RIBA Stage 2
Energy Assessment
6 Lindfield Gardens

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Document prepared for
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Date of issue
30/09/2020

Issue no.
2

Our reference
5207-6 Lindfield Gardens-Energy Assessment-2009-30yp.docx

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Disclaimer

Contents:

Executive Summary
Energy Assessment
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About the Scheme

The proposal comprises refurbishment and extension of an existing house to create 9 residential units with an internal floor area of approximately 711m^2. The development is located in the London Borough of Camden.

Planning policy

The scheme has been developed in accordance with the GLA Guidance and Camden Planning Guidance Energy efficiency and adaptation (July 2020). According to the planning policies, the scheme should achieve:

- Greatest possible reduction – meeting Part L1B for retained thermal elements (London Plan 5.4, Local Plan CC1)
- 20% Reduction in CO_2 from onsite renewables (London Plan 5.4, 5.7, Local Plan CC1)
- BREEAM DR Excellent

Summary

All flats have been modelled for the purposes of the energy assessment. The scheme complies with the 2013 Building Regulations Part L and the minimum energy efficiency targets in the following documents have been followed:

- Refurbishment (Part L1B) – Consequential improvements to refurbished areas have been made to ensure that the building complies with Part L, to the extent that such improvements are technically, functionally, and economically feasible.

In addition, the CO_2 emissions of the scheme have been calculated using the SAP 10.0 carbon emission factors, and the scheme can achieve:

- An on-site CO_2 reduction of 3.5% beyond Building Regulations through energy efficiency measures. The design team has maximised the passive design measure, however, the existing wall cannot be further insulated due to interstitial condensation risk. Therefore, no further CO_2 improvement can be achieved.
- No renewable technologies have been specified for the project due to site constrains and conservation criteria.
- BREEAM DR 2014 Energy credits:
    - Ene 01 – 0 credits
    - Ene 02 – 3 credits (Excellent standard)
    - Ene 03 – 6 credits
    - Ene 04 – 0 credits

Executive Summary
Energy Assessment
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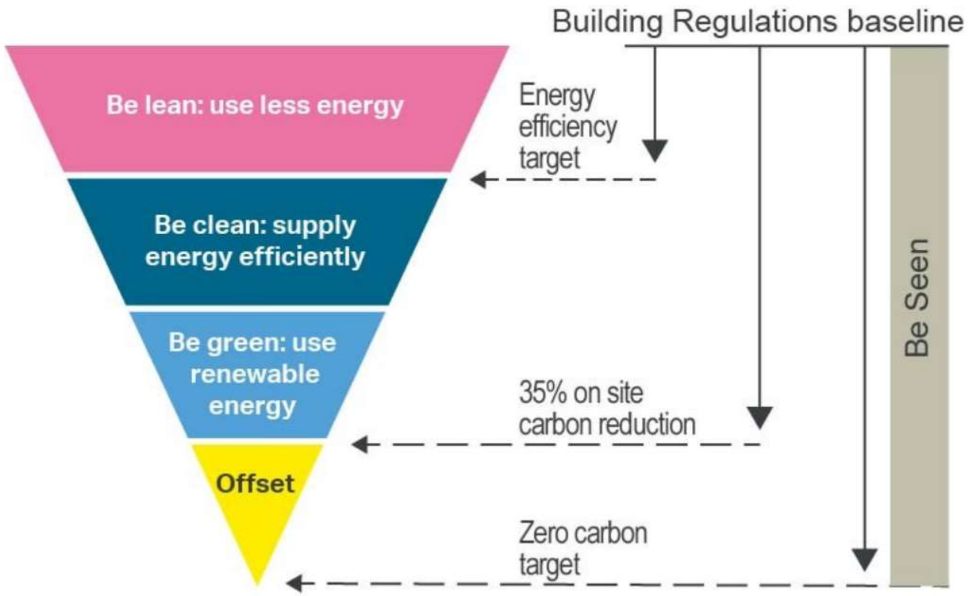
Energy hierarchy

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



Source: Greater London Authority

Key measures

Key measures identified for each stage are shown below:

- Be Lean:
  - Low U–values for new opaque elements and fenestration
  - Low g–value for new windows and rooflights
  - High efficiency lighting
- Be Clean:
  - No communal heating system has been provided due to BREEAM scoring (a communal system will result in higher operational cost compared to the baseline case and therefore no credits can be awarded)
- Be Green:
  - No renewable technologies have been specified due to site constrains and conservation criteria.

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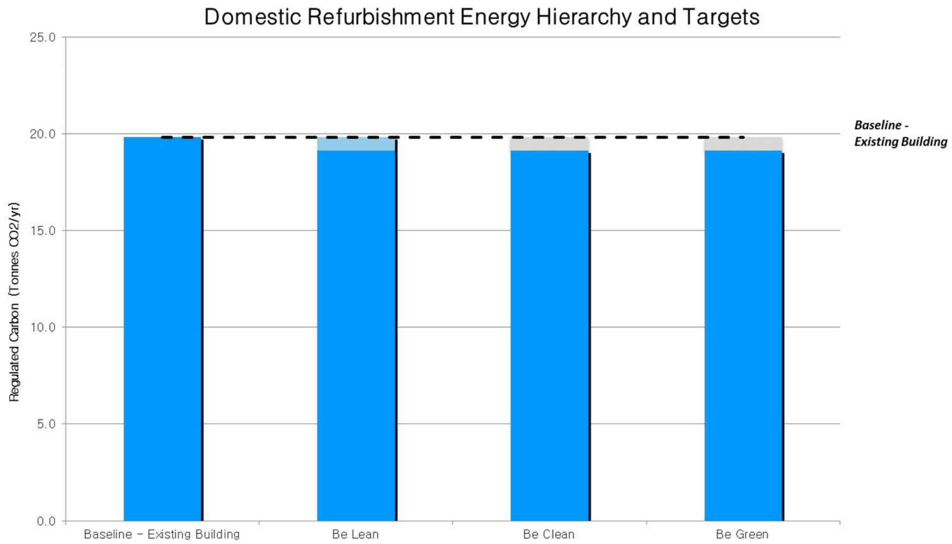
GLA's Energy Hierarchy: Regulated carbon emissions

The proposed scheme has followed the energy hierarchy. A graphical illustration of how the scheme performs in relation to Building Regulations and the Energy Hierarchy is shown below. Carbon dioxide emission factors for SAP 10.0 have been used for the calculation.

As demonstrated in the figure the proposed scheme will reduce carbon emissions by 3.5% from the fabric energy efficiency measures described in the 'Be Lean' section. No renewable technologies have been specified due to site constrains and conservation criteria.

Therefore, the scheme meets and exceeds Building Regulations and Local Plan policy.



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Regulated CO_2 emissions

Site-wide				
GLA's Energy Hierarchy: Regulated CO_2 – Calculated using SAP 2012 CO_2 factors				
	Baseline:	Be lean:	Be clean:	Be green:
CO_2 emissions (tCO_2/yr)	21.45	20.54	–	–
CO_2 emissions saving (tCO_2/yr)	–	0.91	–	–
Saving from each stage (%)	–	4.2	–	–
Total CO_2 emissions saving (tCO_2/yr)	0.91			
4.2% total CO_2 savings over Building Regulations Part L achieved				
GLA's Energy Hierarchy: Regulated CO_2 – Calculated using SAP 10.0 CO_2 factors				
	Baseline:	Be lean:	Be clean:	Be green:
CO_2 emissions (tCO_2/yr)	19.83	19.14	–	–
CO_2 emissions saving (tCO_2/yr)	–	0.69	–	–
Saving from each stage (%)	–	3.5	–	–
Total CO_2 emissions saving (tCO_2/yr)	0.69			
3.5% total CO_2 savings over Building Regulations Part L achieved				

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Emission factors:

The Greater London Authority (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 10.0) demonstrating this. Although SAP 10.0 is not in use yet, the GLA Guidance encourages the use of SAP 10.0 carbon emission factors from January 2019 in areas where there are no opportunities to connect to existing or planned district heat networks. Any applicants proposing to use the SAP 2012 emissions factors is required to provide adequate justification.

SAP 2012 emission factors can be used where:

- The scheme is located within a Heat Network Priority area; and
- There is potential to connect to an existing network using gas-engine CHP or a new network using low-emission CHP; and
- The heat network operator has, or is in the process of developing, a strategy to decarbonise the network and has shared it with the GLA

While the proposed scheme is expected to comply with SAP 2012 for Building Regulation compliance, the assessment presents total emissions using SAP10.0 as it is required for demonstrating performance against planning policy targets. The revised factors are below:

Fuel Type	Carbon Factor (kg CO_2/kWh)	
	SAP 2012	SAP10.0
Natural Gas	0.216	0.210
Grid Electricity	0.519	0.233

The carbon emissions of the scheme have been calculated using Building Regulations methodology for estimating energy performance against Part L 2013 requirements, and the outputs have been manually converted for the SAP 10.0 emission factors using a spreadsheet.

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Methodology

The purpose of an energy assessment is to demonstrate that climate change mitigation measures comply with London Plan energy policies, including the energy hierarchy. It also ensures energy remains an integral part of the scheme's design and evolution.

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 Assessment Guidance: Greater London Authority guidance on preparing energy assessments as part of planning applications (April 2020)". The scheme has been developed in accordance with the Intend to Publish London Plan 2019.

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

- Baseline: A calculation of the Part L 2013 Building Regulations compliant CO_2 emission baseline using approved software. The baseline assumes a gas boiler would provide heating and any active cooling would be electrically powered and fabric has been modelled as per Appendix 4 of GLA's Guidance.
- Be 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 Intent to Publish London Plan 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.
- Be Clean: In accordance with Policy 5.6 of London Plan and Intent to Publish London Plan 2019 Policy 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.
- Be Green: In accordance with Policy 5.7 of London Plan and Intent to Publish London Plan 2019 Policy 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.

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Establishing CO_2 emissions

As required by the GLA both the regulated and unregulated emissions of the development must be quantified and demonstrated. The total emissions for the scheme are shown below.

CO_2 Emissions – Regulated and Unregulated (tonnes CO_2/yr) – SAP 10.0 – Residential			
	Regulated Emissions	Unregulated Emissions	Total Emissions
Baseline: Part L 2013	19.83	5.32	25.15
Be Lean: Use less energy	19.14	5.32	24.45
Be Clean: Supply energy efficiently	–	–	–
Be Green: Use renewable energy	–	–	–

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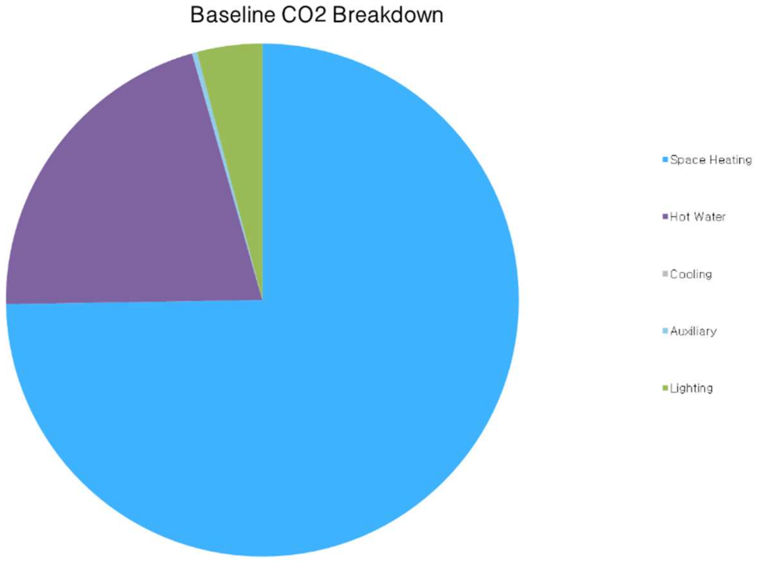
Building regulations Part L 2013 minimum compliance

The total baseline carbon emissions for the whole scheme is 19.83 tonnes CO_2/yr (using SAP 10.0 carbon dioxide emission factors).

The pie chart provides a breakdown of the specific carbon emissions by system over the course of one year. The chart shows that space heating is the primary source of carbon dioxide emissions, and hot water is the second largest.

Carbon Emissions in tonnes CO_2/yr.				
Heating	Hot Water	Cooling	Auxiliary	Lighting
14.82	4.13	0.00	0.06	0.81



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Be Lean: summary

Demand reduction measures have reduced the scheme's carbon emissions by 3.5% (using SAP 10.0 figures) over the minimum Part L 2013 Building Regulations baseline.

U-values

Element	Minimum Building Regulations U-value W/m²K (Appendix 4 – GLA guidance)	Proposed U-value W/m²K
Flat roof – Existing	0.18	0.18*
Flat roof – New	0.18	0.14
Pitched roof – Existing	0.18	0.18*
Pitched roof – New	0.18	0.14
Wall – Existing	0.55	0.55*
Wall – New	0.25	0.14
Corridor wall	0.55	0.55*
Ground floor	0.55	0.55*
Exposed floor	0.55	0.55*
Windows – Existing	1.60 (g-value 0.63)	1.60 (g-value 0.63)
Windows – New	1.60 (g-value 0.50)	1.30 (g-value 0.50)
Rooflights – Existing	1.60 (g-value 0.63)	1.60 (g-value 0.63)
Rooflights – New	1.60 (g-value 0.50)	1.30 (g-value 0.50)
Doors	1.80	1.30

*The Building has been fully refurbished and insulated in 2009, therefore the above values have been assumed. It has been estimated that the existing elements cannot be insulated further without increasing the interstitial condensation risk. A dynamic condensation risk analysis (using WUFI) is required in case the existing elements are thermally upgraded.

Party walls will be fully filled cavity with effective sealing at all exposed edges and in line with insulation layers in abutting elements.

Air permeability

A reduced air permeability has been targeted as per the table below:

	Minimum Building Regulations	Proposed
Air permeability (m^3/hm^2 @50 Pa)	10	10

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 and cracks in masonry walls typically caused by poor perpends in the blockwork or brickwork. 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 default psi-value has been used for all junctions due to the existing structure.

Thermal Mass:

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

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Heating

The scheme has been modelled with a gas boiler with an efficiency of 89.5%. Heat will be provided via radiators and will be controlled with a programmer, thermostat and TRVs.

Hot Water

The hot water will be provided by the main gas heating system (gas boilers with an efficiency of 89.5%). No hot water cylinder has been specified.

Ventilation

Natural ventilation with extract fans for toilet and kitchen has been specified for all dwellings.

Cooling

The existing house has an air conditioning unit. Air conditioning will be provided for flat 1 (ground floor) to ensure occupant thermal comfort, with an energy label class of A and variable speed compressors. No cooling has been specified for the remaining flats.

Lighting

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

Energy demand following energy efficiency measures (MWh/year)

Space Heating	Hot water	Lighting	Auxiliary	Cooling	Unregulated gas	Unregulated electricity
69.0	18.7	2.8	0.3	0.0	0.0	11.8

Fabric energy efficiency

Baseline Fabric Energy Efficiency (MWh/year)	Design Fabric Energy Efficiency (MWh/year)	Improvement (%)
65.59	64.84	1%

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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 in Policy SI4

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

1. Reduce the amount of heat entering the building through orientation, shading, high albedo materials, fenestration, insulation, and the provision of green infrastructure
2. Minimise internal heat generation through energy efficient design
3. Manage the heat within the building through exposed internal thermal mass and high ceilings
4. Provide passive ventilation
5. Provide mechanical ventilation
6. Provide active cooling systems

Avoiding overheating: measures taken

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

1. Reduce the amount of heat entering the building through orientation, shading, high albedo materials, fenestration, insulation, and the provision of green infrastructure
    - Solar control – all methods controlling solar gain to within tolerable limits have been considered. The location, size, design and type of window openings and glazing have been optimised and reduced solar gain factors from low emissivity new windows have been specified.
    - 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.
    - High albedo materials: A high albedo (reflective) surface has been specified for the roof in order to minimise the heat absorbed by the roof, and significant thermal insulation has been specified to prevent any heat absorbed being transferred into the building.
    - Insulation levels have been maximised and the resulting U–values for the new elements 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.

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2. Minimise internal heat generation through energy efficient design
    - Internal heat gains have been minimised where possible. The scheme will target the BREEAM Domestic Refurbishment Energy 5: Energy Labelled White Goods. Energy efficient appliances will help reduce internal heat gain and reduce the cooling requirement.
    - Energy efficient lighting will also be specified as per the 'Be Lean' section.
3. Manage the heat within the building through exposed internal thermal mass and high ceilings
    - 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.
    - Room heights – high ceilings are traditionally used in hot climates to allow thermal stratification so that occupants can inhabit the lower cooler space, and to decrease the transfer of heat gain through the roof. The proposed building has floor to ceiling heights of more than 2.5m. As the roof will be well insulated to below building regulations, there will be minimal penetration of heat through the roof.
4. Provide passive ventilation
    - Openable windows are specified on all facades of the building.
    - Shallow floorplates have been specified with dual aspect units, where possible, to allow for cross ventilation. 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.
5. Provide mechanical ventilation
    - Natural ventilation with extract fans for toilet and kitchen has been specified for all dwellings.
    - The mechanical systems will comply with the Domestic Building Services Compliance Guide.

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Overheating risk

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

Areas	Overheating risk from SBEM and SAP
Flat 1	Not significant
Flat 2	Slight
Flat 3	Slight
Flat 4	Slight
Flat 5	Slight
Flat 6	Medium
Flat 7	Medium
Flat 8	Medium
Flat 9	Medium

According to the GLA guidance on preparing energy assessments (April 2020) Section 8, a dynamic modelling in line with CIBSE TM52 and TM59 should be carried out to assess the risk of overheating. The dynamic overheating analysis has been carried out by eight Associates '5207-6 Lindfield Gardens-Overheating-2009-07yp', issued on the 07/09/2020, confirms that the scheme meets the CIBSE TM52 and TM59 requirements.

Active cooling

Air conditioning has just been specified for Flat 1(ground floor). No cooling has been specified for other flats since the overheating analysis demonstrates the there is no significant risk of overheating and the passive design measured are enough to guarantee the occupant's comfort.

For flat 1, to ensure the cooling system is the most carbon efficient possible the following parameters have been selected:

- Location: Indoor cooling units have been specified on a localised basis where internal gains are too high. The units will be fully fitted with local temperature controls for optimal usage.
- The location of the outdoor units that 'dump' the heat has been carefully conspired carefully so not to cause problems for people and the environment, and not to add to the urban heat island effect. They will be located on the roof space and will allow adequate air movement around the condensing units; this will ensure maximum operating efficiency and will limit the impacts of dumped heat on people and the environment.
- The AC systems will follow the Domestic Building Services Compliance Guide

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Heating infrastructure including CHP

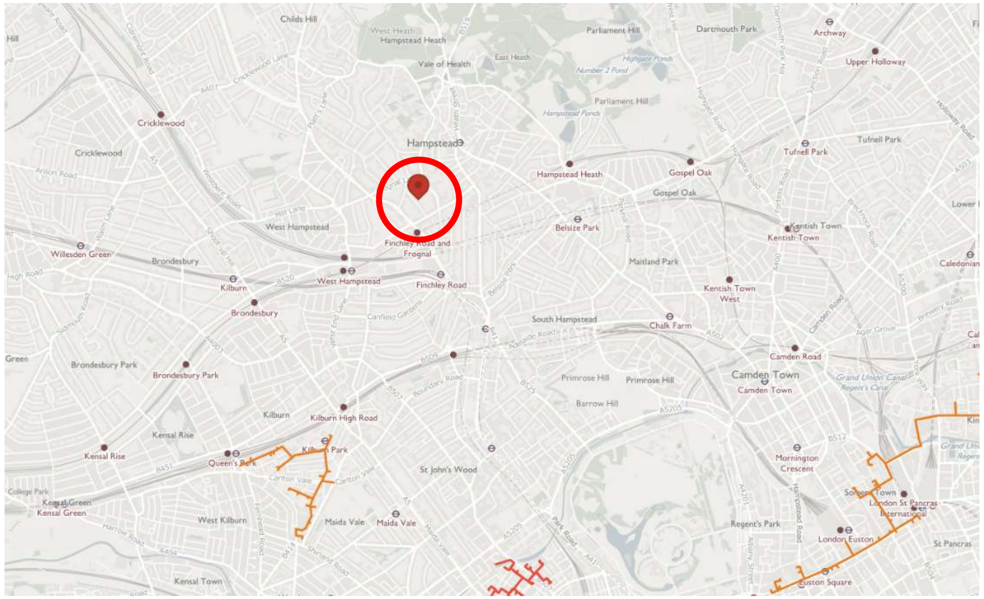
Once demand for energy has been minimised, schemes must demonstrate how their energy systems have been selected in accordance with the order of preference in Policy 5.6B of London Plan and Policy SI3 of Intended to publish London Plan. This has involved a systematic appraisal of the potential to connect to existing or planned heating networks and on site communal and CHP systems.

To comply with London Plan Policy SI 3, developments in Heat Network Priority Areas (HNPAs) should have a communal low-temperature heating system and should select a heat source in accordance with the following heating hierarchy:

a) connect to local existing or planned heat networks
b) use zero-emission or local secondary heat sources (in conjunction with heat pump, if required)
c) use low-emission combined heat and power (only where there is a case for CHP to enable the delivery of an area-wide heat network, meet the development's electricity demand and provide demand response to the local electricity network)
d) use ultra-low NOx gas boilers

Connect to local existing or planned heat network

The illustration below shows the London heat map. Red lines are existing heat networks and orange lines are proposed heat networks. The red circle shows the location of the proposed scheme.



A review of the London Heat Map demonstrates that there are no existing networks present within connectable range of the scheme. Therefore, a connection is not possible.

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Use zero-emission and/or local secondary heat sources

According to the GLA and Intend to Publish London Plan Policy SI3, the exploitation of local energy opportunities to maximise the use of locally available energy sources whilst minimising primary energy demand and carbon emissions is encouraged. Secondary heat includes environmental sources such as air, water and ground; and waste sources such as heat from the sewerage system, sewage treatment plants, the tube network, data centres and chiller systems.

There are no local available waste heat sources for the scheme. The possibilities of capturing waste heat from nearby sources has been undertaken, however the amount of heat available is likely a fraction of the scheme's demand which makes its collection trivial within the context of the scheme.

Use low-emission combined heat and power (CHP)

In accordance with section 9 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 residential 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.

Use ultra-low NOx gas boilers

Where it is clearly demonstrate that the above heating options (District heating, local secondary heat source and CHP) have been fully investigated and ruled out, then a site-wide heating strategy led by ultra-low NOx gas boilers can be considered.

In accordance with section 9 of the GLA guidance for Energy Planning, where it is demonstrable that a site wide network is not feasible then an individual heating strategy can be implemented. A site wide network will not be adopted because local conditions are not favourable to centralised distribution. Therefore, it is considered that distribution losses would be relatively large and the effectiveness and carbon reducing potential would be undermined when compared to an individual servicing strategy.

Moreover, the scheme is required to achieve a BREEAM Excellent rating. The score for the energy credits is calculated based on the EER (Energy efficiency rating) improvement and primary energy. The EER is based on the energy costs associated with space heating, water heating, ventilation, and lighting. Any communal system will result in distribution losses and a slightly higher cost compared to the baseline. Therefore, no energy credits can be achieved if a communal heating system is specified and a BREEAM DR 'Excellent' rating is not achievable.

Therefore, an individual heating system has been specified for each dwelling.

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Renewable Energy Feasibility:

In line with Policy SI2 of the Intend to publish London Plan 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.

Each technology has been assessed under 3 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:

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

- Local, site-specific impact: (Maximum score of 5)
  - Local planning criteria = ✓✓
  - Land used by all components = ✓
  - Noise impact from operation = ✓
  - Interaction on the current building design = ✓
  - 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 = ✓
  - Servicing requirements (low or high) = ✓
  - Maintenance costs (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 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.

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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 large to meet the required CO_2 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, and storage of the biomass fuel. A detailed feasibility study will be required to investigate the suitability.

Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)
✓	✓✓✓	✓✓✓✓✓
Local air quality impacts, increased transport usage, increased plant space, 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.

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Photovoltaic Panels (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 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 very small potential roof area, however, due to the visual impact that the PVs are likely to have on the conservation value, PV panels are not considered to be acceptable.

Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)
✓✓✓ No local air quality impacts, use of unutilised roof space, no noise issues, good orientation, and slightly increased buildability issues for wiring and metering.	✓✓ Increased capital costs of installation, typical payback of 10-15 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.

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Solar Thermal – Rejected

Solar water heating systems use the energy from the sun to heat water for 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 very small potential roof area, however due to the visual impact that the solar thermal panels are likely to have on the conservation value, they are not considered to be acceptable.

Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)
✓✓✓ No local air quality impacts, use of unutilised roof space, no noise issues, good orientation, slightly increased buildability issues for piping and cylinders.	✓✓✓ Increased capital costs of installation, typical payback of 8–10 years, Heat Incentive available, limited servicing and maintenance i.e. 1 visit per year, 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.

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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 groups within the local community could also affect the viability of wind energy for the project.

Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)
✓	✓✓✓✓	✓✓✓✓✓
No local air quality impacts, use of unutilised roof space, medium noise issues, relatively limited wind speeds in local area, increased buildability issues for wiring and metering.	Medium capital costs of installation, typical payback of 5 years, Feed in Tariff available, 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

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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 boreholes, 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 boreholes 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 were viable.

From the boreholes 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 / borehole 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.

The installation cost for a Ground Source Heat pump is typically high compared to a gas-boiler installation. Moreover, the installation of the ground collector it will be hard due to the existing structures that are on site. Therefore, the GSHP has been rejected.

Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)
✓✓	✓	✓✓✓✓✓ ✓✓✓
No local air quality impacts, no visual impact, 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 >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.	Medium carbon saving from gas displacement, consumes some electricity so benefits from decarbonisation, no local air impact, high embodied energy of equipment.

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Air Source Heat Pump (GSHP) – Rejected

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˚C, however, the performance will reduce to below the required 3 to 1 carbon saving ratio in winter, and they 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. There is limited available space in the scheme and no ASHPs can be specified on the roof due to conservation. Moreover, the heating demand of the scheme will be high compared to new builds, because of the existing wall fabric that cannot be further upgraded due to interstitial condensation risk. Therefore, an electric ASHP will increase the operational cost and would not be viable. The ASHP has been rejected.

Local, site-specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)
✓✓✓ No local air quality impacts, use of unutilised roof space, over visual impact, low noise issues, 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.	✓✓✓✓✓ ✓✓ Medium carbon saving from gas displacement, less efficient in winter, consumes electricity so benefits from decarbonisation, no local air impact, high embodied energy of equipment.

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Summary comparison matrix

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

Renewable Technology	Comments	Local, site–specific impact (out of 5)	Economic viability (out of 5)	CO_2 and sustainability (out of 10)	Total Score
Biomass Boiler	Rejected – High air quality impact	✓	✓✓✓	✓✓✓✓✓	9
Photovoltaic	Accepted – High CO_2 savings and have low visual impact	✓✓✓	✓✓	✓✓✓✓✓ ✓✓✓	13
Solar Thermal	Rejected – Low CO_2 savings compared to PV panels	✓✓✓	✓✓✓	✓✓✓✓✓ ✓	12
Wind Energy	Rejected – High visual and noise impact	✓	✓✓✓✓	✓✓✓✓✓	10
GSHP	Rejected – High capital cost	✓✓	✓	✓✓✓✓✓ ✓✓✓	11
ASHP	Accepted – Can provide carbon savings with minimal site impact	✓✓✓	✓✓	✓✓✓✓✓ ✓✓	12

Photovoltaic panels, solar thermal panels and ASHPs have scored the best. However, due to the limited amount of roof, visual impact and conservation criteria, no renewable technologies have been specified.

Conclusion
Energy Assessment
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Summary

All flats have been modelled for the purposes of the energy assessment. The scheme complies with the 2013 Building Regulations Part L and the minimum energy efficiency targets in the following documents have been followed:

- Refurbishment (Part L1B) – Consequential improvements to refurbished areas have been made to ensure that the building complies with Part L, to the extent that such improvements are technically, functionally, and economically feasible.

In addition, the CO_2 emissions of the scheme have been calculated using the SAP 10.0 carbon emission factors, and the scheme can achieve:

- An on-site CO_2 reduction of 3.5% beyond Building Regulations through energy efficiency measures. The design team has maximised the passive design measure, however, the existing wall cannot be further insulated due to interstitial condensation risk. Therefore, no further CO_2 improvement can be achieved.
- No renewable technologies have been specified for the project due to site constrains and conservation criteria.
- BREEAM DR 2014 Energy credits:
  - Ene 01 – 0 credits
  - Ene 02 – 3 credits (Excellent standard)
  - Ene 03 – 6 credits
  - Ene 04 – 0 credits

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Total fuel consumption

The total gas and electricity consumption are shown in the table below.

Energy source	Total fuel consumption (MWh/year)
Grid electricity	14.9
Gas boilers (communal/individual)	87.7
Gas CHP	–
Connection to existing District Heating network	–
Other gas use (e.g. cookers)	–

Appendix B
Energy Assessment
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SAP and BRUKL files

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 – DER from the Baseline scenario DER SAP worksheet
- Be Lean Residential – DER from the Be Lean scenario DER SAP worksheet

Appendix B
Energy Assessment
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Baseline Residential – DER from the Baseline scenario DER SAP worksheet

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 1-Existing

Address : Flat 1, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	92.28	(1a)	x	4.18	(2a)	=	385.73	(3a)
First floor	40.18	(1b)	x	2.5	(2b)	=	100.45	(3b)
Second floor	106.16	(1c)	x	2.63	(2c)	=	279.2	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	238.62	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	765.38	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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							5	x 10 =	50	(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) =	50	÷ (5) =	0.07	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)
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			
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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.57	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
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) =	0.48	(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

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

0.61	0.6	0.59	0.53	0.52	0.46	0.46	0.44	0.48	0.52	0.54	0.56

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	(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	(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=	0.69	0.68	0.67	0.64	0.63	0.6	0.6	0.6	0.62	0.63	0.65	0.66	(24d)

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

(25)m=	0.69	0.68	0.67	0.64	0.63	0.6	0.6	0.6	0.62	0.63	0.65	0.66	(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			4.26	x 1.8	= 7.668			(26)
Windows Type 1			3.44	x1/[1/(1.6)+ 0.04]	= 5.17			(27)
Windows Type 2			1.56	x1/[1/(1.6)+ 0.04]	= 2.35			(27)
Windows Type 3			0.67	x1/[1/(1.6)+ 0.04]	= 1.01			(27)
Windows Type 4			0.7	x1/[1/(1.6)+ 0.04]	= 1.05			(27)
Windows Type 5			0.72	x1/[1/(1.6)+ 0.04]	= 1.08			(27)
Windows Type 6			0.52	x1/[1/(1.6)+ 0.04]	= 0.78			(27)
Windows Type 7			0.72	x1/[1/(1.6)+ 0.04]	= 1.08			(27)
Windows Type 8			1.3	x1/[1/(1.6)+ 0.04]	= 1.95			(27)
Windows Type 9			1	x1/[1/(1.6)+ 0.04]	= 1.5			(27)
Windows Type 10			8.58	x1/[1/(1.6)+ 0.04]	= 12.9			(27)
Rooflights Type 1			0.47	x1/[1/(1.6) + 0.04]	= 0.752			(27b)
Rooflights Type 2			0.63	x1/[1/(1.6) + 0.04]	= 1.008			(27b)
Rooflights Type 3			0.84	x1/[1/(1.6) + 0.04]	= 1.344			(27b)
Rooflights Type 4			0.62	x1/[1/(1.6) + 0.04]	= 0.992			(27b)
Rooflights Type 5			2.36	x1/[1/(1.6) + 0.04]	= 3.776			(27b)
Rooflights Type 6			2.15	x1/[1/(1.6) + 0.04]	= 3.44			(27b)

DER WorkSheet: New dwelling design stage

Rooflights Type 7			3.27	x1/[1/(1.6) + 0.04]	=	5.232				(27b)
Rooflights Type 8			0.89	x1/[1/(1.6) + 0.04]	=	1.424				(27b)
Rooflights Type 9			1.29	x1/[1/(1.6) + 0.04]	=	2.064				(27b)
Rooflights Type 10			2.37	x1/[1/(1.6) + 0.04]	=	3.792				(27b)
Floor Type 1			191.44	x 0.55	=	105.292				(28)
Floor Type 2			10.26	x 0.55	=	5.643				(28)
Walls Type1	145.59	0	145.59	x 0.55	=	80.07				(29)
Walls Type2	147.31	12.75	134.56	x 0.55	=	74.01				(29)
Walls Type3	42.7	14.84	27.86	x 0.28	=	7.8				(29)
Roof Type1	88.47	17.67	70.8	x 0.18	=	12.74				(30)
Roof Type2	28.75	0	28.75	x 0.18	=	5.18				(30)
Total area of elements, m²			654.52							(31)
Party wall			53.98	x 0	=	0				(32)
Party ceiling			84.47							(32b)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) — (26)…(30) + (32) = **360.06** (33)

Heat capacity Cm = S(A x k) — ((28)…(30) + (32) + (32a)…(32e) = **35022.54** (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K — **98.18** (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss — (33) + (36) = **458.24** (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	173.69	171.85	170.05	161.57	159.99	152.61	152.61	151.24	155.45	159.99	163.19	166.55	(38)

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

(39)m=	631.93	630.09	628.28	619.81	618.22	610.84	610.84	609.48	613.69	618.22	621.43	624.79	

Average = Sum(39)$_{1…12}$ /12= **619.8** (39)

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

(40)m=	2.65	2.64	2.63	2.6	2.59	2.56	2.56	2.55	2.57	2.59	2.6	2.62	

Average = Sum(40)$_{1…12}$ /12= **2.6** (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 — **3.05** (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 — **112.3** (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	123.53	119.04	114.55	110.06	105.57	101.07	101.07	105.57	110.06	114.55	119.04	123.53	

Total = Sum(44)$_{1…12}$ = **1347.64** (44)

DER WorkSheet: New dwelling design stage

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	183.2	160.23	165.34	144.15	138.31	119.35	110.6	126.91	128.43	149.67	163.38	177.42	

Total = Sum(45)1...12 = 1766.97 (45)

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

(46)m=	27.48	24.03	24.8	21.62	20.75	17.9	16.59	19.04	19.26	22.45	24.51	26.61	(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)

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	50.96	46.03	50.96	49.32	50.96	49.32	50.96	50.96	49.32	50.96	49.32	50.96	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	234.16	206.25	216.3	193.46	189.27	168.67	161.56	177.87	177.74	200.63	212.69	228.38	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	234.16	206.25	216.3	193.46	189.27	168.67	161.56	177.87	177.74	200.63	212.69	228.38

Output from water heater (annual)1...12 — 2366.97 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	73.65	64.78	67.71	60.26	58.73	52.01	49.51	54.94	55.03	62.51	66.65	71.73	(65)

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=	152.61	152.61	152.61	152.61	152.61	152.61	152.61	152.61	152.61	152.61	152.61	152.61	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	45.62	40.52	32.95	24.94	18.65	15.74	17.01	22.11	29.68	37.68	43.98	46.88	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	406.41	410.63	400	377.38	348.82	321.98	304.05	299.83	310.46	333.08	361.64	388.48	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	38.26	38.26	38.26	38.26	38.26	38.26	38.26	38.26	38.26	38.26	38.26	38.26	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	(71)

Water heating gains (Table 5)

(72)m=	99	96.4	91.01	83.69	78.94	72.24	66.55	73.84	76.43	84.01	92.57	96.41	(72)

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

(73)m=	622.81	619.33	595.75	557.8	518.18	481.74	459.39	467.56	488.35	526.56	569.97	603.56	(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 m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast 0.9x	0.77	x	0.72	x	11.28	x	0.63	x	0.7	=	2.48	(75)
Northeast 0.9x	0.77	x	1	x	11.28	x	0.63	x	0.7	=	6.9	(75)
Northeast 0.9x	0.77	x	8.58	x	11.28	x	0.63	x	0.7	=	29.59	(75)
Northeast 0.9x	0.77	x	0.72	x	22.97	x	0.63	x	0.7	=	5.05	(75)
Northeast 0.9x	0.77	x	1	x	22.97	x	0.63	x	0.7	=	14.04	(75)
Northeast 0.9x	0.77	x	8.58	x	22.97	x	0.63	x	0.7	=	60.22	(75)
Northeast 0.9x	0.77	x	0.72	x	41.38	x	0.63	x	0.7	=	9.11	(75)
Northeast 0.9x	0.77	x	1	x	41.38	x	0.63	x	0.7	=	25.29	(75)
Northeast 0.9x	0.77	x	8.58	x	41.38	x	0.63	x	0.7	=	108.5	(75)
Northeast 0.9x	0.77	x	0.72	x	67.96	x	0.63	x	0.7	=	14.95	(75)
Northeast 0.9x	0.77	x	1	x	67.96	x	0.63	x	0.7	=	41.54	(75)
Northeast 0.9x	0.77	x	8.58	x	67.96	x	0.63	x	0.7	=	178.19	(75)
Northeast 0.9x	0.77	x	0.72	x	91.35	x	0.63	x	0.7	=	20.1	(75)
Northeast 0.9x	0.77	x	1	x	91.35	x	0.63	x	0.7	=	55.83	(75)
Northeast 0.9x	0.77	x	8.58	x	91.35	x	0.63	x	0.7	=	239.52	(75)
Northeast 0.9x	0.77	x	0.72	x	97.38	x	0.63	x	0.7	=	21.43	(75)
Northeast 0.9x	0.77	x	1	x	97.38	x	0.63	x	0.7	=	59.52	(75)
Northeast 0.9x	0.77	x	8.58	x	97.38	x	0.63	x	0.7	=	255.36	(75)
Northeast 0.9x	0.77	x	0.72	x	91.1	x	0.63	x	0.7	=	20.05	(75)
Northeast 0.9x	0.77	x	1	x	91.1	x	0.63	x	0.7	=	55.68	(75)
Northeast 0.9x	0.77	x	8.58	x	91.1	x	0.63	x	0.7	=	238.88	(75)

DER WorkSheet: New dwelling design stage

Northeast	0.9x	0.77	x	0.72	x	72.63	x	0.63	x	0.7	=	15.98	(75)
Northeast	0.9x	0.77	x	1	x	72.63	x	0.63	x	0.7	=	44.39	(75)
Northeast	0.9x	0.77	x	8.58	x	72.63	x	0.63	x	0.7	=	190.44	(75)
Northeast	0.9x	0.77	x	0.72	x	50.42	x	0.63	x	0.7	=	11.09	(75)
Northeast	0.9x	0.77	x	1	x	50.42	x	0.63	x	0.7	=	30.82	(75)
Northeast	0.9x	0.77	x	8.58	x	50.42	x	0.63	x	0.7	=	132.21	(75)
Northeast	0.9x	0.77	x	0.72	x	28.07	x	0.63	x	0.7	=	6.18	(75)
Northeast	0.9x	0.77	x	1	x	28.07	x	0.63	x	0.7	=	17.16	(75)
Northeast	0.9x	0.77	x	8.58	x	28.07	x	0.63	x	0.7	=	73.6	(75)
Northeast	0.9x	0.77	x	0.72	x	14.2	x	0.63	x	0.7	=	3.12	(75)
Northeast	0.9x	0.77	x	1	x	14.2	x	0.63	x	0.7	=	8.68	(75)
Northeast	0.9x	0.77	x	8.58	x	14.2	x	0.63	x	0.7	=	37.23	(75)
Northeast	0.9x	0.77	x	0.72	x	9.21	x	0.63	x	0.7	=	2.03	(75)
Northeast	0.9x	0.77	x	1	x	9.21	x	0.63	x	0.7	=	5.63	(75)
Northeast	0.9x	0.77	x	8.58	x	9.21	x	0.63	x	0.7	=	24.16	(75)
Southeast	0.9x	0.77	x	0.7	x	36.79	x	0.63	x	0.7	=	7.87	(77)
Southeast	0.9x	0.77	x	0.52	x	36.79	x	0.63	x	0.7	=	11.69	(77)
Southeast	0.9x	0.77	x	1.3	x	36.79	x	0.63	x	0.7	=	43.85	(77)
Southeast	0.9x	0.77	x	0.7	x	62.67	x	0.63	x	0.7	=	13.41	(77)
Southeast	0.9x	0.77	x	0.52	x	62.67	x	0.63	x	0.7	=	19.92	(77)
Southeast	0.9x	0.77	x	1.3	x	62.67	x	0.63	x	0.7	=	74.7	(77)
Southeast	0.9x	0.77	x	0.7	x	85.75	x	0.63	x	0.7	=	18.34	(77)
Southeast	0.9x	0.77	x	0.52	x	85.75	x	0.63	x	0.7	=	27.26	(77)
Southeast	0.9x	0.77	x	1.3	x	85.75	x	0.63	x	0.7	=	102.21	(77)
Southeast	0.9x	0.77	x	0.7	x	106.25	x	0.63	x	0.7	=	22.73	(77)
Southeast	0.9x	0.77	x	0.52	x	106.25	x	0.63	x	0.7	=	33.77	(77)
Southeast	0.9x	0.77	x	1.3	x	106.25	x	0.63	x	0.7	=	126.64	(77)
Southeast	0.9x	0.77	x	0.7	x	119.01	x	0.63	x	0.7	=	25.46	(77)
Southeast	0.9x	0.77	x	0.52	x	119.01	x	0.63	x	0.7	=	37.83	(77)
Southeast	0.9x	0.77	x	1.3	x	119.01	x	0.63	x	0.7	=	141.85	(77)
Southeast	0.9x	0.77	x	0.7	x	118.15	x	0.63	x	0.7	=	25.28	(77)
Southeast	0.9x	0.77	x	0.52	x	118.15	x	0.63	x	0.7	=	37.55	(77)
Southeast	0.9x	0.77	x	1.3	x	118.15	x	0.63	x	0.7	=	140.82	(77)
Southeast	0.9x	0.77	x	0.7	x	113.91	x	0.63	x	0.7	=	24.37	(77)
Southeast	0.9x	0.77	x	0.52	x	113.91	x	0.63	x	0.7	=	36.2	(77)
Southeast	0.9x	0.77	x	1.3	x	113.91	x	0.63	x	0.7	=	135.77	(77)
Southeast	0.9x	0.77	x	0.7	x	104.39	x	0.63	x	0.7	=	22.33	(77)
Southeast	0.9x	0.77	x	0.52	x	104.39	x	0.63	x	0.7	=	33.18	(77)
Southeast	0.9x	0.77	x	1.3	x	104.39	x	0.63	x	0.7	=	124.42	(77)
Southeast	0.9x	0.77	x	0.7	x	92.85	x	0.63	x	0.7	=	19.86	(77)
Southeast	0.9x	0.77	x	0.52	x	92.85	x	0.63	x	0.7	=	29.51	(77)

DER WorkSheet: New dwelling design stage

Southeast	0.9x	0.77	x	1.3	x	92.85	x	0.63	x	0.7	=	110.67	(77)
Southeast	0.9x	0.77	x	0.7	x	69.27	x	0.63	x	0.7	=	14.82	(77)
Southeast	0.9x	0.77	x	0.52	x	69.27	x	0.63	x	0.7	=	22.02	(77)
Southeast	0.9x	0.77	x	1.3	x	69.27	x	0.63	x	0.7	=	82.56	(77)
Southeast	0.9x	0.77	x	0.7	x	44.07	x	0.63	x	0.7	=	9.43	(77)
Southeast	0.9x	0.77	x	0.52	x	44.07	x	0.63	x	0.7	=	14.01	(77)
Southeast	0.9x	0.77	x	1.3	x	44.07	x	0.63	x	0.7	=	52.53	(77)
Southeast	0.9x	0.77	x	0.7	x	31.49	x	0.63	x	0.7	=	6.74	(77)
Southeast	0.9x	0.77	x	0.52	x	31.49	x	0.63	x	0.7	=	10.01	(77)
Southeast	0.9x	0.77	x	1.3	x	31.49	x	0.63	x	0.7	=	37.53	(77)
Southwest	0.9x	0.77	x	3.44	x	36.79		0.63	x	0.7	=	38.68	(79)
Southwest	0.9x	0.77	x	1.56	x	36.79		0.63	x	0.7	=	17.54	(79)
Southwest	0.9x	0.77	x	0.67	x	36.79		0.63	x	0.7	=	7.53	(79)
Southwest	0.9x	0.77	x	0.72	x	36.79		0.63	x	0.7	=	8.1	(79)
Southwest	0.9x	0.77	x	3.44	x	62.67		0.63	x	0.7	=	65.89	(79)
Southwest	0.9x	0.77	x	1.56	x	62.67		0.63	x	0.7	=	29.88	(79)
Southwest	0.9x	0.77	x	0.67	x	62.67		0.63	x	0.7	=	12.83	(79)
Southwest	0.9x	0.77	x	0.72	x	62.67		0.63	x	0.7	=	13.79	(79)
Southwest	0.9x	0.77	x	3.44	x	85.75		0.63	x	0.7	=	90.15	(79)
Southwest	0.9x	0.77	x	1.56	x	85.75		0.63	x	0.7	=	40.88	(79)
Southwest	0.9x	0.77	x	0.67	x	85.75		0.63	x	0.7	=	17.56	(79)
Southwest	0.9x	0.77	x	0.72	x	85.75		0.63	x	0.7	=	18.87	(79)
Southwest	0.9x	0.77	x	3.44	x	106.25		0.63	x	0.7	=	111.7	(79)
Southwest	0.9x	0.77	x	1.56	x	106.25		0.63	x	0.7	=	50.66	(79)
Southwest	0.9x	0.77	x	0.67	x	106.25		0.63	x	0.7	=	21.76	(79)
Southwest	0.9x	0.77	x	0.72	x	106.25		0.63	x	0.7	=	23.38	(79)
Southwest	0.9x	0.77	x	3.44	x	119.01		0.63	x	0.7	=	125.12	(79)
Southwest	0.9x	0.77	x	1.56	x	119.01		0.63	x	0.7	=	56.74	(79)
Southwest	0.9x	0.77	x	0.67	x	119.01		0.63	x	0.7	=	24.37	(79)
Southwest	0.9x	0.77	x	0.72	x	119.01		0.63	x	0.7	=	26.19	(79)
Southwest	0.9x	0.77	x	3.44	x	118.15		0.63	x	0.7	=	124.21	(79)
Southwest	0.9x	0.77	x	1.56	x	118.15		0.63	x	0.7	=	56.33	(79)
Southwest	0.9x	0.77	x	0.67	x	118.15		0.63	x	0.7	=	24.19	(79)
Southwest	0.9x	0.77	x	0.72	x	118.15		0.63	x	0.7	=	26	(79)
Southwest	0.9x	0.77	x	3.44	x	113.91		0.63	x	0.7	=	119.75	(79)
Southwest	0.9x	0.77	x	1.56	x	113.91		0.63	x	0.7	=	54.31	(79)
Southwest	0.9x	0.77	x	0.67	x	113.91		0.63	x	0.7	=	23.32	(79)
Southwest	0.9x	0.77	x	0.72	x	113.91		0.63	x	0.7	=	25.06	(79)
Southwest	0.9x	0.77	x	3.44	x	104.39		0.63	x	0.7	=	109.75	(79)
Southwest	0.9x	0.77	x	1.56	x	104.39		0.63	x	0.7	=	49.77	(79)
Southwest	0.9x	0.77	x	0.67	x	104.39		0.63	x	0.7	=	21.38	(79)

DER WorkSheet: New dwelling design stage

Southwest 0.9x	0.77	x	0.72	x	104.39		0.63	x	0.7	=	22.97	(79)
Southwest 0.9x	0.77	x	3.44	x	92.85		0.63	x	0.7	=	97.62	(79)
Southwest 0.9x	0.77	x	1.56	x	92.85		0.63	x	0.7	=	44.27	(79)
Southwest 0.9x	0.77	x	0.67	x	92.85		0.63	x	0.7	=	19.01	(79)
Southwest 0.9x	0.77	x	0.72	x	92.85		0.63	x	0.7	=	20.43	(79)
Southwest 0.9x	0.77	x	3.44	x	69.27		0.63	x	0.7	=	72.82	(79)
Southwest 0.9x	0.77	x	1.56	x	69.27		0.63	x	0.7	=	33.02	(79)
Southwest 0.9x	0.77	x	0.67	x	69.27		0.63	x	0.7	=	14.18	(79)
Southwest 0.9x	0.77	x	0.72	x	69.27		0.63	x	0.7	=	15.24	(79)
Southwest 0.9x	0.77	x	3.44	x	44.07		0.63	x	0.7	=	46.33	(79)
Southwest 0.9x	0.77	x	1.56	x	44.07		0.63	x	0.7	=	21.01	(79)
Southwest 0.9x	0.77	x	0.67	x	44.07		0.63	x	0.7	=	9.02	(79)
Southwest 0.9x	0.77	x	0.72	x	44.07		0.63	x	0.7	=	9.7	(79)
Southwest 0.9x	0.77	x	3.44	x	31.49		0.63	x	0.7	=	33.1	(79)
Southwest 0.9x	0.77	x	1.56	x	31.49		0.63	x	0.7	=	15.01	(79)
Southwest 0.9x	0.77	x	0.67	x	31.49		0.63	x	0.7	=	6.45	(79)
Southwest 0.9x	0.77	x	0.72	x	31.49		0.63	x	0.7	=	6.93	(79)
Rooflights 0.9x	1	x	0.47	x	26	x	0.63	x	0.8	=	11.09	(82)
Rooflights 0.9x	1	x	0.63	x	26	x	0.63	x	0.8	=	14.86	(82)
Rooflights 0.9x	1	x	0.84	x	26	x	0.63	x	0.8	=	29.72	(82)
Rooflights 0.9x	1	x	0.62	x	26	x	0.63	x	0.8	=	7.31	(82)
Rooflights 0.9x	1	x	2.36	x	26	x	0.63	x	0.8	=	27.83	(82)
Rooflights 0.9x	1	x	2.15	x	26	x	0.63	x	0.8	=	25.36	(82)
Rooflights 0.9x	1	x	3.27	x	26	x	0.63	x	0.8	=	38.57	(82)
Rooflights 0.9x	1	x	0.89	x	26	x	0.63	x	0.8	=	10.5	(82)
Rooflights 0.9x	1	x	1.29	x	26	x	0.63	x	0.8	=	15.21	(82)
Rooflights 0.9x	1	x	2.37	x	26	x	0.63	x	0.8	=	27.95	(82)
Rooflights 0.9x	1	x	0.47	x	54	x	0.63	x	0.8	=	23.02	(82)
Rooflights 0.9x	1	x	0.63	x	54	x	0.63	x	0.8	=	30.86	(82)
Rooflights 0.9x	1	x	0.84	x	54	x	0.63	x	0.8	=	61.73	(82)
Rooflights 0.9x	1	x	0.62	x	54	x	0.63	x	0.8	=	15.19	(82)
Rooflights 0.9x	1	x	2.36	x	54	x	0.63	x	0.8	=	57.81	(82)
Rooflights 0.9x	1	x	2.15	x	54	x	0.63	x	0.8	=	52.66	(82)
Rooflights 0.9x	1	x	3.27	x	54	x	0.63	x	0.8	=	80.1	(82)
Rooflights 0.9x	1	x	0.89	x	54	x	0.63	x	0.8	=	21.8	(82)
Rooflights 0.9x	1	x	1.29	x	54	x	0.63	x	0.8	=	31.6	(82)
Rooflights 0.9x	1	x	2.37	x	54	x	0.63	x	0.8	=	58.05	(82)
Rooflights 0.9x	1	x	0.47	x	96	x	0.63	x	0.8	=	40.93	(82)
Rooflights 0.9x	1	x	0.63	x	96	x	0.63	x	0.8	=	54.87	(82)
Rooflights 0.9x	1	x	0.84	x	96	x	0.63	x	0.8	=	109.73	(82)
Rooflights 0.9x	1	x	0.62	x	96	x	0.63	x	0.8	=	27	(82)

Rooflights 0.9x	1	x	2.36	x	96	x	0.63	x	0.8	=	102.77	(82)
Rooflights 0.9x	1	x	2.15	x	96	x	0.63	x	0.8	=	93.62	(82)
Rooflights 0.9x	1	x	3.27	x	96	x	0.63	x	0.8	=	142.39	(82)
Rooflights 0.9x	1	x	0.89	x	96	x	0.63	x	0.8	=	38.76	(82)
Rooflights 0.9x	1	x	1.29	x	96	x	0.63	x	0.8	=	56.17	(82)
Rooflights 0.9x	1	x	2.37	x	96	x	0.63	x	0.8	=	103.2	(82)
Rooflights 0.9x	1	x	0.47	x	150	x	0.63	x	0.8	=	63.96	(82)
Rooflights 0.9x	1	x	0.63	x	150	x	0.63	x	0.8	=	85.73	(82)
Rooflights 0.9x	1	x	0.84	x	150	x	0.63	x	0.8	=	171.46	(82)
Rooflights 0.9x	1	x	0.62	x	150	x	0.63	x	0.8	=	42.18	(82)
Rooflights 0.9x	1	x	2.36	x	150	x	0.63	x	0.8	=	160.57	(82)
Rooflights 0.9x	1	x	2.15	x	150	x	0.63	x	0.8	=	146.29	(82)
Rooflights 0.9x	1	x	3.27	x	150	x	0.63	x	0.8	=	222.49	(82)
Rooflights 0.9x	1	x	0.89	x	150	x	0.63	x	0.8	=	60.56	(82)
Rooflights 0.9x	1	x	1.29	x	150	x	0.63	x	0.8	=	87.77	(82)
Rooflights 0.9x	1	x	2.37	x	150	x	0.63	x	0.8	=	161.25	(82)
Rooflights 0.9x	1	x	0.47	x	192	x	0.63	x	0.8	=	81.87	(82)
Rooflights 0.9x	1	x	0.63	x	192	x	0.63	x	0.8	=	109.73	(82)
Rooflights 0.9x	1	x	0.84	x	192	x	0.63	x	0.8	=	219.47	(82)
Rooflights 0.9x	1	x	0.62	x	192	x	0.63	x	0.8	=	54	(82)
Rooflights 0.9x	1	x	2.36	x	192	x	0.63	x	0.8	=	205.54	(82)
Rooflights 0.9x	1	x	2.15	x	192	x	0.63	x	0.8	=	187.25	(82)
Rooflights 0.9x	1	x	3.27	x	192	x	0.63	x	0.8	=	284.79	(82)
Rooflights 0.9x	1	x	0.89	x	192	x	0.63	x	0.8	=	77.51	(82)
Rooflights 0.9x	1	x	1.29	x	192	x	0.63	x	0.8	=	112.35	(82)
Rooflights 0.9x	1	x	2.37	x	192	x	0.63	x	0.8	=	206.41	(82)
Rooflights 0.9x	1	x	0.47	x	200	x	0.63	x	0.8	=	85.28	(82)
Rooflights 0.9x	1	x	0.63	x	200	x	0.63	x	0.8	=	114.31	(82)
Rooflights 0.9x	1	x	0.84	x	200	x	0.63	x	0.8	=	228.61	(82)
Rooflights 0.9x	1	x	0.62	x	200	x	0.63	x	0.8	=	56.25	(82)
Rooflights 0.9x	1	x	2.36	x	200	x	0.63	x	0.8	=	214.1	(82)
Rooflights 0.9x	1	x	2.15	x	200	x	0.63	x	0.8	=	195.05	(82)
Rooflights 0.9x	1	x	3.27	x	200	x	0.63	x	0.8	=	296.65	(82)
Rooflights 0.9x	1	x	0.89	x	200	x	0.63	x	0.8	=	80.74	(82)
Rooflights 0.9x	1	x	1.29	x	200	x	0.63	x	0.8	=	117.03	(82)
Rooflights 0.9x	1	x	2.37	x	200	x	0.63	x	0.8	=	215.01	(82)
Rooflights 0.9x	1	x	0.47	x	189	x	0.63	x	0.8	=	80.59	(82)
Rooflights 0.9x	1	x	0.63	x	189	x	0.63	x	0.8	=	108.02	(82)
Rooflights 0.9x	1	x	0.84	x	189	x	0.63	x	0.8	=	216.04	(82)
Rooflights 0.9x	1	x	0.62	x	189	x	0.63	x	0.8	=	53.15	(82)
Rooflights 0.9x	1	x	2.36	x	189	x	0.63	x	0.8	=	202.32	(82)

DER WorkSheet: New dwelling design stage

Rooflights 0.9x	1	x	2.15	x	189	x	0.63	x	0.8	=	184.32	(82)
Rooflights 0.9x	1	x	3.27	x	189	x	0.63	x	0.8	=	280.34	(82)
Rooflights 0.9x	1	x	0.89	x	189	x	0.63	x	0.8	=	76.3	(82)
Rooflights 0.9x	1	x	1.29	x	189	x	0.63	x	0.8	=	110.59	(82)
Rooflights 0.9x	1	x	2.37	x	189	x	0.63	x	0.8	=	203.18	(82)
Rooflights 0.9x	1	x	0.47	x	157	x	0.63	x	0.8	=	66.94	(82)
Rooflights 0.9x	1	x	0.63	x	157	x	0.63	x	0.8	=	89.73	(82)
Rooflights 0.9x	1	x	0.84	x	157	x	0.63	x	0.8	=	179.46	(82)
Rooflights 0.9x	1	x	0.62	x	157	x	0.63	x	0.8	=	44.15	(82)
Rooflights 0.9x	1	x	2.36	x	157	x	0.63	x	0.8	=	168.07	(82)
Rooflights 0.9x	1	x	2.15	x	157	x	0.63	x	0.8	=	153.11	(82)
Rooflights 0.9x	1	x	3.27	x	157	x	0.63	x	0.8	=	232.87	(82)
Rooflights 0.9x	1	x	0.89	x	157	x	0.63	x	0.8	=	63.38	(82)
Rooflights 0.9x	1	x	1.29	x	157	x	0.63	x	0.8	=	91.87	(82)
Rooflights 0.9x	1	x	2.37	x	157	x	0.63	x	0.8	=	168.78	(82)
Rooflights 0.9x	1	x	0.47	x	115	x	0.63	x	0.8	=	49.03	(82)
Rooflights 0.9x	1	x	0.63	x	115	x	0.63	x	0.8	=	65.73	(82)
Rooflights 0.9x	1	x	0.84	x	115	x	0.63	x	0.8	=	131.45	(82)
Rooflights 0.9x	1	x	0.62	x	115	x	0.63	x	0.8	=	32.34	(82)
Rooflights 0.9x	1	x	2.36	x	115	x	0.63	x	0.8	=	123.11	(82)
Rooflights 0.9x	1	x	2.15	x	115	x	0.63	x	0.8	=	112.15	(82)
Rooflights 0.9x	1	x	3.27	x	115	x	0.63	x	0.8	=	170.58	(82)
Rooflights 0.9x	1	x	0.89	x	115	x	0.63	x	0.8	=	46.43	(82)
Rooflights 0.9x	1	x	1.29	x	115	x	0.63	x	0.8	=	67.29	(82)
Rooflights 0.9x	1	x	2.37	x	115	x	0.63	x	0.8	=	123.63	(82)
Rooflights 0.9x	1	x	0.47	x	66	x	0.63	x	0.8	=	28.14	(82)
Rooflights 0.9x	1	x	0.63	x	66	x	0.63	x	0.8	=	37.72	(82)
Rooflights 0.9x	1	x	0.84	x	66	x	0.63	x	0.8	=	75.44	(82)
Rooflights 0.9x	1	x	0.62	x	66	x	0.63	x	0.8	=	18.56	(82)
Rooflights 0.9x	1	x	2.36	x	66	x	0.63	x	0.8	=	70.65	(82)
Rooflights 0.9x	1	x	2.15	x	66	x	0.63	x	0.8	=	64.37	(82)
Rooflights 0.9x	1	x	3.27	x	66	x	0.63	x	0.8	=	97.9	(82)
Rooflights 0.9x	1	x	0.89	x	66	x	0.63	x	0.8	=	26.64	(82)
Rooflights 0.9x	1	x	1.29	x	66	x	0.63	x	0.8	=	38.62	(82)
Rooflights 0.9x	1	x	2.37	x	66	x	0.63	x	0.8	=	70.95	(82)
Rooflights 0.9x	1	x	0.47	x	33	x	0.63	x	0.8	=	14.07	(82)
Rooflights 0.9x	1	x	0.63	x	33	x	0.63	x	0.8	=	18.86	(82)
Rooflights 0.9x	1	x	0.84	x	33	x	0.63	x	0.8	=	37.72	(82)
Rooflights 0.9x	1	x	0.62	x	33	x	0.63	x	0.8	=	9.28	(82)
Rooflights 0.9x	1	x	2.36	x	33	x	0.63	x	0.8	=	35.33	(82)
Rooflights 0.9x	1	x	2.15	x	33	x	0.63	x	0.8	=	32.18	(82)

DER WorkSheet: New dwelling design stage

Rooflights 0.9x	1	x	3.27	x	33	x	0.63	x	0.8	=	48.95	(82)
Rooflights 0.9x	1	x	0.89	x	33	x	0.63	x	0.8	=	13.32	(82)
Rooflights 0.9x	1	x	1.29	x	33	x	0.63	x	0.8	=	19.31	(82)
Rooflights 0.9x	1	x	2.37	x	33	x	0.63	x	0.8	=	35.48	(82)
Rooflights 0.9x	1	x	0.47	x	21	x	0.63	x	0.8	=	8.95	(82)
Rooflights 0.9x	1	x	0.63	x	21	x	0.63	x	0.8	=	12	(82)
Rooflights 0.9x	1	x	0.84	x	21	x	0.63	x	0.8	=	24	(82)
Rooflights 0.9x	1	x	0.62	x	21	x	0.63	x	0.8	=	5.91	(82)
Rooflights 0.9x	1	x	2.36	x	21	x	0.63	x	0.8	=	22.48	(82)
Rooflights 0.9x	1	x	2.15	x	21	x	0.63	x	0.8	=	20.48	(82)
Rooflights 0.9x	1	x	3.27	x	21	x	0.63	x	0.8	=	31.15	(82)
Rooflights 0.9x	1	x	0.89	x	21	x	0.63	x	0.8	=	8.48	(82)
Rooflights 0.9x	1	x	1.29	x	21	x	0.63	x	0.8	=	12.29	(82)
Rooflights 0.9x	1	x	2.37	x	21	x	0.63	x	0.8	=	22.58	(82)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	382.63	742.55	1227.62	1827.58	2291.9	2373.71	2248.26	1892.98	1437.23	880.59	475.55	315.9	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	1005.44	1361.88	1823.37	2385.38	2810.09	2855.46	2707.65	2360.54	1925.58	1407.14	1045.53	919.46	(84)

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	1	0.99	0.97	0.93	0.84	0.73	0.8	0.94	0.99	1	1	(86)

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

(87)m=	18.05	18.28	18.74	19.39	20.02	20.53	20.78	20.71	20.24	19.43	18.64	18.03	(87)

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

(88)m=	18.94	18.94	18.94	18.96	18.97	18.99	18.99	18.99	18.98	18.97	18.96	18.95	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	1	0.99	0.96	0.88	0.71	0.49	0.58	0.87	0.98	1	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	16.39	16.62	17.08	17.73	18.34	18.79	18.95	18.92	18.57	17.79	16.99	16.38	(90)

fLA = Living area ÷ (4) = | 0.15 | (91)

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

(92)m=	16.63	16.86	17.32	17.97	18.58	19.04	19.21	19.18	18.81	18.03	17.23	16.62	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	16.63	16.86	17.32	17.97	18.58	19.04	19.21	19.18	18.81	18.03	17.23	16.62	(93)

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

Utilisation factor for gains, hm:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m=	1	0.99	0.98	0.94	0.87	0.72	0.53	0.61	0.86	0.97	0.99	1	(94)

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	1002.29	1351.83	1787.74	2253.94	2431.05	2050.61	1424.97	1433.35	1663.76	1370.58	1039.57	917.25	(95)

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)

Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]

(97)m=	7791.26	7538.32	6798.83	5624.09	4255.01	2711.97	1596.5	1696.53	2892.17	4590.88	6296.32	7757.88	(97)

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

(98)m=	5051	4157.32	3728.25	2426.51	1357.03	0	0	0	0	2395.9	3784.86	5089.43

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 27990.3 (98)

Space heating requirement in kWh/m²/year 117.3 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	5741.92	4520.24	4632.02	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.51	0.58	0.52	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	2902.09	2628.26	2413.04	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	3213.4	3052.36	2694.15	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m
set (104)m to zero if (104)m < 3 × (98)m

(104)m=	0	0	0	0	0	0	315.53	0	0	0	0	0

Total = Sum(104) = 315.53 (104)

Cooled fraction — f C = cooled area ÷ (4) = 0.29 (105)

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

Total = Sum(104) = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

(107)m=	0	0	0	0	0	0	23.14	0	0	0	0	0

Total = Sum(107) = 23.14 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 0.1 (108)

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)
Cooling System Energy Efficiency Ratio		4.32	(209)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)												
5051	4157.32	3728.25	2426.51	1357.03	0	0	0	0	2395.9	3784.86	5089.43	

DER WorkSheet: New dwelling design stage

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

5593.58	4603.9	4128.74	2687.17	1502.8	0	0	0	0	2653.27	4191.43	5636.14

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 30997.01 (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)

234.16	206.25	216.3	193.46	189.27	168.67	161.56	177.87	177.74	200.63	212.69	228.38

Efficiency of water heater 81 (216)

(217)m=	89.84	89.81	89.74	89.54	89.05	81	81	81	81	89.51	89.75	89.86

(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	260.63	229.65	241.04	216.06	212.55	208.23	199.45	219.59	219.44	224.15	236.98	254.15

Total = Sum(219a)$_{1...12}$ = 2721.92 (219)

Space cooling fuel, kWh/month.

(221)m = (107)m÷ (209)

(221)m=	0	0	0	0	0	0	5.36	0	0	0	0	0

Total = Sum(221)$_{6...8}$ = 5.36 (221)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		30997.01	
Water heating fuel used		2721.92	
Space cooling fuel used		5.36	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		30	(231)
Electricity for lighting		805.58	(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	=	6695.35	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	587.93	(264)
Space and water heating	(261) + (262) + (263) + (264) =			7283.29	(265)
Space cooling	(221) x	0.519	=	2.78	(266)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	418.1	(268)
Total CO2, kg/year		sum of (265)…(271) =		7719.74	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		32.35	(273)

DER WorkSheet: New dwelling design stage

EI rating (section 14)	64	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 2-Existing

Address : Flat 2, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	98.7	(1a)	x	2.5	(2a)	=	246.75	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	98.7	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			246.75	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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) =	0.12	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)

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

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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.62	(18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

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) =	0.53	(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

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

DER WorkSheet: New dwelling design stage

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

0.67	0.66	0.65	0.58	0.57	0.5	0.5	0.49	0.53	0.57	0.59	0.62

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	(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	(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=	0.73	0.72	0.71	0.67	0.66	0.63	0.63	0.62	0.64	0.66	0.68	0.69	(24d)

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

(25)m=	0.73	0.72	0.71	0.67	0.66	0.63	0.63	0.62	0.64	0.66	0.68	0.69	(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			2.2	x	1.8	=	3.96			(26)
Windows Type 1			6.4	x1/[1/(1.6)+ 0.04]		=	9.62			(27)
Windows Type 2			1.2	x1/[1/(1.6)+ 0.04]		=	1.8			(27)
Windows Type 3			8.58	x1/[1/(1.6)+ 0.04]		=	12.9			(27)
Windows Type 4			1.39	x1/[1/(1.6)+ 0.04]		=	2.09			(27)
Floor			98.7	x	0.55	=	54.285			(28)
Walls Type1	22.19	5.56	16.63	x	0.55	=	9.15			(29)
Walls Type2	31.7	17.38	14.32	x	0.28	=	4.01			(29)
Walls Type3	12.82	2.2	10.62	x	0.55	=	5.84			(29)
Roof	33.18	0	33.18	x	0.18	=	5.97			(30)
Total area of elements, m²			198.59							(31)
Party wall			36.56	x	0	=	0			(32)
Party ceiling			65.52							(32b)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 117.71 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 18812.95 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K 29.79 (36)

DER WorkSheet: New dwelling design stage

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 147.5 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	59.19	58.47	57.77	54.47	53.85	50.97	50.97	50.44	52.08	53.85	55.1	56.4	(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=	206.69	205.97	205.27	201.96	201.35	198.47	198.47	197.94	199.58	201.35	202.6	203.9	

Average = Sum(39)$_{1…12}$ /12= 201.96 (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=	2.09	2.09	2.08	2.05	2.04	2.01	2.01	2.01	2.02	2.04	2.05	2.07	

Average = Sum(40)$_{1…12}$ /12= 2.05 (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 2.73 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 104.18 (43)

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

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	114.6	110.43	106.26	102.1	97.93	93.76	93.76	97.93	102.1	106.26	110.43	114.6	

Total = Sum(44)$_{1…12}$ = 1250.15 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(45)m=	169.94	148.63	153.38	133.72	128.31	110.72	102.6	117.73	119.14	138.84	151.56	164.58	

Total = Sum(45)$_{1…12}$ = 1639.14 (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=	25.49	22.3	23.01	20.06	19.25	16.61	15.39	17.66	17.87	20.83	22.73	24.69	(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)

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	50.96	46.03	50.96	49.32	49.9	46.24	47.78	49.9	49.32	50.96	49.32	50.96	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	220.9	194.66	204.34	183.03	178.21	156.96	150.38	167.63	168.45	189.8	200.87	215.54	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	220.9	194.66	204.34	183.03	178.21	156.96	150.38	167.63	168.45	189.8	200.87	215.54

Output from water heater (annual)$_{1...12}$ — 2230.77 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	69.25	60.93	63.74	56.79	55.14	48.37	46.06	51.62	51.94	58.9	62.72	67.46	(65)

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=	136.36	136.36	136.36	136.36	136.36	136.36	136.36	136.36	136.36	136.36	136.36	136.36	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	28.33	25.16	20.46	15.49	11.58	9.78	10.56	13.73	18.43	23.4	27.31	29.12	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	254.21	256.85	250.2	236.05	218.18	201.39	190.18	187.54	194.19	208.34	226.2	242.99	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	(71)

Water heating gains (Table 5)

(72)m=	93.07	90.67	85.67	78.87	74.11	67.19	61.91	69.38	72.14	79.17	87.11	90.68	(72)

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

(73)m=	442.52	439.58	423.24	397.32	370.78	345.26	329.56	337.56	351.67	377.82	407.54	429.69	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast	0.9x	0.77	x	6.4	x	11.28	x	0.63	x	0.7	=	22.07	(75)
Northeast	0.9x	0.77	x	1.2	x	11.28	x	0.63	x	0.7	=	8.28	(75)
Northeast	0.9x	0.77	x	8.58	x	11.28	x	0.63	x	0.7	=	29.59	(75)
Northeast	0.9x	0.77	x	6.4	x	22.97	x	0.63	x	0.7	=	44.92	(75)
Northeast	0.9x	0.77	x	1.2	x	22.97	x	0.63	x	0.7	=	16.85	(75)
Northeast	0.9x	0.77	x	8.58	x	22.97	x	0.63	x	0.7	=	60.22	(75)
Northeast	0.9x	0.77	x	6.4	x	41.38	x	0.63	x	0.7	=	80.93	(75)
Northeast	0.9x	0.77	x	1.2	x	41.38	x	0.63	x	0.7	=	30.35	(75)
Northeast	0.9x	0.77	x	8.58	x	41.38	x	0.63	x	0.7	=	108.5	(75)
Northeast	0.9x	0.77	x	6.4	x	67.96	x	0.63	x	0.7	=	132.92	(75)
Northeast	0.9x	0.77	x	1.2	x	67.96	x	0.63	x	0.7	=	49.84	(75)
Northeast	0.9x	0.77	x	8.58	x	67.96	x	0.63	x	0.7	=	178.19	(75)
Northeast	0.9x	0.77	x	6.4	x	91.35	x	0.63	x	0.7	=	178.67	(75)
Northeast	0.9x	0.77	x	1.2	x	91.35	x	0.63	x	0.7	=	67	(75)
Northeast	0.9x	0.77	x	8.58	x	91.35	x	0.63	x	0.7	=	239.52	(75)
Northeast	0.9x	0.77	x	6.4	x	97.38	x	0.63	x	0.7	=	190.48	(75)
Northeast	0.9x	0.77	x	1.2	x	97.38	x	0.63	x	0.7	=	71.43	(75)
Northeast	0.9x	0.77	x	8.58	x	97.38	x	0.63	x	0.7	=	255.36	(75)
Northeast	0.9x	0.77	x	6.4	x	91.1	x	0.63	x	0.7	=	178.19	(75)
Northeast	0.9x	0.77	x	1.2	x	91.1	x	0.63	x	0.7	=	66.82	(75)
Northeast	0.9x	0.77	x	8.58	x	91.1	x	0.63	x	0.7	=	238.88	(75)
Northeast	0.9x	0.77	x	6.4	x	72.63	x	0.63	x	0.7	=	142.05	(75)
Northeast	0.9x	0.77	x	1.2	x	72.63	x	0.63	x	0.7	=	53.27	(75)
Northeast	0.9x	0.77	x	8.58	x	72.63	x	0.63	x	0.7	=	190.44	(75)
Northeast	0.9x	0.77	x	6.4	x	50.42	x	0.63	x	0.7	=	98.62	(75)
Northeast	0.9x	0.77	x	1.2	x	50.42	x	0.63	x	0.7	=	36.98	(75)
Northeast	0.9x	0.77	x	8.58	x	50.42	x	0.63	x	0.7	=	132.21	(75)
Northeast	0.9x	0.77	x	6.4	x	28.07	x	0.63	x	0.7	=	54.9	(75)
Northeast	0.9x	0.77	x	1.2	x	28.07	x	0.63	x	0.7	=	20.59	(75)
Northeast	0.9x	0.77	x	8.58	x	28.07	x	0.63	x	0.7	=	73.6	(75)
Northeast	0.9x	0.77	x	6.4	x	14.2	x	0.63	x	0.7	=	27.77	(75)
Northeast	0.9x	0.77	x	1.2	x	14.2	x	0.63	x	0.7	=	10.41	(75)
Northeast	0.9x	0.77	x	8.58	x	14.2	x	0.63	x	0.7	=	37.23	(75)
Northeast	0.9x	0.77	x	6.4	x	9.21	x	0.63	x	0.7	=	18.02	(75)
Northeast	0.9x	0.77	x	1.2	x	9.21	x	0.63	x	0.7	=	6.76	(75)
Northeast	0.9x	0.77	x	8.58	x	9.21	x	0.63	x	0.7	=	24.16	(75)
Northwest	0.9x	0.77	x	1.39	x	11.28	x	0.63	x	0.7	=	19.17	(81)
Northwest	0.9x	0.77	x	1.39	x	22.97	x	0.63	x	0.7	=	39.03	(81)
Northwest	0.9x	0.77	x	1.39	x	41.38	x	0.63	x	0.7	=	70.31	(81)

DER WorkSheet: New dwelling design stage

Northwest	0.9x	0.77	x	1.39	x	67.96	x	0.63	x	0.7	=	115.47	(81)
Northwest	0.9x	0.77	x	1.39	x	91.35	x	0.63	x	0.7	=	155.22	(81)
Northwest	0.9x	0.77	x	1.39	x	97.38	x	0.63	x	0.7	=	165.48	(81)
Northwest	0.9x	0.77	x	1.39	x	91.1	x	0.63	x	0.7	=	154.8	(81)
Northwest	0.9x	0.77	x	1.39	x	72.63	x	0.63	x	0.7	=	123.41	(81)
Northwest	0.9x	0.77	x	1.39	x	50.42	x	0.63	x	0.7	=	85.68	(81)
Northwest	0.9x	0.77	x	1.39	x	28.07	x	0.63	x	0.7	=	47.69	(81)
Northwest	0.9x	0.77	x	1.39	x	14.2	x	0.63	x	0.7	=	24.12	(81)
Northwest	0.9x	0.77	x	1.39	x	9.21	x	0.63	x	0.7	=	15.66	(81)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	79.1	161.01	290.1	476.42	640.4	682.74	638.69	509.17	353.49	196.77	99.53	64.6	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	521.62	600.6	713.33	873.74	1011.19	1028	968.24	846.73	705.15	574.59	507.07	494.29	(84)

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	1	0.99	0.98	0.93	0.84	0.73	0.79	0.94	0.99	1	1	(86)

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

(87)m=	18.62	18.79	19.15	19.7	20.24	20.67	20.86	20.8	20.42	19.75	19.11	18.61	(87)

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

(88)m=	19.27	19.28	19.28	19.3	19.31	19.33	19.33	19.33	19.32	19.31	19.3	19.29	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	1	0.99	0.97	0.89	0.73	0.52	0.61	0.89	0.98	1	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	17.18	17.36	17.72	18.27	18.79	19.17	19.29	19.28	18.98	18.33	17.69	17.18	(90)

fLA = Living area ÷ (4) = 0.32 (91)

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

(92)m=	17.65	17.82	18.18	18.73	19.26	19.65	19.8	19.77	19.44	18.79	18.15	17.64	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	17.65	17.82	18.18	18.73	19.26	19.65	19.8	19.77	19.44	18.79	18.15	17.64	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.99	0.96	0.89	0.76	0.59	0.67	0.9	0.98	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	519.6	596.73	703.25	839.11	903.22	779.31	570.16	566.79	631.32	562.54	503.94	492.72	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	2758.27	2660.72	2397.98	1986.06	1522.12	1003.13	634.98	666.81	1066.07	1649.1	2238.53	2740.96	(97)

DER WorkSheet: New dwelling design stage

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(98)m=	1665.56	1387	1260.88	825.8	460.46	0	0	0	0	808.4	1248.9	1672.69

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 9329.71 (98)

Space heating requirement in kWh/m²/year 94.53 (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		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
Space heating requirement (calculated above)	1665.56	1387	1260.88	825.8	460.46	0	0	0	0	808.4	1248.9	1672.69	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	1844.48	1535.99	1396.33	914.51	509.92	0	0	0	0	895.24	1383.06	1852.38	(211)

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 10331.9 (211)

Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] } x 100 ÷ (208)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Output from water heater (calculated above)	220.9	194.66	204.34	183.03	178.21	156.96	150.38	167.63	168.45	189.8	200.87	215.54	
Efficiency of water heater													81 (216)
(217)m=	89.1	89.04	88.88	88.46	87.5	81	81	81	81	88.37	88.89	89.13	(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	247.92	218.62	229.91	206.92	203.67	193.77	185.65	206.96	207.97	214.78	225.99	241.82	

Total = Sum(219a)$_{1...12}$ = 2583.97 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			10331.9	
Water heating fuel used			2583.97	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		30	(231)
Electricity for lighting			500.29	(232)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh	**Emissions** kg CO2/year

DER WorkSheet: New dwelling design stage

Space heating (main system 1)	(211) x	0.216	=	2231.69	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	558.14	(264)
Space and water heating	(261) + (262) + (263) + (264) =			2789.83	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	259.65	(268)
Total CO2, kg/year		sum of (265)…(271) =		3065.05	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		31.05	(273)
EI rating (section 14)				71	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 3-Existing

Address : Flat 3, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	39.67	(1a)	x	3.1	(2a)	=	122.98	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	39.67	(4)						
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	=	122.98	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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							2	x 10 =	20	(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) =	20	÷ (5) =	0.16	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)

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

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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.66	(18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

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) =	0.56	(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
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

DER WorkSheet: New dwelling design stage

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

0.72	0.7	0.69	0.62	0.61	0.54	0.54	0.52	0.56	0.61	0.63	0.66

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	(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	(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=	0.76	0.75	0.74	0.69	0.68	0.64	0.64	0.64	0.66	0.68	0.7	0.72	(24d)

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

(25)m=	0.76	0.75	0.74	0.69	0.68	0.64	0.64	0.64	0.66	0.68	0.7	0.72	(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			2.2	x	1.8	=	3.96			(26)
Windows Type 1			0.71	x1/[1/(1.6)+ 0.04]		=	1.07			(27)
Windows Type 2			6.68	x1/[1/(1.6)+ 0.04]		=	10.05			(27)
Floor			39.67	x	0.55	=	21.8185			(28)
Walls Type1	46.29	7.39	38.9	x	0.55	=	21.4			(29)
Walls Type2	23.82	2.2	21.62	x	0.55	=	11.89			(29)
Total area of elements, m²			109.78							(31)
Party wall			27.35	x	0	=	0			(32)
Party ceiling			39.67							(32b)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 70.18 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 9422.38 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K 16.47 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 86.64 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	30.76	30.35	29.95	28.08	27.73	26.1	26.1	25.8	26.73	27.73	28.44	29.18	(38)

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

(39)m=	117.4	116.99	116.6	114.72	114.37	112.74	112.74	112.44	113.37	114.37	115.08	115.82	

Average = Sum(39)$_{1…12}$ /12= 114.72 (39)

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

(40)m=	2.96	2.95	2.94	2.89	2.88	2.84	2.84	2.83	2.86	2.88	2.9	2.92

Average = Sum(40)$_{1…12}$ /12= 2.89 (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 1.4 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 70.94 (43)

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

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

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

(44)m=	78.03	75.2	72.36	69.52	66.68	63.85	63.85	66.68	69.52	72.36	75.2	78.03

Total = Sum(44)$_{1…12}$ = 851.28 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	115.72	101.21	104.44	91.05	87.37	75.39	69.86	80.17	81.13	94.54	103.2	112.07

Total = Sum(45)$_{1…12}$ = 1116.16 (45)

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

(46)m=	17.36	15.18	15.67	13.66	13.11	11.31	10.48	12.03	12.17	14.18	15.48	16.81	(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)

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	39.77	34.61	36.87	34.28	33.98	31.49	32.54	33.98	34.28	36.87	37.08	39.77	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	155.49	135.82	141.31	125.34	121.35	106.88	102.4	114.15	115.41	131.42	140.28	151.84	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	155.49	135.82	141.31	125.34	121.35	106.88	102.4	114.15	115.41	131.42	140.28	151.84	

Output from water heater (annual)$_{1...12}$ 1541.68 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	48.42	42.31	43.94	38.85	37.55	32.94	31.36	35.15	35.55	40.65	43.59	47.2	(65)

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=	69.88	69.88	69.88	69.88	69.88	69.88	69.88	69.88	69.88	69.88	69.88	69.88	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	13.67	12.14	9.87	7.47	5.59	4.72	5.1	6.62	8.89	11.29	13.18	14.05	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	120.7	121.96	118.8	112.08	103.6	95.63	90.3	89.05	92.2	98.92	107.41	115.38	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	29.99	29.99	29.99	29.99	29.99	29.99	29.99	29.99	29.99	29.99	29.99	29.99	(69)
Pumps and fans gains (Table 5a)													
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	(71)
Water heating gains (Table 5)													
(72)m=	65.08	62.95	59.07	53.95	50.46	45.75	42.15	47.25	49.37	54.64	60.54	63.45	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	246.41	244.01	234.7	220.47	206.61	193.06	184.52	189.88	197.43	211.82	228.08	239.84	(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 m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southwest	0.9x	0.77	x	6.68	x	36.79		0.63	x	0.7	=	75.11	(79)
Southwest	0.9x	0.77	x	6.68	x	62.67		0.63	x	0.7	=	127.95	(79)
Southwest	0.9x	0.77	x	6.68	x	85.75		0.63	x	0.7	=	175.06	(79)
Southwest	0.9x	0.77	x	6.68	x	106.25		0.63	x	0.7	=	216.91	(79)
Southwest	0.9x	0.77	x	6.68	x	119.01		0.63	x	0.7	=	242.96	(79)

Southwest	0.9x	0.77	x	6.68	x	118.15		0.63	x	0.7	=	241.2	(79)
Southwest	0.9x	0.77	x	6.68	x	113.91		0.63	x	0.7	=	232.55	(79)
Southwest	0.9x	0.77	x	6.68	x	104.39		0.63	x	0.7	=	213.11	(79)
Southwest	0.9x	0.77	x	6.68	x	92.85		0.63	x	0.7	=	189.56	(79)
Southwest	0.9x	0.77	x	6.68	x	69.27		0.63	x	0.7	=	141.41	(79)
Southwest	0.9x	0.77	x	6.68	x	44.07		0.63	x	0.7	=	89.97	(79)
Southwest	0.9x	0.77	x	6.68	x	31.49		0.63	x	0.7	=	64.28	(79)
Northwest	0.9x	0.77	x	0.71	x	11.28	x	0.63	x	0.7	=	2.45	(81)
Northwest	0.9x	0.77	x	0.71	x	22.97	x	0.63	x	0.7	=	4.98	(81)
Northwest	0.9x	0.77	x	0.71	x	41.38	x	0.63	x	0.7	=	8.98	(81)
Northwest	0.9x	0.77	x	0.71	x	67.96	x	0.63	x	0.7	=	14.75	(81)
Northwest	0.9x	0.77	x	0.71	x	91.35	x	0.63	x	0.7	=	19.82	(81)
Northwest	0.9x	0.77	x	0.71	x	97.38	x	0.63	x	0.7	=	21.13	(81)
Northwest	0.9x	0.77	x	0.71	x	91.1	x	0.63	x	0.7	=	19.77	(81)
Northwest	0.9x	0.77	x	0.71	x	72.63	x	0.63	x	0.7	=	15.76	(81)
Northwest	0.9x	0.77	x	0.71	x	50.42	x	0.63	x	0.7	=	10.94	(81)
Northwest	0.9x	0.77	x	0.71	x	28.07	x	0.63	x	0.7	=	6.09	(81)
Northwest	0.9x	0.77	x	0.71	x	14.2	x	0.63	x	0.7	=	3.08	(81)
Northwest	0.9x	0.77	x	0.71	x	9.21	x	0.63	x	0.7	=	2	(81)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	77.56	132.93	184.04	231.66	262.78	262.33	252.31	228.87	200.5	147.5	93.05	66.28	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	323.98	376.95	418.74	452.13	469.39	455.39	436.83	418.75	397.93	359.32	321.13	306.12	(84)

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=	0.99	0.99	0.98	0.96	0.93	0.86	0.77	0.8	0.91	0.97	0.99	0.99	(86)

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

(87)m=	18.08	18.3	18.71	19.29	19.87	20.41	20.71	20.67	20.24	19.49	18.7	18.06	(87)

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

(88)m=	18.77	18.78	18.78	18.8	18.81	18.83	18.83	18.84	18.82	18.81	18.8	18.79	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.98	0.97	0.94	0.88	0.74	0.51	0.56	0.82	0.95	0.98	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	16.32	16.54	16.95	17.53	18.09	18.58	18.78	18.76	18.45	17.73	16.95	16.31	(90)

fLA = Living area ÷ (4) = | 0.85 | (91)

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

(92)m=	17.81	18.04	18.45	19.02	19.6	20.13	20.42	20.38	19.97	19.22	18.43	17.8	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	17.81	18.04	18.45	19.02	19.6	20.13	20.42	20.38	19.97	19.22	18.43	17.8	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.98	0.97	0.95	0.9	0.83	0.72	0.75	0.88	0.95	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	319.58	369.21	405.3	427.56	424.23	376.38	314.14	313.38	348.68	342.42	314.73	302.54	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1586.6	1537.12	1392.96	1161.25	903.88	623.55	430.5	447.48	665.41	986.05	1304.33	1574.7	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	942.67	784.83	734.82	528.25	356.87	0	0	0	0	478.86	712.52	946.49	

Total per year (kWh/year) = Sum(98)1...5,9...12 = 5485.31 (98)

Space heating requirement in kWh/m²/year 138.27 (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		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
Space heating requirement (calculated above)													
	942.67	784.83	734.82	528.25	356.87	0	0	0	0	478.86	712.52	946.49	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	1043.93	869.14	813.75	585	395.2	0	0	0	0	530.3	789.05	1048.17	

Total (kWh/year) =Sum(211)1...5,10...12= 6074.54 (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)													
	155.49	135.82	141.31	125.34	121.35	106.88	102.4	114.15	115.41	131.42	140.28	151.84	
Efficiency of water heater												81	(216)
(217)m=	88.86	88.8	88.66	88.35	87.74	81	81	81	81	88.12	88.63	88.89	(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m													
(219)m=	174.99	152.96	159.39	141.86	138.3	131.95	126.42	140.92	142.48	149.13	158.29	170.81	

Total = Sum(219a)1...12 = 1787.5 (219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		6074.54

DER WorkSheet: New dwelling design stage

Water heating fuel used		1787.5	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =	30	(231)
Electricity for lighting		241.36	(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	=	1312.1	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	386.1	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1698.2	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	125.27	(268)
Total CO2, kg/year		sum of (265)…(271) =		1839.04	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		46.36	(273)
EI rating (section 14)				71	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 4-Existing

Address : Flat 4, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	61.01	(1a) x	2.5	(2a) =	152.52	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	61.01	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	152.52	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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) =	0.2	(8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)				
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)
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				
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			10	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.7	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used				
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) =		0.59	(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
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

DER WorkSheet: New dwelling design stage

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

0.76	0.74	0.73	0.65	0.64	0.56	0.56	0.55	0.59	0.64	0.67	0.7

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	(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	(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=	0.79	0.77	0.76	0.71	0.7	0.66	0.66	0.65	0.68	0.7	0.72	0.74	(24d)

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

(25)m=	0.79	0.77	0.76	0.71	0.7	0.66	0.66	0.65	0.68	0.7	0.72	0.74	(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			2.2	x	1.8	=	3.96			(26)
Windows Type 1			1.69	x1/[1/(1.6)+ 0.04]		=	2.54			(27)
Windows Type 2			3.55	x1/[1/(1.6)+ 0.04]		=	5.34			(27)
Windows Type 3			1.39	x1/[1/(1.6)+ 0.04]		=	2.09			(27)
Walls Type1	20.15	5.56	14.59	x	0.55	=	8.02			(29)
Walls Type2	28.61	5.24	23.37	x	0.28	=	6.54			(29)
Walls Type3	15.55	2.2	13.35	x	0.55	=	7.34			(29)
Roof	8.86	0	8.86	x	0.18	=	1.59			(30)
Total area of elements, m²			73.17							(31)
Party wall			21.72	x	0	=	0			(32)
Party floor			61.01							(32a)
Party ceiling			52.15							(32b)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 43.71 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 11071.73 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K 10.98 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

DER WorkSheet: New dwelling design stage

Total fabric heat loss	(33) + (36) =	54.68	(37)
Ventilation heat loss calculated monthly	(38)m = 0.33 × (25)m x (5)		

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	39.51	38.96	38.41	35.85	35.37	33.13	33.13	32.72	33.99	35.37	36.34	37.35	(38)

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

(39)m=	94.2	93.64	93.09	90.53	90.05	87.81	87.81	87.4	88.67	90.05	91.02	92.03	

Average = Sum(39)$_{1...12}$ /12= 90.52 (39)

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

(40)m=	1.54	1.53	1.53	1.48	1.48	1.44	1.44	1.43	1.45	1.48	1.49	1.51	

Average = Sum(40)$_{1...12}$ /12= 1.48 (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 2.01 (42)
if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 86.25 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	94.88	91.43	87.98	84.53	81.08	77.63	77.63	81.08	84.53	87.98	91.43	94.88	
										Total = Sum(44)$_{1...12}$ =		1035.01	(44)
Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)													
(45)m=	140.7	123.06	126.98	110.71	106.23	91.66	84.94	97.47	98.63	114.95	125.48	136.26	
										Total = Sum(45)$_{1...12}$ =		1357.07	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	21.1	18.46	19.05	16.61	15.93	13.75	12.74	14.62	14.8	17.24	18.82	20.44	(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)
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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 | 0 | (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	48.35	42.08	44.83	41.68	41.32	38.28	39.56	41.32	41.68	44.83	45.09	48.35	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	189.05	165.14	171.81	152.39	147.54	129.95	124.5	138.79	140.32	159.78	170.56	184.61	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	189.05	165.14	171.81	152.39	147.54	129.95	124.5	138.79	140.32	159.78	170.56	184.61

Output from water heater (annual)$_{1...12}$ | 1874.43 | (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	58.87	51.44	53.43	47.23	45.65	40.05	38.13	42.74	43.22	49.43	52.99	57.39	(65)

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=	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	20.03	17.79	14.47	10.95	8.19	6.91	7.47	9.71	13.03	16.54	19.31	20.58	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	175.49	177.31	172.72	162.95	150.62	139.03	131.28	129.46	134.05	143.82	156.15	167.74	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	(71)

Water heating gains (Table 5)

(72)m=	79.13	76.54	71.81	65.6	61.36	55.62	51.25	57.44	60.02	66.44	73.6	77.14	(72)

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

(73)m=	330.79	327.79	315.15	295.65	276.31	257.71	246.16	252.77	263.26	282.95	305.21	321.62	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast	0.9x	0.77	x	1.69	x	11.28	x	0.63	x	0.7	=	5.83	(75)
Northeast	0.9x	0.77	x	3.55	x	11.28	x	0.63	x	0.7	=	12.24	(75)
Northeast	0.9x	0.77	x	1.69	x	22.97	x	0.63	x	0.7	=	11.86	(75)
Northeast	0.9x	0.77	x	3.55	x	22.97	x	0.63	x	0.7	=	24.92	(75)
Northeast	0.9x	0.77	x	1.69	x	41.38	x	0.63	x	0.7	=	21.37	(75)
Northeast	0.9x	0.77	x	3.55	x	41.38	x	0.63	x	0.7	=	44.89	(75)
Northeast	0.9x	0.77	x	1.69	x	67.96	x	0.63	x	0.7	=	35.1	(75)
Northeast	0.9x	0.77	x	3.55	x	67.96	x	0.63	x	0.7	=	73.73	(75)
Northeast	0.9x	0.77	x	1.69	x	91.35	x	0.63	x	0.7	=	47.18	(75)
Northeast	0.9x	0.77	x	3.55	x	91.35	x	0.63	x	0.7	=	99.1	(75)
Northeast	0.9x	0.77	x	1.69	x	97.38	x	0.63	x	0.7	=	50.3	(75)
Northeast	0.9x	0.77	x	3.55	x	97.38	x	0.63	x	0.7	=	105.65	(75)
Northeast	0.9x	0.77	x	1.69	x	91.1	x	0.63	x	0.7	=	47.05	(75)
Northeast	0.9x	0.77	x	3.55	x	91.1	x	0.63	x	0.7	=	98.84	(75)
Northeast	0.9x	0.77	x	1.69	x	72.63	x	0.63	x	0.7	=	37.51	(75)
Northeast	0.9x	0.77	x	3.55	x	72.63	x	0.63	x	0.7	=	78.79	(75)
Northeast	0.9x	0.77	x	1.69	x	50.42	x	0.63	x	0.7	=	26.04	(75)
Northeast	0.9x	0.77	x	3.55	x	50.42	x	0.63	x	0.7	=	54.7	(75)
Northeast	0.9x	0.77	x	1.69	x	28.07	x	0.63	x	0.7	=	14.5	(75)
Northeast	0.9x	0.77	x	3.55	x	28.07	x	0.63	x	0.7	=	30.45	(75)
Northeast	0.9x	0.77	x	1.69	x	14.2	x	0.63	x	0.7	=	7.33	(75)
Northeast	0.9x	0.77	x	3.55	x	14.2	x	0.63	x	0.7	=	15.4	(75)
Northeast	0.9x	0.77	x	1.69	x	9.21	x	0.63	x	0.7	=	4.76	(75)
Northeast	0.9x	0.77	x	3.55	x	9.21	x	0.63	x	0.7	=	10	(75)
Northwest	0.9x	0.77	x	1.39	x	11.28	x	0.63	x	0.7	=	19.17	(81)
Northwest	0.9x	0.77	x	1.39	x	22.97	x	0.63	x	0.7	=	39.03	(81)
Northwest	0.9x	0.77	x	1.39	x	41.38	x	0.63	x	0.7	=	70.31	(81)
Northwest	0.9x	0.77	x	1.39	x	67.96	x	0.63	x	0.7	=	115.47	(81)
Northwest	0.9x	0.77	x	1.39	x	91.35	x	0.63	x	0.7	=	155.22	(81)
Northwest	0.9x	0.77	x	1.39	x	97.38	x	0.63	x	0.7	=	165.48	(81)
Northwest	0.9x	0.77	x	1.39	x	91.1	x	0.63	x	0.7	=	154.8	(81)
Northwest	0.9x	0.77	x	1.39	x	72.63	x	0.63	x	0.7	=	123.41	(81)
Northwest	0.9x	0.77	x	1.39	x	50.42	x	0.63	x	0.7	=	85.68	(81)
Northwest	0.9x	0.77	x	1.39	x	28.07	x	0.63	x	0.7	=	47.69	(81)
Northwest	0.9x	0.77	x	1.39	x	14.2	x	0.63	x	0.7	=	24.12	(81)
Northwest	0.9x	0.77	x	1.39	x	9.21	x	0.63	x	0.7	=	15.66	(81)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	37.24	75.8	136.58	224.3	301.5	321.43	300.69	239.71	166.42	92.64	46.86	30.41	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	368.03	403.59	451.73	519.95	577.81	579.14	546.85	492.48	429.68	375.59	352.07	352.03	(84)

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	1	0.99	0.98	0.92	0.8	0.65	0.72	0.92	0.99	1	1	(86)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(87)m=	19.27	19.41	19.7	20.15	20.56	20.85	20.95	20.93	20.68	20.18	19.67	19.27	(87)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(88)m=	19.65	19.66	19.67	19.7	19.71	19.73	19.73	19.74	19.72	19.71	19.69	19.68	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(89)m=	1	0.99	0.99	0.96	0.88	0.7	0.49	0.56	0.86	0.98	0.99	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(90)m=	18.1	18.25	18.55	19.01	19.4	19.66	19.72	19.72	19.54	19.05	18.54	18.13	(90)

fLA = Living area ÷ (4) = | 0.4 | (91)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(92)m=	18.57	18.71	19.01	19.46	19.86	20.14	20.21	20.2	19.99	19.5	18.99	18.59	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(93)m=	18.57	18.71	19.01	19.46	19.86	20.14	20.21	20.2	19.99	19.5	18.99	18.59	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.99	0.96	0.89	0.73	0.55	0.63	0.88	0.98	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	366.52	401	445.61	499.77	513.4	423.86	303.01	308.78	376.86	366.72	349.7	350.85	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1343.96	1293.36	1164.18	956.1	734.82	486.23	317.25	332.19	522.54	801.23	1082.39	1323.92	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	727.21	599.67	534.62	328.55	164.74	0	0	0	0	323.27	527.54	723.96	

Total per year (kWh/year) = Sum(98)1...5,9...12 = | 3929.55 | (98)

Space heating requirement in kWh/m²/year | 64.41 | (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		90.3	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

DER WorkSheet: New dwelling design stage

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)														
	727.21	599.67	534.62	328.55	164.74	0	0	0	0	323.27	527.54	723.96		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	805.33	664.08	592.04	363.85	182.44	0	0	0	0	357.99	584.2	801.73		
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													4351.66	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	189.05	165.14	171.81	152.39	147.54	129.95	124.5	138.79	140.32	159.78	170.56	184.61		
Efficiency of water heater													81	(216)
(217)m=	88.21	88.12	87.85	87.13	85.65	81	81	81	81	87	87.84	88.24		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	214.31	187.41	195.58	174.9	172.25	160.43	153.7	171.34	173.23	183.66	194.18	209.21		
Total = Sum(219a)$_{1...12}$ =													2190.22	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			4351.66	
Water heating fuel used			2190.22	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		30	(231)
Electricity for lighting			353.7	(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	=	939.96	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	473.09	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1413.05	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	183.57	(268)
Total CO2, kg/year		sum of (265)…(271) =		1612.19	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		26.42	(273)
EI rating (section 14)				80	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 5-Existing

Address : Flat 5, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	64.3	(1a)	x	2.5	(2a)	=	160.75	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	64.3	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			160.75	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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) =	0.19	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)

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

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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.69	(18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

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) =	0.58	(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
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

DER WorkSheet: New dwelling design stage

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

0.74	0.73	0.71	0.64	0.63	0.55	0.55	0.54	0.58	0.63	0.66	0.69

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	(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	(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=	0.78	0.77	0.76	0.71	0.7	0.65	0.65	0.65	0.67	0.7	0.72	0.74	(24d)

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

(25)m=	0.78	0.77	0.76	0.71	0.7	0.65	0.65	0.65	0.67	0.7	0.72	0.74	(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			2.2	x	1.8	=	3.96			(26)
Windows Type 1			3.55	x1/[1/(1.6)+ 0.04]		=	5.34			(27)
Windows Type 2			1.39	x1/[1/(1.6)+ 0.04]		=	2.09			(27)
Windows Type 3			1.39	x1/[1/(1.6)+ 0.04]		=	2.09			(27)
Windows Type 4			0.72	x1/[1/(1.6)+ 0.04]		=	1.08			(27)
Windows Type 5			0.52	x1/[1/(1.6)+ 0.04]		=	0.78			(27)
Windows Type 6			0.72	x1/[1/(1.6)+ 0.04]		=	1.08			(27)
Walls Type1	23.74	3.87	19.87	x	0.55	=	10.93			(29)
Walls Type2	26.23	6.33	19.9	x	0.28	=	5.57			(29)
Walls Type3	4.72	2.2	2.52	x	0.55	=	1.39			(29)
Total area of elements, m²			54.69							(31)
Party wall			45.69	x	0	=	0			(32)
Party floor			64.3							(32a)
Party ceiling			64.3							(32b)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 37.18 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 12868.41 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K — 8.2 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss — (33) + (36) = — 45.39 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	41.21	40.64	40.08	37.46	36.96	34.68	34.68	34.25	35.56	36.96	37.96	39	(38)

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

(39)m=	86.6	86.03	85.47	82.84	82.35	80.07	80.07	79.64	80.95	82.35	83.35	84.39	

Average = Sum(39)$_{1...12}$ /12= 82.84 (39)

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

(40)m=	1.35	1.34	1.33	1.29	1.28	1.25	1.25	1.24	1.26	1.28	1.3	1.31

Average = Sum(40)$_{1...12}$ /12= 1.29 (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 — 2.1 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 — 88.51 (43)

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

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	97.36	93.82	90.28	86.74	83.2	79.66	79.66	83.2	86.74	90.28	93.82	97.36

Total = Sum(44)$_{1...12}$ = 1062.07 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	144.38	126.27	130.3	113.6	109	94.06	87.16	100.02	101.21	117.95	128.76	139.82

Total = Sum(45)$_{1...12}$ = 1392.55 (45)

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

(46)m=	21.66	18.94	19.55	17.04	16.35	14.11	13.07	15	15.18	17.69	19.31	20.97	(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)

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)

DER WorkSheet: New dwelling design stage

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 | 0 | (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	49.61	43.18	46	42.77	42.4	39.28	40.59	42.4	42.77	46	46.27	49.61	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	193.99	169.45	176.31	156.37	151.4	133.34	127.75	142.41	143.99	163.96	175.02	189.43	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	193.99	169.45	176.31	156.37	151.4	133.34	127.75	142.41	143.99	163.96	175.02	189.43	

Output from water heater (annual)$_{1...12}$ | 1923.44 | (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	60.41	52.78	54.83	48.47	46.84	41.1	39.13	43.86	44.35	50.72	54.38	58.89	(65)

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=	105.01	105.01	105.01	105.01	105.01	105.01	105.01	105.01	105.01	105.01	105.01	105.01	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	21.39	19	15.45	11.7	8.74	7.38	7.98	10.37	13.91	17.67	20.62	21.98	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	183.65	185.55	180.75	170.53	157.62	145.49	137.39	135.48	140.29	150.51	163.41	175.54	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	(71)

Water heating gains (Table 5)

(72)m=	81.19	78.54	73.69	67.31	62.96	57.08	52.59	58.95	61.59	68.17	75.53	79.16	(72)

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

(73)m=	343.73	340.6	327.39	307.04	286.83	267.45	255.46	262.3	273.3	293.85	317.06	334.19	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast	0.9x	0.77	x	3.55	x	11.28	x	0.63	x	0.7	=	12.24	(75)
Northeast	0.9x	0.77	x	0.72	x	11.28	x	0.63	x	0.7	=	2.48	(75)
Northeast	0.9x	0.77	x	3.55	x	22.97	x	0.63	x	0.7	=	24.92	(75)
Northeast	0.9x	0.77	x	0.72	x	22.97	x	0.63	x	0.7	=	5.05	(75)
Northeast	0.9x	0.77	x	3.55	x	41.38	x	0.63	x	0.7	=	44.89	(75)
Northeast	0.9x	0.77	x	0.72	x	41.38	x	0.63	x	0.7	=	9.11	(75)
Northeast	0.9x	0.77	x	3.55	x	67.96	x	0.63	x	0.7	=	73.73	(75)
Northeast	0.9x	0.77	x	0.72	x	67.96	x	0.63	x	0.7	=	14.95	(75)
Northeast	0.9x	0.77	x	3.55	x	91.35	x	0.63	x	0.7	=	99.1	(75)
Northeast	0.9x	0.77	x	0.72	x	91.35	x	0.63	x	0.7	=	20.1	(75)
Northeast	0.9x	0.77	x	3.55	x	97.38	x	0.63	x	0.7	=	105.65	(75)
Northeast	0.9x	0.77	x	0.72	x	97.38	x	0.63	x	0.7	=	21.43	(75)
Northeast	0.9x	0.77	x	3.55	x	91.1	x	0.63	x	0.7	=	98.84	(75)
Northeast	0.9x	0.77	x	0.72	x	91.1	x	0.63	x	0.7	=	20.05	(75)
Northeast	0.9x	0.77	x	3.55	x	72.63	x	0.63	x	0.7	=	78.79	(75)
Northeast	0.9x	0.77	x	0.72	x	72.63	x	0.63	x	0.7	=	15.98	(75)
Northeast	0.9x	0.77	x	3.55	x	50.42	x	0.63	x	0.7	=	54.7	(75)
Northeast	0.9x	0.77	x	0.72	x	50.42	x	0.63	x	0.7	=	11.09	(75)
Northeast	0.9x	0.77	x	3.55	x	28.07	x	0.63	x	0.7	=	30.45	(75)
Northeast	0.9x	0.77	x	0.72	x	28.07	x	0.63	x	0.7	=	6.18	(75)
Northeast	0.9x	0.77	x	3.55	x	14.2	x	0.63	x	0.7	=	15.4	(75)
Northeast	0.9x	0.77	x	0.72	x	14.2	x	0.63	x	0.7	=	3.12	(75)
Northeast	0.9x	0.77	x	3.55	x	9.21	x	0.63	x	0.7	=	10	(75)
Northeast	0.9x	0.77	x	0.72	x	9.21	x	0.63	x	0.7	=	2.03	(75)
Southeast	0.9x	0.77	x	1.39	x	36.79	x	0.63	x	0.7	=	31.26	(77)
Southeast	0.9x	0.77	x	1.39	x	36.79	x	0.63	x	0.7	=	15.63	(77)
Southeast	0.9x	0.77	x	0.52	x	36.79	x	0.63	x	0.7	=	11.69	(77)
Southeast	0.9x	0.77	x	1.39	x	62.67	x	0.63	x	0.7	=	53.25	(77)
Southeast	0.9x	0.77	x	1.39	x	62.67	x	0.63	x	0.7	=	26.62	(77)
Southeast	0.9x	0.77	x	0.52	x	62.67	x	0.63	x	0.7	=	19.92	(77)
Southeast	0.9x	0.77	x	1.39	x	85.75	x	0.63	x	0.7	=	72.86	(77)
Southeast	0.9x	0.77	x	1.39	x	85.75	x	0.63	x	0.7	=	36.43	(77)
Southeast	0.9x	0.77	x	0.52	x	85.75	x	0.63	x	0.7	=	27.26	(77)
Southeast	0.9x	0.77	x	1.39	x	106.25	x	0.63	x	0.7	=	90.27	(77)
Southeast	0.9x	0.77	x	1.39	x	106.25	x	0.63	x	0.7	=	45.14	(77)
Southeast	0.9x	0.77	x	0.52	x	106.25	x	0.63	x	0.7	=	33.77	(77)
Southeast	0.9x	0.77	x	1.39	x	119.01	x	0.63	x	0.7	=	101.11	(77)
Southeast	0.9x	0.77	x	1.39	x	119.01	x	0.63	x	0.7	=	50.56	(77)
Southeast	0.9x	0.77	x	0.52	x	119.01	x	0.63	x	0.7	=	37.83	(77)

Southeast	0.9x	0.77	x	1.39	x	118.15	x	0.63	x	0.7	=	100.38	(77)
Southeast	0.9x	0.77	x	1.39	x	118.15	x	0.63	x	0.7	=	50.19	(77)
Southeast	0.9x	0.77	x	0.52	x	118.15	x	0.63	x	0.7	=	37.55	(77)
Southeast	0.9x	0.77	x	1.39	x	113.91	x	0.63	x	0.7	=	96.78	(77)
Southeast	0.9x	0.77	x	1.39	x	113.91	x	0.63	x	0.7	=	48.39	(77)
Southeast	0.9x	0.77	x	0.52	x	113.91	x	0.63	x	0.7	=	36.2	(77)
Southeast	0.9x	0.77	x	1.39	x	104.39	x	0.63	x	0.7	=	88.69	(77)
Southeast	0.9x	0.77	x	1.39	x	104.39	x	0.63	x	0.7	=	44.35	(77)
Southeast	0.9x	0.77	x	0.52	x	104.39	x	0.63	x	0.7	=	33.18	(77)
Southeast	0.9x	0.77	x	1.39	x	92.85	x	0.63	x	0.7	=	78.89	(77)
Southeast	0.9x	0.77	x	1.39	x	92.85	x	0.63	x	0.7	=	39.44	(77)
Southeast	0.9x	0.77	x	0.52	x	92.85	x	0.63	x	0.7	=	29.51	(77)
Southeast	0.9x	0.77	x	1.39	x	69.27	x	0.63	x	0.7	=	58.85	(77)
Southeast	0.9x	0.77	x	1.39	x	69.27	x	0.63	x	0.7	=	29.43	(77)
Southeast	0.9x	0.77	x	0.52	x	69.27	x	0.63	x	0.7	=	22.02	(77)
Southeast	0.9x	0.77	x	1.39	x	44.07	x	0.63	x	0.7	=	37.44	(77)
Southeast	0.9x	0.77	x	1.39	x	44.07	x	0.63	x	0.7	=	18.72	(77)
Southeast	0.9x	0.77	x	0.52	x	44.07	x	0.63	x	0.7	=	14.01	(77)
Southeast	0.9x	0.77	x	1.39	x	31.49	x	0.63	x	0.7	=	26.75	(77)
Southeast	0.9x	0.77	x	1.39	x	31.49	x	0.63	x	0.7	=	13.38	(77)
Southeast	0.9x	0.77	x	0.52	x	31.49	x	0.63	x	0.7	=	10.01	(77)
Southwest	0.9x	0.77	x	0.72	x	36.79		0.63	x	0.7	=	8.1	(79)
Southwest	0.9x	0.77	x	0.72	x	62.67		0.63	x	0.7	=	13.79	(79)
Southwest	0.9x	0.77	x	0.72	x	85.75		0.63	x	0.7	=	18.87	(79)
Southwest	0.9x	0.77	x	0.72	x	106.25		0.63	x	0.7	=	23.38	(79)
Southwest	0.9x	0.77	x	0.72	x	119.01		0.63	x	0.7	=	26.19	(79)
Southwest	0.9x	0.77	x	0.72	x	118.15		0.63	x	0.7	=	26	(79)
Southwest	0.9x	0.77	x	0.72	x	113.91		0.63	x	0.7	=	25.06	(79)
Southwest	0.9x	0.77	x	0.72	x	104.39		0.63	x	0.7	=	22.97	(79)
Southwest	0.9x	0.77	x	0.72	x	92.85		0.63	x	0.7	=	20.43	(79)
Southwest	0.9x	0.77	x	0.72	x	69.27		0.63	x	0.7	=	15.24	(79)
Southwest	0.9x	0.77	x	0.72	x	44.07		0.63	x	0.7	=	9.7	(79)
Southwest	0.9x	0.77	x	0.72	x	31.49		0.63	x	0.7	=	6.93	(79)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	81.4	143.55	209.41	281.24	334.88	341.21	325.32	283.96	234.07	162.16	98.39	69.09	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	425.14	484.15	536.8	588.28	621.71	608.66	580.78	546.26	507.37	456.01	415.46	403.28	(84)

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

DER WorkSheet: New dwelling design stage

(86)m=	1	0.99	0.99	0.96	0.9	0.75	0.58	0.63	0.86	0.97	0.99	1	(86)

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

(87)m=	19.56	19.72	20	20.38	20.7	20.92	20.98	20.97	20.83	20.41	19.94	19.56	(87)

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

(88)m=	19.8	19.81	19.82	19.85	19.86	19.88	19.88	19.89	19.87	19.86	19.84	19.83	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	0.99	0.98	0.95	0.85	0.65	0.45	0.5	0.79	0.96	0.99	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.51	18.68	18.95	19.35	19.65	19.85	19.88	19.88	19.78	19.39	18.92	18.53	(90)

fLA = Living area ÷ (4) = 0.38 (91)

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

(92)m=	18.9	19.07	19.35	19.74	20.05	20.25	20.29	20.29	20.17	19.78	19.3	18.92	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	18.9	19.07	19.35	19.74	20.05	20.25	20.29	20.29	20.17	19.78	19.3	18.92	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.98	0.95	0.86	0.69	0.5	0.55	0.81	0.96	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	422.89	479.37	525.48	556.18	535.06	417.32	289.65	300.47	411.26	437.35	411.33	401.6	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1264.73	1219.23	1098	897.94	687.57	452.39	295.8	309.99	491.55	755.79	1017.15	1242.03	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	626.32	497.18	425.96	246.06	113.47	0	0	0	0	236.92	436.19	625.28	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 3207.38 (98)

Space heating requirement in kWh/m²/year 49.88 (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		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
Space heating requirement (calculated above)													
	626.32	497.18	425.96	246.06	113.47	0	0	0	0	236.92	436.19	625.28	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	693.6	550.59	471.71	272.5	125.65	0	0	0	0	262.37	483.04	692.45	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 3551.92 (211)

DER WorkSheet: New dwelling design stage

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)

193.99	169.45	176.31	156.37	151.4	133.34	127.75	142.41	143.99	163.96	175.02	189.43

Efficiency of water heater 81 (216)

(217)m=	87.91	87.74	87.36	86.44	84.74	81	81	81	81	86.25	87.43	87.95

(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	220.66	193.13	201.81	180.9	178.67	164.62	157.72	175.82	177.76	190.1	200.2	215.38

Total = Sum(219a)$_{1...12}$ = 2256.77 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		3551.92	
Water heating fuel used		2256.77	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
Total electricity for the above, kWh/year (sum of (230a)…(230g) =)		30	(231)
Electricity for lighting		377.71	(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	=	767.21	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	487.46	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1254.68	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	15.57	(267)
Electricity for lighting	(232)	x	0.519	=	196.03	(268)
Total CO2, kg/year			sum of (265)…(271) =		1466.28	(272)
Dwelling CO2 Emission Rate			(272) ÷ (4) =		22.8	(273)
EI rating (section 14)					82	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 6-Existing

Address :	Flat 6, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	61.76	(1a) x	2.5	(2a) =	154.4	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	61.76	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		154.4	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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) =	0.19	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)

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

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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.69	(18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

Number of sides sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.92	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.64	(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
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

DER WorkSheet: New dwelling design stage

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

0.82	0.8	0.79	0.71	0.69	0.61	0.61	0.59	0.64	0.69	0.72	0.75

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	(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	(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=	0.84	0.82	0.81	0.75	0.74	0.69	0.69	0.68	0.71	0.74	0.76	0.78	(24d)

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

(25)m=	0.84	0.82	0.81	0.75	0.74	0.69	0.69	0.68	0.71	0.74	0.76	0.78	(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			2.2	x 1.8	= 3.96			(26)
Windows Type 1			5.42	x1/[1/(1.6)+ 0.04]	= 8.15			(27)
Windows Type 2			0.53	x1/[1/(1.6)+ 0.04]	= 0.8			(27)
Windows Type 3			0.45	x1/[1/(1.6)+ 0.04]	= 0.68			(27)
Windows Type 4			2.85	x1/[1/(1.6)+ 0.04]	= 4.29			(27)
Walls Type1	56.44	11.29	45.15	x 0.55	= 24.83			(29)
Walls Type2	16.52	2.2	14.32	x 0.55	= 7.88			(29)
Total area of elements, m²			72.96					(31)
Party wall			24.38	x 0	= 0			(32)
Party floor			61.76					(32a)
Party ceiling			61.76					(32b)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 53.65 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 12139.63 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K 10.94 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 64.59 (37)

DER WorkSheet: New dwelling design stage

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	42.56	41.89	41.24	38.19	37.62	34.96	34.96	34.47	35.98	37.62	38.77	39.98	(38)

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

(39)m=	107.15	106.48	105.83	102.78	102.21	99.55	99.55	99.06	100.57	102.21	103.36	104.57	

Average = Sum(39)$_{1...12}$ /12= 102.78 (39)

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

(40)m=	1.73	1.72	1.71	1.66	1.65	1.61	1.61	1.6	1.63	1.65	1.67	1.69	

Average = Sum(40)$_{1...12}$ /12= 1.66 (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 2.03 (42)
if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 86.77 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	95.45	91.98	88.51	85.04	81.57	78.1	78.1	81.57	85.04	88.51	91.98	95.45	

Total = Sum(44)$_{1...12}$ = 1041.28 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	141.55	123.8	127.75	111.38	106.87	92.22	85.46	98.06	99.23	115.65	126.24	137.08	

Total = Sum(45)$_{1...12}$ = 1365.28 (45)

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

(46)m=	21.23	18.57	19.16	16.71	16.03	13.83	12.82	14.71	14.88	17.35	18.94	20.56	(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)

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 | 0 | (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	48.64	42.34	45.1	41.94	41.57	38.51	39.8	41.57	41.94	45.1	45.36	48.64	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	190.19	166.14	172.85	153.31	148.43	130.73	125.25	139.63	141.17	160.75	171.6	185.72	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	190.19	166.14	172.85	153.31	148.43	130.73	125.25	139.63	141.17	160.75	171.6	185.72

Output from water heater (annual)$_{1...12}$ | 1885.78 | (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	59.23	51.75	53.75	47.52	45.93	40.29	38.36	43	43.48	49.73	53.31	57.74	(65)

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=	101.55	101.55	101.55	101.55	101.55	101.55	101.55	101.55	101.55	101.55	101.55	101.55	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	20.14	17.89	14.55	11.01	8.23	6.95	7.51	9.76	13.1	16.64	19.42	20.7	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	177.36	179.2	174.57	164.69	152.23	140.51	132.69	130.85	135.49	145.36	157.82	169.54	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	33.15	33.15	33.15	33.15	33.15	33.15	33.15	33.15	33.15	33.15	33.15	33.15	(69)
Pumps and fans gains (Table 5a)													
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	(71)
Water heating gains (Table 5)													
(72)m=	79.6	77.01	72.25	66	61.73	55.96	51.56	57.79	60.39	66.84	74.05	77.61	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	333.57	330.56	317.82	298.16	278.65	259.89	248.23	254.86	265.44	285.3	307.75	324.31	(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 m²	Flux Table 6a	g_ Table 6b	FF Table 6c	Gains (W)

DER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	5.42	x	36.79	0.63	x	0.7	=	60.95	(79)
Southwest	0.9x	0.77	x	0.53	x	36.79	0.63	x	0.7	=	23.84	(79)
Southwest	0.9x	0.77	x	0.45	x	36.79	0.63	x	0.7	=	10.12	(79)
Southwest	0.9x	0.77	x	2.85	x	36.79	0.63	x	0.7	=	32.05	(79)
Southwest	0.9x	0.77	x	5.42	x	62.67	0.63	x	0.7	=	103.81	(79)
Southwest	0.9x	0.77	x	0.53	x	62.67	0.63	x	0.7	=	40.61	(79)
Southwest	0.9x	0.77	x	0.45	x	62.67	0.63	x	0.7	=	17.24	(79)
Southwest	0.9x	0.77	x	2.85	x	62.67	0.63	x	0.7	=	54.59	(79)
Southwest	0.9x	0.77	x	5.42	x	85.75	0.63	x	0.7	=	142.04	(79)
Southwest	0.9x	0.77	x	0.53	x	85.75	0.63	x	0.7	=	55.56	(79)
Southwest	0.9x	0.77	x	0.45	x	85.75	0.63	x	0.7	=	23.59	(79)
Southwest	0.9x	0.77	x	2.85	x	85.75	0.63	x	0.7	=	74.69	(79)
Southwest	0.9x	0.77	x	5.42	x	106.25	0.63	x	0.7	=	176	(79)
Southwest	0.9x	0.77	x	0.53	x	106.25	0.63	x	0.7	=	68.84	(79)
Southwest	0.9x	0.77	x	0.45	x	106.25	0.63	x	0.7	=	29.22	(79)
Southwest	0.9x	0.77	x	2.85	x	106.25	0.63	x	0.7	=	92.54	(79)
Southwest	0.9x	0.77	x	5.42	x	119.01	0.63	x	0.7	=	197.13	(79)
Southwest	0.9x	0.77	x	0.53	x	119.01	0.63	x	0.7	=	77.11	(79)
Southwest	0.9x	0.77	x	0.45	x	119.01	0.63	x	0.7	=	32.73	(79)
Southwest	0.9x	0.77	x	2.85	x	119.01	0.63	x	0.7	=	103.66	(79)
Southwest	0.9x	0.77	x	5.42	x	118.15	0.63	x	0.7	=	195.71	(79)
Southwest	0.9x	0.77	x	0.53	x	118.15	0.63	x	0.7	=	76.55	(79)
Southwest	0.9x	0.77	x	0.45	x	118.15	0.63	x	0.7	=	32.5	(79)
Southwest	0.9x	0.77	x	2.85	x	118.15	0.63	x	0.7	=	102.91	(79)
Southwest	0.9x	0.77	x	5.42	x	113.91	0.63	x	0.7	=	188.68	(79)
Southwest	0.9x	0.77	x	0.53	x	113.91	0.63	x	0.7	=	73.8	(79)
Southwest	0.9x	0.77	x	0.45	x	113.91	0.63	x	0.7	=	31.33	(79)
Southwest	0.9x	0.77	x	2.85	x	113.91	0.63	x	0.7	=	99.21	(79)
Southwest	0.9x	0.77	x	5.42	x	104.39	0.63	x	0.7	=	172.91	(79)
Southwest	0.9x	0.77	x	0.53	x	104.39	0.63	x	0.7	=	67.63	(79)
Southwest	0.9x	0.77	x	0.45	x	104.39	0.63	x	0.7	=	28.71	(79)
Southwest	0.9x	0.77	x	2.85	x	104.39	0.63	x	0.7	=	90.92	(79)
Southwest	0.9x	0.77	x	5.42	x	92.85	0.63	x	0.7	=	153.8	(79)
Southwest	0.9x	0.77	x	0.53	x	92.85	0.63	x	0.7	=	60.16	(79)
Southwest	0.9x	0.77	x	0.45	x	92.85	0.63	x	0.7	=	25.54	(79)
Southwest	0.9x	0.77	x	2.85	x	92.85	0.63	x	0.7	=	80.87	(79)
Southwest	0.9x	0.77	x	5.42	x	69.27	0.63	x	0.7	=	114.74	(79)
Southwest	0.9x	0.77	x	0.53	x	69.27	0.63	x	0.7	=	44.88	(79)
Southwest	0.9x	0.77	x	0.45	x	69.27	0.63	x	0.7	=	19.05	(79)
Southwest	0.9x	0.77	x	2.85	x	69.27	0.63	x	0.7	=	60.33	(79)
Southwest	0.9x	0.77	x	5.42	x	44.07	0.63	x	0.7	=	73	(79)

Southwest	0.9x	0.77	x	0.53	x	44.07	0.63	x	0.7	=	28.55	(79)
Southwest	0.9x	0.77	x	0.45	x	44.07	0.63	x	0.7	=	12.12	(79)
Southwest	0.9x	0.77	x	2.85	x	44.07	0.63	x	0.7	=	38.39	(79)
Southwest	0.9x	0.77	x	5.42	x	31.49	0.63	x	0.7	=	52.16	(79)
Southwest	0.9x	0.77	x	0.53	x	31.49	0.63	x	0.7	=	20.4	(79)
Southwest	0.9x	0.77	x	0.45	x	31.49	0.63	x	0.7	=	8.66	(79)
Southwest	0.9x	0.77	x	2.85	x	31.49	0.63	x	0.7	=	27.43	(79)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	126.95	216.25	295.88	366.61	410.63	407.66	393.03	360.19	320.37	239	152.06	108.64	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	460.52	546.81	613.7	664.77	689.28	667.55	641.25	615.05	585.81	524.3	459.81	432.95	(84)

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=	0.99	0.99	0.98	0.95	0.9	0.78	0.62	0.66	0.85	0.96	0.99	1	(86)

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

(87)m=	19.17	19.38	19.71	20.15	20.54	20.83	20.95	20.93	20.73	20.22	19.64	19.17	(87)

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

(88)m=	19.52	19.52	19.53	19.57	19.57	19.6	19.6	19.61	19.59	19.57	19.56	19.55	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.99	0.97	0.93	0.85	0.67	0.45	0.5	0.77	0.95	0.99	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	17.9	18.12	18.45	18.91	19.27	19.53	19.59	19.59	19.45	18.99	18.4	17.92	(90)

fLA = Living area ÷ (4) = 0.41 (91)

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

(92)m=	18.42	18.64	18.97	19.42	19.79	20.06	20.15	20.14	19.98	19.49	18.91	18.43	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	18.42	18.64	18.97	19.42	19.79	20.06	20.15	20.14	19.98	19.49	18.91	18.43	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.98	0.97	0.93	0.86	0.71	0.52	0.57	0.8	0.94	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	456.43	537.61	593.87	619.66	590.56	471.77	336.6	348.29	466.87	494.74	452.49	429.89	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1513.35	1463.17	1319.69	1081.05	826.7	544	353.29	370.79	590.95	909.07	1220.66	1488.29	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	786.35	621.98	540.01	332.2	175.69	0	0	0	0	308.26	553.08	787.45	

DER WorkSheet: New dwelling design stage

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4105.01 (98)

Space heating requirement in kWh/m²/year 66.47 (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		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	
Space heating requirement (calculated above)	786.35	621.98	540.01	332.2	175.69	0	0	0	0	308.26	553.08	787.45		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	870.82	688.79	598.02	367.88	194.56	0	0	0	0	341.38	612.49	872.04		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													4545.97	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	190.19	166.14	172.85	153.31	148.43	130.73	125.25	139.63	141.17	160.75	171.6	185.72		
Efficiency of water heater													81	(216)
(217)m=	88.32	88.17	87.85	87.14	85.79	81	81	81	81	86.88	87.91	88.36		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	215.33	188.44	196.75	175.94	173.02	161.4	154.63	172.38	174.28	185.02	195.2	210.18		
Total = Sum(219a)$_{1...12}$ =													2202.57	(219)

Annual totals **kWh/year** **kWh/year**

Space heating fuel used, main system 1			4545.97	
Water heating fuel used			2202.57	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		30	(231)
Electricity for lighting			355.65	(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	=	981.93	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)

DER WorkSheet: New dwelling design stage

Water heating	(219) x	0.216	=	475.76	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1457.69	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	184.58	(268)
Total CO2, kg/year		sum of (265)…(271) =		1657.84	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		26.84	(273)
EI rating (section 14)				79	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 7-Existing

Address : Flat 7, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	37.6	(1a) x	1.86	(2a) =	69.94	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	37.6	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	69.94	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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							2	x 10 =	20	(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) =	20	÷ (5) =	0.29	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)
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			
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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.79	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
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) =	0.67	(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
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

DER WorkSheet: New dwelling design stage

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

0.85	0.84	0.82	0.73	0.72	0.63	0.63	0.62	0.67	0.72	0.75	0.78

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	(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	(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=	0.86	0.85	0.83	0.77	0.76	0.7	0.7	0.69	0.72	0.76	0.78	0.81	(24d)

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

(25)m=	0.86	0.85	0.83	0.77	0.76	0.7	0.7	0.69	0.72	0.76	0.78	0.81	(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			2.2	x	1.8	=	3.96			(26)
Windows Type 1			3.63	x1/[1/(1.6)+ 0.04]		=	5.46			(27)
Windows Type 2			2.67	x1/[1/(1.6)+ 0.04]		=	4.02			(27)
Rooflights			0.82	x1/[1/(1.6) + 0.04]		=	1.312			(27b)
Walls Type1	10.35	6.3	4.05	x	0.55	=	2.23			(29)
Walls Type2	16.58	2.2	14.38	x	0.55	=	7.91			(29)
Roof Type1	35.62	1.64	33.98	x	0.18	=	6.12			(30)
Roof Type2	13.82	0	13.82	x	0.18	=	2.49			(30)
Total area of elements, m²			76.37							(31)
Party wall			15.11	x	0	=	0			(32)
Party floor			37.6							(32a)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 34.64 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 3906.27 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K 11.46 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 46.1 (37)

DER WorkSheet: New dwelling design stage

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	19.91	19.59	19.27	17.77	17.49	16.19	16.19	15.95	16.69	17.49	18.06	18.65	(38)

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

(39)m=	66.01	65.68	65.36	63.87	63.59	62.28	62.28	62.04	62.79	63.59	64.15	64.75	

Average = Sum(39)1…12 /12= 63.87 (39)

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

(40)m=	1.76	1.75	1.74	1.7	1.69	1.66	1.66	1.65	1.67	1.69	1.71	1.72	

Average = Sum(40)1…12 /12= 1.7 (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 1.34 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 69.6 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	76.56	73.78	70.99	68.21	65.43	62.64	62.64	65.43	68.21	70.99	73.78	76.56	

Total = Sum(44)1…12 = 835.23 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	113.54	99.3	102.47	89.34	85.72	73.97	68.55	78.66	79.6	92.76	101.26	109.96	

Total = Sum(45)1…12 = 1095.12 (45)

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

(46)m=	17.03	14.9	15.37	13.4	12.86	11.1	10.28	11.8	11.94	13.91	15.19	16.49	(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)

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	39.02	33.96	36.18	33.64	33.34	30.89	31.92	33.34	33.64	36.18	36.38	39.02	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	152.56	133.26	138.65	122.98	119.06	104.86	100.47	112	113.23	128.94	137.64	148.97	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	152.56	133.26	138.65	122.98	119.06	104.86	100.47	112	113.23	128.94	137.64	148.97

Output from water heater (annual)$_{1...12}$ — 1512.63 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	47.51	41.51	43.12	38.11	36.84	32.32	30.77	34.49	34.88	39.89	42.76	46.32	(65)

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=	67.21	67.21	67.21	67.21	67.21	67.21	67.21	67.21	67.21	67.21	67.21	67.21	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	12.88	11.44	9.3	7.04	5.26	4.44	4.8	6.24	8.38	10.64	12.41	13.23	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	115.55	116.75	113.73	107.29	99.17	91.54	86.44	85.24	88.27	94.7	102.82	110.45	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	(69)
Pumps and fans gains (Table 5a)													
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	(71)
Water heating gains (Table 5)													
(72)m=	63.85	61.77	57.95	52.94	49.51	44.89	41.36	46.36	48.44	53.61	59.39	62.25	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	238.44	236.11	227.14	213.43	200.11	187.03	178.77	184	191.24	205.11	220.79	232.1	(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 m²	Flux Table 6a	g_ Table 6b	FF Table 6c	Gains (W)

Northeast 0.9x	0.77	x	3.63	x	11.28	x	0.63	x	0.7	=	12.52	(75)
Northeast 0.9x	0.77	x	3.63	x	22.97	x	0.63	x	0.7	=	25.48	(75)
Northeast 0.9x	0.77	x	3.63	x	41.38	x	0.63	x	0.7	=	45.9	(75)
Northeast 0.9x	0.77	x	3.63	x	67.96	x	0.63	x	0.7	=	75.39	(75)
Northeast 0.9x	0.77	x	3.63	x	91.35	x	0.63	x	0.7	=	101.34	(75)
Northeast 0.9x	0.77	x	3.63	x	97.38	x	0.63	x	0.7	=	108.04	(75)
Northeast 0.9x	0.77	x	3.63	x	91.1	x	0.63	x	0.7	=	101.07	(75)
Northeast 0.9x	0.77	x	3.63	x	72.63	x	0.63	x	0.7	=	80.57	(75)
Northeast 0.9x	0.77	x	3.63	x	50.42	x	0.63	x	0.7	=	55.94	(75)
Northeast 0.9x	0.77	x	3.63	x	28.07	x	0.63	x	0.7	=	31.14	(75)
Northeast 0.9x	0.77	x	3.63	x	14.2	x	0.63	x	0.7	=	15.75	(75)
Northeast 0.9x	0.77	x	3.63	x	9.21	x	0.63	x	0.7	=	10.22	(75)
Northwest 0.9x	0.77	x	2.67	x	11.28	x	0.63	x	0.7	=	9.21	(81)
Northwest 0.9x	0.77	x	2.67	x	22.97	x	0.63	x	0.7	=	18.74	(81)
Northwest 0.9x	0.77	x	2.67	x	41.38	x	0.63	x	0.7	=	33.76	(81)
Northwest 0.9x	0.77	x	2.67	x	67.96	x	0.63	x	0.7	=	55.45	(81)
Northwest 0.9x	0.77	x	2.67	x	91.35	x	0.63	x	0.7	=	74.54	(81)
Northwest 0.9x	0.77	x	2.67	x	97.38	x	0.63	x	0.7	=	79.46	(81)
Northwest 0.9x	0.77	x	2.67	x	91.1	x	0.63	x	0.7	=	74.34	(81)
Northwest 0.9x	0.77	x	2.67	x	72.63	x	0.63	x	0.7	=	59.26	(81)
Northwest 0.9x	0.77	x	2.67	x	50.42	x	0.63	x	0.7	=	41.14	(81)
Northwest 0.9x	0.77	x	2.67	x	28.07	x	0.63	x	0.7	=	22.9	(81)
Northwest 0.9x	0.77	x	2.67	x	14.2	x	0.63	x	0.7	=	11.58	(81)
Northwest 0.9x	0.77	x	2.67	x	9.21	x	0.63	x	0.7	=	7.52	(81)
Rooflights 0.9x	1	x	0.82	x	15.92	x	0.63	x	0.8	=	11.84	(82)
Rooflights 0.9x	1	x	0.82	x	32.51	x	0.63	x	0.8	=	24.18	(82)
Rooflights 0.9x	1	x	0.82	x	59.5	x	0.63	x	0.8	=	44.26	(82)
Rooflights 0.9x	1	x	0.82	x	100.03	x	0.63	x	0.8	=	74.42	(82)
Rooflights 0.9x	1	x	0.82	x	136.88	x	0.63	x	0.8	=	101.82	(82)
Rooflights 0.9x	1	x	0.82	x	147.03	x	0.63	x	0.8	=	109.38	(82)
Rooflights 0.9x	1	x	0.82	x	137.1	x	0.63	x	0.8	=	101.99	(82)
Rooflights 0.9x	1	x	0.82	x	107.76	x	0.63	x	0.8	=	80.17	(82)
Rooflights 0.9x	1	x	0.82	x	73.17	x	0.63	x	0.8	=	54.43	(82)
Rooflights 0.9x	1	x	0.82	x	39.91	x	0.63	x	0.8	=	29.69	(82)
Rooflights 0.9x	1	x	0.82	x	20.03	x	0.63	x	0.8	=	14.9	(82)
Rooflights 0.9x	1	x	0.82	x	13.01	x	0.63	x	0.8	=	9.67	(82)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	33.56	68.4	123.93	205.25	277.7	296.88	277.39	220	151.51	83.73	42.23	27.42	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	272	304.52	351.07	418.69	477.81	483.91	456.16	404	342.75	288.84	263.02	259.51	(84)

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	0.86	0.71	0.56	0.64	0.87	0.97	0.99	1	(86)

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

(87)m=	19.13	19.3	19.64	20.15	20.59	20.87	20.96	20.94	20.69	20.14	19.57	19.12	(87)

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

(88)m=	19.5	19.51	19.51	19.54	19.55	19.57	19.57	19.58	19.56	19.55	19.54	19.53	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.99	0.98	0.93	0.81	0.59	0.4	0.47	0.79	0.96	0.99	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	17.85	18.02	18.37	18.88	19.29	19.52	19.56	19.56	19.4	18.88	18.32	17.86	(90)

fLA = Living area ÷ (4) = 0.89 (91)

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

(92)m=	18.99	19.16	19.5	20.01	20.45	20.73	20.81	20.79	20.55	20	19.44	18.99	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	18.99	19.16	19.5	20.01	20.45	20.73	20.81	20.79	20.55	20	19.44	18.99	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.98	0.94	0.84	0.69	0.54	0.62	0.85	0.96	0.99	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	270.08	301.1	342.86	392.5	403.56	333.46	247.6	249.07	291.7	278.67	260.07	257.98	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	969.83	936.79	850.03	709.79	556.66	381.68	262.28	272.36	405.27	597.86	791.38	957.56	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	520.62	427.18	377.33	228.45	113.91	0	0	0	0	237.47	382.54	520.49	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2808 (98)

Space heating requirement in kWh/m²/year 74.68 (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		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
Space heating requirement (calculated above)													
	520.62	427.18	377.33	228.45	113.91	0	0	0	0	237.47	382.54	520.49	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	576.54	473.07	417.87	252.99	126.15	0	0	0	0	262.98	423.63	576.4	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 3109.64 (211)

DER WorkSheet: New dwelling design stage

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)

	152.56	133.26	138.65	122.98	119.06	104.86	100.47	112	113.23	128.94	137.64	148.97		
Efficiency of water heater													81	(216)
(217)m=	88.01	87.9	87.6	86.81	85.3	81	81	81	81	86.79	87.64	88.05		(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	173.34	151.61	158.28	141.66	139.59	129.46	124.03	138.27	139.8	148.56	157.06	169.19		
								Total = Sum(219a)$_{1...12}$ =					1770.84	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			3109.64	
Water heating fuel used			1770.84	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		30	(231)
Electricity for lighting			227.4	(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	=	671.68	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	382.5	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1054.18	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	15.57	(267)
Electricity for lighting	(232)	x	0.519	=	118.02	(268)
Total CO2, kg/year			sum of (265)…(271) =		1187.78	(272)
Dwelling CO2 Emission Rate			(272) ÷ (4) =		31.59	(273)
EI rating (section 14)					81	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 8-Existing

Address : Flat 8, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	42.28	(1a)	x	2.06	(2a)	=	87.1	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	42.28	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			87.1	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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							2	x 10 =	20	(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) =	20	÷ (5) =	0.23	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)
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			
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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.73	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
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) =	0.62	(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
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

DER WorkSheet: New dwelling design stage

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

0.79	0.78	0.76	0.68	0.67	0.59	0.59	0.57	0.62	0.67	0.7	0.73

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	(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	(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=	0.81	0.8	0.79	0.73	0.72	0.67	0.67	0.66	0.69	0.72	0.74	0.77	(24d)

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

(25)m=	0.81	0.8	0.79	0.73	0.72	0.67	0.67	0.66	0.69	0.72	0.74	0.77	(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			2.2	x	1.8	=	3.96			(26)
Windows			2.73	x1/[1/(1.6)+ 0.04]		=	4.11			(27)
Rooflights Type 1			0.82	x1/[1/(1.6) + 0.04]		=	1.312			(27b)
Rooflights Type 2			0.82	x1/[1/(1.6) + 0.04]		=	1.312			(27b)
Rooflights Type 3			0.36	x1/[1/(1.6) + 0.04]		=	0.576			(27b)
Walls Type1	1.98	0	1.98	x	0.55	=	1.09			(29)
Walls Type2	6.4	2.2	4.2	x	0.55	=	2.31			(29)
Walls Type3	8.72	2.73	5.99	x	0.28	=	1.68			(29)
Roof Type1	25.2	0	25.2	x	0.18	=	4.54			(30)
Roof Type2	23.07	0.36	22.71	x	0.18	=	4.09			(30)
Roof Type3	4.86	3.28	1.58	x	0.18	=	0.28			(30)
Total area of elements, m²			70.23							(31)
Party wall			33.48	x	0	=	0			(32)
Party floor			42.28							(32a)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 27.52 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 4606.94 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K | 10.53 | (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = | 38.06 | (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	23.36	23.01	22.67	21.06	20.76	19.36	19.36	19.1	19.9	20.76	21.37	22	(38)

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

(39)m=	61.41	61.07	60.72	59.12	58.82	57.42	57.42	57.16	57.96	58.82	59.42	60.06	

Average = Sum(39)$_{1…12}$ /12= | 59.12 | (39)

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

(40)m=	1.45	1.44	1.44	1.4	1.39	1.36	1.36	1.35	1.37	1.39	1.41	1.42	

Average = Sum(40)$_{1…12}$ /12= | 1.4 | (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 | 1.47 | (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 72.7 | (43)

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

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	79.97	77.07	74.16	71.25	68.34	65.43	65.43	68.34	71.25	74.16	77.07	79.97

Total = Sum(44)$_{1…12}$ = | 872.45 | (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	118.6	103.73	107.04	93.32	89.54	77.27	71.6	82.16	83.14	96.9	105.77	114.86

Total = Sum(45)$_{1…12}$ = | 1143.92 | (45)

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

(46)m=	17.79	15.56	16.06	14	13.43	11.59	10.74	12.32	12.47	14.53	15.87	17.23	(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)

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)

DER WorkSheet: New dwelling design stage

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	40.75	35.47	37.79	35.14	34.83	32.27	33.34	34.83	35.14	37.79	38.01	40.75	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	159.35	139.2	144.83	128.46	124.37	109.54	104.94	116.99	118.28	134.69	143.77	155.61	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	159.35	139.2	144.83	128.46	124.37	109.54	104.94	116.99	118.28	134.69	143.77	155.61	

Output from water heater (annual)1…12 — 1580.03 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	49.62	43.36	45.04	39.81	38.48	33.76	32.14	36.03	36.43	41.67	44.67	48.38	(65)

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=	73.41	73.41	73.41	73.41	73.41	73.41	73.41	73.41	73.41	73.41	73.41	73.41	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	14.45	12.84	10.44	7.9	5.91	4.99	5.39	7	9.4	11.94	13.93	14.85	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	127.31	128.63	125.3	118.21	109.27	100.86	95.24	93.92	97.25	104.34	113.28	121.69	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	30.34	30.34	30.34	30.34	30.34	30.34	30.34	30.34	30.34	30.34	30.34	30.34	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	(71)

Water heating gains (Table 5)

(72)m=	66.7	64.52	60.53	55.3	51.72	46.89	43.2	48.42	50.6	56	62.04	65.03	(72)

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

(73)m=	256.48	254.01	244.3	229.43	214.92	200.75	191.86	197.37	205.27	220.3	237.28	249.59	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast	0.9x	0.77	x	2.73	x	11.28	x	0.63	x	0.7	=	9.41	(75)
Northeast	0.9x	0.77	x	2.73	x	22.97	x	0.63	x	0.7	=	19.16	(75)
Northeast	0.9x	0.77	x	2.73	x	41.38	x	0.63	x	0.7	=	34.52	(75)
Northeast	0.9x	0.77	x	2.73	x	67.96	x	0.63	x	0.7	=	56.7	(75)
Northeast	0.9x	0.77	x	2.73	x	91.35	x	0.63	x	0.7	=	76.21	(75)
Northeast	0.9x	0.77	x	2.73	x	97.38	x	0.63	x	0.7	=	81.25	(75)
Northeast	0.9x	0.77	x	2.73	x	91.1	x	0.63	x	0.7	=	76.01	(75)
Northeast	0.9x	0.77	x	2.73	x	72.63	x	0.63	x	0.7	=	60.59	(75)
Northeast	0.9x	0.77	x	2.73	x	50.42	x	0.63	x	0.7	=	42.07	(75)
Northeast	0.9x	0.77	x	2.73	x	28.07	x	0.63	x	0.7	=	23.42	(75)
Northeast	0.9x	0.77	x	2.73	x	14.2	x	0.63	x	0.7	=	11.84	(75)
Northeast	0.9x	0.77	x	2.73	x	9.21	x	0.63	x	0.7	=	7.69	(75)
Rooflights	0.9x	1	x	0.82	x	15.92	x	0.63	x	0.8	=	11.84	(82)
Rooflights	0.9x	1	x	0.82	x	40.5	x	0.63	x	0.8	=	30.13	(82)
Rooflights	0.9x	1	x	0.36	x	26	x	0.63	x	0.8	=	4.25	(82)
Rooflights	0.9x	1	x	0.82	x	32.51	x	0.63	x	0.8	=	24.18	(82)
Rooflights	0.9x	1	x	0.82	x	73.74	x	0.63	x	0.8	=	54.86	(82)
Rooflights	0.9x	1	x	0.36	x	54	x	0.63	x	0.8	=	8.82	(82)
Rooflights	0.9x	1	x	0.82	x	59.5	x	0.63	x	0.8	=	44.26	(82)
Rooflights	0.9x	1	x	0.82	x	111.06	x	0.63	x	0.8	=	82.61	(82)
Rooflights	0.9x	1	x	0.36	x	96	x	0.63	x	0.8	=	15.68	(82)
Rooflights	0.9x	1	x	0.82	x	100.03	x	0.63	x	0.8	=	74.42	(82)
Rooflights	0.9x	1	x	0.82	x	150.59	x	0.63	x	0.8	=	112.02	(82)
Rooflights	0.9x	1	x	0.36	x	150	x	0.63	x	0.8	=	24.49	(82)
Rooflights	0.9x	1	x	0.82	x	136.88	x	0.63	x	0.8	=	101.82	(82)
Rooflights	0.9x	1	x	0.82	x	177.61	x	0.63	x	0.8	=	132.12	(82)
Rooflights	0.9x	1	x	0.36	x	192	x	0.63	x	0.8	=	31.35	(82)
Rooflights	0.9x	1	x	0.82	x	147.03	x	0.63	x	0.8	=	109.38	(82)
Rooflights	0.9x	1	x	0.82	x	179.47	x	0.63	x	0.8	=	133.51	(82)
Rooflights	0.9x	1	x	0.36	x	200	x	0.63	x	0.8	=	32.66	(82)
Rooflights	0.9x	1	x	0.82	x	137.1	x	0.63	x	0.8	=	101.99	(82)
Rooflights	0.9x	1	x	0.82	x	171.77	x	0.63	x	0.8	=	127.78	(82)
Rooflights	0.9x	1	x	0.36	x	189	x	0.63	x	0.8	=	30.86	(82)
Rooflights	0.9x	1	x	0.82	x	107.76	x	0.63	x	0.8	=	80.17	(82)
Rooflights	0.9x	1	x	0.82	x	151.65	x	0.63	x	0.8	=	112.82	(82)
Rooflights	0.9x	1	x	0.36	x	157	x	0.63	x	0.8	=	25.64	(82)
Rooflights	0.9x	1	x	0.82	x	73.17	x	0.63	x	0.8	=	54.43	(82)
Rooflights	0.9x	1	x	0.82	x	125.02	x	0.63	x	0.8	=	93.01	(82)
Rooflights	0.9x	1	x	0.36	x	115	x	0.63	x	0.8	=	18.78	(82)

DER WorkSheet: New dwelling design stage

Rooflights 0.9x	1	x	0.82	x	39.91	x	0.63	x	0.8	=	29.69	(82)
Rooflights 0.9x	1	x	0.82	x	84.48	x	0.63	x	0.8	=	62.84	(82)
Rooflights 0.9x	1	x	0.36	x	66	x	0.63	x	0.8	=	10.78	(82)
Rooflights 0.9x	1	x	0.82	x	20.03	x	0.63	x	0.8	=	14.9	(82)
Rooflights 0.9x	1	x	0.82	x	49.44	x	0.63	x	0.8	=	36.78	(82)
Rooflights 0.9x	1	x	0.36	x	33	x	0.63	x	0.8	=	5.39	(82)
Rooflights 0.9x	1	x	0.82	x	13.01	x	0.63	x	0.8	=	9.67	(82)
Rooflights 0.9x	1	x	0.82	x	34.03	x	0.63	x	0.8	=	25.31	(82)
Rooflights 0.9x	1	x	0.36	x	21	x	0.63	x	0.8	=	3.43	(82)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	55.63	107.02	177.08	267.63	341.51	356.79	336.64	279.21	208.28	126.73	68.91	46.11	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	312.11	361.03	421.37	497.06	556.43	557.55	528.5	476.58	413.55	347.03	306.19	295.7	(84)

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	0.93	0.81	0.62	0.47	0.53	0.8	0.96	0.99	1	(86)

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

(87)m=	19.49	19.68	20.01	20.46	20.79	20.95	20.99	20.98	20.85	20.41	19.89	19.49	(87)

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

(88)m=	19.72	19.73	19.74	19.76	19.77	19.8	19.8	19.8	19.79	19.77	19.76	19.75	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.99	0.97	0.9	0.74	0.52	0.35	0.4	0.71	0.94	0.99	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.38	18.57	18.9	19.35	19.64	19.78	19.79	19.8	19.71	19.32	18.8	18.39	(90)

fLA = Living area ÷ (4) = | 0.88 | (91)

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

(92)m=	19.36	19.54	19.87	20.32	20.65	20.81	20.84	20.84	20.71	20.27	19.76	19.35	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	19.36	19.54	19.87	20.32	20.65	20.81	20.84	20.84	20.71	20.27	19.76	19.35	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.97	0.91	0.79	0.6	0.45	0.52	0.78	0.95	0.99	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	309.91	356.24	408.25	453.48	439.03	336.79	239.16	245.99	323.3	329.87	302.33	294.03	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	924.75	894.27	812.05	675.19	526.28	356.41	243.54	253.5	383.2	568.97	752.14	910.08	(97)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(98)m=	457.44	361.56	300.42	159.63	64.92	0	0	0	0	177.89	323.86	458.34

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2304.07 (98)

Space heating requirement in kWh/m²/year 54.5 (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		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
Space heating requirement (calculated above)	457.44	361.56	300.42	159.63	64.92	0	0	0	0	177.89	323.86	458.34	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	506.58	400.4	332.69	176.78	71.89	0	0	0	0	197	358.65	507.57	(211)

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 2551.57 (211)

Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] } x 100 ÷ (208)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Output from water heater (calculated above)	159.35	139.2	144.83	128.46	124.37	109.54	104.94	116.99	118.28	134.69	143.77	155.61	
Efficiency of water heater												81	(216)
(217)m=	87.7	87.51	87.05	85.9	83.97	81	81	81	81	86.04	87.22	87.75	(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(219)m=	181.71	159.07	166.38	149.54	148.12	135.23	129.56	144.43	146.02	156.53	164.84	177.34

Total = Sum(219a)$_{1...12}$ = 1858.77 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			2551.57	
Water heating fuel used			1858.77	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		30	(231)
Electricity for lighting			255.21	(232)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh	**Emissions** kg CO2/year

DER WorkSheet: New dwelling design stage

Space heating (main system 1)	(211) x		0.216	=	551.14	(261)
Space heating (secondary)	(215) x		0.519	=	0	(263)
Water heating	(219) x		0.216	=	401.49	(264)
Space and water heating	(261) + (262) + (263) + (264) =				952.63	(265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	15.57	(267)
Electricity for lighting	(232) x		0.519	=	132.46	(268)
Total CO2, kg/year		sum of (265)…(271) =			1100.66	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =			26.03	(273)
EI rating (section 14)					83	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 9-Existing

Address : Flat 9, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	66.9	(1a)	x	2.05	(2a)	=	137.14	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	66.9	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			137.14	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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) =	0.22	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)

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

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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.72	(18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

Number of sides sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.92	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.66	(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
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

DER WorkSheet: New dwelling design stage

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

0.85	0.83	0.81	0.73	0.71	0.63	0.63	0.61	0.66	0.71	0.75	0.78

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	(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	(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=	0.86	0.85	0.83	0.77	0.76	0.7	0.7	0.69	0.72	0.76	0.78	0.81	(24d)

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

(25)m=	0.86	0.85	0.83	0.77	0.76	0.7	0.7	0.69	0.72	0.76	0.78	0.81	(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			2.2	x	1.8	=	3.96			(26)
Windows Type 1			1.78	x1/[1/(1.6)+ 0.04]		=	2.68			(27)
Windows Type 2			1.75	x1/[1/(1.6)+ 0.04]		=	2.63			(27)
Windows Type 3			1.55	x1/[1/(1.6)+ 0.04]		=	2.33			(27)
Rooflights Type 1			0.82	x1/[1/(1.6) + 0.04]		=	1.312			(27b)
Rooflights Type 2			0.82	x1/[1/(1.6) + 0.04]		=	1.312			(27b)
Rooflights Type 3			0.36	x1/[1/(1.6) + 0.04]		=	0.576			(27b)
Walls Type1	32.03	6.83	25.2	x	0.55	=	13.86			(29)
Walls Type2	17.06	2.2	14.86	x	0.55	=	8.17			(29)
Walls Type3	3.91	0	3.91	x	0.28	=	1.09			(29)
Roof Type1	49.43	4.1	45.33	x	0.18	=	8.16			(30)
Roof Type2	25.67	0.72	24.95	x	0.18	=	4.49			(30)
Roof Type3	13.6	0	13.6	x	0.18	=	2.45			(30)
Total area of elements, m²			141.7							(31)
Party wall			18.94	x	0	=	0			(32)
Party floor			66.9							(32a)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 59.7 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 6881.45 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K | 21.26 | (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = | 80.96 | (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	38.89	38.26	37.64	34.73	34.19	31.66	31.66	31.19	32.63	34.19	35.29	36.44	(38)

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

(39)m=	119.85	119.22	118.6	115.69	115.15	112.62	112.62	112.15	113.59	115.15	116.25	117.4	

Average = $Sum(39)_{1...12}$ /12= | 115.69 | (39)

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

(40)m=	1.79	1.78	1.77	1.73	1.72	1.68	1.68	1.68	1.7	1.72	1.74	1.75	

Average = $Sum(40)_{1...12}$ /12= | 1.73 | (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 | 2.17 | (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 90.21 | (43)

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

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m=	99.24	95.63	92.02	88.41	84.8	81.19	81.19	84.8	88.41	92.02	95.63	99.24	

Total = $Sum(44)_{1...12}$ = | 1082.57 | (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	147.16	128.71	132.82	115.79	111.11	95.88	88.84	101.95	103.17	120.23	131.24	142.52	

Total = $Sum(45)_{1...12}$ = | 1419.42 | (45)

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

(46)m=	22.07	19.31	19.92	17.37	16.67	14.38	13.33	15.29	15.48	18.03	19.69	21.38	(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)

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	50.57	44.01	46.89	43.6	43.21	40.04	41.38	43.21	43.6	46.89	47.16	50.57	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	197.73	172.73	179.71	159.39	154.32	135.92	130.22	145.16	146.77	167.12	178.4	193.09	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	197.73	172.73	179.71	159.39	154.32	135.92	130.22	145.16	146.77	167.12	178.4	193.09	

Output from water heater (annual)$_{1...12}$ — 1960.56 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	61.57	53.8	55.88	49.4	47.75	41.89	39.88	44.7	45.2	51.7	55.43	60.03	(65)

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=	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	21.3	18.92	15.39	11.65	8.71	7.35	7.94	10.33	13.86	17.6	20.54	21.9	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	189.96	191.93	186.96	176.39	163.04	150.49	142.11	140.14	145.11	155.68	169.03	181.58	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	33.84	33.84	33.84	33.84	33.84	33.84	33.84	33.84	33.84	33.84	33.84	33.84	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	(71)

Water heating gains (Table 5)

(72)m=	82.76	80.06	75.11	68.61	64.18	58.18	53.61	60.08	62.78	69.49	76.98	80.69	(72)

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

(73)m=	352.55	349.44	335.99	315.18	294.45	274.55	262.19	269.08	280.28	301.3	325.08	342.69	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Southeast	0.9x	0.77	x	1.78	x	36.79	x	0.63	x	0.7	=	20.02	(77)
Southeast	0.9x	0.77	x	1.78	x	62.67	x	0.63	x	0.7	=	34.09	(77)
Southeast	0.9x	0.77	x	1.78	x	85.75	x	0.63	x	0.7	=	46.65	(77)
Southeast	0.9x	0.77	x	1.78	x	106.25	x	0.63	x	0.7	=	57.8	(77)
Southeast	0.9x	0.77	x	1.78	x	119.01	x	0.63	x	0.7	=	64.74	(77)
Southeast	0.9x	0.77	x	1.78	x	118.15	x	0.63	x	0.7	=	64.27	(77)
Southeast	0.9x	0.77	x	1.78	x	113.91	x	0.63	x	0.7	=	61.97	(77)
Southeast	0.9x	0.77	x	1.78	x	104.39	x	0.63	x	0.7	=	56.79	(77)
Southeast	0.9x	0.77	x	1.78	x	92.85	x	0.63	x	0.7	=	50.51	(77)
Southeast	0.9x	0.77	x	1.78	x	69.27	x	0.63	x	0.7	=	37.68	(77)
Southeast	0.9x	0.77	x	1.78	x	44.07	x	0.63	x	0.7	=	23.97	(77)
Southeast	0.9x	0.77	x	1.78	x	31.49	x	0.63	x	0.7	=	17.13	(77)
Southwest	0.9x	0.77	x	1.75	x	36.79		0.63	x	0.7	=	39.36	(79)
Southwest	0.9x	0.77	x	1.75	x	62.67		0.63	x	0.7	=	67.04	(79)
Southwest	0.9x	0.77	x	1.75	x	85.75		0.63	x	0.7	=	91.72	(79)
Southwest	0.9x	0.77	x	1.75	x	106.25		0.63	x	0.7	=	113.65	(79)
Southwest	0.9x	0.77	x	1.75	x	119.01		0.63	x	0.7	=	127.3	(79)
Southwest	0.9x	0.77	x	1.75	x	118.15		0.63	x	0.7	=	126.38	(79)
Southwest	0.9x	0.77	x	1.75	x	113.91		0.63	x	0.7	=	121.84	(79)
Southwest	0.9x	0.77	x	1.75	x	104.39		0.63	x	0.7	=	111.66	(79)
Southwest	0.9x	0.77	x	1.75	x	92.85		0.63	x	0.7	=	99.32	(79)
Southwest	0.9x	0.77	x	1.75	x	69.27		0.63	x	0.7	=	74.09	(79)
Southwest	0.9x	0.77	x	1.75	x	44.07		0.63	x	0.7	=	47.14	(79)
Southwest	0.9x	0.77	x	1.75	x	31.49		0.63	x	0.7	=	33.68	(79)
Northwest	0.9x	0.77	x	1.55	x	11.28	x	0.63	x	0.7	=	5.34	(81)
Northwest	0.9x	0.77	x	1.55	x	22.97	x	0.63	x	0.7	=	10.88	(81)
Northwest	0.9x	0.77	x	1.55	x	41.38	x	0.63	x	0.7	=	19.6	(81)
Northwest	0.9x	0.77	x	1.55	x	67.96	x	0.63	x	0.7	=	32.19	(81)
Northwest	0.9x	0.77	x	1.55	x	91.35	x	0.63	x	0.7	=	43.27	(81)
Northwest	0.9x	0.77	x	1.55	x	97.38	x	0.63	x	0.7	=	46.13	(81)
Northwest	0.9x	0.77	x	1.55	x	91.1	x	0.63	x	0.7	=	43.15	(81)
Northwest	0.9x	0.77	x	1.55	x	72.63	x	0.63	x	0.7	=	34.4	(81)
Northwest	0.9x	0.77	x	1.55	x	50.42	x	0.63	x	0.7	=	23.88	(81)
Northwest	0.9x	0.77	x	1.55	x	28.07	x	0.63	x	0.7	=	13.3	(81)
Northwest	0.9x	0.77	x	1.55	x	14.2	x	0.63	x	0.7	=	6.73	(81)
Northwest	0.9x	0.77	x	1.55	x	9.21	x	0.63	x	0.7	=	4.36	(81)
Rooflights	0.9x	1	x	0.82	x	40.5	x	0.63	x	0.8	=	45.19	(82)
Rooflights	0.9x	1	x	0.82	x	15.92	x	0.63	x	0.8	=	11.84	(82)
Rooflights	0.9x	1	x	0.36	x	26	x	0.63	x	0.8	=	8.49	(82)

Rooflights 0.9x	1	x	0.82	x	73.74	x	0.63	x	0.8	=	82.29	(82)
Rooflights 0.9x	1	x	0.82	x	32.51	x	0.63	x	0.8	=	24.18	(82)
Rooflights 0.9x	1	x	0.36	x	54	x	0.63	x	0.8	=	17.64	(82)
Rooflights 0.9x	1	x	0.82	x	111.06	x	0.63	x	0.8	=	123.92	(82)
Rooflights 0.9x	1	x	0.82	x	59.5	x	0.63	x	0.8	=	44.26	(82)
Rooflights 0.9x	1	x	0.36	x	96	x	0.63	x	0.8	=	31.35	(82)
Rooflights 0.9x	1	x	0.82	x	150.59	x	0.63	x	0.8	=	168.04	(82)
Rooflights 0.9x	1	x	0.82	x	100.03	x	0.63	x	0.8	=	74.42	(82)
Rooflights 0.9x	1	x	0.36	x	150	x	0.63	x	0.8	=	48.99	(82)
Rooflights 0.9x	1	x	0.82	x	177.61	x	0.63	x	0.8	=	198.18	(82)
Rooflights 0.9x	1	x	0.82	x	136.88	x	0.63	x	0.8	=	101.82	(82)
Rooflights 0.9x	1	x	0.36	x	192	x	0.63	x	0.8	=	62.71	(82)
Rooflights 0.9x	1	x	0.82	x	179.47	x	0.63	x	0.8	=	200.26	(82)
Rooflights 0.9x	1	x	0.82	x	147.03	x	0.63	x	0.8	=	109.38	(82)
Rooflights 0.9x	1	x	0.36	x	200	x	0.63	x	0.8	=	65.32	(82)
Rooflights 0.9x	1	x	0.82	x	171.77	x	0.63	x	0.8	=	191.68	(82)
Rooflights 0.9x	1	x	0.82	x	137.1	x	0.63	x	0.8	=	101.99	(82)
Rooflights 0.9x	1	x	0.36	x	189	x	0.63	x	0.8	=	61.73	(82)
Rooflights 0.9x	1	x	0.82	x	151.65	x	0.63	x	0.8	=	169.23	(82)
Rooflights 0.9x	1	x	0.82	x	107.76	x	0.63	x	0.8	=	80.17	(82)
Rooflights 0.9x	1	x	0.36	x	157	x	0.63	x	0.8	=	51.27	(82)
Rooflights 0.9x	1	x	0.82	x	125.02	x	0.63	x	0.8	=	139.51	(82)
Rooflights 0.9x	1	x	0.82	x	73.17	x	0.63	x	0.8	=	54.43	(82)
Rooflights 0.9x	1	x	0.36	x	115	x	0.63	x	0.8	=	37.56	(82)
Rooflights 0.9x	1	x	0.82	x	84.48	x	0.63	x	0.8	=	94.27	(82)
Rooflights 0.9x	1	x	0.82	x	39.91	x	0.63	x	0.8	=	29.69	(82)
Rooflights 0.9x	1	x	0.36	x	66	x	0.63	x	0.8	=	21.56	(82)
Rooflights 0.9x	1	x	0.82	x	49.44	x	0.63	x	0.8	=	55.17	(82)
Rooflights 0.9x	1	x	0.82	x	20.03	x	0.63	x	0.8	=	14.9	(82)
Rooflights 0.9x	1	x	0.36	x	33	x	0.63	x	0.8	=	10.78	(82)
Rooflights 0.9x	1	x	0.82	x	34.03	x	0.63	x	0.8	=	37.97	(82)
Rooflights 0.9x	1	x	0.82	x	13.01	x	0.63	x	0.8	=	9.67	(82)
Rooflights 0.9x	1	x	0.36	x	21	x	0.63	x	0.8	=	6.86	(82)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	130.24	236.12	357.51	495.08	598.02	611.74	582.35	503.52	405.21	270.58	158.68	109.68	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	482.79	585.55	693.5	810.26	892.47	886.29	844.54	772.59	685.49	571.88	483.76	452.37	(84)

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	0.85	0.7	0.55	0.61	0.84	0.96	0.99	1	(86)

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

(87)m=	19.09	19.31	19.69	20.19	20.61	20.87	20.96	20.94	20.73	20.18	19.56	19.08	(87)

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

(88)m=	19.48	19.48	19.49	19.52	19.53	19.55	19.55	19.56	19.54	19.53	19.51	19.5	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.99	0.97	0.91	0.79	0.58	0.39	0.44	0.75	0.95	0.99	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	17.79	18.02	18.39	18.9	19.28	19.5	19.54	19.54	19.41	18.91	18.29	17.8	(90)

fLA = Living area ÷ (4) = 0.38 (91)

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

(92)m=	18.28	18.51	18.88	19.39	19.78	20.02	20.08	20.07	19.91	19.39	18.77	18.28	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	18.28	18.51	18.88	19.39	19.78	20.02	20.08	20.07	19.91	19.39	18.77	18.28	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.98	0.96	0.91	0.8	0.62	0.45	0.51	0.77	0.94	0.99	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	478.81	575.9	668.35	738.4	716.46	553.8	379.83	392.95	529.91	539.35	476.59	449.41	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1675.79	1622.53	1468.52	1213.28	930.29	610.31	391.95	411.96	659.67	1011.85	1356.59	1653.2	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	890.55	703.34	595.33	341.92	159.09	0	0	0	0	351.54	633.6	895.61	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4570.97 (98)

Space heating requirement in kWh/m²/year 68.33 (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		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
Space heating requirement (calculated above)													
	890.55	703.34	595.33	341.92	159.09	0	0	0	0	351.54	633.6	895.61	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	986.22	778.89	659.28	378.64	176.18	0	0	0	0	389.3	701.66	991.82	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 5061.98 (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)

197.73	172.73	179.71	159.39	154.32	135.92	130.22	145.16	146.77	167.12	178.4	193.09

Efficiency of water heater 81 (216)

(217)m=	88.45	88.3	87.96	87.12	85.47	81	81	81	81	87.08	88.08	88.5

(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	223.54	195.61	204.31	182.96	180.56	167.8	160.76	179.21	181.19	191.92	202.55	218.19

Total = Sum(219a)$_{1...12}$ = 2288.61 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			5061.98	
Water heating fuel used			2288.61	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		30	(231)
Electricity for lighting			376.23	(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	=	1093.39	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	494.34	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1587.73	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	195.26	(268)
Total CO2, kg/year		sum of (265)…(271) =		1798.56	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		26.88	(273)
EI rating (section 14)				78	(274)

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

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 1-Lean

Address : Flat 1, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	92.28	(1a)	x	4.18	(2a)	=	385.73	(3a)
First floor	40.18	(1b)	x	2.5	(2b)	=	100.45	(3b)
Second floor	106.16	(1c)	x	2.63	(2c)	=	279.2	(3c)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	238.62	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	765.38	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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							5	x 10 =	50	(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) =	50	÷ (5) =	0.07	(8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)				
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)
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				
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			10	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.57	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used				
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) =	0.48	(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

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

0.61	0.6	0.59	0.53	0.52	0.46	0.46	0.44	0.48	0.52	0.54	0.56

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	(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	(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=	0.69	0.68	0.67	0.64	0.63	0.6	0.6	0.6	0.62	0.63	0.65	0.66	(24d)

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

(25)m=	0.69	0.68	0.67	0.64	0.63	0.6	0.6	0.6	0.62	0.63	0.65	0.66	(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			4.26	x 1.3	= 5.538			(26)
Windows Type 1			3.44	x1/[1/(1.6)+ 0.04]	= 5.17			(27)
Windows Type 2			1.56	x1/[1/(1.6)+ 0.04]	= 2.35			(27)
Windows Type 3			0.67	x1/[1/(1.6)+ 0.04]	= 1.01			(27)
Windows Type 4			0.7	x1/[1/(1.6)+ 0.04]	= 1.05			(27)
Windows Type 5			0.72	x1/[1/(1.6)+ 0.04]	= 1.08			(27)
Windows Type 6			0.52	x1/[1/(1.6)+ 0.04]	= 0.78			(27)
Windows Type 7			0.72	x1/[1/(1.6)+ 0.04]	= 1.08			(27)
Windows Type 8			1.3	x1/[1/(1.6)+ 0.04]	= 1.95			(27)
Windows Type 9			1	x1/[1/(1.3)+ 0.04]	= 1.24			(27)
Windows Type 10			8.58	x1/[1/(1.3)+ 0.04]	= 10.6			(27)
Rooflights Type 1			0.47	x1/[1/(1.6) + 0.04]	= 0.752			(27b)
Rooflights Type 2			0.63	x1/[1/(1.6) + 0.04]	= 1.008			(27b)
Rooflights Type 3			0.84	x1/[1/(1.6) + 0.04]	= 1.344			(27b)
Rooflights Type 4			0.62	x1/[1/(1.6) + 0.04]	= 0.992			(27b)
Rooflights Type 5			2.36	x1/[1/(1.6) + 0.04]	= 3.776			(27b)
Rooflights Type 6			2.15	x1/[1/(1.6) + 0.04]	= 3.44			(27b)

DER WorkSheet: New dwelling design stage

Rooflights Type 7			3.27	x1/[1/(1.6) + 0.04] =		5.232			(27b)
Rooflights Type 8			0.89	x1/[1/(1.6) + 0.04] =		1.424			(27b)
Rooflights Type 9			1.29	x1/[1/(1.6) + 0.04] =		2.064			(27b)
Rooflights Type 10			2.37	x1/[1/(1.6) + 0.04] =		3.792			(27b)
Floor Type 1			191.44	x	0.55	= 105.292			(28)
Floor Type 2			10.26	x	0.55	= 5.643			(28)
Walls Type1	145.59	0	145.59	x	0.55	= 80.07			(29)
Walls Type2	147.31	12.75	134.56	x	0.55	= 74.01			(29)
Walls Type3	42.7	14.84	27.86	x	0.14	= 3.9			(29)
Roof Type1	88.47	17.67	70.8	x	0.18	= 12.74			(30)
Roof Type2	28.75	0	28.75	x	0.14	= 4.03			(30)
Total area of elements, m²			654.52						(31)
Party wall			53.98	x	0	= 0			(32)
Party ceiling			84.47						(32b)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 350.04 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 35022.54 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K 98.18 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 448.22 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	173.69	171.85	170.05	161.57	159.99	152.61	152.61	151.24	155.45	159.99	163.19	166.55	(38)

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

(39)m=	621.91	620.07	618.27	609.79	608.21	600.83	600.83	599.46	603.67	608.21	611.42	614.77	

Average = Sum(39)1…12 /12= 609.79 (39)

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

(40)m=	2.61	2.6	2.59	2.56	2.55	2.52	2.52	2.51	2.53	2.55	2.56	2.58

Average = Sum(40)1…12 /12= 2.56 (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 3.05 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 106.69 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m=	117.36	113.09	108.82	104.55	100.29	96.02	96.02	100.29	104.55	108.82	113.09	117.36

Total = Sum(44)1…12 = 1280.26 (44)

DER WorkSheet: New dwelling design stage

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	174.04	152.21	157.07	136.94	131.4	113.38	105.07	120.57	122.01	142.19	155.21	168.55	

Total = Sum(45)1…12 = 1678.62 (45)

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

(46)m=	26.11	22.83	23.56	20.54	19.71	17.01	15.76	18.08	18.3	21.33	23.28	25.28	(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)

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	50.96	46.03	50.96	49.32	50.96	47.35	48.93	50.96	49.32	50.96	49.32	50.96	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	225	198.24	208.03	186.25	182.35	160.74	154	171.53	171.32	193.15	204.52	219.5	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	225	198.24	208.03	186.25	182.35	160.74	154	171.53	171.32	193.15	204.52	219.5

Output from water heater (annual)1…12 2274.63 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	70.61	62.12	64.97	57.86	56.43	49.54	47.17	52.83	52.9	60.02	63.94	68.78	(65)

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=	152.61	152.61	152.61	152.61	152.61	152.61	152.61	152.61	152.61	152.61	152.61	152.61	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	36.49	32.41	26.36	19.96	14.92	12.59	13.61	17.69	23.74	30.14	35.18	37.51	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	406.41	410.63	400	377.38	348.82	321.98	304.05	299.83	310.46	333.08	361.64	388.48	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	38.26	38.26	38.26	38.26	38.26	38.26	38.26	38.26	38.26	38.26	38.26	38.26	(69)
Pumps and fans gains (Table 5a)													
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	-122.09	(71)
Water heating gains (Table 5)													
(72)m=	94.9	92.44	87.32	80.36	75.85	68.8	63.4	71.01	73.47	80.67	88.8	92.45	(72)
Total internal gains =						(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m							
(73)m=	609.59	607.26	585.47	549.48	511.36	475.16	452.83	460.3	479.45	515.67	557.4	590.22	(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 m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast 0.9x	0.77	x	0.72	x	11.28	x	0.63	x	0.7	=	2.48	(75)
Northeast 0.9x	0.77	x	1	x	11.28	x	0.5	x	0.7	=	5.47	(75)
Northeast 0.9x	0.77	x	8.58	x	11.28	x	0.5	x	0.7	=	23.48	(75)
Northeast 0.9x	0.77	x	0.72	x	22.97	x	0.63	x	0.7	=	5.05	(75)
Northeast 0.9x	0.77	x	1	x	22.97	x	0.5	x	0.7	=	11.14	(75)
Northeast 0.9x	0.77	x	8.58	x	22.97	x	0.5	x	0.7	=	47.8	(75)
Northeast 0.9x	0.77	x	0.72	x	41.38	x	0.63	x	0.7	=	9.11	(75)
Northeast 0.9x	0.77	x	1	x	41.38	x	0.5	x	0.7	=	20.07	(75)
Northeast 0.9x	0.77	x	8.58	x	41.38	x	0.5	x	0.7	=	86.11	(75)
Northeast 0.9x	0.77	x	0.72	x	67.96	x	0.63	x	0.7	=	14.95	(75)
Northeast 0.9x	0.77	x	1	x	67.96	x	0.5	x	0.7	=	32.97	(75)
Northeast 0.9x	0.77	x	8.58	x	67.96	x	0.5	x	0.7	=	141.42	(75)
Northeast 0.9x	0.77	x	0.72	x	91.35	x	0.63	x	0.7	=	20.1	(75)
Northeast 0.9x	0.77	x	1	x	91.35	x	0.5	x	0.7	=	44.31	(75)
Northeast 0.9x	0.77	x	8.58	x	91.35	x	0.5	x	0.7	=	190.1	(75)
Northeast 0.9x	0.77	x	0.72	x	97.38	x	0.63	x	0.7	=	21.43	(75)
Northeast 0.9x	0.77	x	1	x	97.38	x	0.5	x	0.7	=	47.24	(75)
Northeast 0.9x	0.77	x	8.58	x	97.38	x	0.5	x	0.7	=	202.66	(75)
Northeast 0.9x	0.77	x	0.72	x	91.1	x	0.63	x	0.7	=	20.05	(75)
Northeast 0.9x	0.77	x	1	x	91.1	x	0.5	x	0.7	=	44.19	(75)
Northeast 0.9x	0.77	x	8.58	x	91.1	x	0.5	x	0.7	=	189.59	(75)

DER WorkSheet: New dwelling design stage

Northeast 0.9x	0.77	x	0.72	x	72.63	x	0.63	x	0.7	=	15.98	(75)
Northeast 0.9x	0.77	x	1	x	72.63	x	0.5	x	0.7	=	35.23	(75)
Northeast 0.9x	0.77	x	8.58	x	72.63	x	0.5	x	0.7	=	151.14	(75)
Northeast 0.9x	0.77	x	0.72	x	50.42	x	0.63	x	0.7	=	11.09	(75)
Northeast 0.9x	0.77	x	1	x	50.42	x	0.5	x	0.7	=	24.46	(75)
Northeast 0.9x	0.77	x	8.58	x	50.42	x	0.5	x	0.7	=	104.93	(75)
Northeast 0.9x	0.77	x	0.72	x	28.07	x	0.63	x	0.7	=	6.18	(75)
Northeast 0.9x	0.77	x	1	x	28.07	x	0.5	x	0.7	=	13.62	(75)
Northeast 0.9x	0.77	x	8.58	x	28.07	x	0.5	x	0.7	=	58.41	(75)
Northeast 0.9x	0.77	x	0.72	x	14.2	x	0.63	x	0.7	=	3.12	(75)
Northeast 0.9x	0.77	x	1	x	14.2	x	0.5	x	0.7	=	6.89	(75)
Northeast 0.9x	0.77	x	8.58	x	14.2	x	0.5	x	0.7	=	29.54	(75)
Northeast 0.9x	0.77	x	0.72	x	9.21	x	0.63	x	0.7	=	2.03	(75)
Northeast 0.9x	0.77	x	1	x	9.21	x	0.5	x	0.7	=	4.47	(75)
Northeast 0.9x	0.77	x	8.58	x	9.21	x	0.5	x	0.7	=	19.18	(75)
Southeast 0.9x	0.77	x	0.7	x	36.79	x	0.63	x	0.7	=	7.87	(77)
Southeast 0.9x	0.77	x	0.52	x	36.79	x	0.63	x	0.7	=	11.69	(77)
Southeast 0.9x	0.77	x	1.3	x	36.79	x	0.63	x	0.7	=	43.85	(77)
Southeast 0.9x	0.77	x	0.7	x	62.67	x	0.63	x	0.7	=	13.41	(77)
Southeast 0.9x	0.77	x	0.52	x	62.67	x	0.63	x	0.7	=	19.92	(77)
Southeast 0.9x	0.77	x	1.3	x	62.67	x	0.63	x	0.7	=	74.7	(77)
Southeast 0.9x	0.77	x	0.7	x	85.75	x	0.63	x	0.7	=	18.34	(77)
Southeast 0.9x	0.77	x	0.52	x	85.75	x	0.63	x	0.7	=	27.26	(77)
Southeast 0.9x	0.77	x	1.3	x	85.75	x	0.63	x	0.7	=	102.21	(77)
Southeast 0.9x	0.77	x	0.7	x	106.25	x	0.63	x	0.7	=	22.73	(77)
Southeast 0.9x	0.77	x	0.52	x	106.25	x	0.63	x	0.7	=	33.77	(77)
Southeast 0.9x	0.77	x	1.3	x	106.25	x	0.63	x	0.7	=	126.64	(77)
Southeast 0.9x	0.77	x	0.7	x	119.01	x	0.63	x	0.7	=	25.46	(77)
Southeast 0.9x	0.77	x	0.52	x	119.01	x	0.63	x	0.7	=	37.83	(77)
Southeast 0.9x	0.77	x	1.3	x	119.01	x	0.63	x	0.7	=	141.85	(77)
Southeast 0.9x	0.77	x	0.7	x	118.15	x	0.63	x	0.7	=	25.28	(77)
Southeast 0.9x	0.77	x	0.52	x	118.15	x	0.63	x	0.7	=	37.55	(77)
Southeast 0.9x	0.77	x	1.3	x	118.15	x	0.63	x	0.7	=	140.82	(77)
Southeast 0.9x	0.77	x	0.7	x	113.91	x	0.63	x	0.7	=	24.37	(77)
Southeast 0.9x	0.77	x	0.52	x	113.91	x	0.63	x	0.7	=	36.2	(77)
Southeast 0.9x	0.77	x	1.3	x	113.91	x	0.63	x	0.7	=	135.77	(77)
Southeast 0.9x	0.77	x	0.7	x	104.39	x	0.63	x	0.7	=	22.33	(77)
Southeast 0.9x	0.77	x	0.52	x	104.39	x	0.63	x	0.7	=	33.18	(77)
Southeast 0.9x	0.77	x	1.3	x	104.39	x	0.63	x	0.7	=	124.42	(77)
Southeast 0.9x	0.77	x	0.7	x	92.85	x	0.63	x	0.7	=	19.86	(77)
Southeast 0.9x	0.77	x	0.52	x	92.85	x	0.63	x	0.7	=	29.51	(77)

DER WorkSheet: New dwelling design stage

Southeast	0.9x	0.77	x	1.3	x	92.85	x	0.63	x	0.7	=	110.67	(77)
Southeast	0.9x	0.77	x	0.7	x	69.27	x	0.63	x	0.7	=	14.82	(77)
Southeast	0.9x	0.77	x	0.52	x	69.27	x	0.63	x	0.7	=	22.02	(77)
Southeast	0.9x	0.77	x	1.3	x	69.27	x	0.63	x	0.7	=	82.56	(77)
Southeast	0.9x	0.77	x	0.7	x	44.07	x	0.63	x	0.7	=	9.43	(77)
Southeast	0.9x	0.77	x	0.52	x	44.07	x	0.63	x	0.7	=	14.01	(77)
Southeast	0.9x	0.77	x	1.3	x	44.07	x	0.63	x	0.7	=	52.53	(77)
Southeast	0.9x	0.77	x	0.7	x	31.49	x	0.63	x	0.7	=	6.74	(77)
Southeast	0.9x	0.77	x	0.52	x	31.49	x	0.63	x	0.7	=	10.01	(77)
Southeast	0.9x	0.77	x	1.3	x	31.49	x	0.63	x	0.7	=	37.53	(77)
Southwest	0.9x	0.77	x	3.44	x	36.79		0.63	x	0.7	=	38.68	(79)
Southwest	0.9x	0.77	x	1.56	x	36.79		0.63	x	0.7	=	17.54	(79)
Southwest	0.9x	0.77	x	0.67	x	36.79		0.63	x	0.7	=	7.53	(79)
Southwest	0.9x	0.77	x	0.72	x	36.79		0.63	x	0.7	=	8.1	(79)
Southwest	0.9x	0.77	x	3.44	x	62.67		0.63	x	0.7	=	65.89	(79)
Southwest	0.9x	0.77	x	1.56	x	62.67		0.63	x	0.7	=	29.88	(79)
Southwest	0.9x	0.77	x	0.67	x	62.67		0.63	x	0.7	=	12.83	(79)
Southwest	0.9x	0.77	x	0.72	x	62.67		0.63	x	0.7	=	13.79	(79)
Southwest	0.9x	0.77	x	3.44	x	85.75		0.63	x	0.7	=	90.15	(79)
Southwest	0.9x	0.77	x	1.56	x	85.75		0.63	x	0.7	=	40.88	(79)
Southwest	0.9x	0.77	x	0.67	x	85.75		0.63	x	0.7	=	17.56	(79)
Southwest	0.9x	0.77	x	0.72	x	85.75		0.63	x	0.7	=	18.87	(79)
Southwest	0.9x	0.77	x	3.44	x	106.25		0.63	x	0.7	=	111.7	(79)
Southwest	0.9x	0.77	x	1.56	x	106.25		0.63	x	0.7	=	50.66	(79)
Southwest	0.9x	0.77	x	0.67	x	106.25		0.63	x	0.7	=	21.76	(79)
Southwest	0.9x	0.77	x	0.72	x	106.25		0.63	x	0.7	=	23.38	(79)
Southwest	0.9x	0.77	x	3.44	x	119.01		0.63	x	0.7	=	125.12	(79)
Southwest	0.9x	0.77	x	1.56	x	119.01		0.63	x	0.7	=	56.74	(79)
Southwest	0.9x	0.77	x	0.67	x	119.01		0.63	x	0.7	=	24.37	(79)
Southwest	0.9x	0.77	x	0.72	x	119.01		0.63	x	0.7	=	26.19	(79)
Southwest	0.9x	0.77	x	3.44	x	118.15		0.63	x	0.7	=	124.21	(79)
Southwest	0.9x	0.77	x	1.56	x	118.15		0.63	x	0.7	=	56.33	(79)
Southwest	0.9x	0.77	x	0.67	x	118.15		0.63	x	0.7	=	24.19	(79)
Southwest	0.9x	0.77	x	0.72	x	118.15		0.63	x	0.7	=	26	(79)
Southwest	0.9x	0.77	x	3.44	x	113.91		0.63	x	0.7	=	119.75	(79)
Southwest	0.9x	0.77	x	1.56	x	113.91		0.63	x	0.7	=	54.31	(79)
Southwest	0.9x	0.77	x	0.67	x	113.91		0.63	x	0.7	=	23.32	(79)
Southwest	0.9x	0.77	x	0.72	x	113.91		0.63	x	0.7	=	25.06	(79)
Southwest	0.9x	0.77	x	3.44	x	104.39		0.63	x	0.7	=	109.75	(79)
Southwest	0.9x	0.77	x	1.56	x	104.39		0.63	x	0.7	=	49.77	(79)
Southwest	0.9x	0.77	x	0.67	x	104.39		0.63	x	0.7	=	21.38	(79)

DER WorkSheet: New dwelling design stage

Southwest 0.9x	0.77	x	0.72	x	104.39		0.63	x	0.7	=	22.97	(79)
Southwest 0.9x	0.77	x	3.44	x	92.85		0.63	x	0.7	=	97.62	(79)
Southwest 0.9x	0.77	x	1.56	x	92.85		0.63	x	0.7	=	44.27	(79)
Southwest 0.9x	0.77	x	0.67	x	92.85		0.63	x	0.7	=	19.01	(79)
Southwest 0.9x	0.77	x	0.72	x	92.85		0.63	x	0.7	=	20.43	(79)
Southwest 0.9x	0.77	x	3.44	x	69.27		0.63	x	0.7	=	72.82	(79)
Southwest 0.9x	0.77	x	1.56	x	69.27		0.63	x	0.7	=	33.02	(79)
Southwest 0.9x	0.77	x	0.67	x	69.27		0.63	x	0.7	=	14.18	(79)
Southwest 0.9x	0.77	x	0.72	x	69.27		0.63	x	0.7	=	15.24	(79)
Southwest 0.9x	0.77	x	3.44	x	44.07		0.63	x	0.7	=	46.33	(79)
Southwest 0.9x	0.77	x	1.56	x	44.07		0.63	x	0.7	=	21.01	(79)
Southwest 0.9x	0.77	x	0.67	x	44.07		0.63	x	0.7	=	9.02	(79)
Southwest 0.9x	0.77	x	0.72	x	44.07		0.63	x	0.7	=	9.7	(79)
Southwest 0.9x	0.77	x	3.44	x	31.49		0.63	x	0.7	=	33.1	(79)
Southwest 0.9x	0.77	x	1.56	x	31.49		0.63	x	0.7	=	15.01	(79)
Southwest 0.9x	0.77	x	0.67	x	31.49		0.63	x	0.7	=	6.45	(79)
Southwest 0.9x	0.77	x	0.72	x	31.49		0.63	x	0.7	=	6.93	(79)
Rooflights 0.9x	1	x	0.47	x	26	x	0.63	x	0.8	=	11.09	(82)
Rooflights 0.9x	1	x	0.63	x	26	x	0.63	x	0.8	=	14.86	(82)
Rooflights 0.9x	1	x	0.84	x	26	x	0.63	x	0.8	=	29.72	(82)
Rooflights 0.9x	1	x	0.62	x	26	x	0.63	x	0.8	=	7.31	(82)
Rooflights 0.9x	1	x	2.36	x	26	x	0.63	x	0.8	=	27.83	(82)
Rooflights 0.9x	1	x	2.15	x	26	x	0.63	x	0.8	=	25.36	(82)
Rooflights 0.9x	1	x	3.27	x	26	x	0.63	x	0.8	=	38.57	(82)
Rooflights 0.9x	1	x	0.89	x	26	x	0.63	x	0.8	=	10.5	(82)
Rooflights 0.9x	1	x	1.29	x	26	x	0.63	x	0.8	=	15.21	(82)
Rooflights 0.9x	1	x	2.37	x	26	x	0.63	x	0.8	=	27.95	(82)
Rooflights 0.9x	1	x	0.47	x	54	x	0.63	x	0.8	=	23.02	(82)
Rooflights 0.9x	1	x	0.63	x	54	x	0.63	x	0.8	=	30.86	(82)
Rooflights 0.9x	1	x	0.84	x	54	x	0.63	x	0.8	=	61.73	(82)
Rooflights 0.9x	1	x	0.62	x	54	x	0.63	x	0.8	=	15.19	(82)
Rooflights 0.9x	1	x	2.36	x	54	x	0.63	x	0.8	=	57.81	(82)
Rooflights 0.9x	1	x	2.15	x	54	x	0.63	x	0.8	=	52.66	(82)
Rooflights 0.9x	1	x	3.27	x	54	x	0.63	x	0.8	=	80.1	(82)
Rooflights 0.9x	1	x	0.89	x	54	x	0.63	x	0.8	=	21.8	(82)
Rooflights 0.9x	1	x	1.29	x	54	x	0.63	x	0.8	=	31.6	(82)
Rooflights 0.9x	1	x	2.37	x	54	x	0.63	x	0.8	=	58.05	(82)
Rooflights 0.9x	1	x	0.47	x	96	x	0.63	x	0.8	=	40.93	(82)
Rooflights 0.9x	1	x	0.63	x	96	x	0.63	x	0.8	=	54.87	(82)
Rooflights 0.9x	1	x	0.84	x	96	x	0.63	x	0.8	=	109.73	(82)
Rooflights 0.9x	1	x	0.62	x	96	x	0.63	x	0.8	=	27	(82)

Rooflights 0.9x	1	x	2.36	x	96	x	0.63	x	0.8	=	102.77	(82)
Rooflights 0.9x	1	x	2.15	x	96	x	0.63	x	0.8	=	93.62	(82)
Rooflights 0.9x	1	x	3.27	x	96	x	0.63	x	0.8	=	142.39	(82)
Rooflights 0.9x	1	x	0.89	x	96	x	0.63	x	0.8	=	38.76	(82)
Rooflights 0.9x	1	x	1.29	x	96	x	0.63	x	0.8	=	56.17	(82)
Rooflights 0.9x	1	x	2.37	x	96	x	0.63	x	0.8	=	103.2	(82)
Rooflights 0.9x	1	x	0.47	x	150	x	0.63	x	0.8	=	63.96	(82)
Rooflights 0.9x	1	x	0.63	x	150	x	0.63	x	0.8	=	85.73	(82)
Rooflights 0.9x	1	x	0.84	x	150	x	0.63	x	0.8	=	171.46	(82)
Rooflights 0.9x	1	x	0.62	x	150	x	0.63	x	0.8	=	42.18	(82)
Rooflights 0.9x	1	x	2.36	x	150	x	0.63	x	0.8	=	160.57	(82)
Rooflights 0.9x	1	x	2.15	x	150	x	0.63	x	0.8	=	146.29	(82)
Rooflights 0.9x	1	x	3.27	x	150	x	0.63	x	0.8	=	222.49	(82)
Rooflights 0.9x	1	x	0.89	x	150	x	0.63	x	0.8	=	60.56	(82)
Rooflights 0.9x	1	x	1.29	x	150	x	0.63	x	0.8	=	87.77	(82)
Rooflights 0.9x	1	x	2.37	x	150	x	0.63	x	0.8	=	161.25	(82)
Rooflights 0.9x	1	x	0.47	x	192	x	0.63	x	0.8	=	81.87	(82)
Rooflights 0.9x	1	x	0.63	x	192	x	0.63	x	0.8	=	109.73	(82)
Rooflights 0.9x	1	x	0.84	x	192	x	0.63	x	0.8	=	219.47	(82)
Rooflights 0.9x	1	x	0.62	x	192	x	0.63	x	0.8	=	54	(82)
Rooflights 0.9x	1	x	2.36	x	192	x	0.63	x	0.8	=	205.54	(82)
Rooflights 0.9x	1	x	2.15	x	192	x	0.63	x	0.8	=	187.25	(82)
Rooflights 0.9x	1	x	3.27	x	192	x	0.63	x	0.8	=	284.79	(82)
Rooflights 0.9x	1	x	0.89	x	192	x	0.63	x	0.8	=	77.51	(82)
Rooflights 0.9x	1	x	1.29	x	192	x	0.63	x	0.8	=	112.35	(82)
Rooflights 0.9x	1	x	2.37	x	192	x	0.63	x	0.8	=	206.41	(82)
Rooflights 0.9x	1	x	0.47	x	200	x	0.63	x	0.8	=	85.28	(82)
Rooflights 0.9x	1	x	0.63	x	200	x	0.63	x	0.8	=	114.31	(82)
Rooflights 0.9x	1	x	0.84	x	200	x	0.63	x	0.8	=	228.61	(82)
Rooflights 0.9x	1	x	0.62	x	200	x	0.63	x	0.8	=	56.25	(82)
Rooflights 0.9x	1	x	2.36	x	200	x	0.63	x	0.8	=	214.1	(82)
Rooflights 0.9x	1	x	2.15	x	200	x	0.63	x	0.8	=	195.05	(82)
Rooflights 0.9x	1	x	3.27	x	200	x	0.63	x	0.8	=	296.65	(82)
Rooflights 0.9x	1	x	0.89	x	200	x	0.63	x	0.8	=	80.74	(82)
Rooflights 0.9x	1	x	1.29	x	200	x	0.63	x	0.8	=	117.03	(82)
Rooflights 0.9x	1	x	2.37	x	200	x	0.63	x	0.8	=	215.01	(82)
Rooflights 0.9x	1	x	0.47	x	189	x	0.63	x	0.8	=	80.59	(82)
Rooflights 0.9x	1	x	0.63	x	189	x	0.63	x	0.8	=	108.02	(82)
Rooflights 0.9x	1	x	0.84	x	189	x	0.63	x	0.8	=	216.04	(82)
Rooflights 0.9x	1	x	0.62	x	189	x	0.63	x	0.8	=	53.15	(82)
Rooflights 0.9x	1	x	2.36	x	189	x	0.63	x	0.8	=	202.32	(82)

Rooflights 0.9x	1	x	2.15	x	189	x	0.63	x	0.8	=	184.32	(82)
Rooflights 0.9x	1	x	3.27	x	189	x	0.63	x	0.8	=	280.34	(82)
Rooflights 0.9x	1	x	0.89	x	189	x	0.63	x	0.8	=	76.3	(82)
Rooflights 0.9x	1	x	1.29	x	189	x	0.63	x	0.8	=	110.59	(82)
Rooflights 0.9x	1	x	2.37	x	189	x	0.63	x	0.8	=	203.18	(82)
Rooflights 0.9x	1	x	0.47	x	157	x	0.63	x	0.8	=	66.94	(82)
Rooflights 0.9x	1	x	0.63	x	157	x	0.63	x	0.8	=	89.73	(82)
Rooflights 0.9x	1	x	0.84	x	157	x	0.63	x	0.8	=	179.46	(82)
Rooflights 0.9x	1	x	0.62	x	157	x	0.63	x	0.8	=	44.15	(82)
Rooflights 0.9x	1	x	2.36	x	157	x	0.63	x	0.8	=	168.07	(82)
Rooflights 0.9x	1	x	2.15	x	157	x	0.63	x	0.8	=	153.11	(82)
Rooflights 0.9x	1	x	3.27	x	157	x	0.63	x	0.8	=	232.87	(82)
Rooflights 0.9x	1	x	0.89	x	157	x	0.63	x	0.8	=	63.38	(82)
Rooflights 0.9x	1	x	1.29	x	157	x	0.63	x	0.8	=	91.87	(82)
Rooflights 0.9x	1	x	2.37	x	157	x	0.63	x	0.8	=	168.78	(82)
Rooflights 0.9x	1	x	0.47	x	115	x	0.63	x	0.8	=	49.03	(82)
Rooflights 0.9x	1	x	0.63	x	115	x	0.63	x	0.8	=	65.73	(82)
Rooflights 0.9x	1	x	0.84	x	115	x	0.63	x	0.8	=	131.45	(82)
Rooflights 0.9x	1	x	0.62	x	115	x	0.63	x	0.8	=	32.34	(82)
Rooflights 0.9x	1	x	2.36	x	115	x	0.63	x	0.8	=	123.11	(82)
Rooflights 0.9x	1	x	2.15	x	115	x	0.63	x	0.8	=	112.15	(82)
Rooflights 0.9x	1	x	3.27	x	115	x	0.63	x	0.8	=	170.58	(82)
Rooflights 0.9x	1	x	0.89	x	115	x	0.63	x	0.8	=	46.43	(82)
Rooflights 0.9x	1	x	1.29	x	115	x	0.63	x	0.8	=	67.29	(82)
Rooflights 0.9x	1	x	2.37	x	115	x	0.63	x	0.8	=	123.63	(82)
Rooflights 0.9x	1	x	0.47	x	66	x	0.63	x	0.8	=	28.14	(82)
Rooflights 0.9x	1	x	0.63	x	66	x	0.63	x	0.8	=	37.72	(82)
Rooflights 0.9x	1	x	0.84	x	66	x	0.63	x	0.8	=	75.44	(82)
Rooflights 0.9x	1	x	0.62	x	66	x	0.63	x	0.8	=	18.56	(82)
Rooflights 0.9x	1	x	2.36	x	66	x	0.63	x	0.8	=	70.65	(82)
Rooflights 0.9x	1	x	2.15	x	66	x	0.63	x	0.8	=	64.37	(82)
Rooflights 0.9x	1	x	3.27	x	66	x	0.63	x	0.8	=	97.9	(82)
Rooflights 0.9x	1	x	0.89	x	66	x	0.63	x	0.8	=	26.64	(82)
Rooflights 0.9x	1	x	1.29	x	66	x	0.63	x	0.8	=	38.62	(82)
Rooflights 0.9x	1	x	2.37	x	66	x	0.63	x	0.8	=	70.95	(82)
Rooflights 0.9x	1	x	0.47	x	33	x	0.63	x	0.8	=	14.07	(82)
Rooflights 0.9x	1	x	0.63	x	33	x	0.63	x	0.8	=	18.86	(82)
Rooflights 0.9x	1	x	0.84	x	33	x	0.63	x	0.8	=	37.72	(82)
Rooflights 0.9x	1	x	0.62	x	33	x	0.63	x	0.8	=	9.28	(82)
Rooflights 0.9x	1	x	2.36	x	33	x	0.63	x	0.8	=	35.33	(82)
Rooflights 0.9x	1	x	2.15	x	33	x	0.63	x	0.8	=	32.18	(82)

DER WorkSheet: New dwelling design stage

Rooflights 0.9x	1	x	3.27	x	33	x	0.63	x	0.8	=	48.95	(82)
Rooflights 0.9x	1	x	0.89	x	33	x	0.63	x	0.8	=	13.32	(82)
Rooflights 0.9x	1	x	1.29	x	33	x	0.63	x	0.8	=	19.31	(82)
Rooflights 0.9x	1	x	2.37	x	33	x	0.63	x	0.8	=	35.48	(82)
Rooflights 0.9x	1	x	0.47	x	21	x	0.63	x	0.8	=	8.95	(82)
Rooflights 0.9x	1	x	0.63	x	21	x	0.63	x	0.8	=	12	(82)
Rooflights 0.9x	1	x	0.84	x	21	x	0.63	x	0.8	=	24	(82)
Rooflights 0.9x	1	x	0.62	x	21	x	0.63	x	0.8	=	5.91	(82)
Rooflights 0.9x	1	x	2.36	x	21	x	0.63	x	0.8	=	22.48	(82)
Rooflights 0.9x	1	x	2.15	x	21	x	0.63	x	0.8	=	20.48	(82)
Rooflights 0.9x	1	x	3.27	x	21	x	0.63	x	0.8	=	31.15	(82)
Rooflights 0.9x	1	x	0.89	x	21	x	0.63	x	0.8	=	8.48	(82)
Rooflights 0.9x	1	x	1.29	x	21	x	0.63	x	0.8	=	12.29	(82)
Rooflights 0.9x	1	x	2.37	x	21	x	0.63	x	0.8	=	22.58	(82)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	375.1	727.23	1200.01	1782.24	2230.96	2308.74	2187.47	1844.52	1403.59	861.86	466.08	309.76	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	984.69	1334.49	1785.48	2331.72	2742.32	2783.9	2640.31	2304.83	1883.04	1377.54	1023.49	899.97	(84)

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	1	0.99	0.97	0.93	0.84	0.74	0.8	0.94	0.99	1	1	(86)

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

(87)m=	18.08	18.31	18.76	19.4	20.02	20.53	20.78	20.71	20.25	19.44	18.66	18.05	(87)

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

(88)m=	18.96	18.96	18.97	18.99	18.99	19.01	19.01	19.01	19	18.99	18.98	18.98	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	1	0.99	0.96	0.88	0.72	0.5	0.59	0.88	0.98	1	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	16.43	16.66	17.11	17.76	18.36	18.81	18.97	18.95	18.59	17.82	17.03	16.42	(90)

fLA = Living area ÷ (4) = 0.15 (91)

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

(92)m=	16.67	16.9	17.35	18	18.6	19.06	19.23	19.2	18.83	18.05	17.27	16.66	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	16.67	16.9	17.35	18	18.6	19.06	19.23	19.2	18.83	18.05	17.27	16.66	(93)

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

Utilisation factor for gains, hm:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m=	1	0.99	0.98	0.95	0.87	0.73	0.53	0.61	0.87	0.98	0.99	1	(94)

DER WorkSheet: New dwelling design stage

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	981.84	1325.29	1752.53	2209.14	2385.55	2018.83	1410.06	1416.87	1635.72	1343.69	1018.07	897.98	(95)

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)

Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]

(97)m=	7693.04	7442.22	6711	5549.41	4198.92	2679.36	1582.49	1680.75	2857.58	4533.27	6216.55	7659.02	(97)

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

(98)m=	4993.13	4110.58	3689.1	2404.99	1349.14	0	0	0	0	2373.05	3742.9	5030.21

Total per year (kWh/year) = Sum(98)1...5,9...12 = 27693.11 (98)

Space heating requirement in kWh/m²/year 116.06 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	5647.77	4446.12	4555.9	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.5	0.58	0.52	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	2835.75	2571.46	2360.27	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	3126.14	2969.66	2623.62	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m
set (104)m to zero if (104)m < 3 × (98)m

(104)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total = Sum(104)6...8 = 0 (104)

Cooled fraction f C = cooled area ÷ (4) = 0.29 (105)

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

Total = Sum(104)6...8 = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

(107)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total = Sum(107)6...8 = 0 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 0 (108)

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)
Cooling System Energy Efficiency Ratio		4.32	(209)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)												
4993.13	4110.58	3689.1	2404.99	1349.14	0	0	0	0	2373.05	3742.9	5030.21	

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

5529.5	4552.14	4085.38	2663.34	1494.07	0	0	0	0	2627.96	4144.96	5570.55

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 30667.9 (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)

225	198.24	208.03	186.25	182.35	160.74	154	171.53	171.32	193.15	204.52	219.5

Efficiency of water heater 81 (216)

(217)m=	89.86	89.83	89.75	89.56	89.08	81	81	81	81	89.53	89.77	89.87

(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	250.4	220.7	231.79	207.96	204.7	198.44	190.12	211.76	211.51	215.74	227.84	244.25

Total = Sum(219a)$_{1...12}$ = 2615.21 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			30667.9	
Water heating fuel used			2615.21	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		30	(231)
Electricity for lighting			644.47	(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	=	6624.27	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	564.89	(264)
Space and water heating	(261) + (262) + (263) + (264) =				7189.15	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	15.57	(267)
Electricity for lighting	(232)	x	0.519	=	334.48	(268)
Total CO2, kg/year			sum of (265)…(271) =		7539.2	(272)
Dwelling CO2 Emission Rate			(272) ÷ (4) =		31.6	(273)
EI rating (section 14)					64	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 2-Lean

Address : Flat 2, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	98.7	(1a)	x	2.5	(2a)	=	246.75	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	98.7	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	246.75	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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) =	0.12	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)

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

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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.62	(18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

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) =	0.53	(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
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

0.67	0.66	0.65	0.58	0.57	0.5	0.5	0.49	0.53	0.57	0.59	0.62

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	(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	(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=	0.73	0.72	0.71	0.67	0.66	0.63	0.63	0.62	0.64	0.66	0.68	0.69	(24d)

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

(25)m=	0.73	0.72	0.71	0.67	0.66	0.63	0.63	0.62	0.64	0.66	0.68	0.69	(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			2.2	x	1.3	=	2.86			(26)
Windows Type 1			6.4	x1/[1/(1.3)+ 0.04]		=	7.91			(27)
Windows Type 2			1.2	x1/[1/(1.3)+ 0.04]		=	1.48			(27)
Windows Type 3			8.58	x1/[1/(1.3)+ 0.04]		=	10.6			(27)
Windows Type 4			1.39	x1/[1/(1.6)+ 0.04]		=	2.09			(27)
Floor			98.7	x	0.55	=	54.285			(28)
Walls Type1	22.19	5.56	16.63	x	0.55	=	9.15			(29)
Walls Type2	31.7	17.38	14.32	x	0.14	=	2			(29)
Walls Type3	12.82	2.2	10.62	x	0.55	=	5.84			(29)
Roof	33.18	0	33.18	x	0.14	=	4.65			(30)
Total area of elements, m²			198.59							(31)
Party wall			36.56	x	0	=	0			(32)
Party ceiling			65.52							(32b)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 108.62 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 18812.95 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K 29.79 (36)

DER WorkSheet: New dwelling design stage

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 138.41 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	59.19	58.47	57.77	54.47	53.85	50.97	50.97	50.44	52.08	53.85	55.1	56.4	(38)

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

(39)m=	197.6	196.88	196.18	192.87	192.26	189.38	189.38	188.85	190.49	192.26	193.51	194.81	

Average = Sum(39)1…12 /12= 192.87 (39)

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

(40)m=	2	1.99	1.99	1.95	1.95	1.92	1.92	1.91	1.93	1.95	1.96	1.97	

Average = Sum(40)1…12 /12= 1.95 (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 2.73 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 98.97 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	108.87	104.91	100.95	96.99	93.03	89.07	89.07	93.03	96.99	100.95	104.91	108.87	

Total = Sum(44)1…12 = 1187.64 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	161.45	141.2	145.71	127.03	121.89	105.18	97.47	111.84	113.18	131.9	143.98	156.35	

Total = Sum(45)1…12 = 1557.18 (45)

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

(46)m=	24.22	21.18	21.86	19.05	18.28	15.78	14.62	16.78	16.98	19.79	21.6	23.45	(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)

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)

DER WorkSheet: New dwelling design stage

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 | 0 | (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	50.96	46.03	50.96	47.83	47.41	43.93	45.39	47.41	47.83	50.96	49.32	50.96	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	212.41	187.23	196.67	174.86	169.3	149.11	142.86	159.25	161.01	182.86	193.29	207.31	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	212.41	187.23	196.67	174.86	169.3	149.11	142.86	159.25	161.01	182.86	193.29	207.31

Output from water heater (annual)$_{1...12}$ | 2136.16 | (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	66.42	58.46	61.19	54.2	52.38	45.95	43.76	49.04	49.59	56.6	60.2	64.73	(65)

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=	136.36	136.36	136.36	136.36	136.36	136.36	136.36	136.36	136.36	136.36	136.36	136.36	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	22.66	20.13	16.37	12.39	9.26	7.82	8.45	10.98	14.74	18.72	21.85	23.29	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	254.21	256.85	250.2	236.05	218.18	201.39	190.18	187.54	194.19	208.34	226.2	242.99	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	-109.09	(71)

Water heating gains (Table 5)

(72)m=	89.28	86.99	82.24	75.27	70.4	63.83	58.81	65.91	68.88	76.07	83.61	87	(72)

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

(73)m=	433.05	430.87	415.72	390.62	364.76	339.95	324.35	331.35	344.71	370.04	398.57	420.19	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast	0.9x	0.77	x	6.4	x	11.28	x	0.5	x	0.7	=	17.51	(75)
Northeast	0.9x	0.77	x	1.2	x	11.28	x	0.5	x	0.7	=	6.57	(75)
Northeast	0.9x	0.77	x	8.58	x	11.28	x	0.5	x	0.7	=	23.48	(75)
Northeast	0.9x	0.77	x	6.4	x	22.97	x	0.5	x	0.7	=	35.65	(75)
Northeast	0.9x	0.77	x	1.2	x	22.97	x	0.5	x	0.7	=	13.37	(75)
Northeast	0.9x	0.77	x	8.58	x	22.97	x	0.5	x	0.7	=	47.8	(75)
Northeast	0.9x	0.77	x	6.4	x	41.38	x	0.5	x	0.7	=	64.23	(75)
Northeast	0.9x	0.77	x	1.2	x	41.38	x	0.5	x	0.7	=	24.09	(75)
Northeast	0.9x	0.77	x	8.58	x	41.38	x	0.5	x	0.7	=	86.11	(75)
Northeast	0.9x	0.77	x	6.4	x	67.96	x	0.5	x	0.7	=	105.49	(75)
Northeast	0.9x	0.77	x	1.2	x	67.96	x	0.5	x	0.7	=	39.56	(75)
Northeast	0.9x	0.77	x	8.58	x	67.96	x	0.5	x	0.7	=	141.42	(75)
Northeast	0.9x	0.77	x	6.4	x	91.35	x	0.5	x	0.7	=	141.8	(75)
Northeast	0.9x	0.77	x	1.2	x	91.35	x	0.5	x	0.7	=	53.17	(75)
Northeast	0.9x	0.77	x	8.58	x	91.35	x	0.5	x	0.7	=	190.1	(75)
Northeast	0.9x	0.77	x	6.4	x	97.38	x	0.5	x	0.7	=	151.17	(75)
Northeast	0.9x	0.77	x	1.2	x	97.38	x	0.5	x	0.7	=	56.69	(75)
Northeast	0.9x	0.77	x	8.58	x	97.38	x	0.5	x	0.7	=	202.66	(75)
Northeast	0.9x	0.77	x	6.4	x	91.1	x	0.5	x	0.7	=	141.42	(75)
Northeast	0.9x	0.77	x	1.2	x	91.1	x	0.5	x	0.7	=	53.03	(75)
Northeast	0.9x	0.77	x	8.58	x	91.1	x	0.5	x	0.7	=	189.59	(75)
Northeast	0.9x	0.77	x	6.4	x	72.63	x	0.5	x	0.7	=	112.74	(75)
Northeast	0.9x	0.77	x	1.2	x	72.63	x	0.5	x	0.7	=	42.28	(75)
Northeast	0.9x	0.77	x	8.58	x	72.63	x	0.5	x	0.7	=	151.14	(75)
Northeast	0.9x	0.77	x	6.4	x	50.42	x	0.5	x	0.7	=	78.27	(75)
Northeast	0.9x	0.77	x	1.2	x	50.42	x	0.5	x	0.7	=	29.35	(75)
Northeast	0.9x	0.77	x	8.58	x	50.42	x	0.5	x	0.7	=	104.93	(75)
Northeast	0.9x	0.77	x	6.4	x	28.07	x	0.5	x	0.7	=	43.57	(75)
Northeast	0.9x	0.77	x	1.2	x	28.07	x	0.5	x	0.7	=	16.34	(75)
Northeast	0.9x	0.77	x	8.58	x	28.07	x	0.5	x	0.7	=	58.41	(75)
Northeast	0.9x	0.77	x	6.4	x	14.2	x	0.5	x	0.7	=	22.04	(75)
Northeast	0.9x	0.77	x	1.2	x	14.2	x	0.5	x	0.7	=	8.26	(75)
Northeast	0.9x	0.77	x	8.58	x	14.2	x	0.5	x	0.7	=	29.54	(75)
Northeast	0.9x	0.77	x	6.4	x	9.21	x	0.5	x	0.7	=	14.3	(75)
Northeast	0.9x	0.77	x	1.2	x	9.21	x	0.5	x	0.7	=	5.36	(75)
Northeast	0.9x	0.77	x	8.58	x	9.21	x	0.5	x	0.7	=	19.18	(75)
Northwest	0.9x	0.77	x	1.39	x	11.28	x	0.63	x	0.7	=	19.17	(81)
Northwest	0.9x	0.77	x	1.39	x	22.97	x	0.63	x	0.7	=	39.03	(81)
Northwest	0.9x	0.77	x	1.39	x	41.38	x	0.63	x	0.7	=	70.31	(81)

Northwest	0.9x	0.77	x	1.39	x	67.96	x	0.63	x	0.7	=	115.47	(81)
Northwest	0.9x	0.77	x	1.39	x	91.35	x	0.63	x	0.7	=	155.22	(81)
Northwest	0.9x	0.77	x	1.39	x	97.38	x	0.63	x	0.7	=	165.48	(81)
Northwest	0.9x	0.77	x	1.39	x	91.1	x	0.63	x	0.7	=	154.8	(81)
Northwest	0.9x	0.77	x	1.39	x	72.63	x	0.63	x	0.7	=	123.41	(81)
Northwest	0.9x	0.77	x	1.39	x	50.42	x	0.63	x	0.7	=	85.68	(81)
Northwest	0.9x	0.77	x	1.39	x	28.07	x	0.63	x	0.7	=	47.69	(81)
Northwest	0.9x	0.77	x	1.39	x	14.2	x	0.63	x	0.7	=	24.12	(81)
Northwest	0.9x	0.77	x	1.39	x	9.21	x	0.63	x	0.7	=	15.66	(81)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	66.74	135.84	244.74	401.94	540.29	576	538.84	429.57	298.22	166.01	83.97	54.5	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	499.79	566.71	660.46	792.56	905.05	915.95	863.19	760.92	642.94	536.05	482.54	474.69	(84)

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	1	0.99	0.98	0.95	0.87	0.76	0.82	0.95	0.99	1	1	(86)

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

(87)m=	18.69	18.85	19.19	19.71	20.23	20.65	20.85	20.8	20.42	19.78	19.17	18.68	(87)

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

(88)m=	19.33	19.34	19.34	19.36	19.37	19.39	19.39	19.39	19.38	19.37	19.36	19.35	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	1	0.99	0.97	0.92	0.77	0.56	0.65	0.91	0.99	1	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	17.3	17.46	17.8	18.33	18.83	19.22	19.35	19.33	19.03	18.41	17.79	17.3	(90)

fLA = Living area ÷ (4) = 0.32 (91)

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

(92)m=	17.75	17.91	18.25	18.77	19.28	19.68	19.84	19.8	19.48	18.85	18.24	17.75	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	17.75	17.91	18.25	18.77	19.28	19.68	19.84	19.8	19.48	18.85	18.24	17.75	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.99	0.97	0.91	0.79	0.63	0.7	0.91	0.98	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	498.19	563.76	653.09	767.89	826.68	725.49	541.91	536.17	586.46	526.86	480.09	473.44	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	2656.96	2560.95	2305.23	1904.46	1457.63	962.25	612.7	642.82	1024.03	1586.01	2154.77	2639.08	(97)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(98)m=	1606.13	1342.11	1229.2	818.33	469.42	0	0	0	0	788.01	1205.76	1611.24

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 9070.2 (98)

Space heating requirement in kWh/m²/year 91.9 (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		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
Space heating requirement (calculated above)	1606.13	1342.11	1229.2	818.33	469.42	0	0	0	0	788.01	1205.76	1611.24	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	1778.66	1486.28	1361.24	906.24	519.85	0	0	0	0	872.65	1335.29	1784.32	(211)

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 10044.51 (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)	212.41	187.23	196.67	174.86	169.3	149.11	142.86	159.25	161.01	182.86	193.29	207.31	
Efficiency of water heater												81	(216)
(217)m=	89.11	89.05	88.89	88.51	87.63	81	81	81	81	88.39	88.89	89.13	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	238.38	210.26	221.24	197.56	193.19	184.08	176.37	196.61	198.78	206.88	217.45	232.59

Total = Sum(219a)$_{1...12}$ = 2473.38 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			10044.51	
Water heating fuel used			2473.38	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		30	(231)
Electricity for lighting			400.23	(232)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh	**Emissions** kg CO2/year

DER WorkSheet: New dwelling design stage

Space heating (main system 1)	(211) x	0.216	=	2169.61	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	534.25	(264)
Space and water heating	(261) + (262) + (263) + (264) =			2703.87	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	207.72	(268)
Total CO2, kg/year		sum of (265)…(271) =		2927.16	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		29.66	(273)
EI rating (section 14)				73	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 3-Lean

Address : Flat 3, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	39.67	(1a)	x	3.1	(2a)	=	122.98	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	39.67	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			122.98	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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							2	x 10 =	20	(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) =	20	÷ (5) =	0.16	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)
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			
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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.66	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
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) =	0.56	(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
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

DER WorkSheet: New dwelling design stage

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

0.72	0.7	0.69	0.62	0.61	0.54	0.54	0.52	0.56	0.61	0.63	0.66

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	(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	(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=	0.76	0.75	0.74	0.69	0.68	0.64	0.64	0.64	0.66	0.68	0.7	0.72	(24d)

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

(25)m=	0.76	0.75	0.74	0.69	0.68	0.64	0.64	0.64	0.66	0.68	0.7	0.72	(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			2.2	x	1.3	=	2.86			(26)
Windows Type 1			0.71	x1/[1/(1.6)+ 0.04]		=	1.07			(27)
Windows Type 2			6.68	x1/[1/(1.6)+ 0.04]		=	10.05			(27)
Floor			39.67	x	0.55	=	21.8185			(28)
Walls Type1	46.29	7.39	38.9	x	0.55	=	21.4			(29)
Walls Type2	23.82	2.2	21.62	x	0.55	=	11.89			(29)
Total area of elements, m²			109.78							(31)
Party wall			27.35	x	0	=	0			(32)
Party ceiling			39.67							(32b)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 69.08 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 9422.38 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K 16.47 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 85.54 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	30.76	30.35	29.95	28.08	27.73	26.1	26.1	25.8	26.73	27.73	28.44	29.18	(38)

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

(39)m=	116.3	115.89	115.5	113.62	113.27	111.64	111.64	111.34	112.27	113.27	113.98	114.72	

Average = Sum(39)$_{1…12}$ /12= 113.62 (39)

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

(40)m=	2.93	2.92	2.91	2.86	2.86	2.81	2.81	2.81	2.83	2.86	2.87	2.89

Average = Sum(40)1…12 /12= 2.86 (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 1.4 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 67.39 (43)

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

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

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

(44)m=	74.13	71.44	68.74	66.04	63.35	60.65	60.65	63.35	66.04	68.74	71.44	74.13

Total = Sum(44)1…12 = 808.71 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	109.94	96.15	99.22	86.5	83	71.62	66.37	76.16	77.07	89.82	98.04	106.47

Total = Sum(45)1…12 = 1060.35 (45)

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

(46)m=	16.49	14.42	14.88	12.98	12.45	10.74	9.96	11.42	11.56	13.47	14.71	15.97	(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)

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

DER WorkSheet: New dwelling design stage

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	37.78	32.88	35.03	32.57	32.28	29.91	30.91	32.28	32.57	35.03	35.23	37.78	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	147.71	129.03	134.25	119.07	115.28	101.53	97.28	108.44	109.64	124.85	133.27	144.24	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	147.71	129.03	134.25	119.07	115.28	101.53	97.28	108.44	109.64	124.85	133.27	144.24

Output from water heater (annual)$_{1...12}$ 1464.6 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	46	40.19	41.75	36.9	35.67	31.29	29.79	33.39	33.77	38.62	41.41	44.84	(65)

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=	69.88	69.88	69.88	69.88	69.88	69.88	69.88	69.88	69.88	69.88	69.88	69.88	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	10.93	9.71	7.9	5.98	4.47	3.77	4.08	5.3	7.11	9.03	10.54	11.24	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	120.7	121.96	118.8	112.08	103.6	95.63	90.3	89.05	92.2	98.92	107.41	115.38	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	29.99	29.99	29.99	29.99	29.99	29.99	29.99	29.99	29.99	29.99	29.99	29.99	(69)
Pumps and fans gains (Table 5a)													
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	-55.9	(71)
Water heating gains (Table 5)													
(72)m=	61.83	59.81	56.11	51.26	47.94	43.46	40.05	44.88	46.9	51.91	57.51	60.27	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	240.43	238.44	229.77	216.28	202.97	189.83	181.39	186.2	193.18	206.83	222.42	233.85	(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 m²		Flux Table 6a	g_ Table 6b		FF Table 6c		Gains (W)	
Southwest 0.9x	0.77	x	6.68	x	36.79	0.63	x	0.7	=	75.11	(79)
Southwest 0.9x	0.77	x	6.68	x	62.67	0.63	x	0.7	=	127.95	(79)
Southwest 0.9x	0.77	x	6.68	x	85.75	0.63	x	0.7	=	175.06	(79)
Southwest 0.9x	0.77	x	6.68	x	106.25	0.63	x	0.7	=	216.91	(79)
Southwest 0.9x	0.77	x	6.68	x	119.01	0.63	x	0.7	=	242.96	(79)

Southwest 0.9x	0.77	x	6.68	x	118.15		0.63	x	0.7	=	241.2	(79)
Southwest 0.9x	0.77	x	6.68	x	113.91		0.63	x	0.7	=	232.55	(79)
Southwest 0.9x	0.77	x	6.68	x	104.39		0.63	x	0.7	=	213.11	(79)
Southwest 0.9x	0.77	x	6.68	x	92.85		0.63	x	0.7	=	189.56	(79)
Southwest 0.9x	0.77	x	6.68	x	69.27		0.63	x	0.7	=	141.41	(79)
Southwest 0.9x	0.77	x	6.68	x	44.07		0.63	x	0.7	=	89.97	(79)
Southwest 0.9x	0.77	x	6.68	x	31.49		0.63	x	0.7	=	64.28	(79)
Northwest 0.9x	0.77	x	0.71	x	11.28	x	0.63	x	0.7	=	2.45	(81)
Northwest 0.9x	0.77	x	0.71	x	22.97	x	0.63	x	0.7	=	4.98	(81)
Northwest 0.9x	0.77	x	0.71	x	41.38	x	0.63	x	0.7	=	8.98	(81)
Northwest 0.9x	0.77	x	0.71	x	67.96	x	0.63	x	0.7	=	14.75	(81)
Northwest 0.9x	0.77	x	0.71	x	91.35	x	0.63	x	0.7	=	19.82	(81)
Northwest 0.9x	0.77	x	0.71	x	97.38	x	0.63	x	0.7	=	21.13	(81)
Northwest 0.9x	0.77	x	0.71	x	91.1	x	0.63	x	0.7	=	19.77	(81)
Northwest 0.9x	0.77	x	0.71	x	72.63	x	0.63	x	0.7	=	15.76	(81)
Northwest 0.9x	0.77	x	0.71	x	50.42	x	0.63	x	0.7	=	10.94	(81)
Northwest 0.9x	0.77	x	0.71	x	28.07	x	0.63	x	0.7	=	6.09	(81)
Northwest 0.9x	0.77	x	0.71	x	14.2	x	0.63	x	0.7	=	3.08	(81)
Northwest 0.9x	0.77	x	0.71	x	9.21	x	0.63	x	0.7	=	2	(81)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	77.56	132.93	184.04	231.66	262.78	262.33	252.31	228.87	200.5	147.5	93.05	66.28	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	317.99	371.37	413.82	447.94	465.75	452.16	433.7	415.07	393.68	354.33	315.47	300.14	(84)

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=	0.99	0.99	0.98	0.96	0.93	0.87	0.77	0.8	0.91	0.97	0.99	0.99	(86)

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

(87)m=	18.09	18.32	18.72	19.3	19.88	20.41	20.71	20.67	20.24	19.49	18.71	18.07	(87)

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

(88)m=	18.78	18.79	18.79	18.82	18.82	18.85	18.85	18.85	18.84	18.82	18.81	18.81	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.98	0.97	0.94	0.88	0.74	0.51	0.56	0.82	0.95	0.98	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	16.34	16.56	16.97	17.55	18.11	18.59	18.79	18.78	18.46	17.75	16.97	16.33	(90)

fLA = Living area ÷ (4) = | 0.85 | (91)

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

(92)m=	17.83	18.05	18.46	19.03	19.61	20.14	20.42	20.38	19.98	19.23	18.44	17.81	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(93)m=	17.83	18.05	18.46	19.03	19.61	20.14	20.42	20.38	19.98	19.23	18.44	17.81		(93)

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		
Utilisation factor for gains, hm:														
(94)m=	0.99	0.98	0.97	0.95	0.9	0.83	0.72	0.75	0.88	0.95	0.98	0.99		(94)
Useful gains, hmGm , W = (94)m x (84)m														
(95)m=	313.87	364.02	400.87	424.01	421.39	374.12	312.22	311.18	345.6	338.12	309.44	296.8		(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]														
(97)m=	1573.21	1524.2	1381.32	1151.48	896.33	618.29	426.89	443.66	659.66	977.48	1293.04	1561.22		(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m														
(98)m=	936.95	779.64	729.45	523.78	353.35	0	0	0	0	475.69	708.19	940.73		
Total per year (kWh/year) = Sum(98)1...5,9...12 =													5447.77	(98)
Space heating requirement in kWh/m²/year													137.33	(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		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	
Space heating requirement (calculated above)														
	936.95	779.64	729.45	523.78	353.35	0	0	0	0	475.69	708.19	940.73		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	1037.59	863.39	807.81	580.05	391.31	0	0	0	0	526.78	784.26	1041.78		
Total (kWh/year) =Sum(211)1...5,10...12=													6032.97	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	147.71	129.03	134.25	119.07	115.28	101.53	97.28	108.44	109.64	124.85	133.27	144.24		
Efficiency of water heater													81	(216)
(217)m=	88.91	88.85	88.72	88.42	87.82	81	81	81	81	88.19	88.69	88.94		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	166.14	145.22	151.32	134.67	131.27	125.35	120.1	133.88	135.36	141.56	150.27	162.18		
Total = Sum(219a)1...12 =													1697.3	(219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		6032.97

DER WorkSheet: New dwelling design stage

Water heating fuel used			1697.3	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		30	(231)
Electricity for lighting			193.09	(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	=	1303.12	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	366.62	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1669.74	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	100.21	(268)
Total CO2, kg/year		sum of (265)…(271) =		1785.52	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		45.01	(273)
EI rating (section 14)				72	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 4-Lean

Address : Flat 4, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	61.01	(1a) x	2.5	(2a) =	152.52	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	61.01	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	152.52	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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) =	0.2	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)
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			
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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.7	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
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) =	0.59	(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
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

DER WorkSheet: New dwelling design stage

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

0.76	0.74	0.73	0.65	0.64	0.56	0.56	0.55	0.59	0.64	0.67	0.7

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	(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	(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=	0.79	0.77	0.76	0.71	0.7	0.66	0.66	0.65	0.68	0.7	0.72	0.74	(24d)

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

(25)m=	0.79	0.77	0.76	0.71	0.7	0.66	0.66	0.65	0.68	0.7	0.72	0.74	(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			2.2	x	1.3	=	2.86			(26)
Windows Type 1			1.69	x1/[1/(1.3)+ 0.04]		=	2.09			(27)
Windows Type 2			3.55	x1/[1/(1.3)+ 0.04]		=	4.39			(27)
Windows Type 3			1.39	x1/[1/(1.6)+ 0.04]		=	2.09			(27)
Walls Type1	20.15	5.56	14.59	x	0.55	=	8.02			(29)
Walls Type2	28.61	5.24	23.37	x	0.14	=	3.27			(29)
Walls Type3	15.55	2.2	13.35	x	0.55	=	7.34			(29)
Roof	8.86	0	8.86	x	0.14	=	1.24			(30)
Total area of elements, m²			73.17							(31)
Party wall			21.72	x	0	=	0			(32)
Party floor			61.01							(32a)
Party ceiling			52.15							(32b)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 37.58 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 11071.73 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K 10.98 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

DER WorkSheet: New dwelling design stage

Total fabric heat loss (33) + (36) = 48.55 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	39.51	38.96	38.41	35.85	35.37	33.13	33.13	32.72	33.99	35.37	36.34	37.35	(38)

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

(39)m=	88.06	87.51	86.96	84.4	83.92	81.68	81.68	81.27	82.54	83.92	84.89	85.9	

Average = $Sum(39)_{1…12}$ /12= 84.39 (39)

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

(40)m=	1.44	1.43	1.43	1.38	1.38	1.34	1.34	1.33	1.35	1.38	1.39	1.41	

Average = $Sum(40)_{1…12}$ /12= 1.38 (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 2.01 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 81.94 (43)

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

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

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

(44)m=	90.13	86.85	83.58	80.3	77.02	73.74	73.74	77.02	80.3	83.58	86.85	90.13	

Total = $Sum(44)_{1…12}$ = 983.26 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	133.66	116.9	120.63	105.17	100.91	87.08	80.69	92.6	93.7	109.2	119.2	129.45	

Total = $Sum(45)_{1…12}$ = 1289.21 (45)

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

(46)m=	20.05	17.54	18.1	15.78	15.14	13.06	12.1	13.89	14.06	16.38	17.88	19.42	(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)

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	45.93	39.98	42.59	39.6	39.25	36.37	37.58	39.25	39.6	42.59	42.83	45.93	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	179.59	156.88	163.22	144.77	140.16	123.45	118.27	131.85	133.3	151.79	162.03	175.38	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	179.59	156.88	163.22	144.77	140.16	123.45	118.27	131.85	133.3	151.79	162.03	175.38

Output from water heater (annual)$_{1...12}$ 1780.71 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	55.93	48.86	50.76	44.87	43.37	38.05	36.23	40.6	41.06	46.96	50.34	54.52	(65)

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=	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	16.02	14.23	11.57	8.76	6.55	5.53	5.97	7.77	10.42	13.24	15.45	16.47	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	175.49	177.31	172.72	162.95	150.62	139.03	131.28	129.46	134.05	143.82	156.15	167.74	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	-80.4	(71)

Water heating gains (Table 5)

(72)m=	75.17	72.72	68.22	62.32	58.29	52.84	48.69	54.57	57.02	63.11	69.92	73.28	(72)

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

(73)m=	322.83	320.4	308.67	290.18	271.61	253.55	242.1	247.95	257.65	276.32	297.67	313.65	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast	0.9x	0.77	x	1.69	x	11.28	x	0.5	x	0.7	=	4.62	(75)
Northeast	0.9x	0.77	x	3.55	x	11.28	x	0.5	x	0.7	=	9.72	(75)
Northeast	0.9x	0.77	x	1.69	x	22.97	x	0.5	x	0.7	=	9.41	(75)
Northeast	0.9x	0.77	x	3.55	x	22.97	x	0.5	x	0.7	=	19.78	(75)
Northeast	0.9x	0.77	x	1.69	x	41.38	x	0.5	x	0.7	=	16.96	(75)
Northeast	0.9x	0.77	x	3.55	x	41.38	x	0.5	x	0.7	=	35.63	(75)
Northeast	0.9x	0.77	x	1.69	x	67.96	x	0.5	x	0.7	=	27.86	(75)
Northeast	0.9x	0.77	x	3.55	x	67.96	x	0.5	x	0.7	=	58.51	(75)
Northeast	0.9x	0.77	x	1.69	x	91.35	x	0.5	x	0.7	=	37.44	(75)
Northeast	0.9x	0.77	x	3.55	x	91.35	x	0.5	x	0.7	=	78.65	(75)
Northeast	0.9x	0.77	x	1.69	x	97.38	x	0.5	x	0.7	=	39.92	(75)
Northeast	0.9x	0.77	x	3.55	x	97.38	x	0.5	x	0.7	=	83.85	(75)
Northeast	0.9x	0.77	x	1.69	x	91.1	x	0.5	x	0.7	=	37.34	(75)
Northeast	0.9x	0.77	x	3.55	x	91.1	x	0.5	x	0.7	=	78.44	(75)
Northeast	0.9x	0.77	x	1.69	x	72.63	x	0.5	x	0.7	=	29.77	(75)
Northeast	0.9x	0.77	x	3.55	x	72.63	x	0.5	x	0.7	=	62.54	(75)
Northeast	0.9x	0.77	x	1.69	x	50.42	x	0.5	x	0.7	=	20.67	(75)
Northeast	0.9x	0.77	x	3.55	x	50.42	x	0.5	x	0.7	=	43.41	(75)
Northeast	0.9x	0.77	x	1.69	x	28.07	x	0.5	x	0.7	=	11.51	(75)
Northeast	0.9x	0.77	x	3.55	x	28.07	x	0.5	x	0.7	=	24.17	(75)
Northeast	0.9x	0.77	x	1.69	x	14.2	x	0.5	x	0.7	=	5.82	(75)
Northeast	0.9x	0.77	x	3.55	x	14.2	x	0.5	x	0.7	=	12.22	(75)
Northeast	0.9x	0.77	x	1.69	x	9.21	x	0.5	x	0.7	=	3.78	(75)
Northeast	0.9x	0.77	x	3.55	x	9.21	x	0.5	x	0.7	=	7.93	(75)
Northwest	0.9x	0.77	x	1.39	x	11.28	x	0.63	x	0.7	=	19.17	(81)
Northwest	0.9x	0.77	x	1.39	x	22.97	x	0.63	x	0.7	=	39.03	(81)
Northwest	0.9x	0.77	x	1.39	x	41.38	x	0.63	x	0.7	=	70.31	(81)
Northwest	0.9x	0.77	x	1.39	x	67.96	x	0.63	x	0.7	=	115.47	(81)
Northwest	0.9x	0.77	x	1.39	x	91.35	x	0.63	x	0.7	=	155.22	(81)
Northwest	0.9x	0.77	x	1.39	x	97.38	x	0.63	x	0.7	=	165.48	(81)
Northwest	0.9x	0.77	x	1.39	x	91.1	x	0.63	x	0.7	=	154.8	(81)
Northwest	0.9x	0.77	x	1.39	x	72.63	x	0.63	x	0.7	=	123.41	(81)
Northwest	0.9x	0.77	x	1.39	x	50.42	x	0.63	x	0.7	=	85.68	(81)
Northwest	0.9x	0.77	x	1.39	x	28.07	x	0.63	x	0.7	=	47.69	(81)
Northwest	0.9x	0.77	x	1.39	x	14.2	x	0.63	x	0.7	=	24.12	(81)
Northwest	0.9x	0.77	x	1.39	x	9.21	x	0.63	x	0.7	=	15.66	(81)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	33.51	68.22	122.9	201.84	271.31	289.25	270.59	215.71	149.76	83.36	42.17	27.37	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	356.34	388.62	431.57	492.02	542.92	542.8	512.69	463.67	407.41	359.69	339.84	341.01	(84)

DER WorkSheet: New dwelling design stage

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	1	0.99	0.98	0.93	0.8	0.65	0.72	0.92	0.99	1	1	(86)

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

(87)m=	19.37	19.51	19.78	20.2	20.59	20.87	20.96	20.94	20.71	20.23	19.76	19.38	(87)

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

(88)m=	19.73	19.74	19.74	19.78	19.78	19.81	19.81	19.82	19.8	19.78	19.77	19.76	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	1	0.99	0.97	0.89	0.71	0.5	0.57	0.87	0.98	1	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.26	18.4	18.68	19.12	19.5	19.75	19.8	19.8	19.63	19.16	18.68	18.29	(90)

fLA = Living area ÷ (4) = | 0.4 | (91)

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

(92)m=	18.7	18.84	19.12	19.55	19.93	20.19	20.26	20.25	20.06	19.59	19.11	18.73	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	18.7	18.84	19.12	19.55	19.93	20.19	20.26	20.25	20.06	19.59	19.11	18.73	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.99	0.97	0.9	0.74	0.56	0.63	0.88	0.98	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	355.11	386.51	426.56	475.14	486.94	401.89	287.29	293.27	359.89	352.13	337.88	340.06	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1268.54	1220.03	1097.4	899.13	690.75	456.96	299.21	313.14	491.9	754.47	1019.64	1247.75	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	679.59	560.13	499.1	305.27	151.63	0	0	0	0	299.34	490.87	675.32	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = | 3661.25 | (98)

Space heating requirement in kWh/m²/year | 60.01 | (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		90.3	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

DER WorkSheet: New dwelling design stage

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)														
	679.59	560.13	499.1	305.27	151.63	0	0	0	0	299.34	490.87	675.32		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	752.59	620.29	552.72	338.06	167.92	0	0	0	0	331.49	543.6	747.86		
								Total (kWh/year) =Sum(211)$_{1...5,10....12}$=					4054.54	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	179.59	156.88	163.22	144.77	140.16	123.45	118.27	131.85	133.3	151.79	162.03	175.38		
Efficiency of water heater													81	(216)
(217)m=	88.18	88.09	87.82	87.08	85.58	81	81	81	81	86.94	87.8	88.21		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	203.66	178.1	185.87	166.24	163.78	152.41	146.02	162.77	164.57	174.59	184.55	198.81		
								Total = Sum(219a)$_{1...12}$ =					2081.38	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			4054.54	
Water heating fuel used			2081.38	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		30	(231)
Electricity for lighting			282.96	(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	=	875.78	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	449.58	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1325.36	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	146.86	(268)
Total CO2, kg/year		sum of (265)…(271) =		1487.79	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		24.39	(273)
EI rating (section 14)				81	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 5-Lean

Address : Flat 5, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	64.3	(1a)	x	2.5	(2a)	=	160.75	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	64.3	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			160.75	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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) =	0.19	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)
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			
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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.69	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
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) =	0.58	(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
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

DER WorkSheet: New dwelling design stage

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

0.74	0.73	0.71	0.64	0.63	0.55	0.55	0.54	0.58	0.63	0.66	0.69

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	(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	(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=	0.78	0.77	0.76	0.71	0.7	0.65	0.65	0.65	0.67	0.7	0.72	0.74	(24d)

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

(25)m=	0.78	0.77	0.76	0.71	0.7	0.65	0.65	0.65	0.67	0.7	0.72	0.74	(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			2.2	x	1.3	=	2.86			(26)
Windows Type 1			3.55	x1/[1/(1.3)+ 0.04]		=	4.39			(27)
Windows Type 2			1.39	x1/[1/(1.3)+ 0.04]		=	1.72			(27)
Windows Type 3			1.39	x1/[1/(1.6)+ 0.04]		=	2.09			(27)
Windows Type 4			0.72	x1/[1/(1.6)+ 0.04]		=	1.08			(27)
Windows Type 5			0.52	x1/[1/(1.6)+ 0.04]		=	0.78			(27)
Windows Type 6			0.72	x1/[1/(1.6)+ 0.04]		=	1.08			(27)
Walls Type1	23.74	3.87	19.87	x	0.55	=	10.93			(29)
Walls Type2	26.23	6.33	19.9	x	0.14	=	2.79			(29)
Walls Type3	4.72	2.2	2.52	x	0.55	=	1.39			(29)
Total area of elements, m²			54.69							(31)
Party wall			45.69	x	0	=	0			(32)
Party floor			64.3							(32a)
Party ceiling			64.3							(32b)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U)	(26)…(30) + (32) =	31.6	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	12868.41	(34)
Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K | 8.2 | (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = | 39.81 | (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	41.21	40.64	40.08	37.46	36.96	34.68	34.68	34.25	35.56	36.96	37.96	39	(38)

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

(39)m=	81.02	80.45	79.89	77.26	76.77	74.48	74.48	74.06	75.36	76.77	77.76	78.8	

Average = Sum(39)$_{1...12}$ /12= | 77.26 | (39)

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

(40)m=	1.26	1.25	1.24	1.2	1.19	1.16	1.16	1.15	1.17	1.19	1.21	1.23

Average = Sum(40)$_{1...12}$ /12= | 1.2 | (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 | 2.1 | (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 84.08 | (43)

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

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

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

(44)m=	92.49	89.13	85.76	82.4	79.04	75.67	75.67	79.04	82.4	85.76	89.13	92.49

Total = Sum(44)$_{1...12}$ = | 1008.97 | (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	137.16	119.96	123.79	107.92	103.55	89.36	82.8	95.02	96.15	112.06	122.32	132.83

Total = Sum(45)$_{1...12}$ = | 1322.92 | (45)

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

(46)m=	20.57	17.99	18.57	16.19	15.53	13.4	12.42	14.25	14.42	16.81	18.35	19.92	(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)

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	47.13	41.02	43.7	40.64	40.28	37.32	38.56	40.28	40.64	43.7	43.95	47.13	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	184.29	160.98	167.49	148.56	143.83	126.68	121.37	135.29	136.79	155.76	166.27	179.96	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	184.29	160.98	167.49	148.56	143.83	126.68	121.37	135.29	136.79	155.76	166.27	179.96

Output from water heater (annual)$_{1...12}$ 1827.26 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	57.39	50.14	52.09	46.04	44.5	39.04	37.17	41.66	42.13	48.18	51.66	55.95	(65)

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=	105.01	105.01	105.01	105.01	105.01	105.01	105.01	105.01	105.01	105.01	105.01	105.01	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	17.11	15.2	12.36	9.36	6.99	5.9	6.38	8.29	11.13	14.13	16.5	17.59	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	183.65	185.55	180.75	170.53	157.62	145.49	137.39	135.48	140.29	150.51	163.41	175.54	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	-84.01	(71)

Water heating gains (Table 5)

(72)m=	77.13	74.62	70.01	63.95	59.81	54.22	49.96	56	58.51	64.76	71.75	75.2	(72)

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

(73)m=	335.4	332.87	320.62	301.34	281.93	263.12	251.24	257.28	267.43	286.91	309.16	325.83	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast	0.9x	0.77	x	3.55	x	11.28	x	0.5	x	0.7	=	9.72	(75)
Northeast	0.9x	0.77	x	0.72	x	11.28	x	0.63	x	0.7	=	2.48	(75)
Northeast	0.9x	0.77	x	3.55	x	22.97	x	0.5	x	0.7	=	19.78	(75)
Northeast	0.9x	0.77	x	0.72	x	22.97	x	0.63	x	0.7	=	5.05	(75)
Northeast	0.9x	0.77	x	3.55	x	41.38	x	0.5	x	0.7	=	35.63	(75)
Northeast	0.9x	0.77	x	0.72	x	41.38	x	0.63	x	0.7	=	9.11	(75)
Northeast	0.9x	0.77	x	3.55	x	67.96	x	0.5	x	0.7	=	58.51	(75)
Northeast	0.9x	0.77	x	0.72	x	67.96	x	0.63	x	0.7	=	14.95	(75)
Northeast	0.9x	0.77	x	3.55	x	91.35	x	0.5	x	0.7	=	78.65	(75)
Northeast	0.9x	0.77	x	0.72	x	91.35	x	0.63	x	0.7	=	20.1	(75)
Northeast	0.9x	0.77	x	3.55	x	97.38	x	0.5	x	0.7	=	83.85	(75)
Northeast	0.9x	0.77	x	0.72	x	97.38	x	0.63	x	0.7	=	21.43	(75)
Northeast	0.9x	0.77	x	3.55	x	91.1	x	0.5	x	0.7	=	78.44	(75)
Northeast	0.9x	0.77	x	0.72	x	91.1	x	0.63	x	0.7	=	20.05	(75)
Northeast	0.9x	0.77	x	3.55	x	72.63	x	0.5	x	0.7	=	62.54	(75)
Northeast	0.9x	0.77	x	0.72	x	72.63	x	0.63	x	0.7	=	15.98	(75)
Northeast	0.9x	0.77	x	3.55	x	50.42	x	0.5	x	0.7	=	43.41	(75)
Northeast	0.9x	0.77	x	0.72	x	50.42	x	0.63	x	0.7	=	11.09	(75)
Northeast	0.9x	0.77	x	3.55	x	28.07	x	0.5	x	0.7	=	24.17	(75)
Northeast	0.9x	0.77	x	0.72	x	28.07	x	0.63	x	0.7	=	6.18	(75)
Northeast	0.9x	0.77	x	3.55	x	14.2	x	0.5	x	0.7	=	12.22	(75)
Northeast	0.9x	0.77	x	0.72	x	14.2	x	0.63	x	0.7	=	3.12	(75)
Northeast	0.9x	0.77	x	3.55	x	9.21	x	0.5	x	0.7	=	7.93	(75)
Northeast	0.9x	0.77	x	0.72	x	9.21	x	0.63	x	0.7	=	2.03	(75)
Southeast	0.9x	0.77	x	1.39	x	36.79	x	0.5	x	0.7	=	24.81	(77)
Southeast	0.9x	0.77	x	1.39	x	36.79	x	0.63	x	0.7	=	15.63	(77)
Southeast	0.9x	0.77	x	0.52	x	36.79	x	0.63	x	0.7	=	11.69	(77)
Southeast	0.9x	0.77	x	1.39	x	62.67	x	0.5	x	0.7	=	42.26	(77)
Southeast	0.9x	0.77	x	1.39	x	62.67	x	0.63	x	0.7	=	26.62	(77)
Southeast	0.9x	0.77	x	0.52	x	62.67	x	0.63	x	0.7	=	19.92	(77)
Southeast	0.9x	0.77	x	1.39	x	85.75	x	0.5	x	0.7	=	57.82	(77)
Southeast	0.9x	0.77	x	1.39	x	85.75	x	0.63	x	0.7	=	36.43	(77)
Southeast	0.9x	0.77	x	0.52	x	85.75	x	0.63	x	0.7	=	27.26	(77)
Southeast	0.9x	0.77	x	1.39	x	106.25	x	0.5	x	0.7	=	71.64	(77)
Southeast	0.9x	0.77	x	1.39	x	106.25	x	0.63	x	0.7	=	45.14	(77)
Southeast	0.9x	0.77	x	0.52	x	106.25	x	0.63	x	0.7	=	33.77	(77)
Southeast	0.9x	0.77	x	1.39	x	119.01	x	0.5	x	0.7	=	80.25	(77)
Southeast	0.9x	0.77	x	1.39	x	119.01	x	0.63	x	0.7	=	50.56	(77)
Southeast	0.9x	0.77	x	0.52	x	119.01	x	0.63	x	0.7	=	37.83	(77)

Southeast 0.9x	0.77	x	1.39	x	118.15	x	0.5	x	0.7	=	79.67	(77)
Southeast 0.9x	0.77	x	1.39	x	118.15	x	0.63	x	0.7	=	50.19	(77)
Southeast 0.9x	0.77	x	0.52	x	118.15	x	0.63	x	0.7	=	37.55	(77)
Southeast 0.9x	0.77	x	1.39	x	113.91	x	0.5	x	0.7	=	76.81	(77)
Southeast 0.9x	0.77	x	1.39	x	113.91	x	0.63	x	0.7	=	48.39	(77)
Southeast 0.9x	0.77	x	0.52	x	113.91	x	0.63	x	0.7	=	36.2	(77)
Southeast 0.9x	0.77	x	1.39	x	104.39	x	0.5	x	0.7	=	70.39	(77)
Southeast 0.9x	0.77	x	1.39	x	104.39	x	0.63	x	0.7	=	44.35	(77)
Southeast 0.9x	0.77	x	0.52	x	104.39	x	0.63	x	0.7	=	33.18	(77)
Southeast 0.9x	0.77	x	1.39	x	92.85	x	0.5	x	0.7	=	62.61	(77)
Southeast 0.9x	0.77	x	1.39	x	92.85	x	0.63	x	0.7	=	39.44	(77)
Southeast 0.9x	0.77	x	0.52	x	92.85	x	0.63	x	0.7	=	29.51	(77)
Southeast 0.9x	0.77	x	1.39	x	69.27	x	0.5	x	0.7	=	46.71	(77)
Southeast 0.9x	0.77	x	1.39	x	69.27	x	0.63	x	0.7	=	29.43	(77)
Southeast 0.9x	0.77	x	0.52	x	69.27	x	0.63	x	0.7	=	22.02	(77)
Southeast 0.9x	0.77	x	1.39	x	44.07	x	0.5	x	0.7	=	29.72	(77)
Southeast 0.9x	0.77	x	1.39	x	44.07	x	0.63	x	0.7	=	18.72	(77)
Southeast 0.9x	0.77	x	0.52	x	44.07	x	0.63	x	0.7	=	14.01	(77)
Southeast 0.9x	0.77	x	1.39	x	31.49	x	0.5	x	0.7	=	21.23	(77)
Southeast 0.9x	0.77	x	1.39	x	31.49	x	0.63	x	0.7	=	13.38	(77)
Southeast 0.9x	0.77	x	0.52	x	31.49	x	0.63	x	0.7	=	10.01	(77)
Southwest 0.9x	0.77	x	0.72	x	36.79		0.63	x	0.7	=	8.1	(79)
Southwest 0.9x	0.77	x	0.72	x	62.67		0.63	x	0.7	=	13.79	(79)
Southwest 0.9x	0.77	x	0.72	x	85.75		0.63	x	0.7	=	18.87	(79)
Southwest 0.9x	0.77	x	0.72	x	106.25		0.63	x	0.7	=	23.38	(79)
Southwest 0.9x	0.77	x	0.72	x	119.01		0.63	x	0.7	=	26.19	(79)
Southwest 0.9x	0.77	x	0.72	x	118.15		0.63	x	0.7	=	26	(79)
Southwest 0.9x	0.77	x	0.72	x	113.91		0.63	x	0.7	=	25.06	(79)
Southwest 0.9x	0.77	x	0.72	x	104.39		0.63	x	0.7	=	22.97	(79)
Southwest 0.9x	0.77	x	0.72	x	92.85		0.63	x	0.7	=	20.43	(79)
Southwest 0.9x	0.77	x	0.72	x	69.27		0.63	x	0.7	=	15.24	(79)
Southwest 0.9x	0.77	x	0.72	x	44.07		0.63	x	0.7	=	9.7	(79)
Southwest 0.9x	0.77	x	0.72	x	31.49		0.63	x	0.7	=	6.93	(79)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	72.43	127.42	185.11	247.4	293.57	298.69	284.95	249.4	206.51	143.73	87.49	61.51	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	407.82	460.29	505.73	548.73	575.5	561.81	536.19	506.68	473.94	430.64	396.65	387.34	(84)

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

DER WorkSheet: New dwelling design stage

(86)m=	1	1	0.99	0.97	0.91	0.76	0.59	0.64	0.87	0.98	0.99	1	(86)

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

(87)m=	19.65	19.8	20.05	20.42	20.72	20.93	20.98	20.98	20.84	20.45	20.01	19.65	(87)

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

(88)m=	19.87	19.88	19.89	19.92	19.92	19.95	19.95	19.96	19.94	19.92	19.91	19.9	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	1	0.99	0.98	0.95	0.87	0.67	0.46	0.51	0.8	0.96	0.99	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.65	18.81	19.07	19.44	19.73	19.92	19.95	19.95	19.85	19.49	19.04	18.67	(90)

fLA = Living area ÷ (4) = 0.38 (91)

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

(92)m=	19.02	19.18	19.44	19.81	20.11	20.3	20.34	20.34	20.23	19.85	19.41	19.04	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	19.02	19.18	19.44	19.81	20.11	20.3	20.34	20.34	20.23	19.85	19.41	19.04	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.98	0.95	0.87	0.7	0.51	0.56	0.82	0.96	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	406.04	456.53	496.77	522.79	502.76	393.04	273.34	283.62	389.04	415.06	393.33	386.02	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1192.89	1148.87	1033.62	842.99	645.26	424.46	278.51	291.65	461.71	710.35	957.01	1169.59	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	585.42	465.26	399.41	230.55	106.01	0	0	0	0	219.7	405.85	582.97	

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 2995.17 (98)

Space heating requirement in kWh/m²/year 46.58 (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		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
Space heating requirement (calculated above)													
	585.42	465.26	399.41	230.55	106.01	0	0	0	0	219.7	405.85	582.97	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	648.3	515.23	442.32	255.31	117.4	0	0	0	0	243.3	449.44	645.6	

Total (kWh/year) =$Sum(211)_{1...5,10...12}$= 3316.91 (211)

DER WorkSheet: New dwelling design stage

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)

184.29	160.98	167.49	148.56	143.83	126.68	121.37	135.29	136.79	155.76	166.27	179.96

Efficiency of water heater 81 (216)

(217)m=	87.88	87.71	87.34	86.41	84.7	81	81	81	81	86.19	87.38	87.92

(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	209.7	183.54	191.77	171.92	169.81	156.39	149.83	167.03	168.87	180.71	190.28	204.69

Total = Sum(219a)$_{1...12}$ = 2144.53 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		3316.91	
Water heating fuel used		2144.53	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =	30	(231)
Electricity for lighting		302.17	(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	=	716.45	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	463.22	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1179.67	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	156.82	(268)
Total CO2, kg/year		sum of (265)…(271) =		1352.07	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		21.03	(273)
EI rating (section 14)				83	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 6-Lean

Address : Flat 6, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	61.76	(1a) x	2.5	(2a) =	154.4	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	61.76	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	154.4	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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) =	0.19	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)

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

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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.69	(18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

Number of sides sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.92	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.64	(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
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

DER WorkSheet: New dwelling design stage

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

0.82	0.8	0.79	0.71	0.69	0.61	0.61	0.59	0.64	0.69	0.72	0.75

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	(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	(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=	0.84	0.82	0.81	0.75	0.74	0.69	0.69	0.68	0.71	0.74	0.76	0.78	(24d)

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

(25)m=	0.84	0.82	0.81	0.75	0.74	0.69	0.69	0.68	0.71	0.74	0.76	0.78	(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			2.2	x	1.3	=	2.86			(26)
Windows Type 1			5.42	x1/[1/(1.6)+ 0.04]		=	8.15			(27)
Windows Type 2			0.53	x1/[1/(1.6)+ 0.04]		=	0.8			(27)
Windows Type 3			0.45	x1/[1/(1.6)+ 0.04]		=	0.68			(27)
Windows Type 4			2.85	x1/[1/(1.6)+ 0.04]		=	4.29			(27)
Walls Type1	56.44	11.29	45.15	x	0.55	=	24.83			(29)
Walls Type2	16.52	2.2	14.32	x	0.55	=	7.88			(29)
Total area of elements, m²			72.96							(31)
Party wall			24.38	x	0	=	0			(32)
Party floor			61.76							(32a)
Party ceiling			61.76							(32b)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 52.55 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 12139.63 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K 10.94 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 63.49 (37)

DER WorkSheet: New dwelling design stage

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	42.56	41.89	41.24	38.19	37.62	34.96	34.96	34.47	35.98	37.62	38.77	39.98	(38)

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

(39)m=	106.05	105.38	104.73	101.68	101.11	98.45	98.45	97.96	99.47	101.11	102.26	103.47	

Average = $Sum(39)_{1...12}$ /12= 101.68 (39)

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

(40)m=	1.72	1.71	1.7	1.65	1.64	1.59	1.59	1.59	1.61	1.64	1.66	1.68	

Average = $Sum(40)_{1...12}$ /12= 1.65 (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 2.03 (42)
if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 82.43 (43)

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

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

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

(44)m=	90.68	87.38	84.08	80.79	77.49	74.19	74.19	77.49	80.79	84.08	87.38	90.68

Total = $Sum(44)_{1...12}$ = 989.22 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	134.47	117.61	121.36	105.81	101.53	87.61	81.18	93.16	94.27	109.86	119.92	130.23

Total = $Sum(45)_{1...12}$ = 1297.02 (45)

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

(46)m=	20.17	17.64	18.2	15.87	15.23	13.14	12.18	13.97	14.14	16.48	17.99	19.53	(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)

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	46.21	40.22	42.85	39.84	39.49	36.59	37.81	39.49	39.84	42.85	43.09	46.21	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	180.68	157.83	164.21	145.65	141.01	124.2	118.99	132.65	134.11	152.71	163.02	176.44	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	180.68	157.83	164.21	145.65	141.01	124.2	118.99	132.65	134.11	152.71	163.02	176.44

Output from water heater (annual)$_{1...12}$ — 1791.49 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	56.26	49.16	51.07	45.14	43.63	38.28	36.44	40.85	41.3	47.24	50.65	54.85	(65)

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=	101.55	101.55	101.55	101.55	101.55	101.55	101.55	101.55	101.55	101.55	101.55	101.55	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	16.11	14.31	11.64	8.81	6.59	5.56	6.01	7.81	10.48	13.31	15.53	16.56	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	177.36	179.2	174.57	164.69	152.23	140.51	132.69	130.85	135.49	145.36	157.82	169.54	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	33.15	33.15	33.15	33.15	33.15	33.15	33.15	33.15	33.15	33.15	33.15	33.15	(69)
Pumps and fans gains (Table 5a)													
(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	-81.24	(71)
Water heating gains (Table 5)													
(72)m=	75.62	73.16	68.64	62.7	58.64	53.16	48.99	54.9	57.37	63.5	70.34	73.73	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	325.56	323.13	311.3	292.66	273.92	255.7	244.15	250.02	259.8	278.63	300.16	316.29	(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 m²	Flux Table 6a	g_ Table 6b	FF Table 6c	Gains (W)

Southwest	0.9x	0.77	x	5.42	x	36.79	0.63	x	0.7	=	60.95	(79)
Southwest	0.9x	0.77	x	0.53	x	36.79	0.63	x	0.7	=	23.84	(79)
Southwest	0.9x	0.77	x	0.45	x	36.79	0.63	x	0.7	=	10.12	(79)
Southwest	0.9x	0.77	x	2.85	x	36.79	0.63	x	0.7	=	32.05	(79)
Southwest	0.9x	0.77	x	5.42	x	62.67	0.63	x	0.7	=	103.81	(79)
Southwest	0.9x	0.77	x	0.53	x	62.67	0.63	x	0.7	=	40.61	(79)
Southwest	0.9x	0.77	x	0.45	x	62.67	0.63	x	0.7	=	17.24	(79)
Southwest	0.9x	0.77	x	2.85	x	62.67	0.63	x	0.7	=	54.59	(79)
Southwest	0.9x	0.77	x	5.42	x	85.75	0.63	x	0.7	=	142.04	(79)
Southwest	0.9x	0.77	x	0.53	x	85.75	0.63	x	0.7	=	55.56	(79)
Southwest	0.9x	0.77	x	0.45	x	85.75	0.63	x	0.7	=	23.59	(79)
Southwest	0.9x	0.77	x	2.85	x	85.75	0.63	x	0.7	=	74.69	(79)
Southwest	0.9x	0.77	x	5.42	x	106.25	0.63	x	0.7	=	176	(79)
Southwest	0.9x	0.77	x	0.53	x	106.25	0.63	x	0.7	=	68.84	(79)
Southwest	0.9x	0.77	x	0.45	x	106.25	0.63	x	0.7	=	29.22	(79)
Southwest	0.9x	0.77	x	2.85	x	106.25	0.63	x	0.7	=	92.54	(79)
Southwest	0.9x	0.77	x	5.42	x	119.01	0.63	x	0.7	=	197.13	(79)
Southwest	0.9x	0.77	x	0.53	x	119.01	0.63	x	0.7	=	77.11	(79)
Southwest	0.9x	0.77	x	0.45	x	119.01	0.63	x	0.7	=	32.73	(79)
Southwest	0.9x	0.77	x	2.85	x	119.01	0.63	x	0.7	=	103.66	(79)
Southwest	0.9x	0.77	x	5.42	x	118.15	0.63	x	0.7	=	195.71	(79)
Southwest	0.9x	0.77	x	0.53	x	118.15	0.63	x	0.7	=	76.55	(79)
Southwest	0.9x	0.77	x	0.45	x	118.15	0.63	x	0.7	=	32.5	(79)
Southwest	0.9x	0.77	x	2.85	x	118.15	0.63	x	0.7	=	102.91	(79)
Southwest	0.9x	0.77	x	5.42	x	113.91	0.63	x	0.7	=	188.68	(79)
Southwest	0.9x	0.77	x	0.53	x	113.91	0.63	x	0.7	=	73.8	(79)
Southwest	0.9x	0.77	x	0.45	x	113.91	0.63	x	0.7	=	31.33	(79)
Southwest	0.9x	0.77	x	2.85	x	113.91	0.63	x	0.7	=	99.21	(79)
Southwest	0.9x	0.77	x	5.42	x	104.39	0.63	x	0.7	=	172.91	(79)
Southwest	0.9x	0.77	x	0.53	x	104.39	0.63	x	0.7	=	67.63	(79)
Southwest	0.9x	0.77	x	0.45	x	104.39	0.63	x	0.7	=	28.71	(79)
Southwest	0.9x	0.77	x	2.85	x	104.39	0.63	x	0.7	=	90.92	(79)
Southwest	0.9x	0.77	x	5.42	x	92.85	0.63	x	0.7	=	153.8	(79)
Southwest	0.9x	0.77	x	0.53	x	92.85	0.63	x	0.7	=	60.16	(79)
Southwest	0.9x	0.77	x	0.45	x	92.85	0.63	x	0.7	=	25.54	(79)
Southwest	0.9x	0.77	x	2.85	x	92.85	0.63	x	0.7	=	80.87	(79)
Southwest	0.9x	0.77	x	5.42	x	69.27	0.63	x	0.7	=	114.74	(79)
Southwest	0.9x	0.77	x	0.53	x	69.27	0.63	x	0.7	=	44.88	(79)
Southwest	0.9x	0.77	x	0.45	x	69.27	0.63	x	0.7	=	19.05	(79)
Southwest	0.9x	0.77	x	2.85	x	69.27	0.63	x	0.7	=	60.33	(79)
Southwest	0.9x	0.77	x	5.42	x	44.07	0.63	x	0.7	=	73	(79)

DER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	0.53	x	44.07	0.63	x	0.7	=	28.55	(79)
Southwest	0.9x	0.77	x	0.45	x	44.07	0.63	x	0.7	=	12.12	(79)
Southwest	0.9x	0.77	x	2.85	x	44.07	0.63	x	0.7	=	38.39	(79)
Southwest	0.9x	0.77	x	5.42	x	31.49	0.63	x	0.7	=	52.16	(79)
Southwest	0.9x	0.77	x	0.53	x	31.49	0.63	x	0.7	=	20.4	(79)
Southwest	0.9x	0.77	x	0.45	x	31.49	0.63	x	0.7	=	8.66	(79)
Southwest	0.9x	0.77	x	2.85	x	31.49	0.63	x	0.7	=	27.43	(79)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	126.95	216.25	295.88	366.61	410.63	407.66	393.03	360.19	320.37	239	152.06	108.64	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	452.51	539.38	607.18	659.27	684.55	663.36	637.17	610.21	580.17	517.63	452.22	424.93	(84)

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	0.9	0.78	0.62	0.66	0.86	0.97	0.99	1	(86)

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

(87)m=	19.18	19.39	19.72	20.16	20.54	20.84	20.95	20.93	20.73	20.23	19.64	19.17	(87)

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

(88)m=	19.53	19.54	19.54	19.58	19.59	19.62	19.62	19.62	19.61	19.59	19.57	19.56	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.99	0.97	0.94	0.85	0.67	0.45	0.5	0.77	0.95	0.99	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	17.92	18.14	18.47	18.93	19.28	19.54	19.61	19.61	19.47	19	18.42	17.94	(90)

fLA = Living area ÷ (4) = 0.41 (91)

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

(92)m=	18.44	18.66	18.98	19.43	19.8	20.08	20.16	20.15	19.99	19.51	18.92	18.45	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	18.44	18.66	18.98	19.43	19.8	20.08	20.16	20.15	19.99	19.51	18.92	18.45	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.98	0.97	0.93	0.86	0.71	0.52	0.57	0.8	0.95	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	448.73	530.68	588.07	615.13	586.93	468.67	334.13	345.68	463.24	489.23	445.39	422.12	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1499.37	1449.68	1307.59	1071.01	819.13	539.02	350.24	367.53	585.49	900.43	1208.97	1474.17	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	781.68	617.57	535.32	328.23	172.76	0	0	0	0	305.93	549.78	782.73	(98)

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4074 (98)

Space heating requirement in kWh/m²/year 65.96 (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 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	
Space heating requirement (calculated above)	781.68	617.57	535.32	328.23	172.76	0	0	0	0	305.93	549.78	782.73		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	865.64	683.91	592.83	363.49	191.32	0	0	0	0	338.8	608.84	866.81		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													4511.62	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	180.68	157.83	164.21	145.65	141.01	124.2	118.99	132.65	134.11	152.71	163.02	176.44		
Efficiency of water heater													81	(216)
(217)m=	88.39	88.24	87.93	87.22	85.87	81	81	81	81	86.98	87.99	88.43		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	204.4	178.87	186.75	166.99	164.22	153.33	146.9	163.76	165.57	175.58	185.27	199.52		
Total = Sum(219a)$_{1...12}$ =													2091.15	(219)

Annual totals **kWh/year** **kWh/year**

Space heating fuel used, main system 1 4511.62

Water heating fuel used 2091.15

Electricity for pumps, fans and electric keep-hot

central heating pump: 30 (230c)

Total electricity for the above, kWh/year sum of (230a)…(230g) = 30 (231)

Electricity for lighting 284.52 (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	=	974.51	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)

DER WorkSheet: New dwelling design stage

Water heating	(219) x	0.216	=	451.69	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1426.2	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	147.67	(268)
Total CO2, kg/year		sum of (265)…(271) =		1589.44	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		25.74	(273)
EI rating (section 14)				80	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 7-Lean

Address : Flat 7, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	37.6	(1a) x	1.86	(2a) =	69.94	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	37.6	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	69.94	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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							2	x 10 =	20	(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) =	20	÷ (5) =	0.29	(8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)				
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)
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				
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			10	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.79	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used				
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) =		0.67	(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
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

DER WorkSheet: New dwelling design stage

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

0.85	0.84	0.82	0.73	0.72	0.63	0.63	0.62	0.67	0.72	0.75	0.78

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	(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	(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=	0.86	0.85	0.83	0.77	0.76	0.7	0.7	0.69	0.72	0.76	0.78	0.81	(24d)

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

(25)m=	0.86	0.85	0.83	0.77	0.76	0.7	0.7	0.69	0.72	0.76	0.78	0.81	(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			2.2	x	1.3	=	2.86			(26)
Windows Type 1			3.63	x1/[1/(1.6)+ 0.04]		=	5.46			(27)
Windows Type 2			2.67	x1/[1/(1.6)+ 0.04]		=	4.02			(27)
Rooflights			0.82	x1/[1/(1.3) + 0.04]		=	1.066			(27b)
Walls Type1	10.35	6.3	4.05	x	0.55	=	2.23			(29)
Walls Type2	16.58	2.2	14.38	x	0.55	=	7.91			(29)
Roof Type1	35.62	1.64	33.98	x	0.18	=	6.12			(30)
Roof Type2	13.82	0	13.82	x	0.14	=	1.93			(30)
Total area of elements, m²			76.37							(31)
Party wall			15.11	x	0	=	0			(32)
Party floor			37.6							(32a)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 32.55 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 3906.27 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K 11.46 (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 44 (37)

DER WorkSheet: New dwelling design stage

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	19.91	19.59	19.27	17.77	17.49	16.19	16.19	15.95	16.69	17.49	18.06	18.65	(38)

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

(39)m=	63.92	63.59	63.27	61.77	61.49	60.19	60.19	59.95	60.69	61.49	62.06	62.65	

Average = Sum(39)$_{1…12}$ /12= 61.77 (39)

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

(40)m=	1.7	1.69	1.68	1.64	1.64	1.6	1.6	1.59	1.61	1.64	1.65	1.67	

Average = Sum(40)$_{1…12}$ /12= 1.64 (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 1.34 (42)
if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 66.12 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	72.73	70.09	67.45	64.8	62.16	59.51	59.51	62.16	64.8	67.45	70.09	72.73	

Total = Sum(44)$_{1…12}$ = 793.47 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	107.86	94.34	97.35	84.87	81.44	70.27	65.12	74.72	75.62	88.12	96.19	104.46	

Total = Sum(45)$_{1…12}$ = 1040.37 (45)

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

(46)m=	16.18	14.15	14.6	12.73	12.22	10.54	9.77	11.21	11.34	13.22	14.43	15.67	(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)

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

DER WorkSheet: New dwelling design stage

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 | 0 | (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	37.06	32.26	34.37	31.96	31.67	29.35	30.33	31.67	31.96	34.37	34.56	37.06	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	144.93	126.6	131.72	116.83	113.11	99.62	95.44	106.4	107.57	122.49	130.76	141.53	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	144.93	126.6	131.72	116.83	113.11	99.62	95.44	106.4	107.57	122.49	130.76	141.53

Output from water heater (annual)$_{1...12}$ | 1436.99 | (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	45.13	39.43	40.96	36.21	35	30.7	29.23	32.76	33.13	37.89	40.63	44	(65)

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=	67.21	67.21	67.21	67.21	67.21	67.21	67.21	67.21	67.21	67.21	67.21	67.21	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	10.3	9.15	7.44	5.63	4.21	3.55	3.84	4.99	6.7	8.51	9.93	10.59	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	115.55	116.75	113.73	107.29	99.17	91.54	86.44	85.24	88.27	94.7	102.82	110.45	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	-53.76	(71)

Water heating gains (Table 5)

(72)m=	60.66	58.68	55.05	50.29	47.04	42.64	39.29	44.04	46.02	50.93	56.42	59.14	(72)

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

(73)m=	232.67	230.74	222.38	209.38	196.58	183.9	175.74	180.44	187.15	200.3	215.34	226.34	(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 m²	Flux Table 6a	g_ Table 6b	FF Table 6c	Gains (W)

Northeast	0.9x	0.77	x	3.63	x	11.28	x	0.63	x	0.7	=	12.52	(75)
Northeast	0.9x	0.77	x	3.63	x	22.97	x	0.63	x	0.7	=	25.48	(75)
Northeast	0.9x	0.77	x	3.63	x	41.38	x	0.63	x	0.7	=	45.9	(75)
Northeast	0.9x	0.77	x	3.63	x	67.96	x	0.63	x	0.7	=	75.39	(75)
Northeast	0.9x	0.77	x	3.63	x	91.35	x	0.63	x	0.7	=	101.34	(75)
Northeast	0.9x	0.77	x	3.63	x	97.38	x	0.63	x	0.7	=	108.04	(75)
Northeast	0.9x	0.77	x	3.63	x	91.1	x	0.63	x	0.7	=	101.07	(75)
Northeast	0.9x	0.77	x	3.63	x	72.63	x	0.63	x	0.7	=	80.57	(75)
Northeast	0.9x	0.77	x	3.63	x	50.42	x	0.63	x	0.7	=	55.94	(75)
Northeast	0.9x	0.77	x	3.63	x	28.07	x	0.63	x	0.7	=	31.14	(75)
Northeast	0.9x	0.77	x	3.63	x	14.2	x	0.63	x	0.7	=	15.75	(75)
Northeast	0.9x	0.77	x	3.63	x	9.21	x	0.63	x	0.7	=	10.22	(75)
Northwest	0.9x	0.77	x	2.67	x	11.28	x	0.63	x	0.7	=	9.21	(81)
Northwest	0.9x	0.77	x	2.67	x	22.97	x	0.63	x	0.7	=	18.74	(81)
Northwest	0.9x	0.77	x	2.67	x	41.38	x	0.63	x	0.7	=	33.76	(81)
Northwest	0.9x	0.77	x	2.67	x	67.96	x	0.63	x	0.7	=	55.45	(81)
Northwest	0.9x	0.77	x	2.67	x	91.35	x	0.63	x	0.7	=	74.54	(81)
Northwest	0.9x	0.77	x	2.67	x	97.38	x	0.63	x	0.7	=	79.46	(81)
Northwest	0.9x	0.77	x	2.67	x	91.1	x	0.63	x	0.7	=	74.34	(81)
Northwest	0.9x	0.77	x	2.67	x	72.63	x	0.63	x	0.7	=	59.26	(81)
Northwest	0.9x	0.77	x	2.67	x	50.42	x	0.63	x	0.7	=	41.14	(81)
Northwest	0.9x	0.77	x	2.67	x	28.07	x	0.63	x	0.7	=	22.9	(81)
Northwest	0.9x	0.77	x	2.67	x	14.2	x	0.63	x	0.7	=	11.58	(81)
Northwest	0.9x	0.77	x	2.67	x	9.21	x	0.63	x	0.7	=	7.52	(81)
Rooflights	0.9x	1	x	0.82	x	15.92	x	0.5	x	0.8	=	9.4	(82)
Rooflights	0.9x	1	x	0.82	x	32.51	x	0.5	x	0.8	=	19.19	(82)
Rooflights	0.9x	1	x	0.82	x	59.5	x	0.5	x	0.8	=	35.13	(82)
Rooflights	0.9x	1	x	0.82	x	100.03	x	0.5	x	0.8	=	59.06	(82)
Rooflights	0.9x	1	x	0.82	x	136.88	x	0.5	x	0.8	=	80.81	(82)
Rooflights	0.9x	1	x	0.82	x	147.03	x	0.5	x	0.8	=	86.81	(82)
Rooflights	0.9x	1	x	0.82	x	137.1	x	0.5	x	0.8	=	80.94	(82)
Rooflights	0.9x	1	x	0.82	x	107.76	x	0.5	x	0.8	=	63.62	(82)
Rooflights	0.9x	1	x	0.82	x	73.17	x	0.5	x	0.8	=	43.2	(82)
Rooflights	0.9x	1	x	0.82	x	39.91	x	0.5	x	0.8	=	23.56	(82)
Rooflights	0.9x	1	x	0.82	x	20.03	x	0.5	x	0.8	=	11.83	(82)
Rooflights	0.9x	1	x	0.82	x	13.01	x	0.5	x	0.8	=	7.68	(82)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	31.12	63.41	114.8	189.9	256.69	274.31	256.35	203.46	140.28	77.6	39.16	25.42	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	263.79	294.15	337.18	399.28	453.27	458.21	432.09	383.89	327.42	277.9	254.5	251.76	(84)

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

DER WorkSheet: New dwelling design stage

(86)m=	1	0.99	0.99	0.96	0.87	0.72	0.57	0.65	0.88	0.98	0.99	1	(86)

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

(87)m=	19.17	19.34	19.67	20.16	20.6	20.87	20.96	20.94	20.7	20.16	19.6	19.17	(87)

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

(88)m=	19.54	19.55	19.55	19.58	19.59	19.61	19.61	19.62	19.6	19.59	19.58	19.57	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.99	0.98	0.94	0.82	0.61	0.41	0.48	0.8	0.96	0.99	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	17.92	18.09	18.42	18.93	19.33	19.56	19.6	19.6	19.44	18.93	18.38	17.94	(90)

fLA = Living area ÷ (4) = 0.89 (91)

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

(92)m=	19.04	19.2	19.53	20.03	20.46	20.73	20.82	20.8	20.56	20.02	19.47	19.04	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	19.04	19.2	19.53	20.03	20.46	20.73	20.82	20.8	20.56	20.02	19.47	19.04	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.98	0.94	0.86	0.7	0.55	0.63	0.86	0.97	0.99	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	262.13	291.21	330.12	376.6	387.71	321.76	239.52	240.92	281.45	268.99	251.94	250.44	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	942.09	909.56	824.72	687.5	538.74	369.18	253.78	263.52	392.32	579.55	767.9	929.67	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	505.89	415.54	367.98	223.85	112.37	0	0	0	0	231.06	371.49	505.35	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2733.51 (98)

Space heating requirement in kWh/m²/year 72.7 (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		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
Space heating requirement (calculated above)													
	505.89	415.54	367.98	223.85	112.37	0	0	0	0	231.06	371.49	505.35	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	560.23	460.17	407.5	247.89	124.44	0	0	0	0	255.88	411.4	559.63	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 3027.15 (211)

DER WorkSheet: New dwelling design stage

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)

144.93	126.6	131.72	116.83	113.11	99.62	95.44	106.4	107.57	122.49	130.76	141.53

Efficiency of water heater 81 (216)

(217)m=	88.05	87.94	87.65	86.88	85.38	81	81	81	81	86.85	87.68	88.09	(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	164.6	143.96	150.28	134.47	132.47	122.99	117.83	131.36	132.81	141.05	149.13	160.66

Total = Sum(219a)$_{1...12}$ = 1681.61 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		3027.15	
Water heating fuel used		1681.61	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
Total electricity for the above, kWh/year (sum of (230a)…(230g) =)		30	(231)
Electricity for lighting		181.92	(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 =	653.86	(261)
Space heating (secondary)	(215) x	0.519 =	0	(263)
Water heating	(219) x	0.216 =	363.23	(264)
Space and water heating	(261) + (262) + (263) + (264) =		1017.09	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519 =	15.57	(267)
Electricity for lighting	(232) x	0.519 =	94.42	(268)
Total CO2, kg/year		sum of (265)…(271) =	1127.08	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =	29.98	(273)
EI rating (section 14)			82	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 8-Lean

Address : Flat 8, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	42.28	(1a) x	2.06	(2a) =	87.1	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	42.28	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	87.1	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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							2	x 10 =	20	(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) =	20	÷ (5) =	0.23	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)

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

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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.73	(18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

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) =	0.62	(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
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

DER WorkSheet: New dwelling design stage

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

0.79	0.78	0.76	0.68	0.67	0.59	0.59	0.57	0.62	0.67	0.7	0.73

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	(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	(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=	0.81	0.8	0.79	0.73	0.72	0.67	0.67	0.66	0.69	0.72	0.74	0.77	(24d)

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

(25)m=	0.81	0.8	0.79	0.73	0.72	0.67	0.67	0.66	0.69	0.72	0.74	0.77	(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			2.2	x	1.3	=	2.86			(26)
Windows			2.73	x1/[1/(1.3)+ 0.04]		=	3.37			(27)
Rooflights Type 1			0.82	x1/[1/(1.3) + 0.04]		=	1.066			(27b)
Rooflights Type 2			0.82	x1/[1/(1.3) + 0.04]		=	1.066			(27b)
Rooflights Type 3			0.36	x1/[1/(1.3) + 0.04]		=	0.468			(27b)
Walls Type1	1.98	0	1.98	x	0.55	=	1.09			(29)
Walls Type2	6.4	2.2	4.2	x	0.55	=	2.31			(29)
Walls Type3	8.72	2.73	5.99	x	0.14	=	0.84			(29)
Roof Type1	25.2	0	25.2	x	0.18	=	4.54			(30)
Roof Type2	23.07	0.36	22.71	x	0.14	=	3.18			(30)
Roof Type3	4.86	3.28	1.58	x	0.14	=	0.22			(30)
Total area of elements, m²			70.23							(31)
Party wall			33.48	x	0	=	0			(32)
Party floor			42.28							(32a)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 22.91 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 4606.94 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K | 10.53 | (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = | 33.44 | (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	23.36	23.01	22.67	21.06	20.76	19.36	19.36	19.1	19.9	20.76	21.37	22	(38)

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

(39)m=	56.8	56.45	56.11	54.5	54.2	52.8	52.8	52.54	53.34	54.2	54.81	55.44	

Average = Sum(39)$_{1...12}$ /12= | 54.5 | (39)

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

(40)m=	1.34	1.34	1.33	1.29	1.28	1.25	1.25	1.24	1.26	1.28	1.3	1.31

Average = Sum(40)$_{1...12}$ /12= | 1.29 | (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 | 1.47 | (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 69.07 | (43)

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

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

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

(44)m=	75.98	73.21	70.45	67.69	64.92	62.16	62.16	64.92	67.69	70.45	73.21	75.98

Total = Sum(44)$_{1...12}$ = | 828.83 | (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	112.67	98.54	101.69	88.65	85.06	73.4	68.02	78.05	78.99	92.05	100.48	109.11

Total = Sum(45)$_{1...12}$ = | 1086.72 | (45)

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

(46)m=	16.9	14.78	15.25	13.3	12.76	11.01	10.2	11.71	11.85	13.81	15.07	16.37	(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)

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)

DER WorkSheet: New dwelling design stage

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	38.72	33.7	35.9	33.38	33.08	30.66	31.68	33.08	33.38	35.9	36.11	38.72	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	151.39	132.24	137.59	122.03	118.15	104.06	99.7	111.14	112.37	127.95	136.59	147.83	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	151.39	132.24	137.59	122.03	118.15	104.06	99.7	111.14	112.37	127.95	136.59	147.83	

Output from water heater (annual)$_{1...12}$ — 1501.02 (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	47.14	41.19	42.79	37.82	36.56	32.07	30.54	34.22	34.61	39.58	42.44	45.96	(65)

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=	73.41	73.41	73.41	73.41	73.41	73.41	73.41	73.41	73.41	73.41	73.41	73.41	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	11.56	10.27	8.35	6.32	4.73	3.99	4.31	5.6	7.52	9.55	11.15	11.88	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	127.31	128.63	125.3	118.21	109.27	100.86	95.24	93.92	97.25	104.34	113.28	121.69	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	30.34	30.34	30.34	30.34	30.34	30.34	30.34	30.34	30.34	30.34	30.34	30.34	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	-58.73	(71)

Water heating gains (Table 5)

(72)m=	63.36	61.29	57.51	52.53	49.13	44.54	41.04	46	48.07	53.2	58.94	61.77	(72)

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

(73)m=	250.25	248.21	239.18	225.09	211.15	197.41	188.62	193.55	200.86	215.11	231.39	243.37	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast	0.9x	0.77	x	2.73	x	11.28	x	0.5	x	0.7	=	7.47	(75)
Northeast	0.9x	0.77	x	2.73	x	22.97	x	0.5	x	0.7	=	15.21	(75)
Northeast	0.9x	0.77	x	2.73	x	41.38	x	0.5	x	0.7	=	27.4	(75)
Northeast	0.9x	0.77	x	2.73	x	67.96	x	0.5	x	0.7	=	45	(75)
Northeast	0.9x	0.77	x	2.73	x	91.35	x	0.5	x	0.7	=	60.49	(75)
Northeast	0.9x	0.77	x	2.73	x	97.38	x	0.5	x	0.7	=	64.48	(75)
Northeast	0.9x	0.77	x	2.73	x	91.1	x	0.5	x	0.7	=	60.32	(75)
Northeast	0.9x	0.77	x	2.73	x	72.63	x	0.5	x	0.7	=	48.09	(75)
Northeast	0.9x	0.77	x	2.73	x	50.42	x	0.5	x	0.7	=	33.39	(75)
Northeast	0.9x	0.77	x	2.73	x	28.07	x	0.5	x	0.7	=	18.59	(75)
Northeast	0.9x	0.77	x	2.73	x	14.2	x	0.5	x	0.7	=	9.4	(75)
Northeast	0.9x	0.77	x	2.73	x	9.21	x	0.5	x	0.7	=	6.1	(75)
Rooflights	0.9x	1	x	0.82	x	15.92	x	0.5	x	0.8	=	9.4	(82)
Rooflights	0.9x	1	x	0.82	x	40.5	x	0.5	x	0.8	=	23.91	(82)
Rooflights	0.9x	1	x	0.36	x	26	x	0.5	x	0.8	=	3.37	(82)
Rooflights	0.9x	1	x	0.82	x	32.51	x	0.5	x	0.8	=	19.19	(82)
Rooflights	0.9x	1	x	0.82	x	73.74	x	0.5	x	0.8	=	43.54	(82)
Rooflights	0.9x	1	x	0.36	x	54	x	0.5	x	0.8	=	7	(82)
Rooflights	0.9x	1	x	0.82	x	59.5	x	0.5	x	0.8	=	35.13	(82)
Rooflights	0.9x	1	x	0.82	x	111.06	x	0.5	x	0.8	=	65.57	(82)
Rooflights	0.9x	1	x	0.36	x	96	x	0.5	x	0.8	=	12.44	(82)
Rooflights	0.9x	1	x	0.82	x	100.03	x	0.5	x	0.8	=	59.06	(82)
Rooflights	0.9x	1	x	0.82	x	150.59	x	0.5	x	0.8	=	88.91	(82)
Rooflights	0.9x	1	x	0.36	x	150	x	0.5	x	0.8	=	19.44	(82)
Rooflights	0.9x	1	x	0.82	x	136.88	x	0.5	x	0.8	=	80.81	(82)
Rooflights	0.9x	1	x	0.82	x	177.61	x	0.5	x	0.8	=	104.86	(82)
Rooflights	0.9x	1	x	0.36	x	192	x	0.5	x	0.8	=	24.88	(82)
Rooflights	0.9x	1	x	0.82	x	147.03	x	0.5	x	0.8	=	86.81	(82)
Rooflights	0.9x	1	x	0.82	x	179.47	x	0.5	x	0.8	=	105.96	(82)
Rooflights	0.9x	1	x	0.36	x	200	x	0.5	x	0.8	=	25.92	(82)
Rooflights	0.9x	1	x	0.82	x	137.1	x	0.5	x	0.8	=	80.94	(82)
Rooflights	0.9x	1	x	0.82	x	171.77	x	0.5	x	0.8	=	101.42	(82)
Rooflights	0.9x	1	x	0.36	x	189	x	0.5	x	0.8	=	24.49	(82)
Rooflights	0.9x	1	x	0.82	x	107.76	x	0.5	x	0.8	=	63.62	(82)
Rooflights	0.9x	1	x	0.82	x	151.65	x	0.5	x	0.8	=	89.54	(82)
Rooflights	0.9x	1	x	0.36	x	157	x	0.5	x	0.8	=	20.35	(82)
Rooflights	0.9x	1	x	0.82	x	73.17	x	0.5	x	0.8	=	43.2	(82)
Rooflights	0.9x	1	x	0.82	x	125.02	x	0.5	x	0.8	=	73.81	(82)
Rooflights	0.9x	1	x	0.36	x	115	x	0.5	x	0.8	=	14.9	(82)

Rooflights 0.9x	1	x	0.82	x	39.91	x	0.5	x	0.8	=	23.56	(82)
Rooflights 0.9x	1	x	0.82	x	84.48	x	0.5	x	0.8	=	49.88	(82)
Rooflights 0.9x	1	x	0.36	x	66	x	0.5	x	0.8	=	8.55	(82)
Rooflights 0.9x	1	x	0.82	x	20.03	x	0.5	x	0.8	=	11.83	(82)
Rooflights 0.9x	1	x	0.82	x	49.44	x	0.5	x	0.8	=	29.19	(82)
Rooflights 0.9x	1	x	0.36	x	33	x	0.5	x	0.8	=	4.28	(82)
Rooflights 0.9x	1	x	0.82	x	13.01	x	0.5	x	0.8	=	7.68	(82)
Rooflights 0.9x	1	x	0.82	x	34.03	x	0.5	x	0.8	=	20.09	(82)
Rooflights 0.9x	1	x	0.36	x	21	x	0.5	x	0.8	=	2.72	(82)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	44.15	84.94	140.54	212.41	271.04	283.17	267.18	221.6	165.3	100.58	54.69	36.59	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	294.4	333.15	379.72	437.49	482.19	480.58	455.8	415.15	366.16	315.69	286.08	279.96	(84)

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	0.84	0.66	0.5	0.56	0.83	0.97	0.99	1	(86)

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

(87)m=	19.59	19.76	20.05	20.47	20.78	20.95	20.99	20.98	20.86	20.44	19.97	19.59	(87)

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

(88)m=	19.81	19.81	19.82	19.85	19.86	19.88	19.88	19.89	19.87	19.86	19.84	19.83	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.99	0.98	0.92	0.78	0.56	0.38	0.44	0.75	0.95	0.99	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	18.55	18.71	19.01	19.43	19.72	19.86	19.88	19.88	19.8	19.42	18.95	18.56	(90)

fLA = Living area ÷ (4) = 0.88 (91)

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

(92)m=	19.46	19.63	19.92	20.34	20.65	20.82	20.85	20.85	20.73	20.31	19.84	19.47	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	19.46	19.63	19.92	20.34	20.65	20.82	20.85	20.85	20.73	20.31	19.84	19.47	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.98	0.93	0.82	0.64	0.48	0.55	0.81	0.96	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	292.76	329.77	370.81	407.71	397.51	308.76	220.39	226.61	296.13	303.02	283.2	278.71	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	861.32	831.43	753.14	623.35	485.25	328.28	224.53	233.62	353.43	526.52	698.27	846.37	(97)

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

(98)m=	423.01	337.12	284.46	155.26	65.28	0	0	0	0	166.28	298.85	422.33

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2152.58 (98)

Space heating requirement in kWh/m²/year 50.91 (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 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
Space heating requirement (calculated above)	423.01	337.12	284.46	155.26	65.28	0	0	0	0	166.28	298.85	422.33	
(211)m = {[(98)m x (204)] } x 100 ÷ (206) (211)	468.45	373.33	315.01	171.94	72.29	0	0	0	0	184.15	330.95	467.7	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 2383.81 (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)	151.39	132.24	137.59	122.03	118.15	104.06	99.7	111.14	112.37	127.95	136.59	147.83	
Efficiency of water heater													81 (216)
(217)m=	87.65	87.47	87.04	85.96	84.08	81	81	81	81	86.01	87.16	87.69	(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	172.72	151.18	158.07	141.97	140.52	128.47	123.08	137.21	138.72	148.77	156.7	168.58	

Total = Sum(219a)$_{1...12}$ = 1766 (219)

Annual totals **kWh/year** **kWh/year**

Space heating fuel used, main system 1 2383.81

Water heating fuel used 1766

Electricity for pumps, fans and electric keep-hot

central heating pump: 30 (230c)

Total electricity for the above, kWh/year sum of (230a)…(230g) = 30 (231)

Electricity for lighting 204.17 (232)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year

DER WorkSheet: New dwelling design stage

Space heating (main system 1)	(211) x	0.216	=	514.9	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	381.46	(264)
Space and water heating	(261) + (262) + (263) + (264) =			896.36	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	105.96	(268)
Total CO2, kg/year		sum of (265)…(271) =		1017.9	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		24.08	(273)
EI rating (section 14)				84	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Chris Hocknell	**Stroma Number:**	STRO016363
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.26

Property Address: Flat 9-Lean

Address : Flat 9, 6, Lindfield Gardens, LONDON, NW3 6PU

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	66.9	(1a) x	2.05	(2a) =	137.14	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	66.9	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	137.14	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total		m³ 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) =	0.22	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

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)

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

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		10	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.72	(18)

Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used

Number of sides sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.92	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.66	(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
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

0.85	0.83	0.81	0.73	0.71	0.63	0.63	0.61	0.66	0.71	0.75	0.78

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	(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	(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=	0.86	0.85	0.83	0.77	0.76	0.7	0.7	0.69	0.72	0.76	0.78	0.81	(24d)

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

(25)m=	0.86	0.85	0.83	0.77	0.76	0.7	0.7	0.69	0.72	0.76	0.78	0.81	(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			2.2	x	1.3	=	2.86			(26)
Windows Type 1			1.78	x1/[1/(1.6)+ 0.04]		=	2.68			(27)
Windows Type 2			1.75	x1/[1/(1.6)+ 0.04]		=	2.63			(27)
Windows Type 3			1.55	x1/[1/(1.6)+ 0.04]		=	2.33			(27)
Rooflights Type 1			0.82	x1/[1/(1.3) + 0.04]		=	1.066			(27b)
Rooflights Type 2			0.82	x1/[1/(1.3) + 0.04]		=	1.066			(27b)
Rooflights Type 3			0.36	x1/[1/(1.3) + 0.04]		=	0.468			(27b)
Walls Type1	32.03	6.83	25.2	x	0.55	=	13.86			(29)
Walls Type2	17.06	2.2	14.86	x	0.55	=	8.17			(29)
Walls Type3	3.91	0	3.91	x	0.14	=	0.55			(29)
Roof Type1	49.43	4.1	45.33	x	0.18	=	8.16			(30)
Roof Type2	25.67	0.72	24.95	x	0.14	=	3.49			(30)
Roof Type3	13.6	0	13.6	x	0.14	=	1.9			(30)
Total area of elements, m²			141.7							(31)
Party wall			18.94	x	0	=	0			(32)
Party floor			66.9							(32a)

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-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 x U) (26)…(30) + (32) = 55.22 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 6881.45 (34)

Thermal mass parameter (TMP = Cm ÷ 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 x Y) calculated using Appendix K | 21.26 | (36)

if details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = | 76.48 | (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	38.89	38.26	37.64	34.73	34.19	31.66	31.66	31.19	32.63	34.19	35.29	36.44	(38)

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

(39)m=	115.37	114.74	114.12	111.21	110.67	108.13	108.13	107.67	109.11	110.67	111.77	112.92	

Average = $Sum(39)_{1...12}$ /12= | 111.21 | (39)

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

(40)m=	1.72	1.72	1.71	1.66	1.65	1.62	1.62	1.61	1.63	1.65	1.67	1.69

Average = $Sum(40)_{1...12}$ /12= | 1.66 | (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 | 2.17 | (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 85.7 | (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m=	94.27	90.85	87.42	83.99	80.56	77.13	77.13	80.56	83.99	87.42	90.85	94.27

Total = $Sum(44)_{1...12}$ = | 1028.44 | (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)

(45)m=	139.81	122.28	126.18	110	105.55	91.08	84.4	96.85	98.01	114.22	124.68	135.39

Total = $Sum(45)_{1...12}$ = | 1348.45 | (45)

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

(46)m=	20.97	18.34	18.93	16.5	15.83	13.66	12.66	14.53	14.7	17.13	18.7	20.31	(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)

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)

DER WorkSheet: New dwelling design stage

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) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

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	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 | 0 | (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	48.04	41.81	44.55	41.42	41.05	38.04	39.31	41.05	41.42	44.55	44.8	48.04	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	187.85	164.09	170.72	151.42	146.6	129.12	123.71	137.91	139.43	158.77	169.48	183.44	(62)

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	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	187.85	164.09	170.72	151.42	146.6	129.12	123.71	137.91	139.43	158.77	169.48	183.44

Output from water heater (annual)1…12 | 1862.53 | (64)

Heat gains from water heating, kWh/month 0.25 ´ [0.85 × (45)m + (61)m] + 0.8 x [(46)m + (57)m + (59)m]

(65)m=	58.5	51.11	53.09	46.93	45.36	39.79	37.89	42.47	42.94	49.11	52.66	57.03	(65)

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=	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	108.43	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	17.04	15.14	12.31	9.32	6.97	5.88	6.36	8.26	11.09	14.08	16.43	17.52	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	189.96	191.93	186.96	176.39	163.04	150.49	142.11	140.14	145.11	155.68	169.03	181.58	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	33.84	33.84	33.84	33.84	33.84	33.84	33.84	33.84	33.84	33.84	33.84	33.84	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	-86.74	(71)

Water heating gains (Table 5)

(72)m=	78.62	76.06	71.36	65.18	60.97	55.27	50.93	57.08	59.64	66.01	73.13	76.65	(72)

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

(73)m=	344.15	341.65	329.16	309.42	289.5	270.17	257.92	264.01	274.37	294.3	317.12	334.27	(73)

6. Solar gains:

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

DER WorkSheet: New dwelling design stage

Orientation:		Access Factor Table 6d	Area m²	Flux Table 6a	g_ Table 6b	FF Table 6c	Gains (W)	
Southeast	0.9x	0.77	1.78	36.79	0.63	0.7	20.02	(77)
Southeast	0.9x	0.77	1.78	62.67	0.63	0.7	34.09	(77)
Southeast	0.9x	0.77	1.78	85.75	0.63	0.7	46.65	(77)
Southeast	0.9x	0.77	1.78	106.25	0.63	0.7	57.8	(77)
Southeast	0.9x	0.77	1.78	119.01	0.63	0.7	64.74	(77)
Southeast	0.9x	0.77	1.78	118.15	0.63	0.7	64.27	(77)
Southeast	0.9x	0.77	1.78	113.91	0.63	0.7	61.97	(77)
Southeast	0.9x	0.77	1.78	104.39	0.63	0.7	56.79	(77)
Southeast	0.9x	0.77	1.78	92.85	0.63	0.7	50.51	(77)
Southeast	0.9x	0.77	1.78	69.27	0.63	0.7	37.68	(77)
Southeast	0.9x	0.77	1.78	44.07	0.63	0.7	23.97	(77)
Southeast	0.9x	0.77	1.78	31.49	0.63	0.7	17.13	(77)
Southwest	0.9x	0.77	1.75	36.79	0.63	0.7	39.36	(79)
Southwest	0.9x	0.77	1.75	62.67	0.63	0.7	67.04	(79)
Southwest	0.9x	0.77	1.75	85.75	0.63	0.7	91.72	(79)
Southwest	0.9x	0.77	1.75	106.25	0.63	0.7	113.65	(79)
Southwest	0.9x	0.77	1.75	119.01	0.63	0.7	127.3	(79)
Southwest	0.9x	0.77	1.75	118.15	0.63	0.7	126.38	(79)
Southwest	0.9x	0.77	1.75	113.91	0.63	0.7	121.84	(79)
Southwest	0.9x	0.77	1.75	104.39	0.63	0.7	111.66	(79)
Southwest	0.9x	0.77	1.75	92.85	0.63	0.7	99.32	(79)
Southwest	0.9x	0.77	1.75	69.27	0.63	0.7	74.09	(79)
Southwest	0.9x	0.77	1.75	44.07	0.63	0.7	47.14	(79)
Southwest	0.9x	0.77	1.75	31.49	0.63	0.7	33.68	(79)
Northwest	0.9x	0.77	1.55	11.28	0.63	0.7	5.34	(81)
Northwest	0.9x	0.77	1.55	22.97	0.63	0.7	10.88	(81)
Northwest	0.9x	0.77	1.55	41.38	0.63	0.7	19.6	(81)
Northwest	0.9x	0.77	1.55	67.96	0.63	0.7	32.19	(81)
Northwest	0.9x	0.77	1.55	91.35	0.63	0.7	43.27	(81)
Northwest	0.9x	0.77	1.55	97.38	0.63	0.7	46.13	(81)
Northwest	0.9x	0.77	1.55	91.1	0.63	0.7	43.15	(81)
Northwest	0.9x	0.77	1.55	72.63	0.63	0.7	34.4	(81)
Northwest	0.9x	0.77	1.55	50.42	0.63	0.7	23.88	(81)
Northwest	0.9x	0.77	1.55	28.07	0.63	0.7	13.3	(81)
Northwest	0.9x	0.77	1.55	14.2	0.63	0.7	6.73	(81)
Northwest	0.9x	0.77	1.55	9.21	0.63	0.7	4.36	(81)
Rooflights	0.9x	1	0.82	40.5	0.5	0.8	35.87	(82)
Rooflights	0.9x	1	0.82	15.92	0.5	0.8	9.4	(82)
Rooflights	0.9x	1	0.36	26	0.5	0.8	6.74	(82)

DER WorkSheet: New dwelling design stage

Rooflights 0.9x	1	x	0.82	x	73.74	x	0.5	x	0.8	=	65.31	(82)
Rooflights 0.9x	1	x	0.82	x	32.51	x	0.5	x	0.8	=	19.19	(82)
Rooflights 0.9x	1	x	0.36	x	54	x	0.5	x	0.8	=	14	(82)
Rooflights 0.9x	1	x	0.82	x	111.06	x	0.5	x	0.8	=	98.35	(82)
Rooflights 0.9x	1	x	0.82	x	59.5	x	0.5	x	0.8	=	35.13	(82)
Rooflights 0.9x	1	x	0.36	x	96	x	0.5	x	0.8	=	24.88	(82)
Rooflights 0.9x	1	x	0.82	x	150.59	x	0.5	x	0.8	=	133.36	(82)
Rooflights 0.9x	1	x	0.82	x	100.03	x	0.5	x	0.8	=	59.06	(82)
Rooflights 0.9x	1	x	0.36	x	150	x	0.5	x	0.8	=	38.88	(82)
Rooflights 0.9x	1	x	0.82	x	177.61	x	0.5	x	0.8	=	157.29	(82)
Rooflights 0.9x	1	x	0.82	x	136.88	x	0.5	x	0.8	=	80.81	(82)
Rooflights 0.9x	1	x	0.36	x	192	x	0.5	x	0.8	=	49.77	(82)
Rooflights 0.9x	1	x	0.82	x	179.47	x	0.5	x	0.8	=	158.94	(82)
Rooflights 0.9x	1	x	0.82	x	147.03	x	0.5	x	0.8	=	86.81	(82)
Rooflights 0.9x	1	x	0.36	x	200	x	0.5	x	0.8	=	51.84	(82)
Rooflights 0.9x	1	x	0.82	x	171.77	x	0.5	x	0.8	=	152.12	(82)
Rooflights 0.9x	1	x	0.82	x	137.1	x	0.5	x	0.8	=	80.94	(82)
Rooflights 0.9x	1	x	0.36	x	189	x	0.5	x	0.8	=	48.99	(82)
Rooflights 0.9x	1	x	0.82	x	151.65	x	0.5	x	0.8	=	134.31	(82)
Rooflights 0.9x	1	x	0.82	x	107.76	x	0.5	x	0.8	=	63.62	(82)
Rooflights 0.9x	1	x	0.36	x	157	x	0.5	x	0.8	=	40.69	(82)
Rooflights 0.9x	1	x	0.82	x	125.02	x	0.5	x	0.8	=	110.72	(82)
Rooflights 0.9x	1	x	0.82	x	73.17	x	0.5	x	0.8	=	43.2	(82)
Rooflights 0.9x	1	x	0.36	x	115	x	0.5	x	0.8	=	29.81	(82)
Rooflights 0.9x	1	x	0.82	x	84.48	x	0.5	x	0.8	=	74.82	(82)
Rooflights 0.9x	1	x	0.82	x	39.91	x	0.5	x	0.8	=	23.56	(82)
Rooflights 0.9x	1	x	0.36	x	66	x	0.5	x	0.8	=	17.11	(82)
Rooflights 0.9x	1	x	0.82	x	49.44	x	0.5	x	0.8	=	43.78	(82)
Rooflights 0.9x	1	x	0.82	x	20.03	x	0.5	x	0.8	=	11.83	(82)
Rooflights 0.9x	1	x	0.36	x	33	x	0.5	x	0.8	=	8.55	(82)
Rooflights 0.9x	1	x	0.82	x	34.03	x	0.5	x	0.8	=	30.14	(82)
Rooflights 0.9x	1	x	0.82	x	13.01	x	0.5	x	0.8	=	7.68	(82)
Rooflights 0.9x	1	x	0.36	x	21	x	0.5	x	0.8	=	5.44	(82)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	116.72	210.51	316.34	434.94	523.18	534.37	509.02	441.48	357.44	240.55	142	98.43	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	460.87	552.16	645.5	744.36	812.68	804.54	766.94	705.48	631.81	534.86	459.12	432.71	(84)

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	0.87	0.73	0.58	0.64	0.86	0.97	0.99	1	(86)

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

(87)m=	19.13	19.35	19.7	20.18	20.59	20.87	20.96	20.94	20.73	20.19	19.59	19.13	(87)

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

(88)m=	19.52	19.53	19.54	19.57	19.57	19.6	19.6	19.61	19.59	19.57	19.56	19.55	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.99	0.99	0.97	0.93	0.82	0.62	0.41	0.47	0.77	0.95	0.99	1	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	17.87	18.09	18.44	18.93	19.31	19.54	19.59	19.59	19.45	18.95	18.36	17.88	(90)

fLA = Living area ÷ (4) = 0.38 (91)

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

(92)m=	18.35	18.56	18.92	19.4	19.79	20.04	20.11	20.1	19.93	19.42	18.83	18.35	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	18.35	18.56	18.92	19.4	19.79	20.04	20.11	20.1	19.93	19.42	18.83	18.35	(93)

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	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.97	0.93	0.83	0.66	0.48	0.54	0.8	0.95	0.99	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	457.66	544.57	626.07	688.89	673.07	528.16	366.39	378.36	502.95	508.79	453.37	430.33	(95)
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)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1620.99	1567.74	1416.95	1168.12	895.59	588.6	379.45	398.56	636.18	976.02	1310.48	1598.21	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	865.52	687.57	588.42	345.05	165.56	0	0	0	0	347.62	617.11	868.9	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4485.74 (98)

Space heating requirement in kWh/m²/year 67.05 (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		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
Space heating requirement (calculated above)													
	865.52	687.57	588.42	345.05	165.56	0	0	0	0	347.62	617.11	868.9	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	958.49	761.43	651.63	382.11	183.34	0	0	0	0	384.96	683.41	962.24	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 4967.6 (211)

DER WorkSheet: New dwelling design stage

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)

187.85	164.09	170.72	151.42	146.6	129.12	123.71	137.91	139.43	158.77	169.48	183.44

Efficiency of water heater 81 (216)

(217)m=	88.49	88.35	88.03	87.24	85.68	81	81	81	81	87.16	88.12	88.53

(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	212.28	185.74	193.94	173.56	171.11	159.41	152.73	170.25	172.13	182.15	192.33	207.21

Total = Sum(219a)$_{1...12}$ = 2172.84 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		4967.6	
Water heating fuel used		2172.84	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =	30	(231)
Electricity for lighting		300.98	(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	=	1073	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	469.33	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1542.34	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	15.57	(267)
Electricity for lighting	(232) x	0.519	=	156.21	(268)
Total CO2, kg/year		sum of (265)…(271) =		1714.11	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		25.62	(273)
EI rating (section 14)				79	(274)