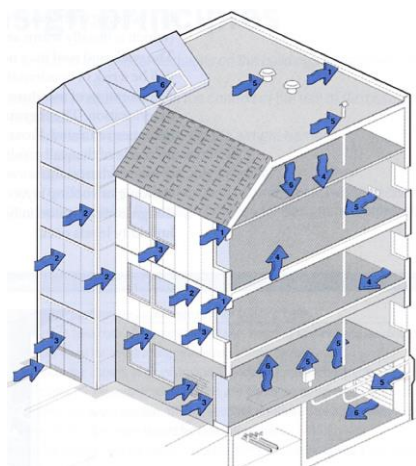
Internal heat gains have been minimised where possible. Energy efficient appliances will help reduce internal heat gain.

Energy efficient lighting will also be specified with an average lumen efficacy of more than 75 lumens per circuit watt.

'Be Clean': Cooling Energy Assessment Antill Road

Avoiding overheating

Measures taken:



Examples of possible air leakage points in a building



Examples of how the thermal mass absorbs heat during day and emits it during night.

- 2) Reduce the amount of heat entering the building in summer (e.g. shading and fenestration)

Direct solar gains will be controlled in the following ways:

- Solar control –The type of glazing has been optimised and reduced solar gain factors from low emissivity windows with a g-value of 0.5 have been specified for the dwelling.
- Light-coloured curtain/roller blinds will be specified to limit solar gain. The shading has also been optimised to avoid substantially reducing daylighting or increasing the requirement for electric lighting.

Heat transfer and infiltration of the new build envelope has been controlled in the following ways:

- Insulation levels have been maximised and the resulting U-values are lower than required by Building Regulations. The build-ups therefore prevent the penetration of heat as much as practically possible. See the 'Be Lean' section of this report for target U-values.
- A reduced air permeability rate of $3 \text{ m}^3/(\text{hr.m}^2) @ 50 \text{ pa}$ has been targeted for the development to minimise uncontrolled air infiltration. This will require attention to detailing and sealing. See 'Be Lean' section of this report for details of how this will be achieved.

- 3) Manage the heat within the building through thermal mass, room height and green roofs.

The following measures have been specified to manage heat accumulation within the building:

- Room heights –The proposed building has floor to ceiling heights of approximately 3.0m to 3.5m. As the roof will be well insulated to achieve a U-value of $0.12 \text{ W/m}^2\text{K}$, there will be minimal penetration of heat through the roof.

'Be Clean': Cooling Energy Assessment Antill Road

Avoiding overheating

Measures taken:



Typical building section demonstrating passive cross ventilation.

- 4) High thermal mass: exposed building fabric materials such as masonry or concrete have been utilised in the form of concrete floors and dense masonry external walls. These materials act as 'thermal batteries'; they absorb heat gains during the day when the building is occupied and 'store' it for an extended period, thereby helping to stabilise daytime temperatures. At night this heat can be dissipated, which 'resets' the heating cycle. Ventilation will also be used at night to purge the stored heat within the structure. A 'ground coupled' system that uses the thermal storage capacity of the ground has not been specified as the passive ventilation option has been selected instead.
- 5) Passive ventilation: Ventilation that does not use fans or mechanical system has been specified to reduce the cooling load.
 - Openable windows are specified for the building. Cross ventilation will be achieved by opening windows on two facades and ensuring there is a clear path for airflow.
 - Night time cooling will also be utilised. This will work in tandem with high thermal mass materials specified. The larger temperature differential that exists between internal and external temperatures at night will allow effective stack ventilation and purging of heat accumulated within the structure during the day.
- 6) Mechanical ventilation: Passive ventilation will not be adequate to cool the building to the required temperature. Mechanical ventilation with heat recovery has been specified for the dwelling which has two wet rooms and has been modelled with a SFP of 0.54 W/l/s and a heat recovery efficiency of 90%.

Overheating risk:

The overheating risk considering all the above described passive measures have been assessed for the scheme:

Areas	Overheating risk from SAP and SBEM
Dwelling	Slight

According to the GLA guidance on preparing energy assessments (October 2018) Section 9, a dynamic modelling to assess the risk of overheating should be carried out. However, due to the overheating results of SAP showing that there is no significant risk of overheating, it has been considered that a dynamic modelling is not required.

'Be Green': Renewable Energy

Energy Assessment

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Renewable energy feasibility:

In line with Policy 5.7 of the London Plan and Draft New London Plan 'Intend to Publish' version 2019 Policy SI2, the feasibility of renewable energy technologies has been considered. A detailed site-specific analysis and associated carbon saving calculations has also been provided for renewable energy technologies considered feasible.

Renewable energy technology Comparison:

Each technology has been assessed under 5 broader categories. There are key criteria for each category on which the technology is evaluated. The key criteria have been given a weighting based on a tick-system, a graphical representation of this is shown below:

✓✓✓✓✓ = 1 scored out of a possible 5

The weighting of each of the criteria within the categories is shown below:

- Local, site-specific impact: (Maximum score of 4)
 - Local planning criteria = ✓✓
 - Land used by all components = ✓
 - Noise impact from operation = ✓
- Suitability and design impact: (Maximum score of 4)
 - Interaction on the current building design = ✓✓
 - Building orientation suitability = ✓
 - Buildability of installation = ✓
- Economic viability: (Maximum score of 5)
 - Capital cost of all components = ✓✓
 - Grants and funding available = ✓
 - Payback periods (years) 3–5, 5–10, 10–15 = ✓✓✓
- Operation and maintenance: (Maximum score of 3)
 - Servicing requirements (low or high) = ✓
 - Maintenance costs (low or high) = ✓
 - Resource use from future maintenance (low or high) = ✓
- CO₂ and sustainability: (Maximum score of 10)
 - Carbon saving per year = ✓✓✓✓
 - Impact of future grid decarbonisation (gas vs. electric) = ✓✓
 - Local air quality/pollution = ✓✓
 - Resource use of installation = ✓✓

Key comments on each of the criteria and the corresponding score will be provided in a table (example below) for each of the technologies. The score for each of the criteria will be summed and each of the technologies will then be ranked. The assessment of each technology is undertaken on the following pages.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO ₂ and sustainability
	✓✓✓✓	✓✓✓✓	✓✓✓✓✓	✓✓✓	✓✓✓✓✓ ✓✓✓✓✓

'Be Green': Renewable Energy

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Biomass & Biofuel:

Rejected



Biomass is normally considered a carbon 'neutral' fuel, as the carbon dioxide emitted on burning has been recently absorbed from the atmosphere by photosynthesis. Although some form of fossil fuel derived inputs are required in the production and transportation of the fuel.

Wood is seen as a by-product of other industries and the small quantity of energy for drying, sawing, pelleting and delivery are typically discounted. Biomass from coppicing is likely to have external energy inputs from fertiliser, cutting, drying etc. and these may need to be considered. In this toolkit, all biomass fuels are considered to have zero net carbon emissions.

Biomass can be burnt directly to provide heat in buildings. Wood from forests, urban tree pruning, farmed coppices or farm and factory waste, is the most common fuel and is used commercially in the form of wood chips or pellets. Biomass boilers can also be designed to burn smokeless to comply with the Clean Air Acts.

Boilers can be fed automatically by screw drives from fuel hoppers. This typically involves daily addition of bagged fuels.

A biomass boiler could be installed on site for supplementary LTHW heating; however, a major factor influencing the suitability of a biomass boiler is the availability of the biomass fuel. A local and reliable fuel source would be essential for the biomass boiler to be an efficient replacement for a conventional boiler system. Therefore, a very comprehensive feasibility assessment needs to be undertaken to understand the practicalities of such a system.

It is estimated that the heating and hot water demand of the site is too small to meet the required CO₂ emissions reduction if a biomass boiler was a standalone system. Therefore, a biomass boiler would need to be combined with energy demand reduction measures and/or CHP. The likely installed cost would be circa £30,000. The additional cost of providing and storing the bio-fuel also needs to be accounted for. The site is likely to be unsuitable for biomass boilers due to site constraints such as limited transport/access issues, and storage of the biomass fuel. A detailed feasibility study will be required to investigate the suitability.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO ₂ and sustainability
Biomass Boiler	✓✓✓✓ Local air quality impacts, increased transport usage on the restricted site, increased plant space.	✓✓✓✓ Increase in plant space required, orientation fine, slightly increased buildability issues.	✓✓✓✓✓ Increased capital costs of installation, typical payback of 8 years	✓✓✓ Increased maintenance relative to gas boiler, resource use not significantly increased if well serviced.	✓✓✓✓✓✓ Very low carbon intensity of feedstock if properly procured. Decarbonisation impact not applicable, air quality issues.

'Be Green': Renewable Energy

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Photovoltaic (PV):

Rejected



Photovoltaic systems convert energy from the sun into electricity through semi-conductor cells. Systems consist of semi-conductor cells connected together and mounted into modules. Modules are connected to an inverter to turn the direct current (DC) output into alternating current (AC) electricity for use in buildings.

Photovoltaic systems can be discreet through being designed as an integral part of the roof. An 'invisible' design using slates or shingles as opposed to an architectural statement could be preferable in a sensitive area.

Photovoltaic panels supply electricity to the building and are attached to electricity gird or to any other electrical load. Excess electricity can be sold to the National Grid when the generated power exceeds the local need. PV systems require only daylight, not sunlight to generate electricity (although more electricity is produced with more sunlight), so energy can still be produced in overcast or cloudy conditions.

The cost of PV cells is heavily dependent on the size of the array. There are significant cost reductions available for larger installations.

The most suitable location for mounting photovoltaic panels is on roofs as they usually have the greatest exposure to the sun. The proposed site has a small potential useable flat roof area of approximately 45 m². However, the site is located between building and is likely to be overshadowed by the building to its south.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO ₂ and sustainability
Photovoltaic	✓✓✓✓ No local air quality impacts, use of unutilised roof space, conservation officer has concerns for part of the site, no noise issues.	✓✓✓✓ Can be added to the roof, good orientation, and slightly increased buildability issues for wiring and metering.	✓✓✓✓✓ Increased capital costs of installation, typical payback of 8 years, Feed in Tariff available.	✓✓✓ Limited servicing and maintenance i.e. 1 visit per year, inverter will require replacement.	✓✓✓✓✓✓ High carbon saving from electricity, uses minimal grid electricity, no local air impact, high embodied energy of panels.

'Be Green': Renewable Energy

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Solar Thermal:

Rejected



Solar water heating systems use the energy from the sun to heat water for non-domestic hot water needs. The systems use a heat collector, generally mounted on the roof in which a fluid is heated by the sun. This fluid is used to heat up water that is stored in either a separate hot water cylinder or a twin coil hot water cylinder inside the building. The systems work very successfully in all parts of the UK, as they can work in diffuse light conditions.

Like photovoltaic panels the most suitable location for mounting solar hot water panels is on roofs as they usually have the greatest exposure to the sun. The proposed site has a small potential useable flat roof area of approximately 45 m². However, the site is located between building and is likely to be overshadowed by the building to its south.

It is estimated that the CO₂ emissions reduction that would be produced by solar hot water as a standalone system would not be adequate to achieve the required CO₂ emissions reduction target. Therefore, a solar hot water system would need to be combined with more energy efficiency strategies, a CHP or additional renewable technologies to achieve the carbon reduction target.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO ₂ and sustainability
Solar Thermal	✓✓✓✓ No local air quality impacts, use of unutilised roof space, conservation officer has concerns for part of the site, no noise issues.	✓✓✓✓ Can be added to the roof, good orientation, and slightly increased buildability issues for piping and cylinders.	✓✓✓✓✓ Increased capital costs of installation, typical payback of 8 years, Renewable Heat Incentive available.	✓✓✓ Limited servicing and maintenance i.e. 1 visit every two years, heat transfer fluid requires replacing every 10 years.	✓✓✓✓✓✓ Lower carbon saving as primarily displacing gas, uses minimal grid electricity, no local air impact, medium embodied energy of panels.

'Be Green': Renewable Energy

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Wind Energy:

Rejected



Wind energy is a cost effective method of renewable power generation. Wind turbines can produce electricity without carbon dioxide emissions in ranges from watts to megawatt outputs. The most common design is for three blades mounted on a horizontal axis, which is free to rotate into the wind on a tall tower.

The blades drive a generator either directly or via a gearbox to produce electricity. The electricity can either be linked to the grid or charge batteries. An inverter is required to convert the electricity from direct current (DC) to alternating current (AC) for feeding into the grid.

Modern quiet wind turbines are becoming viable in low density areas where ease of maintenance and immediate connection to the grid or direct use of the electricity in a building, may make them cost effective, despite lower wind speeds than open areas.

Wind turbines are generally less suited to dense urban areas as their output will be affected by potentially lower and more disrupted wind speeds, and their use of much more cost effective machines may be prohibited by their proximity to some building types. Small turbines can be used in inner city areas mounted on buildings, although there are relatively few installations.

A detailed wind resource evaluation would be required for the site to fully understand the generation potential and payback period. Also, it is likely that planning restrictions and resistance from small groups within the local community could also affect the viability of wind energy for the project.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO ₂ and sustainability
Wind Energy	✓✓✓✓ No local air quality impacts, use of unutilised roof space, conservation officer will have concerns for the site, minor noise issues.	✓✓✓✓ Can be added to the roof, relatively limited wind speeds in local area, increased buildability issues for wiring and metering.	✓✓✓✓✓ Medium capital costs of installation, typical payback < 5 years, Feed in Tariff available.	✓✓✓ Very limited servicing and maintenance, costs of 2–3% typical.	✓✓✓✓✓ High carbon saving from electricity, output limited from urban installation, consumes little grid electricity, no local air impact, low embodied energy of panels.

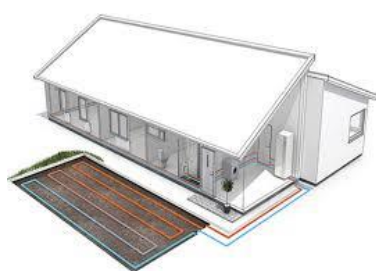
'Be Green': Renewable Energy

Energy Assessment

Antill Road

Ground Source Heat Pump (GSHP):

Rejected



Geo-thermal energy is essentially heat collected from the ground. Heat obtained from the ground may be considered it as a source of heating and cooling within the UK by the use of a geo-thermal heat pump or ground source heat pumps.

A ground source heat pump is a device for converting energy in the form of low level heat to heat at a usable temperature. The heat pump consists of five main parts; ground collector loop/or bores, heat exchanger, compressor, condenser heat exchanger and expansion valve.

At approximately 1.2–1.5 metres down below ground level the temperature is a constant 10 to 12°C. Any bores would need to be sunk to an effective depth of 50 – 120m and a ground feasibility report would be required to ascertain if this method of heat source was viable.

From the bores pre-insulated pipework is laid in the ground to the heat exchanger device. The system is filled with water and antifreeze. The cooled water is pumped around the loop / bore gathering energy as it circulates. The water that has been heated to 10–12°C is returned to the ground source heat exchanger where the energy is transferred to the refrigerant gas. For every 1kW of energy used to compress the refrigerant, the process 'gives up' 4 kW of energy for use in the system being used to heat the building.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO ₂ and sustainability
GSHP	✓✓✓✓✓ No local air quality impacts, not visible so conservation friendly, no noise issues, however the constrained site may prohibit its installation.	✓✓✓✓ Increased buildability issues for pipework and heating emitters internally.	✓✓✓✓✓ High capital costs of installation, typical payback of 15 years where gas is displaced, Renewable Heat Incentive available.	✓✓✓ Limited servicing and maintenance i.e. 1 visit per year, mechanical parts may require replacement over lifespan.	✓✓✓✓✓✓ Limited carbon saving from gas displacement, consumes some electricity so benefits from decarbonisation, no local air impact, high embodied energy of equipment.

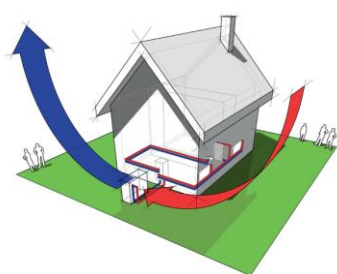
'Be Green': Renewable Energy

Energy Assessment

Antill Road

Air Source Heat Pump (ASHP):

Accepted



Air source heat pump systems work on the same principle as a ground source heat pump although they use the outside air as the heat source.

The coefficients of performance given by air source heat pump systems are inferior to that of ground source systems due to varying air temperatures. In the depth of winter the energy efficiency of an air source system will be lower than that of a ground source system, and it is likely that more back-up heat will be required if an air source unit is fitted. This back-up heat often comes from a direct electric heater. They operate over a varying temperatures range of -15°C to $+25^{\circ}\text{C}$, however, the performance will reduce to below the required 3 to 1 carbon saving ratio in winter, and the also require a defrosting mechanism to melt ice that forms on the air heat exchanger.

ASHPs are cheaper to install than ground source heat pumps but carbon dioxide emission savings will typically be less than that of a ground source heat pump. Typical costs for an installation of this scale are in the region of £5,000.

Air source heat pumps may be more suitable as an HVAC solution for commercial spaces, such as retail and offices which have relatively low heating demands and regular need for cooling. Having a system which is able to both, heat and cool provides versatility and reduces the amount installed plant.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO ₂ and sustainability
ASHP	✓✓✓✓ No local air quality impacts, use of unutilised roof space, conservation officer may have minor concerns over visual impact, no noise issues.	✓✓✓✓ Can be added to the roof, good air-flow on roof, increased buildability issues for pipework and heating emitters internally.	✓✓✓✓✓ Medium– high capital costs of installation, typical payback >15 years where gas is displaced, Renewable Heat Incentive available.	✓✓✓ Limited servicing and maintenance i.e. 1 visit per year, mechanical parts may require replacement over lifespan.	✓✓✓✓✓ ✓✓✓✓✓ Limited carbon saving from gas displacement, less efficient in winter, consumes electricity so benefits from decarbonisation, no local air impact, high embodied energy of equipment.

'Be Green': Summary of Renewable Technologies

Energy Assessment

Antill Road

Summary comparison matrix:

An assessment of the feasibility of each of the technologies is shown below.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO ₂ and sustainability	Total Score
Biomass Boiler	✓✓✓✓	✓✓✓✓	✓✓✓✓✓	✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	15 out of 26
Photovoltaic	✓✓✓✓	✓✓✓✓	✓✓✓✓✓	✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	17 out of 26
Solar Thermal	✓✓✓✓	✓✓✓✓	✓✓✓✓✓	✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	16 out of 26
Wind Energy	✓✓✓✓	✓✓✓✓	✓✓✓✓✓	✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	17 out of 26
GSHP	✓✓✓✓	✓✓✓✓	✓✓✓✓✓	✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	15 out of 26
ASHP	✓✓✓✓	✓✓✓✓	✓✓✓✓✓	✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	16 out of 26

Renewable technology

Conclusion & specification:

Photovoltaic panels and wind energy have scored the best. It is assumed that wind energy would be considered unsuitable for the area and that the local residents would raise concerns over potential noise and turbulence.

Photovoltaic panels for the scheme have been excluded since the site is located between building and is likely to be overshadowed by the building to its south.

Air source heat pumps have scored lower due to their lower economic viability. However, these systems require low maintenance after installation. Therefore, after the initial investment is made these systems keep the running costs to a minimum.

An air source heat pump was accepted for the scheme and will provide both heating and hot water.

Conclusion

Energy Assessment

Antill Road

Summary

The baseline carbon emissions for the whole scheme are 1.90 tonnes CO₂/yr (using draft SAP 10 carbon dioxide emission factors).

As demonstrated, the development will reduce carbon emissions by 59% (using draft SAP 10 carbon dioxide emission factors) over Part L 2013 Building Regulations, with the further inclusion of the proposed ASHP for the dwelling.

Therefore, this document demonstrates compliance with policies outlined in the London Plan (2016), Draft New London Plan 'Intend to Publish' version 2019, Haringey's Local Plan – Strategic Policies (2013 with alterations adopted July 2017) and Development Management DPD (adopted July 2017).

GLA's Energy Hierarchy: regulated carbon emissions Calculated using draft SAP 10 carbon dioxide emission factors				
	Baseline:	Be lean:	Be clean:	Be green:
CO ₂ emissions (tCO ₂ /yr)	1.90	1.74	–	0.78
CO ₂ emissions saving (tCO ₂ /yr)	–	0.15	–	0.97
Saving from each stage (%)	–	8.1	–	50.9
Total CO ₂ emissions saving (tCO ₂ /yr)		1.12		
59% total carbon emissions savings over 2013 Building Regulations Part L achieved (using draft SAP 10 factors)				

Appendix A – Input Sheet

Energy Assessment

Antill Road

Input	Be Lean	Be Clean	Be Green
Exposed / External Floors		0.12 W/m²K	
External Walls		0.14 W/m²K	
Roofs		0.12 W/m²K	
Air permeability		3.m³/hour/m²	
Windows & rooflight		1.30 W/m²K, g-value 0.50	
Thermal Bridging	The dwelling will be designed in line with the accredited construction details (ACD) and therefore it has been indicatively modelled with the accredited thermal bridge Psi-values for the following junctions: • Lintels (E2) • Sill (E3) • Jambs (E4), • Ground floor (E5) • Party floor within a dwelling (E6) • Corners (E16) • Inverted corner (E17) • Party wall between dwellings (E18) The default psi-value has been used for the remaining junctions.		
Mechanical ventilation	Mechanical ventilation with heat recovery has been specified for the dwelling which has two wet rooms and has been modelled with a SFP of 0.54 W/l/s and a heat recovery efficiency of 90%.		
Space Heating	Gas Boiler with 89.5% efficiency	Mitsubishi Ecodan PUHZ-HW50-140VHA2-YHA2-BS with 5KW capacity	
Cooling	No cooling will be provided.		
Hot water	Provided by the main heating system (boiler with notional efficiency)	Same as heating system. Hot water storage cylinder has been modelled to be 150 litres with a specified loss factor of 1.26 kWh/day	
Lighting	Minimum luminaire efficacy of 75 lumens/Watt		

Appendix B – SAP Energy Assessment Antill Road

Further Information:

The emission figures and details of the calculations and methodology used to determine the figures provided within the report can be found in the following pages:

Baseline– TER from the TER SAP worksheet

Be Lean– DER from the Be Lean scenario DER SAP worksheet

Be Green–DER from the Be Green scenario DER SAP worksheet

Appendix B – SAP Energy Assessment Antill Road

Baseline TER Worksheet

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name: Chris Hocknell **Stroma Number:** STRO016363
Software Name: Stroma FSAP 2012 **Software Version:** Version: 1.0.4.23

Property Address: Antill Road

Address :

1. Overall dwelling dimensions:

	Area(m ²)		Av. Height(m)		Volume(m ³)
Ground floor	48.97 (1a)	x	3.5 (2a)	=	171.4 (3a)
First floor	47.72 (1b)	x	3 (2b)	=	143.16 (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	96.69 (4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	314.56 (5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m ³ per hour
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0 (6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0 (6b)
Number of intermittent fans							3	x 10 =	30 (7a)
Number of passive vents							0	x 10 =	0 (7b)
Number of flueless gas fires							0	x 40 =	0 (7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30	÷ (5) =	0.1 (8)
<i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>			
Number of storeys in the dwelling (ns)			0 (9)
Additional infiltration		[(9)-1]x0.1 =	0 (10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction			0 (11)
<i>if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35</i>			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0			0 (12)
If no draught lobby, enter 0.05, else enter 0			0 (13)
Percentage of windows and doors draught stripped			0 (14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =		0 (15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =		0 (16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area			5 (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)			0.35 (18)
<i>Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used</i>			
Number of sides sheltered			2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =		0.85 (20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =		0.29 (21)

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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TER WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
---------	------	------	------	-----	------	------	------	------	---	------	------	------

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

	0.37	0.37	0.36	0.32	0.32	0.28	0.28	0.27	0.29	0.32	0.33	0.34
--	------	------	------	------	------	------	------	------	------	------	------	------

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)

0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =

0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0
---------	---	---	---	---	---	---	---	---	---	---	---	---

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0
---------	---	---	---	---	---	---	---	---	---	---	---	---

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0
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d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56
---------	------	------	------	------	------	------	------	------	------	------	------	------

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m=	0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56
--------	------	------	------	------	------	------	------	------	------	------	------	------

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²	U-value W/m²K	A X U (W/K)	k-value kJ/m²·K	A X k kJ/K
Doors			2.14	x 1	= 2.14		(26)
Windows Type 1			1.51	x1/[1/(1.4)+ 0.04] =	2		(27)
Windows Type 2			1.97	x1/[1/(1.4)+ 0.04] =	2.61		(27)
Windows Type 3			0.49	x1/[1/(1.4)+ 0.04] =	0.65		(27)
Windows Type 4			1.21	x1/[1/(1.4)+ 0.04] =	1.6		(27)
Windows Type 5			2.29	x1/[1/(1.4)+ 0.04] =	3.04		(27)
Windows Type 6			3.37	x1/[1/(1.4)+ 0.04] =	4.47		(27)
Windows Type 7			0.9	x1/[1/(1.4)+ 0.04] =	1.19		(27)
Windows Type 8			0.82	x1/[1/(1.4)+ 0.04] =	1.09		(27)
Windows Type 9			0.88	x1/[1/(1.4)+ 0.04] =	1.17		(27)
Windows Type 10			0.93	x1/[1/(1.4)+ 0.04] =	1.23		(27)
Windows Type 11			0.82	x1/[1/(1.4)+ 0.04] =	1.09		(27)
Floor			48.97	x 0.13	= 6.3661		(28)
Walls	138.88	24.15	114.73	x 0.18	= 20.65		(29)
Roof	48.97	0	48.97	x 0.13	= 6.37		(30)
Total area of elements, m²			236.82				(31)
Party wall			51.5	x 0	= 0		(32)

TER WorkSheet: New dwelling design stage

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = $S(A \times U)$ (26)...(30) + (32) =

64.7

 (33)

Heat capacity $C_m = S(A \times k)$ ((28)...(30) + (32) + (32a)...(32e) =

32306.93

 (34)

Thermal mass parameter (TMP = $C_m \div TFA$) in kJ/m²K Indicative Value: Medium

250

 (35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.

Thermal bridges : $S(L \times Y)$ calculated using Appendix K

29.23

 (36)

if details of thermal bridging are not known (36) = $0.05 \times (31)$

Total fabric heat loss (33) + (36) =

93.93

 (37)

Ventilation heat loss calculated monthly (38)m = $0.33 \times (25)m \times (5)$

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	59.17	58.89	58.61	57.31	57.07	55.94	55.94	55.73	56.37	57.07	57.56	58.08	(38)

Heat transfer coefficient, W/K (39)m = (37) + (38)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(39)m=	153.1	152.82	152.55	151.25	151	149.87	149.87	149.66	150.31	151	151.49	152.01	
Average = $\text{Sum}(39)_{1...12} / 12 =$												151.24	(39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m + (4)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(40)m=	1.58	1.58	1.58	1.56	1.56	1.55	1.55	1.55	1.55	1.56	1.57	1.57	
Average = $\text{Sum}(40)_{1...12} / 12 =$												1.56	(40)

Number of days in month (Table 1a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement:

kWh/year:

Assumed occupancy, N

2.71

 (42)

if $TFA > 13.9$, $N = 1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$

if $TFA \leq 13.9$, $N = 1$

Annual average hot water usage in litres per day $V_{d, \text{average}} = (25 \times N) + 36$

98.48

 (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	108.33	104.39	100.45	96.51	92.58	88.64	88.64	92.58	96.51	100.45	104.39	108.33	
Total = $\text{Sum}(44)_{1...12} =$												1181.81	(44)

Energy content of hot water used - calculated monthly = $4.190 \times V_{d,m} \times n_m \times DT_m / 3600$ kWh/month (see Tables 1b, 1c, 1d)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(45)m=	160.65	140.51	144.99	126.41	121.29	104.67	96.99	111.3	112.62	131.25	143.27	155.58	
Total = $\text{Sum}(45)_{1...12} =$												1549.54	(45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(46)m=	24.1	21.08	21.75	18.96	18.19	15.7	14.55	16.69	16.89	19.69	21.49	23.34	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel

0

 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

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

0

 (48)

Temperature factor from Table 2b

0

 (49)

TER WorkSheet: New dwelling design stage

Energy lost from water storage, kWh/year	(48) x (49) =	0	(50)
b) If manufacturer's declared cylinder loss factor is not known:			
Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)
If community heating see section 4.3			
Volume factor from Table 2a		0	(52)
Temperature factor from Table 2b		0	(53)
Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		0	(55)
Water storage loss calculated for each month	((56)m = (55) x (41)m		
(56)m=		0	0
If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) - (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H			
(57)m=		0	0
Primary circuit loss (annual) from Table 3		0	(58)
Primary circuit loss calculated for each month (59)m = (58) ÷ 365 x (41)m			
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)			
(59)m=		0	0
Combi loss calculated for each month (61)m = (60) ÷ 365 x (41)m			
(61)m=		50.96	46.03
Total heat required for water heating calculated for each month (62)m = 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m			
(62)m=		211.61	186.54
Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)			
(add additional lines if FGHRs and/or WWHRs applies, see Appendix G)			
(63)m=		0	0
Output from water heater			
(64)m=		211.61	186.54
			Output from water heater (annual) ^{1...12}
			2127.14
Heat gains from water heating, kWh/month 0.25 ´ [0.85 x (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]			
(65)m=		66.16	58.23
include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating			

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=	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												
(67)m=	22.36	19.86	16.15	12.23	9.14	7.72	8.34	10.84	14.55	18.47	21.56	22.99
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												
(68)m=	250.86	253.47	246.91	232.94	215.31	198.74	187.68	185.07	191.63	205.6	223.23	239.79
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												
(69)m=	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53
Pumps and fans gains (Table 5a)												
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3
Losses e.g. evaporation (negative values) (Table 5)												
(71)m=	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27

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Water heating gains (Table 5)

(72)m=	88.92	86.65	81.92	74.9	70.06	63.51	58.52	65.59	68.54	75.78	83.29	86.66	(72)
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Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=	428.75	426.58	411.58	386.67	361.11	336.57	321.14	328.1	341.32	366.45	394.68	416.04	(73)
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6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Orientation:	Access Factor Table 6d		Area m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast 0.9x	0.77	x	1.51	x	11.28	x	0.63	x	0.7	=	20.83	(75)
Northeast 0.9x	0.77	x	1.97	x	11.28	x	0.63	x	0.7	=	6.79	(75)
Northeast 0.9x	0.77	x	0.49	x	11.28	x	0.63	x	0.7	=	1.69	(75)
Northeast 0.9x	0.77	x	1.21	x	11.28	x	0.63	x	0.7	=	4.17	(75)
Northeast 0.9x	0.77	x	1.51	x	22.97	x	0.63	x	0.7	=	42.39	(75)
Northeast 0.9x	0.77	x	1.97	x	22.97	x	0.63	x	0.7	=	13.83	(75)
Northeast 0.9x	0.77	x	0.49	x	22.97	x	0.63	x	0.7	=	3.44	(75)
Northeast 0.9x	0.77	x	1.21	x	22.97	x	0.63	x	0.7	=	8.49	(75)
Northeast 0.9x	0.77	x	1.51	x	41.38	x	0.63	x	0.7	=	76.38	(75)
Northeast 0.9x	0.77	x	1.97	x	41.38	x	0.63	x	0.7	=	24.91	(75)
Northeast 0.9x	0.77	x	0.49	x	41.38	x	0.63	x	0.7	=	6.2	(75)
Northeast 0.9x	0.77	x	1.21	x	41.38	x	0.63	x	0.7	=	15.3	(75)
Northeast 0.9x	0.77	x	1.51	x	67.96	x	0.63	x	0.7	=	125.44	(75)
Northeast 0.9x	0.77	x	1.97	x	67.96	x	0.63	x	0.7	=	40.91	(75)
Northeast 0.9x	0.77	x	0.49	x	67.96	x	0.63	x	0.7	=	10.18	(75)
Northeast 0.9x	0.77	x	1.21	x	67.96	x	0.63	x	0.7	=	25.13	(75)
Northeast 0.9x	0.77	x	1.51	x	91.35	x	0.63	x	0.7	=	168.62	(75)
Northeast 0.9x	0.77	x	1.97	x	91.35	x	0.63	x	0.7	=	55	(75)
Northeast 0.9x	0.77	x	0.49	x	91.35	x	0.63	x	0.7	=	13.68	(75)
Northeast 0.9x	0.77	x	1.21	x	91.35	x	0.63	x	0.7	=	33.78	(75)
Northeast 0.9x	0.77	x	1.51	x	97.38	x	0.63	x	0.7	=	179.76	(75)
Northeast 0.9x	0.77	x	1.97	x	97.38	x	0.63	x	0.7	=	58.63	(75)
Northeast 0.9x	0.77	x	0.49	x	97.38	x	0.63	x	0.7	=	14.58	(75)
Northeast 0.9x	0.77	x	1.21	x	97.38	x	0.63	x	0.7	=	36.01	(75)
Northeast 0.9x	0.77	x	1.51	x	91.1	x	0.63	x	0.7	=	168.16	(75)
Northeast 0.9x	0.77	x	1.97	x	91.1	x	0.63	x	0.7	=	54.85	(75)
Northeast 0.9x	0.77	x	0.49	x	91.1	x	0.63	x	0.7	=	13.64	(75)
Northeast 0.9x	0.77	x	1.21	x	91.1	x	0.63	x	0.7	=	33.69	(75)
Northeast 0.9x	0.77	x	1.51	x	72.63	x	0.63	x	0.7	=	134.06	(75)
Northeast 0.9x	0.77	x	1.97	x	72.63	x	0.63	x	0.7	=	43.73	(75)
Northeast 0.9x	0.77	x	0.49	x	72.63	x	0.63	x	0.7	=	10.88	(75)
Northeast 0.9x	0.77	x	1.21	x	72.63	x	0.63	x	0.7	=	26.86	(75)

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Northeast 0.9x	0.77	x	1.51	x	50.42	x	0.63	x	0.7	=	93.07	(75)
Northeast 0.9x	0.77	x	1.97	x	50.42	x	0.63	x	0.7	=	30.36	(75)
Northeast 0.9x	0.77	x	0.49	x	50.42	x	0.63	x	0.7	=	7.55	(75)
Northeast 0.9x	0.77	x	1.21	x	50.42	x	0.63	x	0.7	=	18.65	(75)
Northeast 0.9x	0.77	x	1.51	x	28.07	x	0.63	x	0.7	=	51.81	(75)
Northeast 0.9x	0.77	x	1.97	x	28.07	x	0.63	x	0.7	=	16.9	(75)
Northeast 0.9x	0.77	x	0.49	x	28.07	x	0.63	x	0.7	=	4.2	(75)
Northeast 0.9x	0.77	x	1.21	x	28.07	x	0.63	x	0.7	=	10.38	(75)
Northeast 0.9x	0.77	x	1.51	x	14.2	x	0.63	x	0.7	=	26.21	(75)
Northeast 0.9x	0.77	x	1.97	x	14.2	x	0.63	x	0.7	=	8.55	(75)
Northeast 0.9x	0.77	x	0.49	x	14.2	x	0.63	x	0.7	=	2.13	(75)
Northeast 0.9x	0.77	x	1.21	x	14.2	x	0.63	x	0.7	=	5.25	(75)
Northeast 0.9x	0.77	x	1.51	x	9.21	x	0.63	x	0.7	=	17.01	(75)
Northeast 0.9x	0.77	x	1.97	x	9.21	x	0.63	x	0.7	=	5.55	(75)
Northeast 0.9x	0.77	x	0.49	x	9.21	x	0.63	x	0.7	=	1.38	(75)
Northeast 0.9x	0.77	x	1.21	x	9.21	x	0.63	x	0.7	=	3.41	(75)
Southeast 0.9x	0.77	x	0.82	x	36.79	x	0.63	x	0.7	=	9.22	(77)
Southeast 0.9x	0.77	x	0.88	x	36.79	x	0.63	x	0.7	=	9.9	(77)
Southeast 0.9x	0.77	x	0.93	x	36.79	x	0.63	x	0.7	=	10.46	(77)
Southeast 0.9x	0.77	x	0.82	x	62.67	x	0.63	x	0.7	=	15.71	(77)
Southeast 0.9x	0.77	x	0.88	x	62.67	x	0.63	x	0.7	=	16.86	(77)
Southeast 0.9x	0.77	x	0.93	x	62.67	x	0.63	x	0.7	=	17.81	(77)
Southeast 0.9x	0.77	x	0.82	x	85.75	x	0.63	x	0.7	=	21.49	(77)
Southeast 0.9x	0.77	x	0.88	x	85.75	x	0.63	x	0.7	=	23.06	(77)
Southeast 0.9x	0.77	x	0.93	x	85.75	x	0.63	x	0.7	=	24.37	(77)
Southeast 0.9x	0.77	x	0.82	x	106.25	x	0.63	x	0.7	=	26.63	(77)
Southeast 0.9x	0.77	x	0.88	x	106.25	x	0.63	x	0.7	=	28.58	(77)
Southeast 0.9x	0.77	x	0.93	x	106.25	x	0.63	x	0.7	=	30.2	(77)
Southeast 0.9x	0.77	x	0.82	x	119.01	x	0.63	x	0.7	=	29.82	(77)
Southeast 0.9x	0.77	x	0.88	x	119.01	x	0.63	x	0.7	=	32.01	(77)
Southeast 0.9x	0.77	x	0.93	x	119.01	x	0.63	x	0.7	=	33.83	(77)
Southeast 0.9x	0.77	x	0.82	x	118.15	x	0.63	x	0.7	=	29.61	(77)
Southeast 0.9x	0.77	x	0.88	x	118.15	x	0.63	x	0.7	=	31.78	(77)
Southeast 0.9x	0.77	x	0.93	x	118.15	x	0.63	x	0.7	=	33.58	(77)
Southeast 0.9x	0.77	x	0.82	x	113.91	x	0.63	x	0.7	=	28.55	(77)
Southeast 0.9x	0.77	x	0.88	x	113.91	x	0.63	x	0.7	=	30.63	(77)
Southeast 0.9x	0.77	x	0.93	x	113.91	x	0.63	x	0.7	=	32.38	(77)
Southeast 0.9x	0.77	x	0.82	x	104.39	x	0.63	x	0.7	=	26.16	(77)
Southeast 0.9x	0.77	x	0.88	x	104.39	x	0.63	x	0.7	=	28.07	(77)
Southeast 0.9x	0.77	x	0.93	x	104.39	x	0.63	x	0.7	=	29.67	(77)
Southeast 0.9x	0.77	x	0.82	x	92.85	x	0.63	x	0.7	=	23.27	(77)

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Southeast	0.9x	0.77	x	0.88	x	92.85	x	0.63	x	0.7	=	24.97	(77)
Southeast	0.9x	0.77	x	0.93	x	92.85	x	0.63	x	0.7	=	26.39	(77)
Southeast	0.9x	0.77	x	0.82	x	69.27	x	0.63	x	0.7	=	17.36	(77)
Southeast	0.9x	0.77	x	0.88	x	69.27	x	0.63	x	0.7	=	18.63	(77)
Southeast	0.9x	0.77	x	0.93	x	69.27	x	0.63	x	0.7	=	19.69	(77)
Southeast	0.9x	0.77	x	0.82	x	44.07	x	0.63	x	0.7	=	11.04	(77)
Southeast	0.9x	0.77	x	0.88	x	44.07	x	0.63	x	0.7	=	11.85	(77)
Southeast	0.9x	0.77	x	0.93	x	44.07	x	0.63	x	0.7	=	12.53	(77)
Southeast	0.9x	0.77	x	0.82	x	31.49	x	0.63	x	0.7	=	7.89	(77)
Southeast	0.9x	0.77	x	0.88	x	31.49	x	0.63	x	0.7	=	8.47	(77)
Southeast	0.9x	0.77	x	0.93	x	31.49	x	0.63	x	0.7	=	8.95	(77)
Southwest	0.9x	0.77	x	2.29	x	36.79		0.63	x	0.7	=	51.5	(79)
Southwest	0.9x	0.77	x	3.37	x	36.79		0.63	x	0.7	=	37.89	(79)
Southwest	0.9x	0.77	x	0.9	x	36.79		0.63	x	0.7	=	10.12	(79)
Southwest	0.9x	0.77	x	2.29	x	62.67		0.63	x	0.7	=	87.72	(79)
Southwest	0.9x	0.77	x	3.37	x	62.67		0.63	x	0.7	=	64.55	(79)
Southwest	0.9x	0.77	x	0.9	x	62.67		0.63	x	0.7	=	17.24	(79)
Southwest	0.9x	0.77	x	2.29	x	85.75		0.63	x	0.7	=	120.03	(79)
Southwest	0.9x	0.77	x	3.37	x	85.75		0.63	x	0.7	=	88.32	(79)
Southwest	0.9x	0.77	x	0.9	x	85.75		0.63	x	0.7	=	23.59	(79)
Southwest	0.9x	0.77	x	2.29	x	106.25		0.63	x	0.7	=	148.72	(79)
Southwest	0.9x	0.77	x	3.37	x	106.25		0.63	x	0.7	=	109.43	(79)
Southwest	0.9x	0.77	x	0.9	x	106.25		0.63	x	0.7	=	29.22	(79)
Southwest	0.9x	0.77	x	2.29	x	119.01		0.63	x	0.7	=	166.58	(79)
Southwest	0.9x	0.77	x	3.37	x	119.01		0.63	x	0.7	=	122.57	(79)
Southwest	0.9x	0.77	x	0.9	x	119.01		0.63	x	0.7	=	32.73	(79)
Southwest	0.9x	0.77	x	2.29	x	118.15		0.63	x	0.7	=	165.38	(79)
Southwest	0.9x	0.77	x	3.37	x	118.15		0.63	x	0.7	=	121.68	(79)
Southwest	0.9x	0.77	x	0.9	x	118.15		0.63	x	0.7	=	32.5	(79)
Southwest	0.9x	0.77	x	2.29	x	113.91		0.63	x	0.7	=	159.44	(79)
Southwest	0.9x	0.77	x	3.37	x	113.91		0.63	x	0.7	=	117.32	(79)
Southwest	0.9x	0.77	x	0.9	x	113.91		0.63	x	0.7	=	31.33	(79)
Southwest	0.9x	0.77	x	2.29	x	104.39		0.63	x	0.7	=	146.12	(79)
Southwest	0.9x	0.77	x	3.37	x	104.39		0.63	x	0.7	=	107.51	(79)
Southwest	0.9x	0.77	x	0.9	x	104.39		0.63	x	0.7	=	28.71	(79)
Southwest	0.9x	0.77	x	2.29	x	92.85		0.63	x	0.7	=	129.97	(79)
Southwest	0.9x	0.77	x	3.37	x	92.85		0.63	x	0.7	=	95.63	(79)
Southwest	0.9x	0.77	x	0.9	x	92.85		0.63	x	0.7	=	25.54	(79)
Southwest	0.9x	0.77	x	2.29	x	69.27		0.63	x	0.7	=	96.95	(79)
Southwest	0.9x	0.77	x	3.37	x	69.27		0.63	x	0.7	=	71.34	(79)
Southwest	0.9x	0.77	x	0.9	x	69.27		0.63	x	0.7	=	19.05	(79)

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Southwest 0.9x	0.77	x	2.29	x	44.07	0.63	x	0.7	=	61.69	(79)
Southwest 0.9x	0.77	x	3.37	x	44.07	0.63	x	0.7	=	45.39	(79)
Southwest 0.9x	0.77	x	0.9	x	44.07	0.63	x	0.7	=	12.12	(79)
Southwest 0.9x	0.77	x	2.29	x	31.49	0.63	x	0.7	=	44.07	(79)
Southwest 0.9x	0.77	x	3.37	x	31.49	0.63	x	0.7	=	32.43	(79)
Southwest 0.9x	0.77	x	0.9	x	31.49	0.63	x	0.7	=	8.66	(79)
Northwest 0.9x	0.77	x	0.82	x	11.28	0.63	x	0.7	=	2.83	(81)
Northwest 0.9x	0.77	x	0.82	x	22.97	0.63	x	0.7	=	5.76	(81)
Northwest 0.9x	0.77	x	0.82	x	41.38	0.63	x	0.7	=	10.37	(81)
Northwest 0.9x	0.77	x	0.82	x	67.96	0.63	x	0.7	=	17.03	(81)
Northwest 0.9x	0.77	x	0.82	x	91.35	0.63	x	0.7	=	22.89	(81)
Northwest 0.9x	0.77	x	0.82	x	97.38	0.63	x	0.7	=	24.4	(81)
Northwest 0.9x	0.77	x	0.82	x	91.1	0.63	x	0.7	=	22.83	(81)
Northwest 0.9x	0.77	x	0.82	x	72.63	0.63	x	0.7	=	18.2	(81)
Northwest 0.9x	0.77	x	0.82	x	50.42	0.63	x	0.7	=	12.64	(81)
Northwest 0.9x	0.77	x	0.82	x	28.07	0.63	x	0.7	=	7.03	(81)
Northwest 0.9x	0.77	x	0.82	x	14.2	0.63	x	0.7	=	3.56	(81)
Northwest 0.9x	0.77	x	0.82	x	9.21	0.63	x	0.7	=	2.31	(81)

Solar gains in watts, calculated for each month

(83)m = Sum(74)m ... (82)m

(83)m=	165.4	293.8	434.02	591.47	711.5	727.92	692.82	599.97	488.02	333.34	200.31	140.13	(83)
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Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	594.15	720.37	845.6	978.14	1072.62	1064.49	1013.95	928.07	829.34	699.8	594.98	556.16	(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 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.99	0.96	0.89	0.76	0.6	0.67	0.88	0.98	1	1	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	19.23	19.43	19.76	20.19	20.59	20.86	20.96	20.94	20.72	20.2	19.63	19.2	(87)
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Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	19.63	19.63	19.63	19.64	19.64	19.65	19.65	19.65	19.65	19.64	19.64	19.63	(88)
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Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	0.99	0.98	0.94	0.84	0.65	0.44	0.5	0.8	0.96	0.99	1	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	17.31	17.6	18.08	18.71	19.25	19.56	19.64	19.63	19.42	18.73	17.91	17.27	(90)
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fLA = Living area ÷ (4) = 0.15 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	17.61	17.88	18.34	18.94	19.46	19.76	19.84	19.83	19.62	18.95	18.17	17.56	(92)
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Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	17.61	17.88	18.34	18.94	19.46	19.76	19.84	19.83	19.62	18.95	18.17	17.56	(93)
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8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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Utilisation factor for gains, hm:

(94)m=	0.99	0.99	0.97	0.93	0.83	0.66	0.47	0.53	0.8	0.95	0.99	1	(94)
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Useful gains, hmGm , W = (94)m x (84)m

(95)m=	590.8	711.75	822.34	909.35	892.43	699.03	471.75	490.47	663.04	667.96	588.58	553.72	(95)
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Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
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Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]

(97)m=	2037.55	1984.11	1805.97	1518.28	1171.03	773.27	485.53	513.23	830.07	1261.54	1677.57	2031.56	(97)
--------	---------	---------	---------	---------	---------	--------	--------	--------	--------	---------	---------	---------	------

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	1076.38	855.03	731.82	438.43	207.27	0	0	0	0	441.62	784.08	1099.51	(98)
--------	---------	--------	--------	--------	--------	---	---	---	---	--------	--------	---------	------

Total per year (kWh/year) = Sum(98)_{1...5,9...12} = 5634.15 (98)

Space heating requirement in kWh/m²/year

58.27 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system 0 (201)

Fraction of space heat from main system(s) (202) = 1 – (201) = 1 (202)

Fraction of total heating from main system 1 (204) = (202) × [1 – (203)] = 1 (204)

Efficiency of main space heating system 1 93.4 (206)

Efficiency of secondary/supplementary heating system, % 0 (208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----------

Space heating requirement (calculated above)

1076.38	855.03	731.82	438.43	207.27	0	0	0	0	441.62	784.08	1099.51
---------	--------	--------	--------	--------	---	---	---	---	--------	--------	---------

(211)m = {[(98)m x (204)] } x 100 ÷ (206) (211)

1152.44	915.45	783.54	469.41	221.92	0	0	0	0	472.83	839.48	1177.21
---------	--------	--------	--------	--------	---	---	---	---	--------	--------	---------

Total (kWh/year) =Sum(211)_{1...5,10...12} = 6032.28 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	(215)
---------	---	---	---	---	---	---	---	---	---	---	---	-------

Total (kWh/year) =Sum(215)_{1...5,10...12} = 0 (215)

Water heating

Output from water heater (calculated above)

211.61	186.54	195.95	174	168.47	148.38	142.16	158.47	160.22	182.21	192.59	206.54
--------	--------	--------	-----	--------	--------	--------	--------	--------	--------	--------	--------

Efficiency of water heater 80.3 (216)

(217)m=	88.57	88.41	88.06	87.28	85.57	80.3	80.3	80.3	80.3	87.2	88.21	88.64	(217)
---------	-------	-------	-------	-------	-------	------	------	------	------	------	-------	-------	-------

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	238.92	210.99	222.52	199.36	196.87	184.78	177.03	197.35	199.53	208.97	218.32	233.02	(219)
---------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------

Total = Sum(219a)_{1...12} = 2487.66 (219)

Annual totals

kWh/year kWh/year

Space heating fuel used, main system 1 6032.28

Water heating fuel used 2487.66

Electricity for pumps, fans and electric keep-hot

TER WorkSheet: New dwelling design stage

central heating pump:		30	(230c)
boiler with a fan-assisted flue		45	(230e)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =	75	(231)
Electricity for lighting		394.97	(232)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x	0.216	=	1302.97	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	537.33	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1840.31	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	204.99	(268)
Total CO2, kg/year		sum of (265)...(271) =		2084.22	(272)
TER =				21.56	(273)

Appendix B – SAP Energy Assessment Antill Road

Lean – DER Worksheet

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name: Chris Hocknell **Stroma Number:** STRO016363
Software Name: Stroma FSAP 2012 **Software Version:** Version: 1.0.4.23

Property Address: Antill Road

Address :

1. Overall dwelling dimensions:

	Area(m ²)		Av. Height(m)		Volume(m ³)
Ground floor	48.97 (1a)	x	3.5 (2a)	=	171.4 (3a)
First floor	47.72 (1b)	x	3 (2b)	=	143.16 (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	96.69 (4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	314.56 (5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m ³ per hour
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0 (6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0 (6b)
Number of intermittent fans							0	x 10 =	0 (7a)
Number of passive vents							0	x 10 =	0 (7b)
Number of flueless gas fires							0	x 40 =	0 (7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0 (8)
<i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>			
Number of storeys in the dwelling (ns)			0 (9)
Additional infiltration		[(9)-1]x0.1 =	0 (10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction			0 (11)
<i>if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35</i>			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0			0 (12)
If no draught lobby, enter 0.05, else enter 0			0 (13)
Percentage of windows and doors draught stripped			0 (14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =		0 (15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =		0 (16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area			3 (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)			0.15 (18)
<i>Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used</i>			
Number of sides sheltered			2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =		0.85 (20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =		0.13 (21)

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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DER WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
---------	------	------	------	-----	------	------	------	------	---	------	------	------

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15
--	------	------	------	------	------	------	------	------	------	------	------	------

Calculate effective air change rate for the applicable case

If mechanical ventilation:

0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)

0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =

76.5 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

(24a)m=	0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.25	0.26	0.27
---------	------	------	------	------	------	------	------	------	------	------	------	------

(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0
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(24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0
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(24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0	0	0	0	0	0	0	0	0	0	0	0
---------	---	---	---	---	---	---	---	---	---	---	---	---

(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m=	0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.25	0.26	0.27
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(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²	U-value W/m²K	A X U (W/K)	k-value kJ/m²·K	A X k kJ/K
Doors			2.14	x 1	= 2.14		(26)
Windows Type 1			1.68	x1/[1/(1.3)+ 0.04] =	2.08		(27)
Windows Type 2			2.19	x1/[1/(1.3)+ 0.04] =	2.71		(27)
Windows Type 3			0.54	x1/[1/(1.3)+ 0.04] =	0.67		(27)
Windows Type 4			1.34	x1/[1/(1.3)+ 0.04] =	1.66		(27)
Windows Type 5			2.54	x1/[1/(1.3)+ 0.04] =	3.14		(27)
Windows Type 6			3.74	x1/[1/(1.3)+ 0.04] =	4.62		(27)
Windows Type 7			1	x1/[1/(1.3)+ 0.04] =	1.24		(27)
Windows Type 8			0.91	x1/[1/(1.3)+ 0.04] =	1.12		(27)
Windows Type 9			0.98	x1/[1/(1.3)+ 0.04] =	1.21		(27)
Windows Type 10			1.03	x1/[1/(1.3)+ 0.04] =	1.27		(27)
Windows Type 11			0.91	x1/[1/(1.3)+ 0.04] =	1.12		(27)
Floor			48.97	x 0.12	= 5.8764		(28)
Walls	138.88	26.58	112.3	x 0.14	= 15.72		(29)
Roof	48.97	0	48.97	x 0.12	= 5.88		(30)
Total area of elements, m²			236.82				(31)
Party wall			51.5	x 0	= 0		(32)

DER WorkSheet: New dwelling design stage

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = $S (A \times U)$ (26)...(30) + (32) =

59.82

 (33)

Heat capacity $C_m = S(A \times k)$ ((28)...(30) + (32) + (32a)...(32e) =

31942.43

 (34)

Thermal mass parameter (TMP = $C_m \div TFA$) in kJ/m²K Indicative Value: Medium

250

 (35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.

Thermal bridges : $S (L \times Y)$ calculated using Appendix K

36.28

 (36)

if details of thermal bridging are not known (36) = $0.05 \times (31)$

Total fabric heat loss (33) + (36) =

96.1

 (37)

Ventilation heat loss calculated monthly (38)m = $0.33 \times (25)m \times (5)$

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	29.07	28.74	28.41	26.76	26.42	24.77	24.77	24.44	25.43	26.42	27.09	27.75	(38)

Heat transfer coefficient, W/K (39)m = (37) + (38)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(39)m=	125.17	124.84	124.51	122.85	122.52	120.87	120.87	120.54	121.53	122.52	123.18	123.84	
Average = $\text{Sum}(39)_{1...12} / 12 =$												122.77	(39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m + (4)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(40)m=	1.29	1.29	1.29	1.27	1.27	1.25	1.25	1.25	1.26	1.27	1.27	1.28	
Average = $\text{Sum}(40)_{1...12} / 12 =$												1.27	(40)

Number of days in month (Table 1a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement:

kWh/year:

Assumed occupancy, N

2.71

 (42)

if $TFA > 13.9$, $N = 1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$

if $TFA \leq 13.9$, $N = 1$

Annual average hot water usage in litres per day $V_{d, \text{average}} = (25 \times N) + 36$

98.48

 (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	108.33	104.39	100.45	96.51	92.58	88.64	88.64	92.58	96.51	100.45	104.39	108.33	
Total = $\text{Sum}(44)_{1...12} =$												1181.81	(44)

Energy content of hot water used - calculated monthly = $4.190 \times V_{d,m} \times n_m \times DT_m / 3600$ kWh/month (see Tables 1b, 1c, 1d)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(45)m=	160.65	140.51	144.99	126.41	121.29	104.67	96.99	111.3	112.62	131.25	143.27	155.58	
Total = $\text{Sum}(45)_{1...12} =$												1549.54	(45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(46)m=	24.1	21.08	21.75	18.96	18.19	15.7	14.55	16.69	16.89	19.69	21.49	23.34	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel

0

 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

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

0

 (48)

Temperature factor from Table 2b

0

 (49)

DER WorkSheet: New dwelling design stage

Energy lost from water storage, kWh/year	(48) x (49) =	0	(50)												
b) If manufacturer's declared cylinder loss factor is not known:															
Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)												
If community heating see section 4.3															
Volume factor from Table 2a		0	(52)												
Temperature factor from Table 2b		0	(53)												
Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)												
Enter (50) or (54) in (55)		0	(55)												
Water storage loss calculated for each month	((56)m = (55) x (41)m														
(56)m=		<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> </table>	0	0	0	0	0	0	0	0	0	0	0	0	(56)
0	0	0	0	0	0	0	0	0	0	0	0				
If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) - (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H															
(57)m=		<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> </table>	0	0	0	0	0	0	0	0	0	0	0	0	(57)
0	0	0	0	0	0	0	0	0	0	0	0				
Primary circuit loss (annual) from Table 3		0	(58)												
Primary circuit loss calculated for each month (59)m = (58) ÷ 365 x (41)m															
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)															
(59)m=		<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> </table>	0	0	0	0	0	0	0	0	0	0	0	0	(59)
0	0	0	0	0	0	0	0	0	0	0	0				
Combi loss calculated for each month (61)m = (60) ÷ 365 x (41)m															
(61)m=		<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr><td>50.96</td><td>46.03</td><td>50.96</td><td>47.6</td><td>47.18</td><td>43.71</td><td>45.17</td><td>47.18</td><td>47.6</td><td>50.96</td><td>49.32</td><td>50.96</td></tr> </table>	50.96	46.03	50.96	47.6	47.18	43.71	45.17	47.18	47.6	50.96	49.32	50.96	(61)
50.96	46.03	50.96	47.6	47.18	43.71	45.17	47.18	47.6	50.96	49.32	50.96				
Total heat required for water heating calculated for each month (62)m = 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m															
(62)m=		<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr><td>211.61</td><td>186.54</td><td>195.95</td><td>174</td><td>168.47</td><td>148.38</td><td>142.16</td><td>158.47</td><td>160.22</td><td>182.21</td><td>192.59</td><td>206.54</td></tr> </table>	211.61	186.54	195.95	174	168.47	148.38	142.16	158.47	160.22	182.21	192.59	206.54	(62)
211.61	186.54	195.95	174	168.47	148.38	142.16	158.47	160.22	182.21	192.59	206.54				
Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)															
(add additional lines if FGHRs and/or WWHRs applies, see Appendix G)															
(63)m=		<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> </table>	0	0	0	0	0	0	0	0	0	0	0	0	(63)
0	0	0	0	0	0	0	0	0	0	0	0				
Output from water heater															
(64)m=		<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr><td>211.61</td><td>186.54</td><td>195.95</td><td>174</td><td>168.47</td><td>148.38</td><td>142.16</td><td>158.47</td><td>160.22</td><td>182.21</td><td>192.59</td><td>206.54</td></tr> </table>	211.61	186.54	195.95	174	168.47	148.38	142.16	158.47	160.22	182.21	192.59	206.54	
211.61	186.54	195.95	174	168.47	148.38	142.16	158.47	160.22	182.21	192.59	206.54				
			Output from water heater (annual) ^{1...12}												
			2127.14												
Heat gains from water heating, kWh/month 0.25 ´ [0.85 x (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]															
(65)m=		<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr><td>66.16</td><td>58.23</td><td>60.95</td><td>53.93</td><td>52.12</td><td>45.73</td><td>43.54</td><td>48.8</td><td>49.35</td><td>56.38</td><td>59.97</td><td>64.47</td></tr> </table>	66.16	58.23	60.95	53.93	52.12	45.73	43.54	48.8	49.35	56.38	59.97	64.47	(65)
66.16	58.23	60.95	53.93	52.12	45.73	43.54	48.8	49.35	56.38	59.97	64.47				
include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating															

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=	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												
(67)m=	22.36	19.86	16.15	12.23	9.14	7.72	8.34	10.84	14.55	18.47	21.56	22.99
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												
(68)m=	250.86	253.47	246.91	232.94	215.31	198.74	187.68	185.07	191.63	205.6	223.23	239.79
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												
(69)m=	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53
Pumps and fans gains (Table 5a)												
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3
Losses e.g. evaporation (negative values) (Table 5)												
(71)m=	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27

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Water heating gains (Table 5)

(72)m=

88.92	86.65	81.92	74.9	70.06	63.51	58.52	65.59	68.54	75.78	83.29	86.66
-------	-------	-------	------	-------	-------	-------	-------	-------	-------	-------	-------

 (72)

Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=

428.75	426.58	411.58	386.67	361.11	336.57	321.14	328.1	341.32	366.45	394.68	416.04
--------	--------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------

 (73)

6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Orientation:	Access Factor Table 6d		Area m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)							
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.68</td></tr></table>	1.68	x	<table><tr><td>11.28</td></tr></table>	11.28	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>21.02</td></tr></table>	21.02	(75)
0.77																		
1.68																		
11.28																		
0.5																		
0.8																		
21.02																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>2.19</td></tr></table>	2.19	x	<table><tr><td>11.28</td></tr></table>	11.28	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>6.85</td></tr></table>	6.85	(75)
0.77																		
2.19																		
11.28																		
0.5																		
0.8																		
6.85																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>0.54</td></tr></table>	0.54	x	<table><tr><td>11.28</td></tr></table>	11.28	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>1.69</td></tr></table>	1.69	(75)
0.77																		
0.54																		
11.28																		
0.5																		
0.8																		
1.69																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.34</td></tr></table>	1.34	x	<table><tr><td>11.28</td></tr></table>	11.28	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>4.19</td></tr></table>	4.19	(75)
0.77																		
1.34																		
11.28																		
0.5																		
0.8																		
4.19																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.68</td></tr></table>	1.68	x	<table><tr><td>22.97</td></tr></table>	22.97	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>42.78</td></tr></table>	42.78	(75)
0.77																		
1.68																		
22.97																		
0.5																		
0.8																		
42.78																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>2.19</td></tr></table>	2.19	x	<table><tr><td>22.97</td></tr></table>	22.97	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>13.94</td></tr></table>	13.94	(75)
0.77																		
2.19																		
22.97																		
0.5																		
0.8																		
13.94																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>0.54</td></tr></table>	0.54	x	<table><tr><td>22.97</td></tr></table>	22.97	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>3.44</td></tr></table>	3.44	(75)
0.77																		
0.54																		
22.97																		
0.5																		
0.8																		
3.44																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.34</td></tr></table>	1.34	x	<table><tr><td>22.97</td></tr></table>	22.97	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>8.53</td></tr></table>	8.53	(75)
0.77																		
1.34																		
22.97																		
0.5																		
0.8																		
8.53																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.68</td></tr></table>	1.68	x	<table><tr><td>41.38</td></tr></table>	41.38	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>77.08</td></tr></table>	77.08	(75)
0.77																		
1.68																		
41.38																		
0.5																		
0.8																		
77.08																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>2.19</td></tr></table>	2.19	x	<table><tr><td>41.38</td></tr></table>	41.38	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>25.12</td></tr></table>	25.12	(75)
0.77																		
2.19																		
41.38																		
0.5																		
0.8																		
25.12																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>0.54</td></tr></table>	0.54	x	<table><tr><td>41.38</td></tr></table>	41.38	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>6.19</td></tr></table>	6.19	(75)
0.77																		
0.54																		
41.38																		
0.5																		
0.8																		
6.19																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.34</td></tr></table>	1.34	x	<table><tr><td>41.38</td></tr></table>	41.38	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>15.37</td></tr></table>	15.37	(75)
0.77																		
1.34																		
41.38																		
0.5																		
0.8																		
15.37																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.68</td></tr></table>	1.68	x	<table><tr><td>67.96</td></tr></table>	67.96	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>126.59</td></tr></table>	126.59	(75)
0.77																		
1.68																		
67.96																		
0.5																		
0.8																		
126.59																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>2.19</td></tr></table>	2.19	x	<table><tr><td>67.96</td></tr></table>	67.96	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>41.25</td></tr></table>	41.25	(75)
0.77																		
2.19																		
67.96																		
0.5																		
0.8																		
41.25																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>0.54</td></tr></table>	0.54	x	<table><tr><td>67.96</td></tr></table>	67.96	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>10.17</td></tr></table>	10.17	(75)
0.77																		
0.54																		
67.96																		
0.5																		
0.8																		
10.17																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.34</td></tr></table>	1.34	x	<table><tr><td>67.96</td></tr></table>	67.96	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>25.24</td></tr></table>	25.24	(75)
0.77																		
1.34																		
67.96																		
0.5																		
0.8																		
25.24																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.68</td></tr></table>	1.68	x	<table><tr><td>91.35</td></tr></table>	91.35	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>170.16</td></tr></table>	170.16	(75)
0.77																		
1.68																		
91.35																		
0.5																		
0.8																		
170.16																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>2.19</td></tr></table>	2.19	x	<table><tr><td>91.35</td></tr></table>	91.35	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>55.45</td></tr></table>	55.45	(75)
0.77																		
2.19																		
91.35																		
0.5																		
0.8																		
55.45																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>0.54</td></tr></table>	0.54	x	<table><tr><td>91.35</td></tr></table>	91.35	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>13.67</td></tr></table>	13.67	(75)
0.77																		
0.54																		
91.35																		
0.5																		
0.8																		
13.67																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.34</td></tr></table>	1.34	x	<table><tr><td>91.35</td></tr></table>	91.35	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>33.93</td></tr></table>	33.93	(75)
0.77																		
1.34																		
91.35																		
0.5																		
0.8																		
33.93																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.68</td></tr></table>	1.68	x	<table><tr><td>97.38</td></tr></table>	97.38	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>181.41</td></tr></table>	181.41	(75)
0.77																		
1.68																		
97.38																		
0.5																		
0.8																		
181.41																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>2.19</td></tr></table>	2.19	x	<table><tr><td>97.38</td></tr></table>	97.38	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>59.12</td></tr></table>	59.12	(75)
0.77																		
2.19																		
97.38																		
0.5																		
0.8																		
59.12																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>0.54</td></tr></table>	0.54	x	<table><tr><td>97.38</td></tr></table>	97.38	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>14.58</td></tr></table>	14.58	(75)
0.77																		
0.54																		
97.38																		
0.5																		
0.8																		
14.58																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.34</td></tr></table>	1.34	x	<table><tr><td>97.38</td></tr></table>	97.38	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>36.17</td></tr></table>	36.17	(75)
0.77																		
1.34																		
97.38																		
0.5																		
0.8																		
36.17																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.68</td></tr></table>	1.68	x	<table><tr><td>91.1</td></tr></table>	91.1	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>169.7</td></tr></table>	169.7	(75)
0.77																		
1.68																		
91.1																		
0.5																		
0.8																		
169.7																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>2.19</td></tr></table>	2.19	x	<table><tr><td>91.1</td></tr></table>	91.1	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>55.3</td></tr></table>	55.3	(75)
0.77																		
2.19																		
91.1																		
0.5																		
0.8																		
55.3																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>0.54</td></tr></table>	0.54	x	<table><tr><td>91.1</td></tr></table>	91.1	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>13.64</td></tr></table>	13.64	(75)
0.77																		
0.54																		
91.1																		
0.5																		
0.8																		
13.64																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.34</td></tr></table>	1.34	x	<table><tr><td>91.1</td></tr></table>	91.1	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>33.84</td></tr></table>	33.84	(75)
0.77																		
1.34																		
91.1																		
0.5																		
0.8																		
33.84																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.68</td></tr></table>	1.68	x	<table><tr><td>72.63</td></tr></table>	72.63	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>135.29</td></tr></table>	135.29	(75)
0.77																		
1.68																		
72.63																		
0.5																		
0.8																		
135.29																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>2.19</td></tr></table>	2.19	x	<table><tr><td>72.63</td></tr></table>	72.63	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>44.09</td></tr></table>	44.09	(75)
0.77																		
2.19																		
72.63																		
0.5																		
0.8																		
44.09																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>0.54</td></tr></table>	0.54	x	<table><tr><td>72.63</td></tr></table>	72.63	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>10.87</td></tr></table>	10.87	(75)
0.77																		
0.54																		
72.63																		
0.5																		
0.8																		
10.87																		
Northeast 0.9x	<table><tr><td>0.77</td></tr></table>	0.77	x	<table><tr><td>1.34</td></tr></table>	1.34	x	<table><tr><td>72.63</td></tr></table>	72.63	x	<table><tr><td>0.5</td></tr></table>	0.5	x	<table><tr><td>0.8</td></tr></table>	0.8	=	<table><tr><td>26.98</td></tr></table>	26.98	(75)
0.77																		
1.34																		
72.63																		
0.5																		
0.8																		
26.98																		

DER WorkSheet: New dwelling design stage

Northeast 0.9x	0.77	x	1.68	x	50.42	x	0.5	x	0.8	=	93.92	(75)
Northeast 0.9x	0.77	x	2.19	x	50.42	x	0.5	x	0.8	=	30.61	(75)
Northeast 0.9x	0.77	x	0.54	x	50.42	x	0.5	x	0.8	=	7.55	(75)
Northeast 0.9x	0.77	x	1.34	x	50.42	x	0.5	x	0.8	=	18.73	(75)
Northeast 0.9x	0.77	x	1.68	x	28.07	x	0.5	x	0.8	=	52.28	(75)
Northeast 0.9x	0.77	x	2.19	x	28.07	x	0.5	x	0.8	=	17.04	(75)
Northeast 0.9x	0.77	x	0.54	x	28.07	x	0.5	x	0.8	=	4.2	(75)
Northeast 0.9x	0.77	x	1.34	x	28.07	x	0.5	x	0.8	=	10.43	(75)
Northeast 0.9x	0.77	x	1.68	x	14.2	x	0.5	x	0.8	=	26.45	(75)
Northeast 0.9x	0.77	x	2.19	x	14.2	x	0.5	x	0.8	=	8.62	(75)
Northeast 0.9x	0.77	x	0.54	x	14.2	x	0.5	x	0.8	=	2.13	(75)
Northeast 0.9x	0.77	x	1.34	x	14.2	x	0.5	x	0.8	=	5.27	(75)
Northeast 0.9x	0.77	x	1.68	x	9.21	x	0.5	x	0.8	=	17.16	(75)
Northeast 0.9x	0.77	x	2.19	x	9.21	x	0.5	x	0.8	=	5.59	(75)
Northeast 0.9x	0.77	x	0.54	x	9.21	x	0.5	x	0.8	=	1.38	(75)
Northeast 0.9x	0.77	x	1.34	x	9.21	x	0.5	x	0.8	=	3.42	(75)
Southeast 0.9x	0.77	x	0.91	x	36.79	x	0.5	x	0.8	=	9.28	(77)
Southeast 0.9x	0.77	x	0.98	x	36.79	x	0.5	x	0.8	=	10	(77)
Southeast 0.9x	0.77	x	1.03	x	36.79	x	0.5	x	0.8	=	10.51	(77)
Southeast 0.9x	0.77	x	0.91	x	62.67	x	0.5	x	0.8	=	15.81	(77)
Southeast 0.9x	0.77	x	0.98	x	62.67	x	0.5	x	0.8	=	17.03	(77)
Southeast 0.9x	0.77	x	1.03	x	62.67	x	0.5	x	0.8	=	17.89	(77)
Southeast 0.9x	0.77	x	0.91	x	85.75	x	0.5	x	0.8	=	21.63	(77)
Southeast 0.9x	0.77	x	0.98	x	85.75	x	0.5	x	0.8	=	23.3	(77)
Southeast 0.9x	0.77	x	1.03	x	85.75	x	0.5	x	0.8	=	24.48	(77)
Southeast 0.9x	0.77	x	0.91	x	106.25	x	0.5	x	0.8	=	26.8	(77)
Southeast 0.9x	0.77	x	0.98	x	106.25	x	0.5	x	0.8	=	28.86	(77)
Southeast 0.9x	0.77	x	1.03	x	106.25	x	0.5	x	0.8	=	30.34	(77)
Southeast 0.9x	0.77	x	0.91	x	119.01	x	0.5	x	0.8	=	30.02	(77)
Southeast 0.9x	0.77	x	0.98	x	119.01	x	0.5	x	0.8	=	32.33	(77)
Southeast 0.9x	0.77	x	1.03	x	119.01	x	0.5	x	0.8	=	33.98	(77)
Southeast 0.9x	0.77	x	0.91	x	118.15	x	0.5	x	0.8	=	29.8	(77)
Southeast 0.9x	0.77	x	0.98	x	118.15	x	0.5	x	0.8	=	32.1	(77)
Southeast 0.9x	0.77	x	1.03	x	118.15	x	0.5	x	0.8	=	33.73	(77)
Southeast 0.9x	0.77	x	0.91	x	113.91	x	0.5	x	0.8	=	28.73	(77)
Southeast 0.9x	0.77	x	0.98	x	113.91	x	0.5	x	0.8	=	30.94	(77)
Southeast 0.9x	0.77	x	1.03	x	113.91	x	0.5	x	0.8	=	32.52	(77)
Southeast 0.9x	0.77	x	0.91	x	104.39	x	0.5	x	0.8	=	26.33	(77)
Southeast 0.9x	0.77	x	0.98	x	104.39	x	0.5	x	0.8	=	28.36	(77)
Southeast 0.9x	0.77	x	1.03	x	104.39	x	0.5	x	0.8	=	29.81	(77)
Southeast 0.9x	0.77	x	0.91	x	92.85	x	0.5	x	0.8	=	23.42	(77)

DER WorkSheet: New dwelling design stage

Southeast	0.9x	0.77	x	0.98	x	92.85	x	0.5	x	0.8	=	25.22	(77)
Southeast	0.9x	0.77	x	1.03	x	92.85	x	0.5	x	0.8	=	26.51	(77)
Southeast	0.9x	0.77	x	0.91	x	69.27	x	0.5	x	0.8	=	17.47	(77)
Southeast	0.9x	0.77	x	0.98	x	69.27	x	0.5	x	0.8	=	18.82	(77)
Southeast	0.9x	0.77	x	1.03	x	69.27	x	0.5	x	0.8	=	19.78	(77)
Southeast	0.9x	0.77	x	0.91	x	44.07	x	0.5	x	0.8	=	11.12	(77)
Southeast	0.9x	0.77	x	0.98	x	44.07	x	0.5	x	0.8	=	11.97	(77)
Southeast	0.9x	0.77	x	1.03	x	44.07	x	0.5	x	0.8	=	12.58	(77)
Southeast	0.9x	0.77	x	0.91	x	31.49	x	0.5	x	0.8	=	7.94	(77)
Southeast	0.9x	0.77	x	0.98	x	31.49	x	0.5	x	0.8	=	8.55	(77)
Southeast	0.9x	0.77	x	1.03	x	31.49	x	0.5	x	0.8	=	8.99	(77)
Southwest	0.9x	0.77	x	2.54	x	36.79		0.5	x	0.8	=	51.81	(79)
Southwest	0.9x	0.77	x	3.74	x	36.79		0.5	x	0.8	=	38.15	(79)
Southwest	0.9x	0.77	x	1	x	36.79		0.5	x	0.8	=	10.2	(79)
Southwest	0.9x	0.77	x	2.54	x	62.67		0.5	x	0.8	=	88.26	(79)
Southwest	0.9x	0.77	x	3.74	x	62.67		0.5	x	0.8	=	64.98	(79)
Southwest	0.9x	0.77	x	1	x	62.67		0.5	x	0.8	=	17.37	(79)
Southwest	0.9x	0.77	x	2.54	x	85.75		0.5	x	0.8	=	120.75	(79)
Southwest	0.9x	0.77	x	3.74	x	85.75		0.5	x	0.8	=	88.9	(79)
Southwest	0.9x	0.77	x	1	x	85.75		0.5	x	0.8	=	23.77	(79)
Southwest	0.9x	0.77	x	2.54	x	106.25		0.5	x	0.8	=	149.62	(79)
Southwest	0.9x	0.77	x	3.74	x	106.25		0.5	x	0.8	=	110.15	(79)
Southwest	0.9x	0.77	x	1	x	106.25		0.5	x	0.8	=	29.45	(79)
Southwest	0.9x	0.77	x	2.54	x	119.01		0.5	x	0.8	=	167.59	(79)
Southwest	0.9x	0.77	x	3.74	x	119.01		0.5	x	0.8	=	123.38	(79)
Southwest	0.9x	0.77	x	1	x	119.01		0.5	x	0.8	=	32.99	(79)
Southwest	0.9x	0.77	x	2.54	x	118.15		0.5	x	0.8	=	166.38	(79)
Southwest	0.9x	0.77	x	3.74	x	118.15		0.5	x	0.8	=	122.49	(79)
Southwest	0.9x	0.77	x	1	x	118.15		0.5	x	0.8	=	32.75	(79)
Southwest	0.9x	0.77	x	2.54	x	113.91		0.5	x	0.8	=	160.4	(79)
Southwest	0.9x	0.77	x	3.74	x	113.91		0.5	x	0.8	=	118.09	(79)
Southwest	0.9x	0.77	x	1	x	113.91		0.5	x	0.8	=	31.58	(79)
Southwest	0.9x	0.77	x	2.54	x	104.39		0.5	x	0.8	=	147	(79)
Southwest	0.9x	0.77	x	3.74	x	104.39		0.5	x	0.8	=	108.22	(79)
Southwest	0.9x	0.77	x	1	x	104.39		0.5	x	0.8	=	28.94	(79)
Southwest	0.9x	0.77	x	2.54	x	92.85		0.5	x	0.8	=	130.75	(79)
Southwest	0.9x	0.77	x	3.74	x	92.85		0.5	x	0.8	=	96.26	(79)
Southwest	0.9x	0.77	x	1	x	92.85		0.5	x	0.8	=	25.74	(79)
Southwest	0.9x	0.77	x	2.54	x	69.27		0.5	x	0.8	=	97.54	(79)
Southwest	0.9x	0.77	x	3.74	x	69.27		0.5	x	0.8	=	71.81	(79)
Southwest	0.9x	0.77	x	1	x	69.27		0.5	x	0.8	=	19.2	(79)

DER WorkSheet: New dwelling design stage

Southwest 0.9x	0.77	x	2.54	x	44.07	0.5	x	0.8	=	62.06	(79)
Southwest 0.9x	0.77	x	3.74	x	44.07	0.5	x	0.8	=	45.69	(79)
Southwest 0.9x	0.77	x	1	x	44.07	0.5	x	0.8	=	12.22	(79)
Southwest 0.9x	0.77	x	2.54	x	31.49	0.5	x	0.8	=	44.34	(79)
Southwest 0.9x	0.77	x	3.74	x	31.49	0.5	x	0.8	=	32.64	(79)
Southwest 0.9x	0.77	x	1	x	31.49	0.5	x	0.8	=	8.73	(79)
Northwest 0.9x	0.77	x	0.91	x	11.28	0.5	x	0.8	=	2.85	(81)
Northwest 0.9x	0.77	x	0.91	x	22.97	0.5	x	0.8	=	5.79	(81)
Northwest 0.9x	0.77	x	0.91	x	41.38	0.5	x	0.8	=	10.44	(81)
Northwest 0.9x	0.77	x	0.91	x	67.96	0.5	x	0.8	=	17.14	(81)
Northwest 0.9x	0.77	x	0.91	x	91.35	0.5	x	0.8	=	23.04	(81)
Northwest 0.9x	0.77	x	0.91	x	97.38	0.5	x	0.8	=	24.57	(81)
Northwest 0.9x	0.77	x	0.91	x	91.1	0.5	x	0.8	=	22.98	(81)
Northwest 0.9x	0.77	x	0.91	x	72.63	0.5	x	0.8	=	18.32	(81)
Northwest 0.9x	0.77	x	0.91	x	50.42	0.5	x	0.8	=	12.72	(81)
Northwest 0.9x	0.77	x	0.91	x	28.07	0.5	x	0.8	=	7.08	(81)
Northwest 0.9x	0.77	x	0.91	x	14.2	0.5	x	0.8	=	3.58	(81)
Northwest 0.9x	0.77	x	0.91	x	9.21	0.5	x	0.8	=	2.32	(81)

Solar gains in watts, calculated for each month

(83)m = Sum(74)m ... (82)m

(83)m=	166.53	295.82	437.04	595.63	716.55	733.09	697.74	604.2	491.44	335.65	201.68	141.08	(83)
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Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	595.28	722.4	848.62	982.3	1077.66	1069.67	1018.87	932.31	832.75	702.1	596.36	557.12	(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 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.95	0.85	0.67	0.51	0.57	0.83	0.97	1	1	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	20.47	20.52	20.59	20.69	20.77	20.81	20.82	20.82	20.79	20.68	20.56	20.46	(87)
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Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	19.85	19.85	19.85	19.86	19.87	19.88	19.88	19.88	19.87	19.87	19.86	19.86	(88)
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Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	0.99	0.98	0.92	0.79	0.57	0.39	0.44	0.75	0.96	0.99	1	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	19.12	19.19	19.3	19.45	19.56	19.62	19.63	19.63	19.59	19.45	19.26	19.12	(90)
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fLA = Living area ÷ (4) = 0.15 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	19.32	19.39	19.5	19.65	19.75	19.8	19.81	19.81	19.78	19.64	19.46	19.32	(92)
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Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	19.17	19.24	19.35	19.5	19.6	19.65	19.66	19.66	19.63	19.49	19.31	19.17	(93)
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8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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DER WorkSheet: New dwelling design stage

Utilisation factor for gains, hm:

(94)m=	1	0.99	0.97	0.92	0.78	0.55	0.36	0.42	0.73	0.95	0.99	1	(94)
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Useful gains, hmGm , W = (94)m x (84)m

(95)m=	593.08	715.65	826.36	900.36	836.28	591.14	367.9	389.31	604.39	666.82	591.39	555.6	(95)
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Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
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Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]

(97)m=	1861.83	1790.68	1600.06	1301.68	967.42	610.71	369.92	393.22	671.71	1089.15	1504.44	1854.52	(97)
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Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	943.95	722.42	575.63	288.95	97.57	0	0	0	0	314.22	657.4	966.4	
Total per year (kWh/year) = Sum(98) _{1...5,9...12} =												4566.53	(98)

Space heating requirement in kWh/m²/year

47.23	(99)
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9a. Energy requirements – Individual heating systems including micro-CHP)

Space heating:

Fraction of space heat from secondary/supplementary system 0 (201)

Fraction of space heat from main system(s) (202) = 1 – (201) = 1 (202)

Fraction of total heating from main system 1 (204) = (202) × [1 – (203)] = 1 (204)

Efficiency of main space heating system 1 90.3 (206)

Efficiency of secondary/supplementary heating system, % 0 (208)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
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Space heating requirement (calculated above)

943.95	722.42	575.63	288.95	97.57	0	0	0	0	314.22	657.4	966.4
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(211)m = {[(98)m x (204)] } x 100 ÷ (206) (211)

1045.35	800.02	637.46	319.99	108.05	0	0	0	0	347.97	728.02	1070.21		
Total (kWh/year) =Sum(211) _{1...5,10...12} =												5057.07	(211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	0	
Total (kWh/year) =Sum(215) _{1...5,10...12} =												0	(215)

Water heating

Output from water heater (calculated above)

211.61	186.54	195.95	174	168.47	148.38	142.16	158.47	160.22	182.21	192.59	206.54
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Efficiency of water heater 81 (216)

(217)m= 88.44 88.22 87.74 86.56 84.18 81 81 81 81 86.65 88.01 88.51 (217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	239.27	211.44	223.33	201.01	200.13	183.18	175.5	195.64	197.8	210.29	218.82	233.35	
Total = Sum(219a) _{1...12} =												2489.77	(219)

Annual totals

kWh/year

kWh/year

Space heating fuel used, main system 1 5057.07

Water heating fuel used 2489.77

Electricity for pumps, fans and electric keep-hot

DER WorkSheet: New dwelling design stage

mechanical ventilation - balanced, extract or positive input from outside		259.04	(230a)
central heating pump:		30	(230c)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =	289.04	(231)
Electricity for lighting		394.97	(232)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x	0.216	=	1092.33	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	537.79	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1630.12	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	150.01	(267)
Electricity for lighting	(232) x	0.519	=	204.99	(268)
Total CO2, kg/year		sum of (265)...(271) =		1985.11	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		20.53	(273)
El rating (section 14)				81	(274)

Appendix B – SAP

Energy Assessment

Antill Road

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name: Chris Hocknell **Stroma Number:** STRO016363
Software Name: Stroma FSAP 2012 **Software Version:** Version: 1.0.4.23

Property Address: Antill Road

Address :

1. Overall dwelling dimensions:

	Area(m ²)		Av. Height(m)		Volume(m ³)
Ground floor	48.97 (1a)	x	3.5 (2a)	=	171.4 (3a)
First floor	47.72 (1b)	x	3 (2b)	=	143.16 (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	96.69 (4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	314.56 (5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m ³ per hour
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0 (6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0 (6b)
Number of intermittent fans							0	x 10 =	0 (7a)
Number of passive vents							0	x 10 =	0 (7b)
Number of flueless gas fires							0	x 40 =	0 (7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0 (8)
<i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>			
Number of storeys in the dwelling (ns)			0 (9)
Additional infiltration		[(9)-1]x0.1 =	0 (10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction			0 (11)
<i>if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35</i>			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0			0 (12)
If no draught lobby, enter 0.05, else enter 0			0 (13)
Percentage of windows and doors draught stripped			0 (14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =		0 (15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =		0 (16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area			3 (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)			0.15 (18)
<i>Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used</i>			
Number of sides sheltered			2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =		0.85 (20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =		0.13 (21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
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DER WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
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Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15
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Calculate effective air change rate for the applicable case

If mechanical ventilation:

0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)

0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =

76.5 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

(24a)m=	0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.25	0.26	0.27
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(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0
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(24b)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0
---------	---	---	---	---	---	---	---	---	---	---	---	---

(24c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0	0	0	0	0	0	0	0	0	0	0	0
---------	---	---	---	---	---	---	---	---	---	---	---	---

(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m=	0.28	0.28	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.25	0.26	0.27
--------	------	------	------	------	------	------	------	------	------	------	------	------

(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²	U-value W/m²K	A X U (W/K)	k-value kJ/m²·K	A X k kJ/K
Doors			2.14	x 1	= 2.14		(26)
Windows Type 1			1.68	x1/[1/(1.3)+ 0.04] =	2.08		(27)
Windows Type 2			2.19	x1/[1/(1.3)+ 0.04] =	2.71		(27)
Windows Type 3			0.54	x1/[1/(1.3)+ 0.04] =	0.67		(27)
Windows Type 4			1.34	x1/[1/(1.3)+ 0.04] =	1.66		(27)
Windows Type 5			2.54	x1/[1/(1.3)+ 0.04] =	3.14		(27)
Windows Type 6			3.74	x1/[1/(1.3)+ 0.04] =	4.62		(27)
Windows Type 7			1	x1/[1/(1.3)+ 0.04] =	1.24		(27)
Windows Type 8			0.91	x1/[1/(1.3)+ 0.04] =	1.12		(27)
Windows Type 9			0.98	x1/[1/(1.3)+ 0.04] =	1.21		(27)
Windows Type 10			1.03	x1/[1/(1.3)+ 0.04] =	1.27		(27)
Windows Type 11			0.91	x1/[1/(1.3)+ 0.04] =	1.12		(27)
Floor			48.97	x 0.12	= 5.8764		(28)
Walls	138.88	26.58	112.3	x 0.14	= 15.72		(29)
Roof	48.97	0	48.97	x 0.12	= 5.88		(30)
Total area of elements, m²			236.82				(31)
Party wall			51.5	x 0	= 0		(32)

DER WorkSheet: New dwelling design stage

* for windows and roof windows, use effective window U-value calculated using formula $1/[(1/U\text{-value})+0.04]$ as given in paragraph 3.2

** include the areas on both sides of internal walls and partitions

Fabric heat loss, W/K = $S (A \times U)$ (26)...(30) + (32) =

59.82

 (33)

Heat capacity $C_m = S(A \times k)$ ((28)...(30) + (32) + (32a)...(32e) =

31942.43

 (34)

Thermal mass parameter (TMP = $C_m \div TFA$) in kJ/m²K Indicative Value: Medium

250

 (35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.

Thermal bridges : $S (L \times Y)$ calculated using Appendix K

36.28

 (36)

if details of thermal bridging are not known (36) = $0.05 \times (31)$

Total fabric heat loss (33) + (36) =

96.1

 (37)

Ventilation heat loss calculated monthly (38)m = $0.33 \times (25)m \times (5)$

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	29.07	28.74	28.41	26.76	26.42	24.77	24.77	24.44	25.43	26.42	27.09	27.75	(38)

Heat transfer coefficient, W/K (39)m = (37) + (38)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(39)m=	125.17	124.84	124.51	122.85	122.52	120.87	120.87	120.54	121.53	122.52	123.18	123.84	
Average = Sum(39) _{1...12} / 12 =												122.77	(39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m + (4)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(40)m=	1.29	1.29	1.29	1.27	1.27	1.25	1.25	1.25	1.26	1.27	1.27	1.28	
Average = Sum(40) _{1...12} / 12 =												1.27	(40)

Number of days in month (Table 1a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N

2.71

 (42)

if TFA > 13.9, $N = 1 + 1.76 \times [1 - \exp(-0.000349 \times (TFA - 13.9)^2)] + 0.0013 \times (TFA - 13.9)$

if TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$

98.48

 (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	108.33	104.39	100.45	96.51	92.58	88.64	88.64	92.58	96.51	100.45	104.39	108.33	
Total = Sum(44) _{1...12} =												1181.81	(44)

Energy content of hot water used - calculated monthly = $4.190 \times V_{d,m} \times n_m \times DT_m / 3600$ kWh/month (see Tables 1b, 1c, 1d)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(45)m=	160.65	140.51	144.99	126.41	121.29	104.67	96.99	111.3	112.62	131.25	143.27	155.58	
Total = Sum(45) _{1...12} =												1549.54	(45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(46)m=	24.1	21.08	21.75	18.96	18.19	15.7	14.55	16.69	16.89	19.69	21.49	23.34	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel

150

 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

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

1.26

 (48)

Temperature factor from Table 2b

0.54

 (49)

DER WorkSheet: New dwelling design stage

Energy lost from water storage, kWh/year	(48) x (49) =	0.68	(50)												
b) If manufacturer's declared cylinder loss factor is not known:															
Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)												
If community heating see section 4.3															
Volume factor from Table 2a		0	(52)												
Temperature factor from Table 2b		0	(53)												
Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)												
Enter (50) or (54) in (55)		0.68	(55)												
Water storage loss calculated for each month	((56)m = (55) x (41)m														
(56)m=	<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr> <td>21.09</td><td>19.05</td><td>21.09</td><td>20.41</td><td>21.09</td><td>20.41</td><td>21.09</td><td>21.09</td><td>20.41</td><td>21.09</td><td>20.41</td><td>21.09</td> </tr> </table>	21.09	19.05	21.09	20.41	21.09	20.41	21.09	21.09	20.41	21.09	20.41	21.09		(56)
21.09	19.05	21.09	20.41	21.09	20.41	21.09	21.09	20.41	21.09	20.41	21.09				
If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) - (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H															
(57)m=	<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr> <td>21.09</td><td>19.05</td><td>21.09</td><td>20.41</td><td>21.09</td><td>20.41</td><td>21.09</td><td>21.09</td><td>20.41</td><td>21.09</td><td>20.41</td><td>21.09</td> </tr> </table>	21.09	19.05	21.09	20.41	21.09	20.41	21.09	21.09	20.41	21.09	20.41	21.09		(57)
21.09	19.05	21.09	20.41	21.09	20.41	21.09	21.09	20.41	21.09	20.41	21.09				
Primary circuit loss (annual) from Table 3		0	(58)												
Primary circuit loss calculated for each month (59)m = (58) ÷ 365 x (41)m															
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)															
(59)m=	<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr> <td>23.26</td><td>21.01</td><td>23.26</td><td>22.51</td><td>23.26</td><td>22.51</td><td>23.26</td><td>23.26</td><td>22.51</td><td>23.26</td><td>22.51</td><td>23.26</td> </tr> </table>	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26		(59)
23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26				
Combi loss calculated for each month (61)m = (60) ÷ 365 x (41)m															
(61)m=	<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr> <td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td> </tr> </table>	0	0	0	0	0	0	0	0	0	0	0	0		(61)
0	0	0	0	0	0	0	0	0	0	0	0				
Total heat required for water heating calculated for each month (62)m = 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m															
(62)m=	<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr> <td>205.01</td><td>180.57</td><td>189.35</td><td>169.33</td><td>165.65</td><td>147.59</td><td>141.34</td><td>155.65</td><td>155.55</td><td>175.61</td><td>186.2</td><td>199.94</td> </tr> </table>	205.01	180.57	189.35	169.33	165.65	147.59	141.34	155.65	155.55	175.61	186.2	199.94		(62)
205.01	180.57	189.35	169.33	165.65	147.59	141.34	155.65	155.55	175.61	186.2	199.94				
Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)															
(add additional lines if FGHRs and/or WWHRs applies, see Appendix G)															
(63)m=	<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr> <td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td> </tr> </table>	0	0	0	0	0	0	0	0	0	0	0	0		(63)
0	0	0	0	0	0	0	0	0	0	0	0				
Output from water heater															
(64)m=	<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr> <td>205.01</td><td>180.57</td><td>189.35</td><td>169.33</td><td>165.65</td><td>147.59</td><td>141.34</td><td>155.65</td><td>155.55</td><td>175.61</td><td>186.2</td><td>199.94</td> </tr> </table>	205.01	180.57	189.35	169.33	165.65	147.59	141.34	155.65	155.55	175.61	186.2	199.94		
205.01	180.57	189.35	169.33	165.65	147.59	141.34	155.65	155.55	175.61	186.2	199.94				
											Output from water heater (annual) _{1...12}	2071.78	(64)		
Heat gains from water heating, kWh/month 0.25 ´ [0.85 x (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]															
(65)m=	<table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr> <td>88.9</td><td>78.77</td><td>83.69</td><td>76.37</td><td>75.81</td><td>69.14</td><td>67.73</td><td>72.49</td><td>71.79</td><td>79.13</td><td>81.98</td><td>87.22</td> </tr> </table>	88.9	78.77	83.69	76.37	75.81	69.14	67.73	72.49	71.79	79.13	81.98	87.22		(65)
88.9	78.77	83.69	76.37	75.81	69.14	67.73	72.49	71.79	79.13	81.98	87.22				
include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating															

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=	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33	135.33
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												
(67)m=	22.36	19.86	16.15	12.23	9.14	7.72	8.34	10.84	14.55	18.47	21.56	22.99
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												
(68)m=	250.86	253.47	246.91	232.94	215.31	198.74	187.68	185.07	191.63	205.6	223.23	239.79
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												
(69)m=	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53	36.53
Pumps and fans gains (Table 5a)												
(70)m=	0	0	0	0	0	0	0	0	0	0	0	0
Losses e.g. evaporation (negative values) (Table 5)												
(71)m=	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27	-108.27

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Water heating gains (Table 5)

(72)m=

119.49	117.22	112.49	106.07	101.9	96.03	91.04	97.43	99.7	106.35	113.86	117.23
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 (72)

Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m=

456.32	454.15	439.15	414.84	389.95	366.09	350.65	356.94	369.49	394.02	422.25	443.61
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 (73)

6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Orientation:	Access Factor Table 6d		Area m ²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast 0.9x	0.77	x	1.68	x	11.28	x	0.5	x	0.8	=	21.02	(75)
Northeast 0.9x	0.77	x	2.19	x	11.28	x	0.5	x	0.8	=	6.85	(75)
Northeast 0.9x	0.77	x	0.54	x	11.28	x	0.5	x	0.8	=	1.69	(75)
Northeast 0.9x	0.77	x	1.34	x	11.28	x	0.5	x	0.8	=	4.19	(75)
Northeast 0.9x	0.77	x	1.68	x	22.97	x	0.5	x	0.8	=	42.78	(75)
Northeast 0.9x	0.77	x	2.19	x	22.97	x	0.5	x	0.8	=	13.94	(75)
Northeast 0.9x	0.77	x	0.54	x	22.97	x	0.5	x	0.8	=	3.44	(75)
Northeast 0.9x	0.77	x	1.34	x	22.97	x	0.5	x	0.8	=	8.53	(75)
Northeast 0.9x	0.77	x	1.68	x	41.38	x	0.5	x	0.8	=	77.08	(75)
Northeast 0.9x	0.77	x	2.19	x	41.38	x	0.5	x	0.8	=	25.12	(75)
Northeast 0.9x	0.77	x	0.54	x	41.38	x	0.5	x	0.8	=	6.19	(75)
Northeast 0.9x	0.77	x	1.34	x	41.38	x	0.5	x	0.8	=	15.37	(75)
Northeast 0.9x	0.77	x	1.68	x	67.96	x	0.5	x	0.8	=	126.59	(75)
Northeast 0.9x	0.77	x	2.19	x	67.96	x	0.5	x	0.8	=	41.25	(75)
Northeast 0.9x	0.77	x	0.54	x	67.96	x	0.5	x	0.8	=	10.17	(75)
Northeast 0.9x	0.77	x	1.34	x	67.96	x	0.5	x	0.8	=	25.24	(75)
Northeast 0.9x	0.77	x	1.68	x	91.35	x	0.5	x	0.8	=	170.16	(75)
Northeast 0.9x	0.77	x	2.19	x	91.35	x	0.5	x	0.8	=	55.45	(75)
Northeast 0.9x	0.77	x	0.54	x	91.35	x	0.5	x	0.8	=	13.67	(75)
Northeast 0.9x	0.77	x	1.34	x	91.35	x	0.5	x	0.8	=	33.93	(75)
Northeast 0.9x	0.77	x	1.68	x	97.38	x	0.5	x	0.8	=	181.41	(75)
Northeast 0.9x	0.77	x	2.19	x	97.38	x	0.5	x	0.8	=	59.12	(75)
Northeast 0.9x	0.77	x	0.54	x	97.38	x	0.5	x	0.8	=	14.58	(75)
Northeast 0.9x	0.77	x	1.34	x	97.38	x	0.5	x	0.8	=	36.17	(75)
Northeast 0.9x	0.77	x	1.68	x	91.1	x	0.5	x	0.8	=	169.7	(75)
Northeast 0.9x	0.77	x	2.19	x	91.1	x	0.5	x	0.8	=	55.3	(75)
Northeast 0.9x	0.77	x	0.54	x	91.1	x	0.5	x	0.8	=	13.64	(75)
Northeast 0.9x	0.77	x	1.34	x	91.1	x	0.5	x	0.8	=	33.84	(75)
Northeast 0.9x	0.77	x	1.68	x	72.63	x	0.5	x	0.8	=	135.29	(75)
Northeast 0.9x	0.77	x	2.19	x	72.63	x	0.5	x	0.8	=	44.09	(75)
Northeast 0.9x	0.77	x	0.54	x	72.63	x	0.5	x	0.8	=	10.87	(75)
Northeast 0.9x	0.77	x	1.34	x	72.63	x	0.5	x	0.8	=	26.98	(75)

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Northeast 0.9x	0.77	x	1.68	x	50.42	x	0.5	x	0.8	=	93.92	(75)
Northeast 0.9x	0.77	x	2.19	x	50.42	x	0.5	x	0.8	=	30.61	(75)
Northeast 0.9x	0.77	x	0.54	x	50.42	x	0.5	x	0.8	=	7.55	(75)
Northeast 0.9x	0.77	x	1.34	x	50.42	x	0.5	x	0.8	=	18.73	(75)
Northeast 0.9x	0.77	x	1.68	x	28.07	x	0.5	x	0.8	=	52.28	(75)
Northeast 0.9x	0.77	x	2.19	x	28.07	x	0.5	x	0.8	=	17.04	(75)
Northeast 0.9x	0.77	x	0.54	x	28.07	x	0.5	x	0.8	=	4.2	(75)
Northeast 0.9x	0.77	x	1.34	x	28.07	x	0.5	x	0.8	=	10.43	(75)
Northeast 0.9x	0.77	x	1.68	x	14.2	x	0.5	x	0.8	=	26.45	(75)
Northeast 0.9x	0.77	x	2.19	x	14.2	x	0.5	x	0.8	=	8.62	(75)
Northeast 0.9x	0.77	x	0.54	x	14.2	x	0.5	x	0.8	=	2.13	(75)
Northeast 0.9x	0.77	x	1.34	x	14.2	x	0.5	x	0.8	=	5.27	(75)
Northeast 0.9x	0.77	x	1.68	x	9.21	x	0.5	x	0.8	=	17.16	(75)
Northeast 0.9x	0.77	x	2.19	x	9.21	x	0.5	x	0.8	=	5.59	(75)
Northeast 0.9x	0.77	x	0.54	x	9.21	x	0.5	x	0.8	=	1.38	(75)
Northeast 0.9x	0.77	x	1.34	x	9.21	x	0.5	x	0.8	=	3.42	(75)
Southeast 0.9x	0.77	x	0.91	x	36.79	x	0.5	x	0.8	=	9.28	(77)
Southeast 0.9x	0.77	x	0.98	x	36.79	x	0.5	x	0.8	=	10	(77)
Southeast 0.9x	0.77	x	1.03	x	36.79	x	0.5	x	0.8	=	10.51	(77)
Southeast 0.9x	0.77	x	0.91	x	62.67	x	0.5	x	0.8	=	15.81	(77)
Southeast 0.9x	0.77	x	0.98	x	62.67	x	0.5	x	0.8	=	17.03	(77)
Southeast 0.9x	0.77	x	1.03	x	62.67	x	0.5	x	0.8	=	17.89	(77)
Southeast 0.9x	0.77	x	0.91	x	85.75	x	0.5	x	0.8	=	21.63	(77)
Southeast 0.9x	0.77	x	0.98	x	85.75	x	0.5	x	0.8	=	23.3	(77)
Southeast 0.9x	0.77	x	1.03	x	85.75	x	0.5	x	0.8	=	24.48	(77)
Southeast 0.9x	0.77	x	0.91	x	106.25	x	0.5	x	0.8	=	26.8	(77)
Southeast 0.9x	0.77	x	0.98	x	106.25	x	0.5	x	0.8	=	28.86	(77)
Southeast 0.9x	0.77	x	1.03	x	106.25	x	0.5	x	0.8	=	30.34	(77)
Southeast 0.9x	0.77	x	0.91	x	119.01	x	0.5	x	0.8	=	30.02	(77)
Southeast 0.9x	0.77	x	0.98	x	119.01	x	0.5	x	0.8	=	32.33	(77)
Southeast 0.9x	0.77	x	1.03	x	119.01	x	0.5	x	0.8	=	33.98	(77)
Southeast 0.9x	0.77	x	0.91	x	118.15	x	0.5	x	0.8	=	29.8	(77)
Southeast 0.9x	0.77	x	0.98	x	118.15	x	0.5	x	0.8	=	32.1	(77)
Southeast 0.9x	0.77	x	1.03	x	118.15	x	0.5	x	0.8	=	33.73	(77)
Southeast 0.9x	0.77	x	0.91	x	113.91	x	0.5	x	0.8	=	28.73	(77)
Southeast 0.9x	0.77	x	0.98	x	113.91	x	0.5	x	0.8	=	30.94	(77)
Southeast 0.9x	0.77	x	1.03	x	113.91	x	0.5	x	0.8	=	32.52	(77)
Southeast 0.9x	0.77	x	0.91	x	104.39	x	0.5	x	0.8	=	26.33	(77)
Southeast 0.9x	0.77	x	0.98	x	104.39	x	0.5	x	0.8	=	28.36	(77)
Southeast 0.9x	0.77	x	1.03	x	104.39	x	0.5	x	0.8	=	29.81	(77)
Southeast 0.9x	0.77	x	0.91	x	92.85	x	0.5	x	0.8	=	23.42	(77)

DER WorkSheet: New dwelling design stage

Southeast	0.9x	0.77	x	0.98	x	92.85	x	0.5	x	0.8	=	25.22	(77)
Southeast	0.9x	0.77	x	1.03	x	92.85	x	0.5	x	0.8	=	26.51	(77)
Southeast	0.9x	0.77	x	0.91	x	69.27	x	0.5	x	0.8	=	17.47	(77)
Southeast	0.9x	0.77	x	0.98	x	69.27	x	0.5	x	0.8	=	18.82	(77)
Southeast	0.9x	0.77	x	1.03	x	69.27	x	0.5	x	0.8	=	19.78	(77)
Southeast	0.9x	0.77	x	0.91	x	44.07	x	0.5	x	0.8	=	11.12	(77)
Southeast	0.9x	0.77	x	0.98	x	44.07	x	0.5	x	0.8	=	11.97	(77)
Southeast	0.9x	0.77	x	1.03	x	44.07	x	0.5	x	0.8	=	12.58	(77)
Southeast	0.9x	0.77	x	0.91	x	31.49	x	0.5	x	0.8	=	7.94	(77)
Southeast	0.9x	0.77	x	0.98	x	31.49	x	0.5	x	0.8	=	8.55	(77)
Southeast	0.9x	0.77	x	1.03	x	31.49	x	0.5	x	0.8	=	8.99	(77)
Southwest	0.9x	0.77	x	2.54	x	36.79		0.5	x	0.8	=	51.81	(79)
Southwest	0.9x	0.77	x	3.74	x	36.79		0.5	x	0.8	=	38.15	(79)
Southwest	0.9x	0.77	x	1	x	36.79		0.5	x	0.8	=	10.2	(79)
Southwest	0.9x	0.77	x	2.54	x	62.67		0.5	x	0.8	=	88.26	(79)
Southwest	0.9x	0.77	x	3.74	x	62.67		0.5	x	0.8	=	64.98	(79)
Southwest	0.9x	0.77	x	1	x	62.67		0.5	x	0.8	=	17.37	(79)
Southwest	0.9x	0.77	x	2.54	x	85.75		0.5	x	0.8	=	120.75	(79)
Southwest	0.9x	0.77	x	3.74	x	85.75		0.5	x	0.8	=	88.9	(79)
Southwest	0.9x	0.77	x	1	x	85.75		0.5	x	0.8	=	23.77	(79)
Southwest	0.9x	0.77	x	2.54	x	106.25		0.5	x	0.8	=	149.62	(79)
Southwest	0.9x	0.77	x	3.74	x	106.25		0.5	x	0.8	=	110.15	(79)
Southwest	0.9x	0.77	x	1	x	106.25		0.5	x	0.8	=	29.45	(79)
Southwest	0.9x	0.77	x	2.54	x	119.01		0.5	x	0.8	=	167.59	(79)
Southwest	0.9x	0.77	x	3.74	x	119.01		0.5	x	0.8	=	123.38	(79)
Southwest	0.9x	0.77	x	1	x	119.01		0.5	x	0.8	=	32.99	(79)
Southwest	0.9x	0.77	x	2.54	x	118.15		0.5	x	0.8	=	166.38	(79)
Southwest	0.9x	0.77	x	3.74	x	118.15		0.5	x	0.8	=	122.49	(79)
Southwest	0.9x	0.77	x	1	x	118.15		0.5	x	0.8	=	32.75	(79)
Southwest	0.9x	0.77	x	2.54	x	113.91		0.5	x	0.8	=	160.4	(79)
Southwest	0.9x	0.77	x	3.74	x	113.91		0.5	x	0.8	=	118.09	(79)
Southwest	0.9x	0.77	x	1	x	113.91		0.5	x	0.8	=	31.58	(79)
Southwest	0.9x	0.77	x	2.54	x	104.39		0.5	x	0.8	=	147	(79)
Southwest	0.9x	0.77	x	3.74	x	104.39		0.5	x	0.8	=	108.22	(79)
Southwest	0.9x	0.77	x	1	x	104.39		0.5	x	0.8	=	28.94	(79)
Southwest	0.9x	0.77	x	2.54	x	92.85		0.5	x	0.8	=	130.75	(79)
Southwest	0.9x	0.77	x	3.74	x	92.85		0.5	x	0.8	=	96.26	(79)
Southwest	0.9x	0.77	x	1	x	92.85		0.5	x	0.8	=	25.74	(79)
Southwest	0.9x	0.77	x	2.54	x	69.27		0.5	x	0.8	=	97.54	(79)
Southwest	0.9x	0.77	x	3.74	x	69.27		0.5	x	0.8	=	71.81	(79)
Southwest	0.9x	0.77	x	1	x	69.27		0.5	x	0.8	=	19.2	(79)

DER WorkSheet: New dwelling design stage

Southwest 0.9x	0.77	x	2.54	x	44.07	0.5	x	0.8	=	62.06	(79)
Southwest 0.9x	0.77	x	3.74	x	44.07	0.5	x	0.8	=	45.69	(79)
Southwest 0.9x	0.77	x	1	x	44.07	0.5	x	0.8	=	12.22	(79)
Southwest 0.9x	0.77	x	2.54	x	31.49	0.5	x	0.8	=	44.34	(79)
Southwest 0.9x	0.77	x	3.74	x	31.49	0.5	x	0.8	=	32.64	(79)
Southwest 0.9x	0.77	x	1	x	31.49	0.5	x	0.8	=	8.73	(79)
Northwest 0.9x	0.77	x	0.91	x	11.28	0.5	x	0.8	=	2.85	(81)
Northwest 0.9x	0.77	x	0.91	x	22.97	0.5	x	0.8	=	5.79	(81)
Northwest 0.9x	0.77	x	0.91	x	41.38	0.5	x	0.8	=	10.44	(81)
Northwest 0.9x	0.77	x	0.91	x	67.96	0.5	x	0.8	=	17.14	(81)
Northwest 0.9x	0.77	x	0.91	x	91.35	0.5	x	0.8	=	23.04	(81)
Northwest 0.9x	0.77	x	0.91	x	97.38	0.5	x	0.8	=	24.57	(81)
Northwest 0.9x	0.77	x	0.91	x	91.1	0.5	x	0.8	=	22.98	(81)
Northwest 0.9x	0.77	x	0.91	x	72.63	0.5	x	0.8	=	18.32	(81)
Northwest 0.9x	0.77	x	0.91	x	50.42	0.5	x	0.8	=	12.72	(81)
Northwest 0.9x	0.77	x	0.91	x	28.07	0.5	x	0.8	=	7.08	(81)
Northwest 0.9x	0.77	x	0.91	x	14.2	0.5	x	0.8	=	3.58	(81)
Northwest 0.9x	0.77	x	0.91	x	9.21	0.5	x	0.8	=	2.32	(81)

Solar gains in watts, calculated for each month

(83)m = Sum(74)m ... (82)m

(83)m=	166.53	295.82	437.04	595.63	716.55	733.09	697.74	604.2	491.44	335.65	201.68	141.08	(83)
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Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	622.85	749.97	876.19	1010.47	1106.5	1099.18	1048.39	961.15	860.92	729.67	623.93	584.69	(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 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.94	0.83	0.66	0.5	0.56	0.81	0.97	0.99	1	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	21	21	21	21	21	21	21	21	21	21	21	21	(87)
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Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	19.85	19.85	19.85	19.86	19.87	19.88	19.88	19.88	19.87	19.87	19.86	19.86	(88)
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Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	0.99	0.97	0.92	0.78	0.56	0.38	0.43	0.73	0.95	0.99	1	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	19.85	19.85	19.85	19.86	19.87	19.88	19.88	19.88	19.87	19.87	19.86	19.86	(90)
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fLA = Living area ÷ (4) = 0.15 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	20.02	20.03	20.03	20.04	20.04	20.05	20.05	20.06	20.05	20.04	20.04	20.03	(92)
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Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	20.02	20.03	20.03	20.04	20.04	20.05	20.05	20.06	20.05	20.04	20.04	20.03	(93)
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8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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DER WorkSheet: New dwelling design stage

Utilisation factor for gains, hm:

(94)m=	1	0.99	0.98	0.92	0.79	0.58	0.39	0.45	0.75	0.95	0.99	1	(94)
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Useful gains, hmGm , W = (94)m x (84)m

(95)m=	620.65	743.38	854.77	931.57	872.95	633.9	414.01	434.46	641.67	695.59	618.98	583.15	(95)
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Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
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Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]

(97)m=	1968.03	1888.21	1684.28	1368.45	1021.99	659.06	417.32	440.56	722.87	1156.76	1593.59	1960.73	(97)
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Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	1002.46	769.33	617.15	314.55	110.89	0	0	0	0	343.11	701.72	1024.93	(98)
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Total per year (kWh/year) = Sum(98)_{1...5,9...12} =

4884.13

Space heating requirement in kWh/m²/year

50.51

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

Space heating:

Fraction of space heat from secondary/supplementary system

0

Fraction of space heat from main system(s)

(202) = 1 – (201) =

1

Fraction of total heating from main system 1

(204) = (202) × [1 – (203)] =

1

Efficiency of main space heating system 1

320.55

Efficiency of secondary/supplementary heating system, %

0

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
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Space heating requirement (calculated above)

1002.46	769.33	617.15	314.55	110.89	0	0	0	0	343.11	701.72	1024.93
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(211)m = {[(98)m x (204)] } x 100 ÷ (206)

312.73	240	192.53	98.13	34.59	0	0	0	0	107.04	218.91	319.74
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Total (kWh/year) =Sum(211)_{1...5,10...12} =

1523.68

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0
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Total (kWh/year) =Sum(215)_{1...5,10...12} =

0

Water heating

Output from water heater (calculated above)

205.01	180.57	189.35	169.33	165.65	147.59	141.34	155.65	155.55	175.61	186.2	199.94
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Efficiency of water heater

178.12

(217)m=	178.12	178.12	178.12	178.12	178.12	178.12	178.12	178.12	178.12	178.12	178.12
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Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	115.09	101.37	106.3	95.06	92.99	82.86	79.35	87.38	87.33	98.59	104.53	112.25
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Total = Sum(219a)_{1...12} =

1163.1

Annual totals

kWh/year

kWh/year

Space heating fuel used, main system 1

1523.68

Water heating fuel used

1163.1

Electricity for pumps, fans and electric keep-hot

DER WorkSheet: New dwelling design stage

mechanical ventilation - balanced, extract or positive input from outside

259.04

(230a)

Total electricity for the above, kWh/year

sum of (230a)...(230g) =

259.04

(231)

Electricity for lighting

394.97

(232)

12a. CO2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x	0.519	=	790.79	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.519	=	603.65	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1394.44	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	134.44	(267)
Electricity for lighting	(232) x	0.519	=	204.99	(268)
Total CO2, kg/year	sum of (265)...(271) =			1733.87	(272)
Dwelling CO2 Emission Rate	(272) ÷ (4) =			17.93	(273)
El rating (section 14)				84	(274)