ABBEY CONSULTANTS

Energy Statement

Land to North of Cornells Lane, Widdington, Essex

Mr And Mrs M. Tee

Report No: PA-ES-MT-WN-21-01

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1. Assessment Information

Project Name	Widdington
Project Address	Land to North of Cornells Lane, Widdington, Essex
Developer	Mr and Mrs M. Tee
Developer Address	TBC
Architect	The Clarke Smith Partnership
Architect's Address	Unit 1, Chuck A Bush, Farm Barn, Royston Road, Whittlesford, Cambridge, CB22 4NW
Project Description	Erection of 4 no. detached dwellings and associated works.

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Reviewed by			

Issue Number	Author	Date	Reason
01	MH	24/06/21	Initial Issue
02			
03			

This document has been prepared for Mr and Mrs M. Tee only and solely for the purposes expressly defined herein. We owe no duty of care to any third parties in respect of its content. Therefore, unless expressly agreed by us in signed writing, we hereby exclude all liability to third parties, including liability for negligence, save only for liabilities that cannot be so excluded by operation of applicable law. The consequences of climate change and the effects of future changes in climatic conditions cannot be accurately predicted. This report has been based solely on the specific design assumptions and criteria stated herein

2. Executive Summary

This report considers the predicted energy and CO_2 demand for the proposed development at the Land to North of Cornells Lane, Widdington, Essex which is located in Uttlesford District Council.

The report complies with the policy requirements at both national and local level, as set out in the National Planning Policy Framework (2019) and the Uttlesford District Council's Local Plan (2005). Uttlesford District Council are in the early stages of preparing a new Local Plan. In the meantime, and to bridge the gap between the current Local Plan (2005) and the upcoming one, an Interim Climate Change Planning Policy document has been produced on a non-statutory basis. This report also adheres to the interim policies included within the Uttlesford District Council's Interim Climate Change Planning Policy document.

The proposed site will be built under Part L 2013 (with 2016 amendments) of the Building Regulations and in line with Uttlesford District Council's Interim Policy 12 target to achieve a 19% minimum reduction of the Dwelling Emission Rate (DER) against the Target Emission Rate (TER) as defined in the 2013 Building Regulations.

The development will reduce regulated CO_2 emissions by integrating a range of passive design and energy efficiency measures throughout the building. These measures include improving building fabric standards beyond the requirements of Part L of the Building Regulations. These measures enable the proposed scheme to go beyond Target Emission Rates (TER) and Target Fabric Energy Efficiency (TFEE) minimum standards via energy efficiency measures alone.

Following reduction of the energy demand through fabric and energy efficiency improvements, individual Air Source Heat Pumps (ASHP) have been proposed to supply hot water and space heating to the dwellings. In addition, it is proposed to install 7.5 kWp of PV to the east facing roof elevations across the development.

The regulated energy CO_2 savings expressed in terms of actual and percentage reduction after each stage of the energy hierarchy for the residential parts of the development are provided in the following tables.

The proposed individual ASHPs and inclusion of 7.5 kWp of PV, along with energy efficiency improvements, **save 5.11 tonnes of CO_2 per year** which represents a 41.85% saving over a gas baseline unit and is in excess of a 60% improvement over a Building Regulations baseline. This exceeds the requirements of Uttlesford District Council's Interim Policy 12, which stipulates a minimum 19% reduction is to be achieved.

Total energy demand savings are also expressed after each stage of the energy hierarchy for the development. The 'Be Green' measures alone will provide a saving of 35.16 MWh per year which contributes towards a 74.15% saving in total energy demand compared to a Building Regulations baseline.

Carbon Emissions Gas Baseline

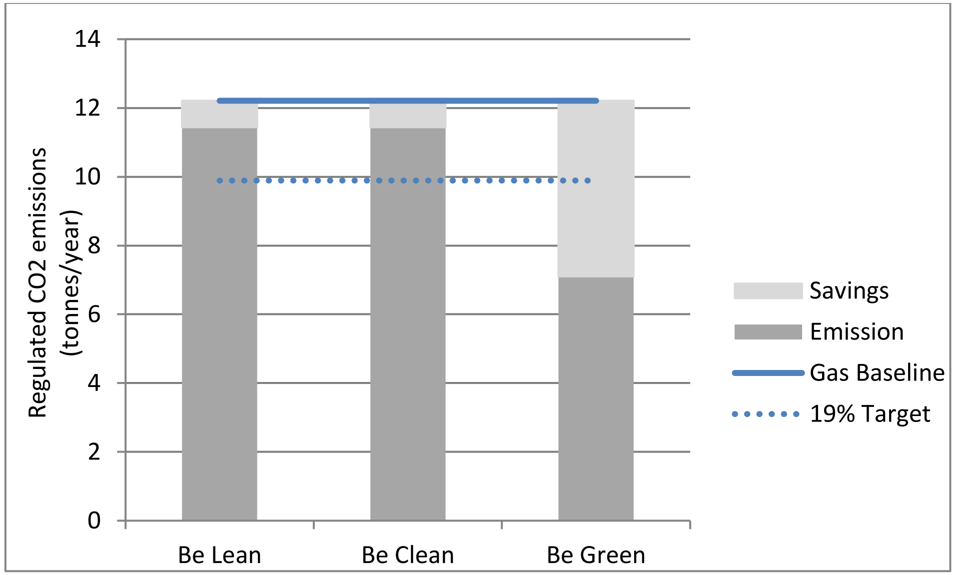
Element	CO_2 - Regulated (tonnes/year)	Total CO_2 Savings	% Saving
Baseline	12.21	0.00	0.00
Be Lean	11.44	0.77	6.31
After Heat Network	11.44	0.77	6.31
Be Green	7.10	5.11	41.85

Building Regulations assessment of the TER allows a fuel factor for use of electricity and therefore the baseline carbon emissions are different than for a gas heated dwelling. When the energy strategy after 'Be Green' is compared against a baseline of Building Regulations the carbon savings are much greater. The following table shows the carbon savings against a TER.

Carbon emissions Building Regulation's comparison

Element	CO_2 - Regulated (tonnes/year)	Improvement %
Baseline	18.18	
Be Green	7.10	60.95%

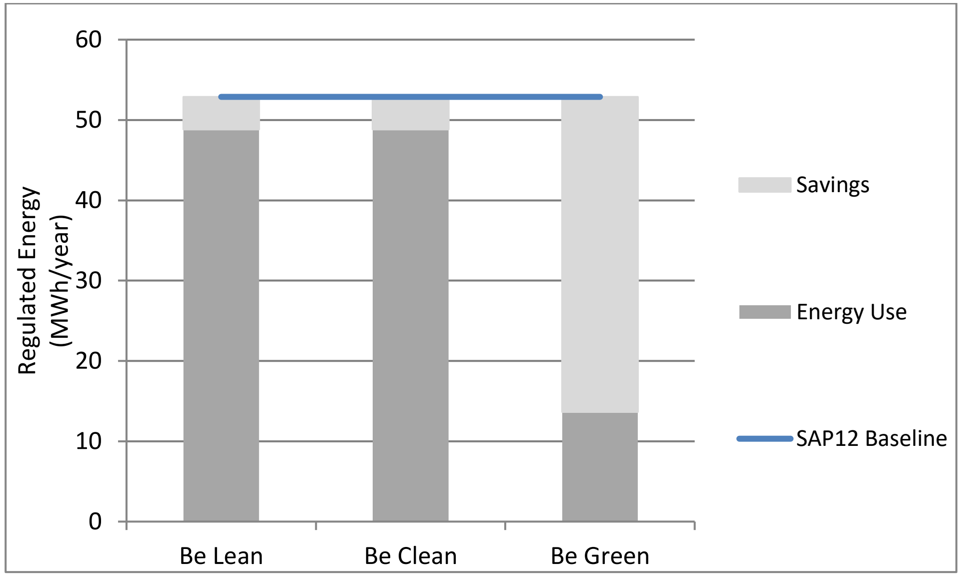
The overall reduction in regulated carbon emission to the residential units compared to a gas baseline can be illustrated graphically as below.



Energy Usage and Savings

Element	Energy - Regulated (MWh/year)	Total Savings (MWh/year)	% Saving
Residential Baseline	52.88	0	0.00
Be Lean	48.83	4.05	7.66
After Heat Network	48.83	4.05	7.66
Be Green	13.67	39.21	74.15

The overall reduction in energy usage to the residential units can be illustrated graphically as below.



The proposed strategy has first reduced energy demand through fabric and energy efficiency measures. The overall Part L Fabric Energy Efficiency (FEE) performance has been reviewed for the 'be lean' position and compared to the baseline stage of the energy hierarchy. The results of this can be seen in the table below. The total improvement has been shown to be 16.74% over Building Regulations.

Element	Target Fabric Energy Efficiency (TFEE) kWh/m^2/year	Dwelling Fabric Energy Efficiency (DFEE) kWh/m^2/year	Improvement (%)
Development Total	62.53	52.06	16.74

Summary

The proposed energy strategy achieves and meets the following requirements:

- Complies with Part L 2013 building regulations (with 2016 amendments) and shows a 60.95% carbon saving over a Building Regulations baseline (TER).
- Exceeds the 19.00% minimum reduction on the dwelling (carbon dioxide) emission rate (DER) against the Target Emission Rate (TER) of 2013 Building Regulations as required in Uttlesford District Council's Interim Policy 12.
- Saves 5.11 tonnes of carbon per year over a gas baseline.
- Shows a 41.85% carbon saving over a gas baseline.
- Total energy saving of 74.15% compared to a Building Regulations baseline (TER).
- Includes improved optimal building fabric improvements, energy efficient design of building services.
- An energy saving of 35.16 MWh/year is to be achieved through the inclusion of individual Air Source Heat Pumps and 7.5 kWp of PV across the scheme.
- Includes improved optimal building fabric improvements and energy efficient design of building services.
- Exceeds the TFEE minimum reduction requirements by 16.74%.

3. Introduction

This document has been prepared by Abbey Consultants (Southern) Ltd, a specialist environmental and energy consultancy on behalf of Mr and Mrs M. Tee.

The following report establishes a baseline assessment of the energy demands and associated CO_2 emissions for the development. The energy hierarchy approach of Be Lean, Be Clean and Be Green is then followed to ensure the maximum viable reductions in energy and regulated CO_2 emissions is achieved.

The proposed development is described as:

Erection of 4 no. detached dwellings and associated works.

The report takes into consideration the layout, use and requirements for the development to recommend a strategy that integrates the most suitable technologies available that are commercially viable, whilst also achieving compliance with all policies both at National and Local level applicable to this development.

Figure 1 presents the proposed site layout.

Figure 1: Site Plan

4. Planning Policy

4.1 National Planning Policy Framework (NPPF) 2019

The NPPF sets out the Government's planning policies for England and how these are expected to be applied. It sets out the Government's requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so. It provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.

Chapter 14 Meeting the challenge of climate change, flooding and coastal change

The following paragraphs set out the Government's position in response to reducing carbon emissions:

Paragraph 150: New development should be planned for in ways that:

a. avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and
b. can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards.

Paragraph 151. To help increase the use and supply of renewable and low carbon energy and heat, plans should:

a. provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);
b. consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and
c. identify opportunities for development to draw its energy supply from decentralised, renewable, or low carbon energy supply systems and for co-locating potential heat customers and suppliers.

Paragraph 153: In determining planning applications, local planning authorities should expect new development to:

a. comply with adopted Local Plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and
b. take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

Paragraph 154: When determining planning applications for renewable and low carbon development, local planning authorities should:

a. not require applicants to demonstrate the overall need for renewable or low carbon energy, and recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and
b. approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.

4.2 Planning update March 2015

The following written statement was published by the Ministry of Housing, Communities & Local Government and The Rt Hon Lord Pickles on the 25th March 2015:

Housing Standard Review

Following the technical Housing Standards Review, Government issued a Ministerial Statement in March 2015 withdrawing all national standards that applied to residential development. This had the impact of cancelling the Code for Sustainable Homes and BREEAM as it pertains to residential development, aside from the management of legacy cases.

Zero Carbon Homes: supporting small builders

The government highlighted their commitment to implementing the zero carbon homes standard in 2016 and in addition to the future strengthening of minimum on-site energy performance requirements introduced in the Infrastructure Act 2015 the powers needed to enable off-site carbon abatement measures (Allowable Solutions) to contribute to achieving the zero carbon standards. However they recognised achieving the zero carbon standards would be a challenge for home builders and in particular smaller home builders and consulted on how an exemption for small sites could operate.

It was decided there would be an exemption for small housing sites of 10 units or fewer, which are most commonly developed by small scale home builders and can be more expensive to develop irrespective of the size of the builder, from the allowable solutions element of the zero carbon homes target. All new homes will be required to meet the strengthened on-site energy performance standard but those building on small sites will not be required to support any further off-site carbon abatement measures.

Housing standards: streamlining the system

It was agreed that all new homes need to be high quality, accessible and sustainable. To achieve this, the government created a new approach for the setting of technical standards for new housing. This rationalises the many differing existing standards into a simpler, streamlined system which it is hoped would reduce burdens and help bring forward much needed new homes.

The new system comprises new additional optional Building Regulations on water and access, and a new national space standard (hereafter referred to as “the new national technical standards”). This system complements the existing set of Building Regulations.

Plan making

Since the date the Deregulation Bill 2015 was given Royal Assent, local planning authorities and qualifying bodies preparing neighbourhood plans should not set in their emerging Local Plans, neighbourhood plans, or supplementary planning documents, any additional local technical standards or requirements relating to the construction, internal layout or performance of new dwellings. This includes any policy requiring any level of the Code for Sustainable Homes to be achieved by new development; the government has now withdrawn the code, aside from the management of legacy cases.

Local planning authorities and qualifying bodies preparing neighbourhood plans are to consider their existing plan policies on technical housing standards or requirements and update them as appropriate, for example through a partial Local Plan review, or a full neighbourhood plan replacement in due course. Local planning authorities may also need to review their local information requirements to ensure that technical detail that is no longer necessary is not requested to support planning applications.

The optional new national technical standards should only be required through any new Local Plan policies if they address a clearly evidenced need, and where their impact on viability has been considered, in accordance with the National Planning Policy Framework and Planning Guidance. Neighbourhood plans should not be used to apply the new national technical standards.

For the specific issue of energy performance, local planning authorities will continue to be able to set and apply policies in their Local Plans which require compliance with energy performance standards that exceed the energy requirements of Building Regulations until commencement of amendments to the Planning and Energy Act 2008 in the Deregulation Bill 2015.

This was expected to happen alongside the introduction of zero carbon homes policy in late 2016. The government stated that, from then, the energy performance requirements in Building Regulations will be set at a level equivalent to the (outgoing) Code for Sustainable Homes Level 4. Until the amendment is commenced, it is expected local planning authorities to take this statement of the government’s intention into account in applying existing policies and not set conditions with requirements above a Code level 4 equivalent. This statement does not modify the National Planning Policy Framework policy allowing the connection of new housing development to low carbon infrastructure such as district heating networks.

Decision taking, transition and compliance:

Where there is an existing plan policy which references the Code for Sustainable Homes, it was decided authorities may continue to apply a requirement for a water efficiency standard equivalent to the new national technical standard, or in the case of energy a standard consistent with Code Level 4.

4.3 Local Policy

Uttlesford District Council

Uttlesford Local Plan

Adopted January 2005

Policy ENV15 – Renewable Energy

Small scale renewable energy development schemes to meet local needs will be permitted if they do not adversely affect the character of sensitive landscapes, nature conservation interests or residential and recreational amenity.

Policy GEN2 – Design:

Development will not be permitted unless its design meets all the following criteria and has regard to adopted Supplementary Design Guidance and Supplementary Planning Documents.

a) It is compatible with the scale, form, layout, appearance and materials of surrounding buildings;
b) It safeguards important environmental features in its setting, enabling their retention and helping to reduce the visual impact of new buildings or structures where appropriate;
c) It provides an environment, which meets the reasonable needs of all potential users.
d) It helps reduce the potential for crime;
e) It helps to minimise water and energy consumption;
f) It has regard to guidance on layout and design adopted as supplementary planning guidance to the development plan.
g) It helps to reduce waste production and encourages recycling and reuse.
h) It minimises the environmental impact on neighbouring properties by appropriate mitigating measures.
i) It would not have a materially adverse effect on the reasonable occupation and enjoyment of a residential or other sensitive property, as a result of loss of privacy, loss of daylight, overbearing impact or overshadowing.

Uttlesford District Council

Interim Climate Change Planning Policy

February 2021

To bridge the gap between the Council's adopted 2005 local plan and the new one, an Interim Climate Change Planning Policy document has been produced on a non-statutory basis. The main purpose of the document is to reiterate to developers that Uttlesford District Council is resolute about climate change mitigation and adaption measures. The Council expects to see this taken on board, when building new developments. It should also help officers in their negotiations to bring forward more climate friendly proposals.

The policies relevant to this Energy Statement are as follows:

Interim Policy 1:

Developers should demonstrate the path that their proposals take towards achieving net-zero carbon by 2030, and all the ways their proposals are working towards this in response to planning law, and also to the guidance set out in the NPPF and Planning Policy Guidance. This should include:

i. Locating the development where the associated climate change impacts and carbon emissions, including those derived from transport associated with the intended use of the development can be minimised, and

ii. Promoting development which minimises carbon emissions and greenhouse gas emissions and maximises the use of renewable or low carbon energy generation.

Interim Policy 2:

Developers should demonstrate how site surroundings and heritage have influenced their choices over climate change mitigation and adaption proposals.

Interim Policy 3:

Development should be designed to minimise consumption of water, and should make adequate and appropriate provision for water recycling. Development should also protect and enhance local water quality including measures to support improvement to a water body's Water Framework Directive status. A condition on all planning permissions for the erection of new residential development will be imposed to trigger the optional requirement under Part G of the Building Regulations for the maximum potential consumption of wholesome water of 110 litres per person per day.

Interim Policy 12:

Developers should demonstrate how green and intelligent design and green infrastructure have contributed to the sustainability of their proposals by reference to the themes in Paragraph 5.1, the general recommendations set out in Paragraph 5.3 and the energy hierarchy in Paragraph 5.37.

Paragraph 5.1
This section covers materials used in individual buildings and associated outdoor private areas. It firstly outlines general requirements and then looks at how this can be achieved through more detailed thematically structured advice and requirements. Themes covered, and which relate to climate change mitigation and adaption are:

- *Sustainable materials;*
- *Living walls and roofs as part of green and blue infrastructure;*
- *Reducing waste;*
- *Natural temperature, lighting and air quality control;*
- *Renewable energy; and*
- *Future proofing.*

Paragraph 5.3
The following recommendations will help developers meet the Council's commitment to achieve net-zero carbon status by 2030, supported and moderated by national policy and local authority guidance, for example contained in the UKGBC Policy Playbook.

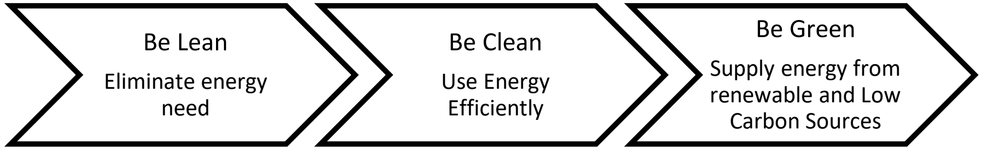
1. *If permitted by emerging national policy, all new homes (including conversions) should meet the Future Homes Standard and be net-zero carbon;*
2. *In the meantime, all new homes (including conversions) should achieve:*
   - *Code for Sustainable Homes Level 4 or equivalent;*
   - *A 19% minimum reduction on the dwelling (carbon dioxide) emission rate (DER) against the Target Emission Rate (TER) as defined in the 2013 Building Regulations, and*
   - *Future proofing to enable all new homes to be easily and affordably upgraded to be net-zero carbon by 2030 without diminishing the overall design;*
3. *All new non-residential development (including conversions) providing more than 25m^2 of floor space should achieve net-zero carbon status;*
4. *Applicants should calculate indoor air quality (CO2 and humidity) and overheating risk performance for all new buildings (including conversions) providing more than 25m^2 of floor space, ensuring buildings will operate in accordance with appropriate recommended levels for that use;*
5. *Applicants should demonstrate how the development maximises opportunities for renewable energy but an absolute minimum of 25% renewables should be achieved;*
6. *Applicants should assure that performance will match design stage predictions for all new buildings (including conversions) providing more than 25m^2 of floor space. This can be done through:*
   - *Demonstration of the development teams own internal processes and quality controls;*
   - *Demonstration of working within a third party process or system to ensure that standards are met on site, e.g. BEPIT Better Building Tool Kit or NEF's Assured Performance Toolkit;*
   - *Certification against independent assessment frameworks, e.g. Home Quality Mark (HQM), BREEAM, Passivhaus and Energiesprong; and*
   - *Energy assessment which, as a minimum should include the following:*
     i. *A calculation of the energy demand and carbon dioxide emissions for the proposed buildings using approved Building Regulations software and carried out by a qualified energy assessor;*
     ii. *Evidence that, as far as practicable, the development's design has been optimised to take into account solar gain, daylighting, ventilation and air quality (Design Optimisation);*

iii. *Evidence that, as far as practicable, the development's fabric performance minimises energy loss (Fabric Improvement); and*
iv. *Evidence that renewable energy sources have been considered and incorporated into the development where appropriate.*

Paragraph 5.37
The energy hierarchy had five priorities:
- *Priority 1 – Energy conservation*
- *Priority 2 – Energy efficiency*
- *Priority 3 – Renewables*
- *Priority 4 – Low emission*
- *Priority 5 – Conventional*

5. Development Approach

The proposed energy strategy follows the established and widely accepted Energy Hierarchy of eliminate energy need (Be Lean), Use energy efficiently (Be Clean) and supply energy from renewable and low carbon sources (Be Green) to enable the maximum viable reductions in regulated and total CO_2 emissions over the baseline.



The proposed energy supply solutions aim to match energy profiles of the development ensuring effective use. The proposed solutions consider viability and flexibility of the scheme from both a technical and economic point of view by identifying best combination of energy efficiency measures as well as decentralised and renewable energy supply solutions.

Using these principles, The Developer will deliver the following objectives:

- Comply with the relevant regulatory requirements.
- Ensure that a reduction in CO_2 beyond Part L 2013 standards is achieved across the site through fabric and energy efficiency measures.
- To propose to reduce energy consumption and carbon dioxide emissions further through the use of on-site renewable or low and zero carbon technologies (LZC).

5.1 Carbon Conversion Factors

The report has been prepared using current SAP 2012 Building Regulation carbon conversion factors as detailed in the table below.

Table 1: Carbon conversion factors

Fuel Type	SAP 2012 CO_2 Conversion Factors (kg/kWh)
Natural Gas	0.216
Grid Electricity	0.519

6. Energy Calculations (Baseline)

A baseline total energy demand has been established for the proposed development. Reductions in demand due to energy conservation measures are considered and form the basis of the energy strategy which follows.

Floor plans for the development have been used in conjunction with proposed building specifications to prepare the sample SAP calculations.

SAP calculations have been carried out to Approved Document Part L1A 2013. The relevant energy loads have been collated from the full SAP calculation sheets and entered into a spread sheet that can be found in the appendices, which calculates the total energy and CO_2 demand.

Regulated Energy Demand is calculated from the energy associated with space heating, hot water and fixed electrical demands (for lights, fans and pumps).

Unregulated energy is the annual electrical energy demand from appliances and would be calculated using the methodology as suggested by SAP2012. SAP calculations are extended to allow for CO_2 emissions associated with appliances and cooking, and to allow for site-wide electricity generation technologies.

Total Energy Demand for the development is calculated from the regulated energy demand figures given above and an additional energy demand associated with unregulated energy.

Energy savings are measured in terms of a reduction in CO_2 emissions and kWh, which are calculated from their association with a particular fuel source. CO_2 Conversion Factors have been taken from Table 2, Building Regulations Part L1A 2013.

6.1 Sample SAP Units

The regulated CO_2 emissions baseline has been established using a Part L1A 2013 Target Emission Rate (TER) of the sample of representative dwellings.

The following table provides the mix used to determine the baseline energy and CO_2 demand for the residential units.

Table 2: Residential Mix

Unit Reference	No. of Units
Plot 1	1
Plot 2	1
Plot 3	1
Plot 4	1
TOTAL:	**4**

6.2 Calculation of Baseline Energy and CO_2 Emissions

Thermal insulation levels and air tightness standards for the baseline case are assumed to just meet the requirements Part L1A 2013 of Building Regulations. The baseline specification as determined by SAP12 is detailed in the table below.

Table 3: Baseline design specification 2013

Element	Baseline Design Specification
Ground Floor	0.13 W/m2K
Exposed Floor	0.13 W/m2K
External Wall	0.18 W/m2K
Party Wall	0.00 W/m2K
Roof – insulated at ceiling	0.13 W/m2K
Roof – insulated at slope	0.13 W/m2K
Roof – flat	0.13 W/m2K
Glazing U-Value	1.40 W/m2K
Door U-Value	1.2 W/m2K
Design Air Permeability	5.00
Space Heating	Mains Gas 88.6% efficient
Heating Controls	Heating System controls
Domestic Hot water	Mains Gas
Ventilation	Natural ventilation with intermittent fans
Low Energy Lighting	100%
Thermal Bridging	Appendix R values

6.3 Energy And CO_2 Demand (Baseline)

Using the specification detailed and the outputs from SAP for the sample units, the baseline energy and carbon figures for the development are detailed in the table below.

Table 4: Predicted Carbon Emissions: Part L1A 2013 Baseline Unit (TER)

Element **Part L1A 2013**	Space Heating Demand	Hot Water demand	Pumps and fans	Lighting	Totals
Energy: Baseline (kWh p.a.)	39,864	10,413	300	2,299	**52,876**
CO_2 Associated with total Energy Demand ($kgCO_2$ p.a./a)	8,611	2,249	156	1,193	**12,209**

7. Passive Design and Energy Efficient Measures (Be Lean)

In accordance with the Energy Hierarchy, the energy demands of the development should be reduced as much as practically viable. The desire is to achieve Part L 2013 Building Regulations compliance before low carbon or renewable measures are introduced.

A range of measures to reduce CO_2 emissions and increase resilience to climate change are proposed in the building design including good building fabric standards as well as energy efficient M&E systems and lighting.

7.1 Passive Design

The development will incorporate a range of passive design measures and energy efficient building fabric that will reduce the demand for space heating, ventilation, and artificial lighting.

Passive design utilises daylight, solar energy and shading to illuminate, heat and shade where necessary and ventilate/cool the buildings, thus requiring less (mechanical) energy to achieve the performance standards for the health and wellbeing of the occupants.

Openable windows are proposed but are not essential to provide a fresh air supply.

Natural ventilation has been considered but is judged to be inappropriate due to the high energy efficiency requirements and the CO_2 reduction target. Therefore, decentralised system 3 mechanical ventilation has been specified as a more suitable approach to extract air from the dwellings.

The ventilation strategy will be reviewed again and developed as the design progresses to ensure compliance with all the relevant regulations and standards. It is assumed, in this scenario, that all windows can still be opened (albeit intermittently) for purge ventilation.

The proposed glazed areas have been designed to maximise daylight and optimise solar gains. This is enhanced by the linear south facing front elevations of the dwellings. The glazing specification has been reviewed to ensure that they provide a balance between solar control and solar gain.

7.2 Building Fabric

To reduce demand for space heating, emphasis has been placed on providing a very high standard of fabric efficiency and reducing heat loss through the building envelope. Approved Document Part L1A 2013 sets out the limiting fabric parameters for each of the building elements. Each stated value represents the area-weighted average U-value. The following table details the proposed U-values to be used in the described exposed element within the fabric of the development.

To further minimise heat loss through the building envelope, air leakage will be made a priority. The airtightness of the dwelling will be set to a level of 4.65 $m^3/h/m^2$ and will utilise continuously running decentralised extract fans (system 3) to ensure the airtightness of the dwellings can be kept low, without compromising on the necessity for good ventilation.

Table 5: Proposed U-Values

Element	Baseline Design Specification	Maximum Allowable SAP 2012	Proposed Design Stage Specification
Ground Floor	0.13 W/m^2K	0.25 W/m^2K	0.12 W/m^2K
Exposed Floor	0.13 W/m^2K	0.25 W/m^2K	N/A
External Wall	0.18 W/m^2K	0.30 W/m^2K	0.19 W/m^2K
Communal Wall	0.18 W/m^2K	0.30 W/m^2K	N/A
Party Wall	0.00 W/m^2K	0.20 W/m^2K	N/A
Roof – insulated at ceiling	0.13 W/m^2K	0.20 W/m^2K	0.11 W/m^2K
Roof – insulated at slope	0.13 W/m^2K	0.20 W/m^2K	0.15 W/m^2K
Roof – flat	0.13 W/m^2K	0.20 W/m^2K	0.15 W/m^2K
Glazing U-Value	1.40 W/m^2K	2.00 W/m^2K	U = 1.40 W/m^2K G = 0.63
Door U-Value	1.20 W/m^2K	2.00 W/m^2K	1.50 W/m^2K
Design Air Permeability (DAP)	5.00	10.00	4.65

7.3 Fabric Energy Efficiency (FEE)

Using the specification detailed previously the overall Part L Fabric Energy Efficiency (FEE) performance has been reviewed for the 'be lean' position and compared to the baseline stage of the energy hierarchy. The results are shown in the following table.

Table 6: Residential FEE Performance

Element	Target Fabric Energy Efficiency (TFEE) kWh/m^2/year	Dwelling Fabric Energy Efficiency (DFEE) kWh/m^2/year	Improvement (%)
Development Total	62.53	52.06	16.74

7.4 Energy And CO_2 Demand (Be Lean)

Using the specification detailed and the outputs from SAP for the sample units, the 'Be Lean' energy and carbon figures for the development are detailed in the table below, and an improvement can be seen when compared to the baseline figures outlined previously in Table 4.

Table 7: Predicted Energy Demand and Carbon Emissions: Be Lean

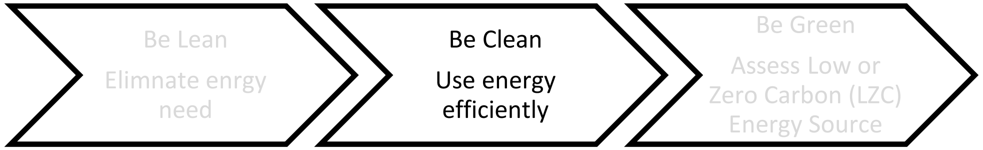
Element Part L1A 2013	Space Heating Demand	Hot Water demand	Pumps and fans	Lighting	Totals
Energy: Be Lean (kWh p.a.)	35,676	10,199	651	2,299	**48,825**
CO_2 Associated with total Energy Demand (kgCO_2 p.a./a)	7,706	2,203	338	1,193	**11,440**

A summary of the CO_2 and energy savings at the 'Be Lean' stage can be found in Table 8 below.

Table 8: CO_2 Savings: Be Lean

Element	CO_2 – Regulated (tonnes/year)	Energy Demand (MWh/year)
Gas Baseline	12.21	52.88
After energy demand reductions	11.44	48.83
Saving	0.77	4.05
Improvement	6%	8%

8. SUPPLY ENERGY EFFICIENTLY (BE CLEAN)



Combined Heat and Power (CHP)

Decentralised energy refers to energy that is generated off the main grid. This may include micro-renewables, heating and cooling. It can also refer to energy from waste plants, combined heat and power, district heating and cooling, as well as geothermal, biomass or solar energy. Decentralised Energy schemes can serve a single building or a whole community, even being built out across entire cities.

The heat source for the communal heating system should be selected in accordance with the following heating hierarchy:

1. Connect to local or existing planned heat networks.
    a. Use zero-emission or local secondary heat sources (in conjunction with heat pump, if required).
    b. Use low-emission combined heat and power (CHP) (only where there is a case for CHP to enable the delivery of an area-wide heat network).
    c. Use ultra-low NOx gas boilers.
2. CHP and ultra-low NOx gas boiler communal or district heating systems should be designed to ensure that they meet the requirements of national and local planning policy.
3. Where a heat network is planned but not yet in existence the development should be designed for connection at a later date.

There are many benefits of decentralised heat generation and Combined Heat and Power (CHP) in terms of cost and CO_2 emissions savings. However, technology such as this is more significant for larger developments, ideally complimented with some non-residential use of heat and electricity. The proposed development size of 4 dwellings is at the very low end of what the industry tends to view as viable for such systems. The development is for residential only and this will result in 'peaky' thermal demands with little anchor load to enable efficient operation of gas fired CHP. This option also risks the potential to increase costs to residents.

The site is neither sufficiently dense nor large enough to warrant investment from 3rd party managing agents or Energy Supply Companies (ESCos). The proposed development would need to be run by an independent agent/company and there would be very little if any interest among existing ESCos in servicing such a small-scale system. Even if it was possible, the cost of managing fuel procurement, customer billing, operation and maintenance would lead to disproportionally and unnecessary high service charges to residents compared to the provision of heat from individual gas boilers.

Based on the anticipated timescale of the proposed development and the predicted trajectory of the national electricity grid decarbonisation, the development of a district heat network powered by fossil fuels is also not considered to be the most carbon efficient approach.

The incorporation of a gas fired combined heat and power (CHP) network will lock the development into relatively carbon intensive gas-fired heating and hot water technology, and will not facilitate the transition to less carbon intensive solutions.

It should also be noted that there is currently no mains gas connection in the village of Widdington. This would increase the level of intrusion and complexity with regards to constructing a gas fired combined heat and power (CHP) network for this development.

9. Renewables Or LZC Technology (Be Green)

The following low and zero carbon technologies have been considered for this scheme:

- Air Source Heat Pump (ASHP)
- Photovoltaic Panels (PV)
- Ground Source Heat Pump (GSHP)
- Wind Turbines
- Biomass Boiler
- Solar Thermal

The assessment has shown that individual Air Source Heat Pumps (ASHPs) and Photovoltaics (PV) are considered to be the most suitable renewable energy options for this development.

All other renewable energy technology options are summarised in the appendices and have been deemed as not appropriate for this development.

9.1 Air Source Heat Pumps (ASHP)

Air at any temperature above absolute zero contains some energy. An air source heat pump transfers some of this energy as heat from one place to another, for example, between the outside and inside of a building. This can provide space heating and hot water. A system can be designed to transfer heat in either direction, to heat or cool the interior of the building in winter and summer respectively. For simplicity, the description below focuses on use for interior heating.

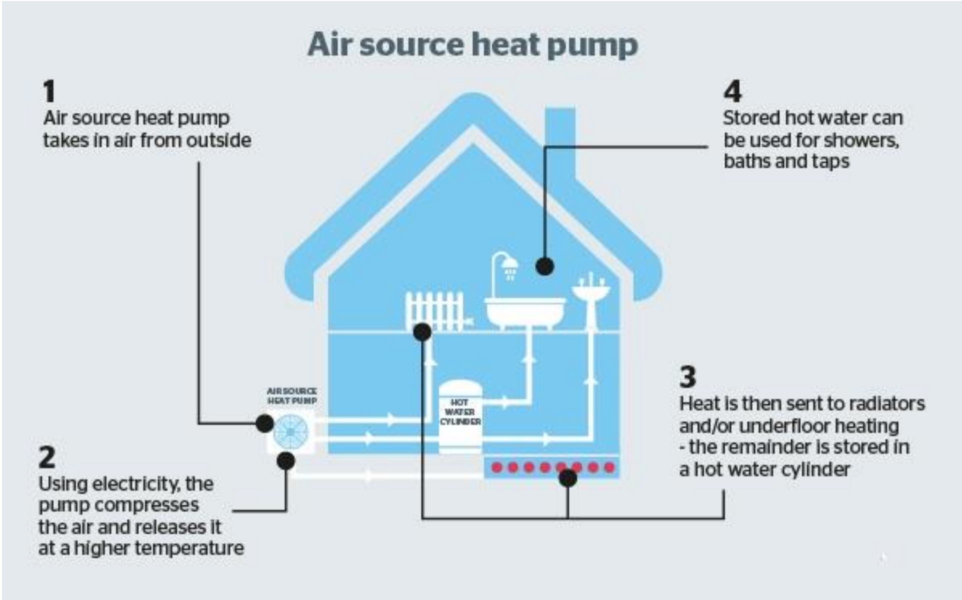
The technology is similar to a refrigerator/freezer or air conditioning unit. The different effect is due to the physical location of the different system components. Just as the pipes on the back of a refrigerator become warm as the interior cools, so an ASHP warms the inside of a building whilst cooling the outside air.

The main components of an ASHP are:

- An outdoor heat exchanger coil, which extracts heat from ambient air.
- An indoor heat exchanger coil, which transfers the heat into hot air ducts, an indoor heating system such as water-filled radiators or underfloor circuits and a domestic hot water tank.

The figure below demonstrates the typical operation of an ASHP system used to supply space heating and hot water to a property.

Figure 2: Example diagram of ASHP System



Some of the key advantages of ASHPs are listed below:

- ASHPs save carbon emissions. Unlike burning oil, gas, LPG or biomass, a heat pump produces no carbon emissions on-site (and no carbon emissions at all, if a renewable energy source is used to power them).
- They save space. There are no fuel storage requirements.
- They require less maintenance than combustion based heating systems.
- Heat pumps can provide cooling in summer, as well as heating in winter.
- There is no combustion involved and no direct emission of harmful gases.

The use of individual Air Source Heat Pumps (ASHP) is proposed for this development to efficiently supply the dwellings with space heating and hot water. The ASHP are to be situated on the ground floor at the rear/side of the houses.

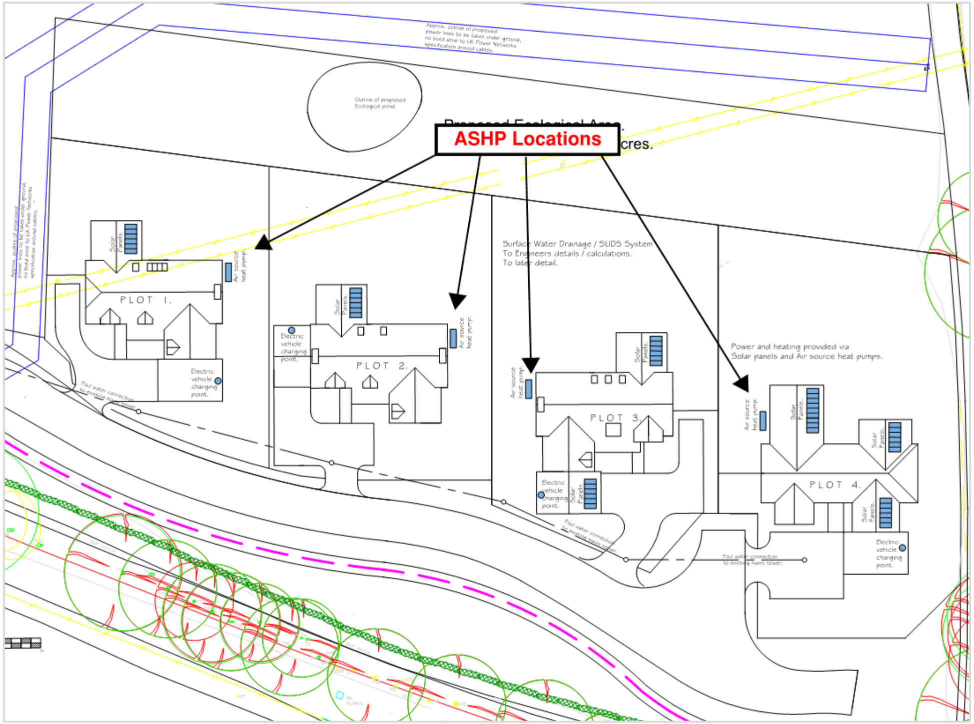
ASHPs will require electricity to operate, however this electricity can be supplied by renewable sources. This will future proof the home against the decarbonisation of the electricity grid.

A datasheet for the ASHP specified within the SAP calculations for the purpose of this report, has been included within the appendices.

The design of this system will be further developed during the detailed design stage.

The figure below shows the proposed location of the ASHP units.

Figure 3: Proposed ASHP locations



9.2 Photovoltaics (PV)

In addition to the use of individual ASHPs, it is proposed that the development will further reduce its net carbon and energy consumption by utilising solar photovoltaics (PV) panels. The following section explores the potential benefits of PV being added to the development and provides a proposal for the inclusion of PV panels.

Typical 300w Panel

- **Height 1.98m**
- **Width 0.95m**

Solar PV technology offers advantages over other low carbon and renewable energy technologies for the following reasons:

Density/scale

- Solar technologies are modular and can be sized to available space constraints and would easily be integrated into the roofscape of the proposed development.
- Solar PV technologies typically require 2-3 times more space to generate the equivalent energy or abate similar emissions as solar thermal panels, but they can be sized to the maximum available roof space.

Technology Integration

- Solar technologies can be easily integrated into the built environment using available roof space. Since they are modular and easily fixed to buildings they can access solar irradiation in almost any location. The technologies can be integrated on almost any roof structure or vertical façade without compromising structural or aesthetic requirements.

- Solar PV systems are generally connected to the dwelling or block via an inverter and any excess generation not utilised on-site is exported seamlessly to the local grid.

Cost-effectiveness

- Solar PV costs have reduced dramatically in the last 2-3 years in the UK, due to increasing demand for the technology driven by sustainability requirements and the Government's stimulus package known as the Feed-In Tariffs (FiTs) scheme which rewards renewable electricity generation with premium tariffs.

CO_2 Abatement Capacity

- Solar PV generates electricity and abates ~2.5 - 3 times more CO_2 than an alternative renewable energy technology that displaces use of gas (e.g. solar hot water technology and/or biomass boilers). Solar PV is well proven with good historical data showing that its performance credentials generally match or exceed manufacturers' claims/modelled generation profiles.

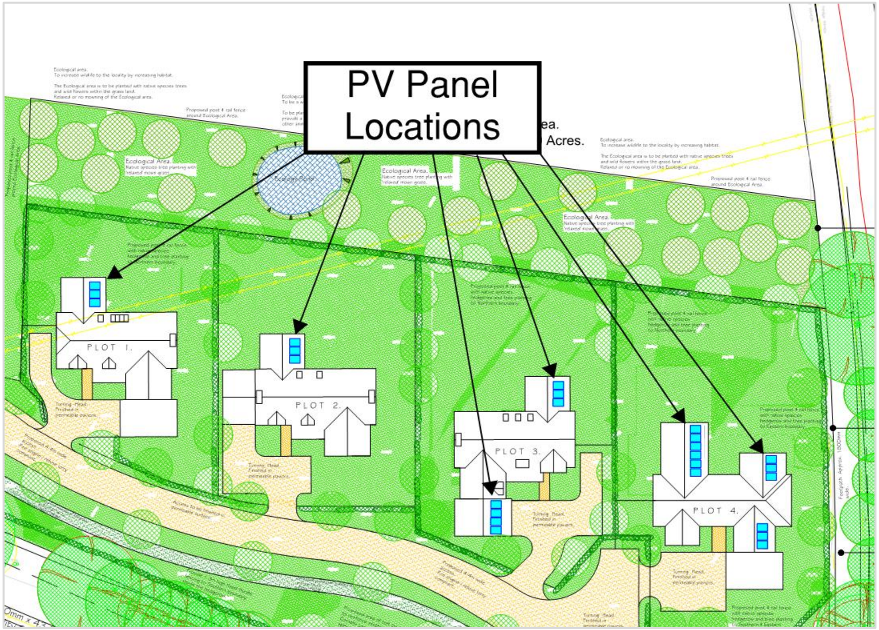
Although the south facing roof elevations on the development are the most efficient in terms of PV cell orientation, they are not deemed appropriate as dormers and gables have been specified in these locations which will limit the capacity for PV. The south facing roofs also face directly onto the new internal access road, and are therefore deemed inappropriate in order to lessen the visual impact of the PV cells. In addition, this PV proposal has given consideration to Uttlesford District Council's Interim Policy 2 and following advice from the Heritage Consultant a decision has been made not to propose installing any PV to the west facing roof elevations, as the PV panels would face toward the conservation area. However, it should be noted that the Applicants are willing to increase the quantity of PV to include the west facing roof elevations if Uttlesford District Council determine that it is appropriate to do so.

In light of the above, the east facing roof elevations are deemed most appropriate in this instance for PV. The table and figure across the page provide full detail of the PV proposal.

Table 9: Proposed PV Schedule

Plot	Roof Elevation Allocated For PV	No. of Panels	Total kWp of PV
Plot 1	East	3	0.9 kWp
Plot 2	East	3	0.9 kWp
Plot 3	East	7	2.1 kWp
Plot 4	East	12	3.6 kWp
	TOTAL:	25	7.5 kWp

Figure 4: Roof Elevations Allocated for PV Panels



The calculated CO_2 and energy savings through the introduction of the photovoltaic panels can be summarised as detailed in the table below and would abate the following in terms of energy and CO_2.

Table 10: Potential Energy and CO_2 abatement from PV

Item	Amount	Metric
Energy	5,118	kWh/year
CO_2	2,656	$kgCO_2$/year

The above table shows that PV would provide an additional saving of 2.66 tonnes of CO_2/year.

9.3 Energy And CO_2 Demand (Be Green)

Using the specification detailed and the outputs from SAP for the sample units, the 'Be Green' energy and carbon figures for the development are detailed in the table below, and an improvement can be seen when compared to Table 4 (baseline) and Table 7 (be lean).

Table 11: Predicted Energy Demand and Carbon Emissions: Be Green

Element Part L1A 2013	Space Heating Demand	Hot Water demand	Pumps and fans	Lighting	Electricity generated by PV	Totals
Energy: Be Green (kWh p.a.)	11,765	4,376	351	2,299	- 5,118	**13,673**
CO_2 Associated with total Energy Demand ($kgCO_2$ p.a./a)	6,106	2,271	182	1,193	- 2,656	**7,096**

A summary of the CO_2 and energy savings at the 'Be Lean' stage can be found in the table below.

Table 12: CO_2 and Energy Savings: Be Green compared against Gas baseline

Element	CO_2 – Regulated (tonnes/year)	Energy Demand (MWh/year)
Gas Baseline	12.21	52.88
After 'Be Green'	7.10	13.67
Saving	5.11	39.21
Improvement	42%	74%

Building Regulations assessment of the TER allows a fuel factor for use of electricity and therefore the baseline carbon emissions are different than for a gas heated dwelling. When the 'Be Green' proposals are compared against a baseline of Building Regulations the carbon savings are much greater. The following table shows the 'Be Green' carbon savings against a Building Regulations TER.

Table 13: CO_2 and Energy Savings: Be Green compared against Building Regulation TER

Element	CO_2 – Regulated (tonnes/year)
Building Regulations Baseline (TER)	18.18
After 'Be Green'	7.10
Saving	11.08
Improvement	60.95%

10. Summer Overheating and Cooling

With a continual drive for energy efficiency through both the Building Regulations and Local Planning Authority requirements, the risk of overheating to dwellings in the summer months is becoming more prevalent. Overheating can be a mild discomfort or a hazard to health if managed incorrectly, so it is vitally important that overheating risk be mitigated to ensure the dwelling will be both energy efficient and comfortable to live in.

Summer overheating is caused when there is excess build-up of heat within a dwelling. This can occur where there is excessive solar gain and limited means to absorb excess heat into the building fabric or purge this heat through ventilation. Summer overheating can be managed through a variety of measures and the chosen solution will vary from development to development. These measures can include:

Limiting solar gain

Glazing g value: This is a measure of how much solar radiation penetrates the glazing. The lower the g value the less solar gain enters a dwelling. Glazing with low g values may have a darker tint to the glazing, so aesthetic considerations are also a factor. Lower g values (below 0.5) are often required in apartments with single facades. Specifying g values below 0.2 will increase cost substantially and also limit the number of available suppliers for glazing.

External shading: Windows can be shaded with Brise Soleil or balconies of the dwelling above to reduce solar gain the in the summer months. If aligned correctly external shading can reduce solar gain in summer and still allow for it in winter when the sun is lower.

Internal Shading: Blinds can be used to limit solar gain in a dwelling. They can either be automatic, triggered by the sun’s presence on the window, or operated manually. Manual operation requires the occupant to be present however, so this option is not a reliable option when trying to mitigate overheating risk.

Purging excess heat build up

Thermal Mass: thermal mass is the measure of a dwellings ability to absorb energy. A dwelling with a high thermal mass (high proportion of concrete) has the ability to absorb heat during the day, which helps maintain a steady internal temperature. This heat can be released back into the dwelling at night time, when the temperature of the dwelling is lower, helping to maintain a consistent internal temperature.

Ventilation: A dwelling can be ventilated to purge excess heat build-up. This can be done through openable windows, especially where cross ventilation is possible. Where ventilation through windows isn’t possible, due to security, noise or pollution issues, Mechanical Ventilation can be used. The ventilation rates required to purge a dwelling can often be quite high, requiring oversized systems.

The SAP calculations have been used to assess the risk of overheating. The results of the assessment show that the dwellings have only a slight risk of overheating at worst and are therefore acceptable in terms of meeting Building Regulations requirements. This has been achieved using the following strategy:

- Thermal Mass
- Decentralised Mechanical Ventilation (continuously running decentralised extract fans)
- A G figure of 0.63 to the glazing

10.1 Over Heating Results: SAP calculations

The dwellings have been assessed as per the requirements of SAP 2012 Appendix P. The results are detailed as below and are shown to comply with Building Regulations.

Table 14: Results of overheating Assessment - SAP

Dwelling	Dwelling Type	Overheating June	Overheating July	Overheating August
Plot 1	House	Not significant	Slight	Slight
Plot 2	House	Not significant	Slight	Slight
Plot 3	House	Not significant	Slight	Slight
Plot 4	Bungalow	Not significant	Slight	Slight

11. Water Saving Measures

The following devices will be incorporated within each home:

- Water efficient taps.
- Water efficient cisterns.
- Low output showers.
- Flow restrictors to manage water pressures to achieve optimum levels.
- Water meters to all premises with guidance on water consumption and savings.

The following specification or similar will be adopted on the development to ensure that the internal water use is reduced to a maximum of 110 litres per head per day in line with Uttlesford District Council's Interim Policy 3.

Table 15: Specification of flow rates and volumes for water using appliances

Water using Appliance	Comment
WC Cisterns	Dual Flush to be limited to maximum of 6/3
Baths	Capacity no greater than 190 litres
Basin taps	Flow rates to be no greater than 3 litres/minute
Kitchen taps	Flow rates to be no greater than 6 litres/minute
Shower	Flow rates to be no greater than 8 litres/minute
Water softener	Not to be installed
Washing Machine	Water usage to be limited to 8.17 Litres per KG
Dishwasher	Water Usage to be limited to 1.25 litres per place setting

Table 16: Water Calculations

Water Calculations					
Installation Type	Unit	Capacity	Use Factor	Fixed use	**Total Use**
		Flow rate		(l/p/day)	**(l/p/day)**
WC Single Flush	Volume (l)	0.00	4.42	0.00	0.00
WC Dual Flush	Full Flush (l)	6.00	1.46	0.00	8.76
	Pt Flush (l)	3.00	2.96	0.00	8.88
WC's (Multiple)	Volume (l)	0.00	4.42	0.00	0.00
Taps Exc. Kitchen	Flow Rate	3.00	1.58	1.58	6.32
Bath (shower present)	(l/s)	190.00	0.11	0.00	20.90
Shower (bath present)	(l/s)	8.00	4.37	0.00	34.96
Bath Only	(l)	0.00	0.50	0.00	0.00
Shower Only	(l/s)	0.00	5.60	0.00	0.00
Kitchen Taps	(l/s)	6.00	0.44	10.36	13.00
Washing Machines	(l/kg/dry)	8.17	2.10	0.00	17.16
Dishwashers	(l/place)	1.25	3.60	0.00	4.50
Waste Disposal	(l/s)	0.00	3.08	0.00	0.00
Water Softener	(l/s)	0.00	1.00	0.00	0.00
Total Calculated Water Use (l/p/day)					**114.50**
Grey/Rain Water Reused (l)					0.00
Normalisation Factor	(Factor)				0.91
Total Internal Consumption (l/p/day)					**104.20**
External Water Use Allowance (l)					5.00
Total Consumption Part G (l/p/day)					**109.20**

12. Conclusions

The energy strategy has followed the accepted Energy Hierarchy Be Lean, Be Clean and Be Green. The energy strategy proposed for the development can be summarised as below.

The proposed individual ASHPs and inclusion of 7.5 kWp of PV, along with energy efficiency improvements, save 5.11 tonnes of CO_2 per year which represents a 41.85% saving over a gas baseline unit and is in excess of a 60% improvement over a Building Regulations baseline. This exceeds the requirements of Uttlesford District Council's Interim Policy 12, which stipulates a minimum 19% reduction is to be achieved.

Total energy demand savings are also expressed after each stage of the energy hierarchy for the development. The 'Be Green' measures alone will provide a saving of 35.16 MWh per year which contributes towards a 74.15% saving in total energy demand compared to a Building Regulations baseline.

Table 17: Proposed Energy Strategy

Element	Measure
Passive	Optimised design to enable controlled solar gain and improved direct and indirect natural lighting
Fabric	Building fabric U values have been enhanced over and above those detailed with Part L1A 2013
Heating	Individual ASHP to supply heat (refer to appendices for product datasheet)
Hot Water	Individual ASHP to supply heat (refer to appendices for product datasheet)
Ventilation	Mechanical ventilation System 3 Low design air permeability (DAP)
Lighting	Energy efficient LED Lighting where applicable
Renewables	7.5 kWp of PV to east facing roof elevations

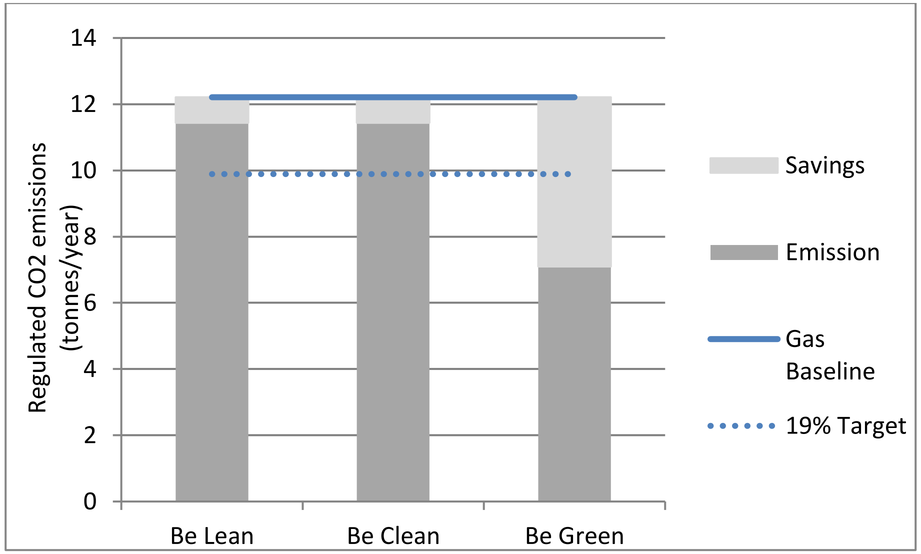
12.1 Total Residential CO_2 And Energy Savings

The summary of the overall reduction in residential CO_2 emissions after each stage of the energy hierarchy is summarised in the table below.

Table 18: Summary of CO_2 Savings Over Gas Baseline

Element	CO_2 - Regulated (tonnes/year)	Total CO_2 Savings	% Saving
Gas Baseline	12.21	0.00	0.00
Be Lean	11.44	0.77	6.31
After Heat Network	11.44	0.77	6.31
Be Green	7.10	5.11	41.85

The overall reduction in regulated carbon emission to the residential units can be illustrated graphically as below.



Building Regulations assessment of the TER allows a fuel factor for use of electricity and therefore the baseline carbon emissions are different than for a gas heated dwelling. When the energy strategy after 'Be Green' is compared against a baseline of Building Regulations the carbon savings are much greater. The following table shows the carbon savings against a TER.

Table 19: Carbon Emissions Building Regulation's (TER) comparison

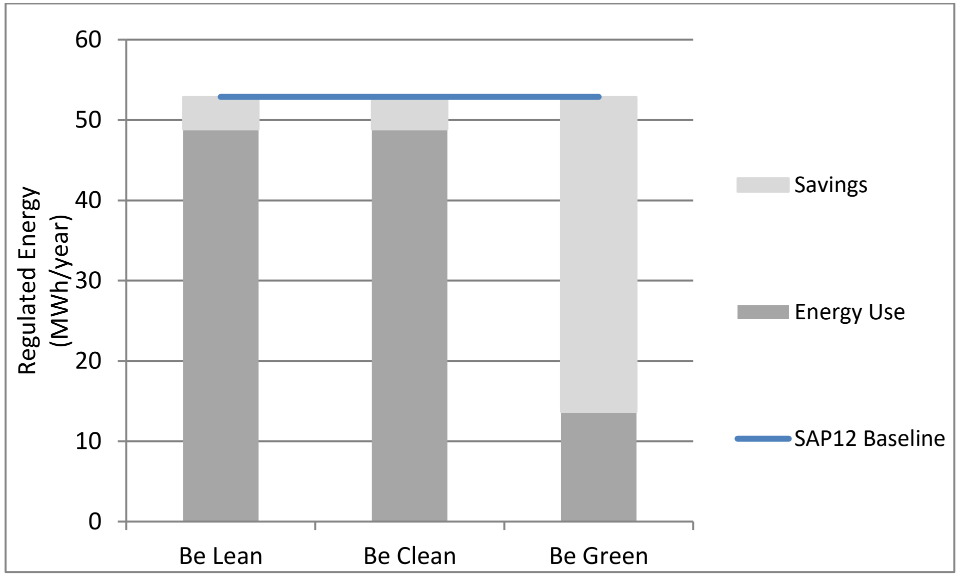
Element	CO_2 - Regulated (tonnes/year)	Improvement %
Baseline	18.18	
Be Green	7.10	60.95%

The summary of the overall reduction in residential energy after each stage of the energy hierarchy is summarised in the table below.

Table 20: Energy Usage and Savings

Element	Energy - Regulated (MWh/year)	Total Savings (MWh/year)	% Saving
Residential Baseline	52.88	0	0.00
Be Lean	48.83	4.05	7.66
After Heat Network	48.83	4.05	7.66
Be Green	13.67	39.21	74.15

The overall reduction in energy usage to the residential units can be illustrated graphically as below.



The proposed strategy has first reduced energy demand through fabric and energy efficiency measures. The overall Part L Fabric Energy Efficiency (FEE) performance has been reviewed for the 'be lean' position and compared to the baseline stage of the energy hierarchy. The improvement has been shown to be 16.74%.

Table 21: Residential FEE Performance

Element	Target Fabric Energy Efficiency (TFEE) kWh/m^2/year	Dwelling Fabric Energy Efficiency (DFEE) kWh/m^2/year	Improvement (%)
Development Total	62.53	52.06	16.74

Summary

The proposed energy strategy achieves and meets the following requirements:

- Complies with Part L 2013 building regulations (with 2016 amendments) and shows a 60.95% carbon saving over a Building Regulations baseline (TER).
- Exceeds the 19.00% minimum reduction on the dwelling (carbon dioxide) emission rate (DER) against the Target Emission Rate (TER) of 2013 Building Regulations as required in Uttlesford District Council's Interim Policy 12.
- Saves 5.11 tonnes of carbon per year over a gas baseline.
- Shows a 41.85% carbon saving over a gas baseline.
- Total energy saving of 74.15% compared to a Building Regulations baseline (TER).
- Includes improved optimal building fabric improvements, energy efficient design of building services.
- An energy saving of 35.16 MWh/year is to be achieved through the inclusion of individual Air Source Heat Pumps and 7.5 kWp of PV across the scheme.
- Includes improved optimal building fabric improvements and energy efficient design of building services.
- Exceeds the TFEE minimum reduction requirements by 16.74%.

13. Appendices

The following pages detail:

- The calculated energy and CO_2 outputs on a type by type basis
- Review of options for renewable energy generation
- Details on the ASHPs
- SAP output sheets

13.1 Appendix A: Energy and CO_2 Performance Type By Type

Energy	Include Unregulated Energy			No	2013	Predicted Energy Demand			
Type	Dwelling Name	TFA	No of Types	Main Heating Fuel Requirement (DER)	Water Fuel Requirement (DER)	Electricity Pumps Fans Requirement (DER)	Electricity Lighting Requirement (DER)	Unit Total	Development Total
Plot 1	House	204.28	1	3096	1098	95	601	4890	4890
Plot 2	House	204.28	1	3096	1098	95	601	4890	4890
Plot 3	House	204.28	1	3096	1098	95	601	4890	4890
Plot 4	Bungalow	144.43	1	2476	1082	67	497	4122	4122
Totals		757.27	4	11,765	4,376	351	2,299	18,791	18,791

CO2	Include Unregulated Energy			No	2013	Predicted CO2 Demand			
Type	Dwelling Name	TFA	No of Types	Main Heating Fuel Requirement (DER)	Water Fuel Requirement (DER)	Electricity Pumps Fans Requirement (DER)	Electricity Lighting Requirement (DER)	Unit Total	Development Total
Plot 1	House	204.28	1	1607	570	49	312	2538	2538
Plot 2	House	204.28	1	1607	570	49	312	2538	2538
Plot 3	House	204.28	1	1607	570	49	312	2538	2538
Plot 4	Bungalow	144.43	1	1285	561	35	258	2140	2140
Totals		757.27	4	6,106	2,271	182	1,193	9,753	9,753

13.2 Appendix B: Renewable Energy Options

The following alternative options to supply low carbon and renewable energy generation have been explored and discounted based on the following reasons:

Wind Turbines

Wind turbines come in a variety of sizes and shapes. Turbines of 1 Kw can be installed to single house and large-scale turbines of 1-2 MW can be installed on a development to generate electricity to multiple dwellings and other buildings. In both instances the electricity generated can be used on site or exported to the grid. Vertical- or horizontal-axis turbines are available.

A roof-mounted 1 kW micro wind system costs up to £3,000. A 2.5 kW pole-mounted system costs between £9,900 and £19,000. A 6 kW pole-mounted system costs between £21,000 and £30,000 (taken from the Energy Saving Trust, TBC by supplier)

- Local average wind speed is a determining factor. A minimum average wind speed of 6 m/s is required.
- Noise considerations can be an issue dependent on density and build-up of the surrounding area.
- Buildings in the immediate area can disrupt wind speed and reduce performance of the system.
- Planning permission will be required along with suitable space to site the turbine, whether ground installed or roof mounted.

Wind turbines have been discounted due to concerns over reliable wind resources. The use of wind turbines is likely to present aesthetic as well as nuisance issues.

Biomass Boilers

Providing a heating system fuelled by plant-based materials such as wood, crops or food waste. Biomass boilers generate heat for space heating and domestic hot water through the combustion of biofuels, such as woodchip, wood pellets or potentially biofuel or bio diesel. Biomass is considered to be virtually zero carbon. They can be used on an individual scale or for multiple dwellings as part of a district-heating network. A back-up heat source should be provided as consistent delivery of fuel is necessary for continued operation.

Biomass is considered a technically-viable option for this development scheme as there are no apparent physical constraints on site in terms of installing biomass boilers or storing a sufficient supply.

- There are, however, concerns regarding a sustainable supply of biomass to the site.
- The capital installation cost would also be high which leads us to the conclusion that biomass would not be a commercially-viable option for this development scheme.

Ground Source Heat Pumps (GSHP)

Ground Source Heat Pumps (GSHPs) operate on the same principle as an Air Source Heat Pump (ASHP) in that they extract heat from a source (in this instance the ground) and compress this energy to increase temperature for space heating and hot water. Pipework is installed into the ground, either through coils or in bore holes and piles, circulating a mix of water and antifreeze to extract energy from the ground, where the year-round temperature is relatively consistent (approx. 10°C at 4 metres depth). This leads to a reliable source of heat for the building.

Again, an electrically powered pump circulates the liquid and powers the compressor, however annual efficiencies for GSHPs tend to be higher than those of ASHPs.

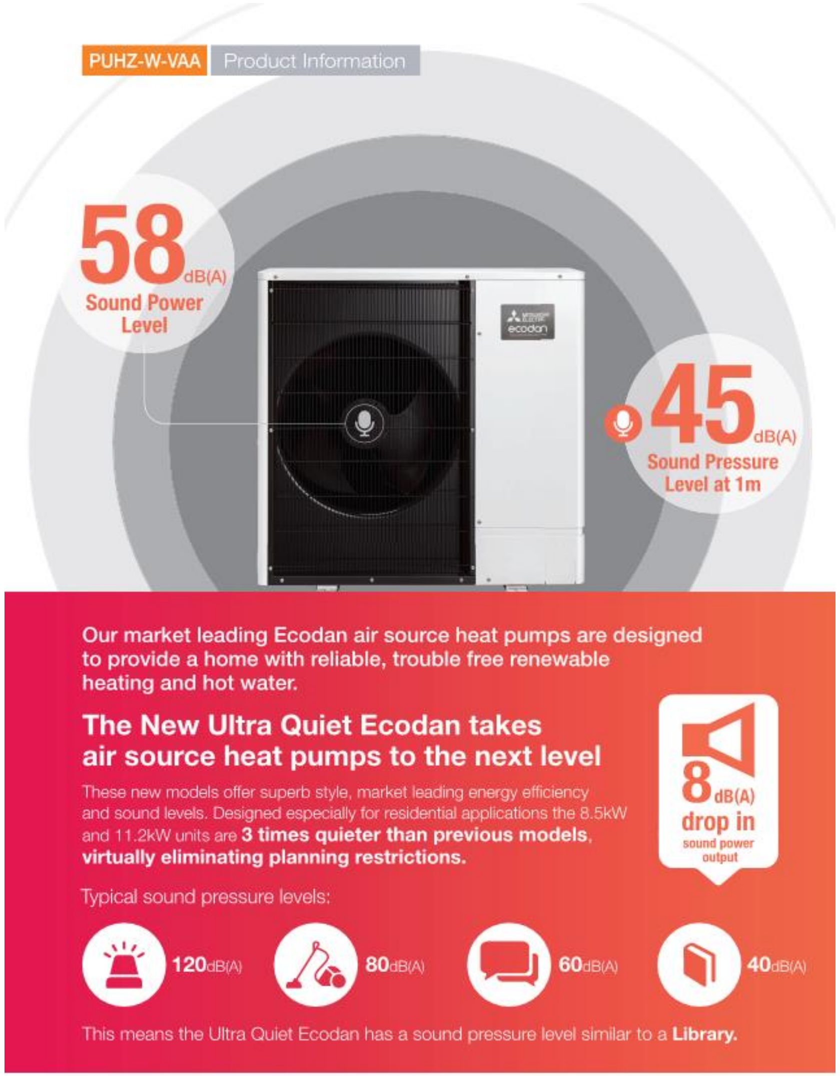
Discounted on the grounds of costs and available space. Incompatible with individual gas boilers and blocks of apartments.

Solar Thermal

Solar Thermal generates domestic hot water from the sun's radiation. Glycol circulates within either flat plate or evacuated tube panels, absorbing heat from the sun, and transferring this energy to a water cylinder. A well designed solar thermal system will account for 50-60% of a dwelling's annual hot water demand. Sizing the system to meet a higher demand will lead to excess heat generation in the summer months and overheating of the system.

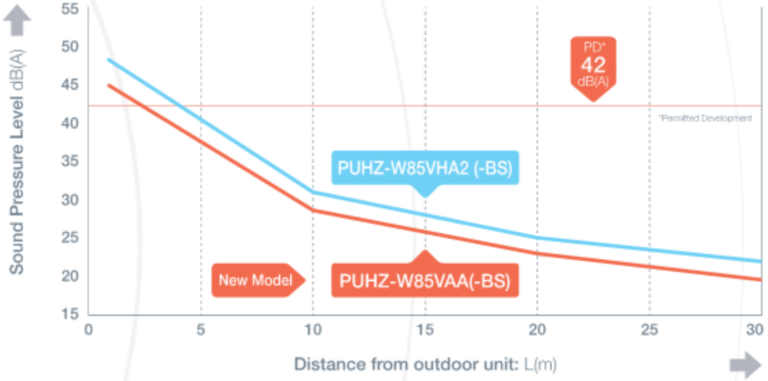
Unsuitable for blocks of flats and low carbon reduction efficiency compared to photovoltaic systems. Solar hot water systems for flatted blocks are only suitable where a central boiler plant room is provided to accommodate a central thermal store.

13.3 Appendix C: ASHP Details



Estimated Noise Levels
Based on the distance from the outdoor unit

Annotation and Measurement Condition
1. Sound data was measured once unit operation was stable.
2. Sound reflection from ground and surrounding walls is not considered.



Low Sound = **Heat Pump Placement Flexibility**

One of the regulations under **Permitted Development**, is that the sound pressure level of an air source heat pump must not exceed 42dB(A) 1m from the neighbours nearest room (Assessment Position).

With class leading **sound power levels of just 58dB(A)**, the Ultra Quiet Ecodan air source heat pump can be located much closer to the assessment position and **pass planning**.

This ultra quiet performance means you can now choose the most convenient location for your Ecodan, causing no disturbance to neighbours.

PASSED

ultraquietecodan.co.uk

ErP A++

PUHZ-W-VAA Product Information

APPROVED PRODUCT

PUHZ-W85VAA: MCS Ref: HP0002/45
PUHZ-W85VAA-BS: MCS Ref: HP0002/46
PUHZ-W112VAA: MCS Ref: HP0002/47
PUHZ-W112VAA-BS: MCS Ref: HP0002/48

Manufactured in the UK

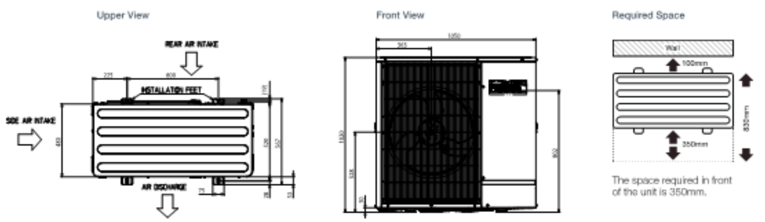
R410A

OUTDOOR UNIT		PUHZ-W85VAA(-BS)	PUHZ-W112VAA(-BS)
HEAT PUMP SPACE HEATER - 55°C	ErP Rating	A++	A++
	η_s	137%	133%
	SCOP	3.50	3.40
HEAT PUMP SPACE HEATER - 35°C	ErP Rating	A++	A++
	η_s	171%	170%
	SCOP	4.35	4.34
HEAT PUMP COMBINATION HEATER - Large Profile*1	ErP Rating	A	A
	η_{wh}	104%	100%
HEATING*2 (A-3/W35)	Capacity (kW)	8.3	11.0
	Power Input (kW)	2.86	3.73
	COP	2.90	2.95
OPERATING AMBIENT TEMPERATURE (°C DB)		-20 ~ +35°C	-20 ~ +35°C
SOUND DATA*3	Pressure Level at 1m (dBA)	45	47
	Power Level (dBA)*4	58	60
WATER DATA	Pipework Size (mm)	28	28
	Flow Rate (l/min)	25.8	32.1
	Water Pressure Drop (kPa)	16.1	24.4
DIMENSIONS (mm)*7	Width	1050	1050
	Depth	480	480
	Height	1020	1020
WEIGHT (kg)		97	118
ELECTRICAL DATA	Electrical Supply	220-240v, 50Hz	220-240v, 50Hz
	Phase	Single	Single
	Nominal Running Current [MAX] (A)	9.1 [22.0]	10.9 [28.0]
	Fuse Rating - MCB Sizes (A)*5	25	32
REFRIGERANT CHARGE (kg) / CO_2 EQUIVALENT (t)	R410A (GWP 2088)	2.4/5.01	3.3/6.89

*1 Combination with EHPT20X-MHCW Cylinder. *2 Under normal heating conditions at outdoor temp: -3°CDB / -4°CWB, outlet water temp 35°C, inlet water temp 30°C.
*3 Under normal heating conditions at outdoor temp: 7°CDB / 6°CWB, outlet water temp 55°C, inlet water temp 47°C as tested to BS EN14511. *4 Sound power level tested to BS EN12102. *5 MCB Sizes BS EN60898-2 & BS EN60947-2.
*6 Flow Temperature Controller (FTC) for standalone systems PAC-IF062B-E Dimensions WxDxH (mm) - 520x150x450

η_s is the seasonal space heating energy efficiency (SCOP) η_{wh} is the water heating energy efficiency

Product Dimensions PUHZ-W85 / 112VAA(-BS)



The space required in front of the unit is 350mm.

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Effective as of April 2018 SAP No. 338239

13.4 Appendix E: SAP Output Sheets

Baseline SAP Sheets

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matt Fitzpatrick	**Stroma Number:**	STRO003572
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.41

Property Address: Plot 1

Address : Plot 1, Widdington, TBC

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	119.31	(1a) x	2.5	(2a) =	298.27	(3a)
First floor	84.97	(1b) x	2.56	(2b) =	217.61	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	204.28	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	515.88	(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							4	x 10 =	40	(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) =	40	÷ (5) =	0.08	(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		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.33	(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) =	0.28	(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

TER WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.35	0.35	0.34	0.31	0.3	0.26	0.26	0.26	0.28	0.3	0.31	0.33

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=	0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(24d)

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

(25)m=	0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(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 Type 1			2.21	x	1.2	=	2.652			(26)
Doors Type 2			1.89	x	1.2	=	2.268			(26)
Windows Type 1			16.92	x1/[1/(1.4)+ 0.04]		=	22.43			(27)
Windows Type 2			3.6	x1/[1/(1.4)+ 0.04]		=	4.77			(27)
Windows Type 3			0.72	x1/[1/(1.4)+ 0.04]		=	0.95			(27)
Windows Type 4			9.9	x1/[1/(1.4)+ 0.04]		=	13.12			(27)
Rooflights			2.16	x1/[1/(1.7) + 0.04]		=	3.672			(27b)
Floor			119.31	x	0.13	=	15.5103			(28)
Walls Type1	170.21	35.24	134.97	x	0.18	=	24.29			(29)
Walls Type2	82.85	0	82.85	x	0.18	=	14.91			(29)
Roof Type1	58.74	0	58.74	x	0.13	=	7.64			(30)
Roof Type2	18.64	0	18.64	x	0.13	=	2.42			(30)
Roof Type3	16.35	0	16.35	x	0.13	=	2.13			(30)
Roof Type4	37.1	2.16	34.94	x	0.13	=	4.54			(30)
Total area of elements, m²			503.2							(31)
Internal wall **			29.96							(32c)
Internal wall **			304.16							(32c)

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Internal floor	84.97				(32d)
Internal ceiling	84.97				(32e)

** 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) =	121.09	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	26228.76	(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		22.25	(36)

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

Total fabric heat loss	(33) + (36) =	143.34	(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=	95.85	95.43	95.02	93.1	92.75	91.08	91.08	90.77	91.72	92.75	93.47	94.23	(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=	239.19	238.77	238.36	236.44	236.08	234.41	234.41	234.1	235.06	236.08	236.81	237.57	

Average = Sum(39)$_{1…12}$ /12= 236.44 (39)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(40)m=	1.17	1.17	1.17	1.16	1.16	1.15	1.15	1.15	1.15	1.16	1.16	1.16	

Average = Sum(40)$_{1…12}$ /12= 1.16 (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 3.01 (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) + 36 105.63 (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=	116.19	111.97	107.74	103.52	99.29	95.07	95.07	99.29	103.52	107.74	111.97	116.19	

Total = Sum(44)$_{1…12}$ = 1267.53 (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=	172.31	150.7	155.51	135.58	130.09	112.26	104.02	119.37	120.79	140.77	153.67	166.87	

Total = Sum(45)$_{1…12}$ = 1661.94 (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=	25.85	22.61	23.33	20.34	19.51	16.84	15.6	17.91	18.12	21.12	23.05	25.03	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

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a) If manufacturer's declared loss factor is known (kWh/day):		1.55	(48)
Temperature factor from Table 2b		0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0.84	(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)		0.84	(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	25.98	23.47	25.98	25.14	25.98	25.14	25.98	25.98	25.14	25.98	25.14	25.98	(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=	25.98	23.47	25.98	25.14	25.98	25.14	25.98	25.98	25.14	25.98	25.14	25.98	(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	221.55	195.18	204.75	183.23	179.33	159.91	153.27	168.61	168.45	190.02	201.32	216.11	(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=	221.55	195.18	204.75	183.23	179.33	159.91	153.27	168.61	168.45	190.02	201.32	216.11

Output from water heater (annual)$_{1...12}$ — 2241.73 (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=	96.69	85.69	91.1	83.2	82.65	75.45	73.98	79.08	78.29	86.2	89.22	94.88	(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=	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	34	30.2	24.56	18.59	13.9	11.73	12.68	16.48	22.12	28.09	32.78	34.95	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	375.1	378.99	369.18	348.3	321.94	297.17	280.62	276.72	286.53	307.41	333.77	358.54	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	(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=	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	(71)

Water heating gains (Table 5)

(72)m=	129.95	127.51	122.45	115.56	111.09	104.79	99.44	106.3	108.73	115.86	123.91	127.52	(72)

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

(73)m=	610.17	607.82	587.3	553.56	518.04	484.8	463.85	470.61	488.5	522.48	561.58	592.13	(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)	
North	0.9x	0.77	x	16.92	x	10.63	x	0.63	x	0.7	=	54.98	(74)
North	0.9x	0.77	x	16.92	x	20.32	x	0.63	x	0.7	=	105.08	(74)
North	0.9x	0.77	x	16.92	x	34.53	x	0.63	x	0.7	=	178.56	(74)
North	0.9x	0.77	x	16.92	x	55.46	x	0.63	x	0.7	=	286.81	(74)
North	0.9x	0.77	x	16.92	x	74.72	x	0.63	x	0.7	=	386.35	(74)
North	0.9x	0.77	x	16.92	x	79.99	x	0.63	x	0.7	=	413.6	(74)
North	0.9x	0.77	x	16.92	x	74.68	x	0.63	x	0.7	=	386.15	(74)
North	0.9x	0.77	x	16.92	x	59.25	x	0.63	x	0.7	=	306.36	(74)
North	0.9x	0.77	x	16.92	x	41.52	x	0.63	x	0.7	=	214.68	(74)
North	0.9x	0.77	x	16.92	x	24.19	x	0.63	x	0.7	=	125.08	(74)
North	0.9x	0.77	x	16.92	x	13.12	x	0.63	x	0.7	=	67.83	(74)
North	0.9x	0.77	x	16.92	x	8.86	x	0.63	x	0.7	=	45.84	(74)
East	0.9x	0.77	x	3.6	x	19.64	x	0.63	x	0.7	=	21.61	(76)
East	0.9x	0.77	x	3.6	x	38.42	x	0.63	x	0.7	=	42.27	(76)
East	0.9x	0.77	x	3.6	x	63.27	x	0.63	x	0.7	=	69.61	(76)
East	0.9x	0.77	x	3.6	x	92.28	x	0.63	x	0.7	=	101.53	(76)
East	0.9x	0.77	x	3.6	x	113.09	x	0.63	x	0.7	=	124.43	(76)
East	0.9x	0.77	x	3.6	x	115.77	x	0.63	x	0.7	=	127.37	(76)
East	0.9x	0.77	x	3.6	x	110.22	x	0.63	x	0.7	=	121.26	(76)
East	0.9x	0.77	x	3.6	x	94.68	x	0.63	x	0.7	=	104.16	(76)
East	0.9x	0.77	x	3.6	x	73.59	x	0.63	x	0.7	=	80.96	(76)
East	0.9x	0.77	x	3.6	x	45.59	x	0.63	x	0.7	=	50.16	(76)
East	0.9x	0.77	x	3.6	x	24.49	x	0.63	x	0.7	=	26.94	(76)
East	0.9x	0.77	x	3.6	x	16.15	x	0.63	x	0.7	=	17.77	(76)
South	0.9x	0.77	x	9.9	x	46.75	x	0.63	x	0.7	=	141.45	(78)
South	0.9x	0.77	x	9.9	x	76.57	x	0.63	x	0.7	=	231.66	(78)
South	0.9x	0.77	x	9.9	x	97.53	x	0.63	x	0.7	=	295.1	(78)
South	0.9x	0.77	x	9.9	x	110.23	x	0.63	x	0.7	=	333.52	(78)
South	0.9x	0.77	x	9.9	x	114.87	x	0.63	x	0.7	=	347.55	(78)
South	0.9x	0.77	x	9.9	x	110.55	x	0.63	x	0.7	=	334.47	(78)

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South	0.9x	0.77	x	9.9	x	108.01	x	0.63	x	0.7	=	326.8	(78)
South	0.9x	0.77	x	9.9	x	104.89	x	0.63	x	0.7	=	317.37	(78)
South	0.9x	0.77	x	9.9	x	101.89	x	0.63	x	0.7	=	308.26	(78)
South	0.9x	0.77	x	9.9	x	82.59	x	0.63	x	0.7	=	249.87	(78)
South	0.9x	0.77	x	9.9	x	55.42	x	0.63	x	0.7	=	167.67	(78)
South	0.9x	0.77	x	9.9	x	40.4	x	0.63	x	0.7	=	122.23	(78)
West	0.9x	0.77	x	0.72	x	19.64	x	0.63	x	0.7	=	4.32	(80)
West	0.9x	0.77	x	0.72	x	38.42	x	0.63	x	0.7	=	8.45	(80)
West	0.9x	0.77	x	0.72	x	63.27	x	0.63	x	0.7	=	13.92	(80)
West	0.9x	0.77	x	0.72	x	92.28	x	0.63	x	0.7	=	20.31	(80)
West	0.9x	0.77	x	0.72	x	113.09	x	0.63	x	0.7	=	24.89	(80)
West	0.9x	0.77	x	0.72	x	115.77	x	0.63	x	0.7	=	25.47	(80)
West	0.9x	0.77	x	0.72	x	110.22	x	0.63	x	0.7	=	24.25	(80)
West	0.9x	0.77	x	0.72	x	94.68	x	0.63	x	0.7	=	20.83	(80)
West	0.9x	0.77	x	0.72	x	73.59	x	0.63	x	0.7	=	16.19	(80)
West	0.9x	0.77	x	0.72	x	45.59	x	0.63	x	0.7	=	10.03	(80)
West	0.9x	0.77	x	0.72	x	24.49	x	0.63	x	0.7	=	5.39	(80)
West	0.9x	0.77	x	0.72	x	16.15	x	0.63	x	0.7	=	3.55	(80)
Rooflights	0.9x	1	x	2.16	x	15.3	x	0.63	x	0.7	=	13.11	(82)
Rooflights	0.9x	1	x	2.16	x	28.48	x	0.63	x	0.7	=	24.41	(82)
Rooflights	0.9x	1	x	2.16	x	50.24	x	0.63	x	0.7	=	43.07	(82)
Rooflights	0.9x	1	x	2.16	x	89.03	x	0.63	x	0.7	=	76.33	(82)
Rooflights	0.9x	1	x	2.16	x	129.88	x	0.63	x	0.7	=	111.35	(82)
Rooflights	0.9x	1	x	2.16	x	143.74	x	0.63	x	0.7	=	123.22	(82)
Rooflights	0.9x	1	x	2.16	x	132.31	x	0.63	x	0.7	=	113.43	(82)
Rooflights	0.9x	1	x	2.16	x	98.56	x	0.63	x	0.7	=	84.5	(82)
Rooflights	0.9x	1	x	2.16	x	62.62	x	0.63	x	0.7	=	53.69	(82)
Rooflights	0.9x	1	x	2.16	x	34.05	x	0.63	x	0.7	=	29.19	(82)
Rooflights	0.9x	1	x	2.16	x	18.64	x	0.63	x	0.7	=	15.98	(82)
Rooflights	0.9x	1	x	2.16	x	12.94	x	0.63	x	0.7	=	11.1	(82)

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

(83)m=	235.48	411.88	600.26	818.49	994.56	1024.14	971.89	833.22	673.79	464.33	283.82	200.49	(83)

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

(84)m=	845.65	1019.7	1187.56	1372.05	1512.6	1508.95	1435.74	1303.83	1162.29	986.81	845.4	792.62	(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	1	0.99	0.95	0.83	0.67	0.75	0.94	0.99	1	1	(86)

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

(87)m=	19.56	19.71	19.96	20.31	20.65	20.89	20.97	20.95	20.76	20.32	19.88	19.53	(87)

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

(88)m=	19.94	19.95	19.95	19.95	19.96	19.96	19.96	19.96	19.96	19.96	19.95	19.95	(88)

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

(89)m=	1	1	1	0.98	0.92	0.75	0.54	0.61	0.9	0.99	1	1	(89)

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

(90)m=	18	18.22	18.59	19.1	19.58	19.88	19.95	19.94	19.73	19.13	18.47	17.97	(90)

fLA = Living area ÷ (4) = 0.11 (91)

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

(92)m=	18.18	18.39	18.74	19.24	19.7	19.99	20.07	20.06	19.85	19.26	18.63	18.15	(92)

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

(93)m=	18.18	18.39	18.74	19.24	19.7	19.99	20.07	20.06	19.85	19.26	18.63	18.15	(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	1	0.99	0.97	0.91	0.75	0.55	0.63	0.89	0.99	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	844.92	1017.37	1179.43	1337.43	1378.11	1135.94	791.75	817.52	1034.49	973.34	843.72	792.13	(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=	3319.22	3220.18	2918.51	2444.44	1889.02	1264.06	812.49	855.74	1351.49	2045.16	2731.26	3313.15	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1840.88	1480.28	1293.87	797.05	380.12	0	0	0	0	797.44	1359.03	1875.64	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 9824.3 (98)

Space heating requirement in kWh/m²/year 48.09 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(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)													
	1840.88	1480.28	1293.87	797.05	380.12	0	0	0	0	797.44	1359.03	1875.64	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	1968.85	1583.19	1383.82	852.45	406.54	0	0	0	0	852.87	1453.5	2006.03	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 10507.27 (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)

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Water heating

Output from water heater (calculated above)

221.55	195.18	204.75	183.23	179.33	159.91	153.27	168.61	168.45	190.02	201.32	216.11

Efficiency of water heater: 79.8 (216)

(217)m=	89.21	89.11	88.87	88.29	86.77	79.8	79.8	79.8	79.8	88.22	88.96	89.26	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	248.33	219.04	230.39	207.54	206.67	200.39	192.06	211.29	211.09	215.38	226.3	242.11

Total = Sum(219a)$_{1...12}$ = 2610.59 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		10507.27	
Water heating fuel used		2610.59	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year — sum of (230a)…(230g) =		75	(231)
Electricity for lighting		600.52	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =		13793.39	(338)

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	=	2269.57	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	563.89	(264)
Space and water heating	(261) + (262) + (263) + (264) =				2833.46	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	311.67	(268)
Total CO2, kg/year			sum of (265)…(271) =		3184.05	(272)

TER = 15.59 (273)

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matt Fitzpatrick	**Stroma Number:**	STRO003572
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.41

Property Address: Plot 2

Address : Plot 2, Widdington, TBC

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	119.31	(1a)	x	2.5	(2a)	=	298.27	(3a)
First floor	84.97	(1b)	x	2.56	(2b)	=	217.61	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	204.28	(4)						
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	=	515.88	(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							4	x 10 =	40	(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) =	40	÷ (5) =	0.08	(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		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.33	(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) =	0.28	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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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

0.35	0.35	0.34	0.31	0.3	0.26	0.26	0.26	0.28	0.3	0.31	0.33

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=	0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(24d)

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

(25)m=	0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(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 Type 1			2.21	x	1.2	=	2.652			(26)
Doors Type 2			1.89	x	1.2	=	2.268			(26)
Windows Type 1			16.92	x1/[1/(1.4)+ 0.04]		=	22.43			(27)
Windows Type 2			3.6	x1/[1/(1.4)+ 0.04]		=	4.77			(27)
Windows Type 3			0.72	x1/[1/(1.4)+ 0.04]		=	0.95			(27)
Windows Type 4			9.9	x1/[1/(1.4)+ 0.04]		=	13.12			(27)
Rooflights			2.16	x1/[1/(1.7) + 0.04]		=	3.672			(27b)
Floor			119.31	x	0.13	=	15.5103			(28)
Walls Type1	170.21	35.24	134.97	x	0.18	=	24.29			(29)
Walls Type2	82.85	0	82.85	x	0.18	=	14.91			(29)
Roof Type1	58.74	0	58.74	x	0.13	=	7.64			(30)
Roof Type2	18.64	0	18.64	x	0.13	=	2.42			(30)
Roof Type3	16.35	0	16.35	x	0.13	=	2.13			(30)
Roof Type4	37.1	2.16	34.94	x	0.13	=	4.54			(30)
Total area of elements, m²			503.2							(31)
Internal wall **			29.96							(32c)
Internal wall **			304.16							(32c)

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Internal floor	84.97			(32d)
Internal ceiling	84.97			(32e)

** 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) =	121.09	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	26228.76	(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		22.25	(36)

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

Total fabric heat loss	(33) + (36) =	143.34	(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=	95.85	95.43	95.02	93.1	92.75	91.08	91.08	90.77	91.72	92.75	93.47	94.23	(38)

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

(39)m=	239.19	238.77	238.36	236.44	236.08	234.41	234.41	234.1	235.06	236.08	236.81	237.57	

Average = Sum(39)$_{1…12}$ /12= 236.44 (39)

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

(40)m=	1.17	1.17	1.17	1.16	1.16	1.15	1.15	1.15	1.15	1.16	1.16	1.16

Average = Sum(40)$_{1…12}$ /12= 1.16 (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 3.01 (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) + 36 105.63 (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=	116.19	111.97	107.74	103.52	99.29	95.07	95.07	99.29	103.52	107.74	111.97	116.19

Total = Sum(44)$_{1…12}$ = 1267.53 (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=	172.31	150.7	155.51	135.58	130.09	112.26	104.02	119.37	120.79	140.77	153.67	166.87

Total = Sum(45)$_{1…12}$ = 1661.94 (45)

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

(46)m=	25.85	22.61	23.33	20.34	19.51	16.84	15.6	17.91	18.12	21.12	23.05	25.03	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):			1.55	(48)
Temperature factor from Table 2b			0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =		0.84	(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)			0.84	(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	25.98	23.47	25.98	25.14	25.98	25.14	25.98	25.98	25.14	25.98	25.14	25.98	(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=	25.98	23.47	25.98	25.14	25.98	25.14	25.98	25.98	25.14	25.98	25.14	25.98	(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	221.55	195.18	204.75	183.23	179.33	159.91	153.27	168.61	168.45	190.02	201.32	216.11	(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=	221.55	195.18	204.75	183.23	179.33	159.91	153.27	168.61	168.45	190.02	201.32	216.11

Output from water heater (annual)1…12 — 2241.73 (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=	96.69	85.69	91.1	83.2	82.65	75.45	73.98	79.08	78.29	86.2	89.22	94.88	(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=	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	(66)

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

(67)m=	34	30.2	24.56	18.59	13.9	11.73	12.68	16.48	22.12	28.09	32.78	34.95	(67)

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

(68)m=	375.1	378.99	369.18	348.3	321.94	297.17	280.62	276.72	286.53	307.41	333.77	358.54	(68)

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

(69)m=	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	(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=	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	(71)

Water heating gains (Table 5)

(72)m=	129.95	127.51	122.45	115.56	111.09	104.79	99.44	106.3	108.73	115.86	123.91	127.52	(72)

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

(73)m=	610.17	607.82	587.3	553.56	518.04	484.8	463.85	470.61	488.5	522.48	561.58	592.13	(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)	
North	0.9x	0.77	x	16.92	x	10.63	x	0.63	x	0.7	=	54.98	(74)
North	0.9x	0.77	x	16.92	x	20.32	x	0.63	x	0.7	=	105.08	(74)
North	0.9x	0.77	x	16.92	x	34.53	x	0.63	x	0.7	=	178.56	(74)
North	0.9x	0.77	x	16.92	x	55.46	x	0.63	x	0.7	=	286.81	(74)
North	0.9x	0.77	x	16.92	x	74.72	x	0.63	x	0.7	=	386.35	(74)
North	0.9x	0.77	x	16.92	x	79.99	x	0.63	x	0.7	=	413.6	(74)
North	0.9x	0.77	x	16.92	x	74.68	x	0.63	x	0.7	=	386.15	(74)
North	0.9x	0.77	x	16.92	x	59.25	x	0.63	x	0.7	=	306.36	(74)
North	0.9x	0.77	x	16.92	x	41.52	x	0.63	x	0.7	=	214.68	(74)
North	0.9x	0.77	x	16.92	x	24.19	x	0.63	x	0.7	=	125.08	(74)
North	0.9x	0.77	x	16.92	x	13.12	x	0.63	x	0.7	=	67.83	(74)
North	0.9x	0.77	x	16.92	x	8.86	x	0.63	x	0.7	=	45.84	(74)
East	0.9x	0.77	x	3.6	x	19.64	x	0.63	x	0.7	=	21.61	(76)
East	0.9x	0.77	x	3.6	x	38.42	x	0.63	x	0.7	=	42.27	(76)
East	0.9x	0.77	x	3.6	x	63.27	x	0.63	x	0.7	=	69.61	(76)
East	0.9x	0.77	x	3.6	x	92.28	x	0.63	x	0.7	=	101.53	(76)
East	0.9x	0.77	x	3.6	x	113.09	x	0.63	x	0.7	=	124.43	(76)
East	0.9x	0.77	x	3.6	x	115.77	x	0.63	x	0.7	=	127.37	(76)
East	0.9x	0.77	x	3.6	x	110.22	x	0.63	x	0.7	=	121.26	(76)
East	0.9x	0.77	x	3.6	x	94.68	x	0.63	x	0.7	=	104.16	(76)
East	0.9x	0.77	x	3.6	x	73.59	x	0.63	x	0.7	=	80.96	(76)
East	0.9x	0.77	x	3.6	x	45.59	x	0.63	x	0.7	=	50.16	(76)
East	0.9x	0.77	x	3.6	x	24.49	x	0.63	x	0.7	=	26.94	(76)
East	0.9x	0.77	x	3.6	x	16.15	x	0.63	x	0.7	=	17.77	(76)
South	0.9x	0.77	x	9.9	x	46.75	x	0.63	x	0.7	=	141.45	(78)
South	0.9x	0.77	x	9.9	x	76.57	x	0.63	x	0.7	=	231.66	(78)
South	0.9x	0.77	x	9.9	x	97.53	x	0.63	x	0.7	=	295.1	(78)
South	0.9x	0.77	x	9.9	x	110.23	x	0.63	x	0.7	=	333.52	(78)
South	0.9x	0.77	x	9.9	x	114.87	x	0.63	x	0.7	=	347.55	(78)
South	0.9x	0.77	x	9.9	x	110.55	x	0.63	x	0.7	=	334.47	(78)

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South	0.9x	0.77	x	9.9	x	108.01	x	0.63	x	0.7	=	326.8	(78)
South	0.9x	0.77	x	9.9	x	104.89	x	0.63	x	0.7	=	317.37	(78)
South	0.9x	0.77	x	9.9	x	101.89	x	0.63	x	0.7	=	308.26	(78)
South	0.9x	0.77	x	9.9	x	82.59	x	0.63	x	0.7	=	249.87	(78)
South	0.9x	0.77	x	9.9	x	55.42	x	0.63	x	0.7	=	167.67	(78)
South	0.9x	0.77	x	9.9	x	40.4	x	0.63	x	0.7	=	122.23	(78)
West	0.9x	0.77	x	0.72	x	19.64	x	0.63	x	0.7	=	4.32	(80)
West	0.9x	0.77	x	0.72	x	38.42	x	0.63	x	0.7	=	8.45	(80)
West	0.9x	0.77	x	0.72	x	63.27	x	0.63	x	0.7	=	13.92	(80)
West	0.9x	0.77	x	0.72	x	92.28	x	0.63	x	0.7	=	20.31	(80)
West	0.9x	0.77	x	0.72	x	113.09	x	0.63	x	0.7	=	24.89	(80)
West	0.9x	0.77	x	0.72	x	115.77	x	0.63	x	0.7	=	25.47	(80)
West	0.9x	0.77	x	0.72	x	110.22	x	0.63	x	0.7	=	24.25	(80)
West	0.9x	0.77	x	0.72	x	94.68	x	0.63	x	0.7	=	20.83	(80)
West	0.9x	0.77	x	0.72	x	73.59	x	0.63	x	0.7	=	16.19	(80)
West	0.9x	0.77	x	0.72	x	45.59	x	0.63	x	0.7	=	10.03	(80)
West	0.9x	0.77	x	0.72	x	24.49	x	0.63	x	0.7	=	5.39	(80)
West	0.9x	0.77	x	0.72	x	16.15	x	0.63	x	0.7	=	3.55	(80)
Rooflights	0.9x	1	x	2.16	x	15.3	x	0.63	x	0.7	=	13.11	(82)
Rooflights	0.9x	1	x	2.16	x	28.48	x	0.63	x	0.7	=	24.41	(82)
Rooflights	0.9x	1	x	2.16	x	50.24	x	0.63	x	0.7	=	43.07	(82)
Rooflights	0.9x	1	x	2.16	x	89.03	x	0.63	x	0.7	=	76.33	(82)
Rooflights	0.9x	1	x	2.16	x	129.88	x	0.63	x	0.7	=	111.35	(82)
Rooflights	0.9x	1	x	2.16	x	143.74	x	0.63	x	0.7	=	123.22	(82)
Rooflights	0.9x	1	x	2.16	x	132.31	x	0.63	x	0.7	=	113.43	(82)
Rooflights	0.9x	1	x	2.16	x	98.56	x	0.63	x	0.7	=	84.5	(82)
Rooflights	0.9x	1	x	2.16	x	62.62	x	0.63	x	0.7	=	53.69	(82)
Rooflights	0.9x	1	x	2.16	x	34.05	x	0.63	x	0.7	=	29.19	(82)
Rooflights	0.9x	1	x	2.16	x	18.64	x	0.63	x	0.7	=	15.98	(82)
Rooflights	0.9x	1	x	2.16	x	12.94	x	0.63	x	0.7	=	11.1	(82)

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

(83)m=	235.48	411.88	600.26	818.49	994.56	1024.14	971.89	833.22	673.79	464.33	283.82	200.49	(83)

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

(84)m=	845.65	1019.7	1187.56	1372.05	1512.6	1508.95	1435.74	1303.83	1162.29	986.81	845.4	792.62	(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	1	0.99	0.95	0.83	0.67	0.75	0.94	0.99	1	1	(86)

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

(87)m=	19.56	19.71	19.96	20.31	20.65	20.89	20.97	20.95	20.76	20.32	19.88	19.53	(87)

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

(88)m=	19.94	19.95	19.95	19.95	19.96	19.96	19.96	19.96	19.96	19.96	19.95	19.95	(88)

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

(89)m=	1	1	1	0.98	0.92	0.75	0.54	0.61	0.9	0.99	1	1	(89)

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

(90)m=	18	18.22	18.59	19.1	19.58	19.88	19.95	19.94	19.73	19.13	18.47	17.97	(90)

fLA = Living area ÷ (4) = 0.11 (91)

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

(92)m=	18.18	18.39	18.74	19.24	19.7	19.99	20.07	20.06	19.85	19.26	18.63	18.15	(92)

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

(93)m=	18.18	18.39	18.74	19.24	19.7	19.99	20.07	20.06	19.85	19.26	18.63	18.15	(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	1	0.99	0.97	0.91	0.75	0.55	0.63	0.89	0.99	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	844.92	1017.37	1179.43	1337.43	1378.11	1135.94	791.75	817.52	1034.49	973.34	843.72	792.13	(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=	3319.22	3220.18	2918.51	2444.44	1889.02	1264.06	812.49	855.74	1351.49	2045.16	2731.26	3313.15	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1840.88	1480.28	1293.87	797.05	380.12	0	0	0	0	797.44	1359.03	1875.64	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 9824.3 (98)

Space heating requirement in kWh/m²/year 48.09 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(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)													
	1840.88	1480.28	1293.87	797.05	380.12	0	0	0	0	797.44	1359.03	1875.64	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	1968.85	1583.19	1383.82	852.45	406.54	0	0	0	0	852.87	1453.5	2006.03	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 10507.27 (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)

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Water heating

Output from water heater (calculated above)

221.55	195.18	204.75	183.23	179.33	159.91	153.27	168.61	168.45	190.02	201.32	216.11

Efficiency of water heater 79.8 (216)

(217)m=	89.21	89.11	88.87	88.29	86.77	79.8	79.8	79.8	79.8	88.22	88.96	89.26	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	248.33	219.04	230.39	207.54	206.67	200.39	192.06	211.29	211.09	215.38	226.3	242.11

Total = Sum(219a)$_{1...12}$ = 2610.59 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		10507.27	
Water heating fuel used		2610.59	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		75	(231)
Electricity for lighting		600.52	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =		13793.39	(338)

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	=	2269.57	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	563.89	(264)
Space and water heating	(261) + (262) + (263) + (264) =			2833.46	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	311.67	(268)
Total CO2, kg/year		sum of (265)…(271) =		3184.05	(272)

TER = 15.59 (273)

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matt Fitzpatrick	**Stroma Number:**	STRO003572
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.41

Property Address: Plot 3

Address : Plot 3, Widdington, TBC

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	119.31	(1a)	x	2.5	(2a)	=	298.27	(3a)
First floor	84.97	(1b)	x	2.56	(2b)	=	217.61	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	204.28	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	515.88	(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							4	x 10 =	40	(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) =	40	÷ (5) =	0.08	(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		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.33	(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) =	0.28	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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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

0.35	0.35	0.34	0.31	0.3	0.26	0.26	0.26	0.28	0.3	0.31	0.33

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=	0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(24d)

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

(25)m=	0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(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 Type 1			2.21	x	1.2	=	2.652			(26)
Doors Type 2			1.89	x	1.2	=	2.268			(26)
Windows Type 1			16.92	x1/[1/(1.4)+ 0.04]		=	22.43			(27)
Windows Type 2			3.6	x1/[1/(1.4)+ 0.04]		=	4.77			(27)
Windows Type 3			0.72	x1/[1/(1.4)+ 0.04]		=	0.95			(27)
Windows Type 4			9.9	x1/[1/(1.4)+ 0.04]		=	13.12			(27)
Rooflights			2.16	x1/[1/(1.7) + 0.04]		=	3.672			(27b)
Floor			119.31	x	0.13	=	15.5103			(28)
Walls Type1	170.21	35.24	134.97	x	0.18	=	24.29			(29)
Walls Type2	82.85	0	82.85	x	0.18	=	14.91			(29)
Roof Type1	58.74	0	58.74	x	0.13	=	7.64			(30)
Roof Type2	18.64	0	18.64	x	0.13	=	2.42			(30)
Roof Type3	16.35	0	16.35	x	0.13	=	2.13			(30)
Roof Type4	37.1	2.16	34.94	x	0.13	=	4.54			(30)
Total area of elements, m²			503.2							(31)
Internal wall **			29.96							(32c)
Internal wall **			304.16							(32c)

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Internal floor	84.97				(32d)
Internal ceiling	84.97				(32e)

** 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) =	121.09	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	26228.76	(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		22.25	(36)

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

Total fabric heat loss	(33) + (36) =	143.34	(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=	95.85	95.43	95.02	93.1	92.75	91.08	91.08	90.77	91.72	92.75	93.47	94.23	(38)

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

(39)m=	239.19	238.77	238.36	236.44	236.08	234.41	234.41	234.1	235.06	236.08	236.81	237.57	

Average = $Sum(39)_{1…12}$ /12= 236.44 (39)

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

(40)m=	1.17	1.17	1.17	1.16	1.16	1.15	1.15	1.15	1.15	1.16	1.16	1.16	

Average = $Sum(40)_{1…12}$ /12= 1.16 (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 — 3.01 (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 — 105.63 (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=	116.19	111.97	107.74	103.52	99.29	95.07	95.07	99.29	103.52	107.74	111.97	116.19	

Total = $Sum(44)_{1…12}$ = 1267.53 (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=	172.31	150.7	155.51	135.58	130.09	112.26	104.02	119.37	120.79	140.77	153.67	166.87	

Total = $Sum(45)_{1…12}$ = 1661.94 (45)

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

(46)m=	25.85	22.61	23.33	20.34	19.51	16.84	15.6	17.91	18.12	21.12	23.05	25.03	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 150 (47)

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

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

Water storage loss:

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a) If manufacturer's declared loss factor is known (kWh/day):		1.55	(48)
Temperature factor from Table 2b		0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0.84	(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)		0.84	(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	25.98	23.47	25.98	25.14	25.98	25.14	25.98	25.98	25.14	25.98	25.14	25.98	(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=	25.98	23.47	25.98	25.14	25.98	25.14	25.98	25.98	25.14	25.98	25.14	25.98	(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	221.55	195.18	204.75	183.23	179.33	159.91	153.27	168.61	168.45	190.02	201.32	216.11	(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=	221.55	195.18	204.75	183.23	179.33	159.91	153.27	168.61	168.45	190.02	201.32	216.11

Output from water heater (annual)1…12 — 2241.73 (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=	96.69	85.69	91.1	83.2	82.65	75.45	73.98	79.08	78.29	86.2	89.22	94.88	(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=	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	(66)

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

(67)m=	34	30.2	24.56	18.59	13.9	11.73	12.68	16.48	22.12	28.09	32.78	34.95	(67)

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

(68)m=	375.1	378.99	369.18	348.3	321.94	297.17	280.62	276.72	286.53	307.41	333.77	358.54	(68)

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

(69)m=	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	(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=	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	(71)

Water heating gains (Table 5)

(72)m=	129.95	127.51	122.45	115.56	111.09	104.79	99.44	106.3	108.73	115.86	123.91	127.52	(72)

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

(73)m=	610.17	607.82	587.3	553.56	518.04	484.8	463.85	470.61	488.5	522.48	561.58	592.13	(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)	
North	0.9x	0.77	x	16.92	x	10.63	x	0.63	x	0.7	=	54.98	(74)
North	0.9x	0.77	x	16.92	x	20.32	x	0.63	x	0.7	=	105.08	(74)
North	0.9x	0.77	x	16.92	x	34.53	x	0.63	x	0.7	=	178.56	(74)
North	0.9x	0.77	x	16.92	x	55.46	x	0.63	x	0.7	=	286.81	(74)
North	0.9x	0.77	x	16.92	x	74.72	x	0.63	x	0.7	=	386.35	(74)
North	0.9x	0.77	x	16.92	x	79.99	x	0.63	x	0.7	=	413.6	(74)
North	0.9x	0.77	x	16.92	x	74.68	x	0.63	x	0.7	=	386.15	(74)
North	0.9x	0.77	x	16.92	x	59.25	x	0.63	x	0.7	=	306.36	(74)
North	0.9x	0.77	x	16.92	x	41.52	x	0.63	x	0.7	=	214.68	(74)
North	0.9x	0.77	x	16.92	x	24.19	x	0.63	x	0.7	=	125.08	(74)
North	0.9x	0.77	x	16.92	x	13.12	x	0.63	x	0.7	=	67.83	(74)
North	0.9x	0.77	x	16.92	x	8.86	x	0.63	x	0.7	=	45.84	(74)
East	0.9x	0.77	x	3.6	x	19.64	x	0.63	x	0.7	=	21.61	(76)
East	0.9x	0.77	x	3.6	x	38.42	x	0.63	x	0.7	=	42.27	(76)
East	0.9x	0.77	x	3.6	x	63.27	x	0.63	x	0.7	=	69.61	(76)
East	0.9x	0.77	x	3.6	x	92.28	x	0.63	x	0.7	=	101.53	(76)
East	0.9x	0.77	x	3.6	x	113.09	x	0.63	x	0.7	=	124.43	(76)
East	0.9x	0.77	x	3.6	x	115.77	x	0.63	x	0.7	=	127.37	(76)
East	0.9x	0.77	x	3.6	x	110.22	x	0.63	x	0.7	=	121.26	(76)
East	0.9x	0.77	x	3.6	x	94.68	x	0.63	x	0.7	=	104.16	(76)
East	0.9x	0.77	x	3.6	x	73.59	x	0.63	x	0.7	=	80.96	(76)
East	0.9x	0.77	x	3.6	x	45.59	x	0.63	x	0.7	=	50.16	(76)
East	0.9x	0.77	x	3.6	x	24.49	x	0.63	x	0.7	=	26.94	(76)
East	0.9x	0.77	x	3.6	x	16.15	x	0.63	x	0.7	=	17.77	(76)
South	0.9x	0.77	x	9.9	x	46.75	x	0.63	x	0.7	=	141.45	(78)
South	0.9x	0.77	x	9.9	x	76.57	x	0.63	x	0.7	=	231.66	(78)
South	0.9x	0.77	x	9.9	x	97.53	x	0.63	x	0.7	=	295.1	(78)
South	0.9x	0.77	x	9.9	x	110.23	x	0.63	x	0.7	=	333.52	(78)
South	0.9x	0.77	x	9.9	x	114.87	x	0.63	x	0.7	=	347.55	(78)
South	0.9x	0.77	x	9.9	x	110.55	x	0.63	x	0.7	=	334.47	(78)

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South	0.9x	0.77	x	9.9	x	108.01	x	0.63	x	0.7	=	326.8	(78)
South	0.9x	0.77	x	9.9	x	104.89	x	0.63	x	0.7	=	317.37	(78)
South	0.9x	0.77	x	9.9	x	101.89	x	0.63	x	0.7	=	308.26	(78)
South	0.9x	0.77	x	9.9	x	82.59	x	0.63	x	0.7	=	249.87	(78)
South	0.9x	0.77	x	9.9	x	55.42	x	0.63	x	0.7	=	167.67	(78)
South	0.9x	0.77	x	9.9	x	40.4	x	0.63	x	0.7	=	122.23	(78)
West	0.9x	0.77	x	0.72	x	19.64	x	0.63	x	0.7	=	4.32	(80)
West	0.9x	0.77	x	0.72	x	38.42	x	0.63	x	0.7	=	8.45	(80)
West	0.9x	0.77	x	0.72	x	63.27	x	0.63	x	0.7	=	13.92	(80)
West	0.9x	0.77	x	0.72	x	92.28	x	0.63	x	0.7	=	20.31	(80)
West	0.9x	0.77	x	0.72	x	113.09	x	0.63	x	0.7	=	24.89	(80)
West	0.9x	0.77	x	0.72	x	115.77	x	0.63	x	0.7	=	25.47	(80)
West	0.9x	0.77	x	0.72	x	110.22	x	0.63	x	0.7	=	24.25	(80)
West	0.9x	0.77	x	0.72	x	94.68	x	0.63	x	0.7	=	20.83	(80)
West	0.9x	0.77	x	0.72	x	73.59	x	0.63	x	0.7	=	16.19	(80)
West	0.9x	0.77	x	0.72	x	45.59	x	0.63	x	0.7	=	10.03	(80)
West	0.9x	0.77	x	0.72	x	24.49	x	0.63	x	0.7	=	5.39	(80)
West	0.9x	0.77	x	0.72	x	16.15	x	0.63	x	0.7	=	3.55	(80)
Rooflights	0.9x	1	x	2.16	x	15.3	x	0.63	x	0.7	=	13.11	(82)
Rooflights	0.9x	1	x	2.16	x	28.48	x	0.63	x	0.7	=	24.41	(82)
Rooflights	0.9x	1	x	2.16	x	50.24	x	0.63	x	0.7	=	43.07	(82)
Rooflights	0.9x	1	x	2.16	x	89.03	x	0.63	x	0.7	=	76.33	(82)
Rooflights	0.9x	1	x	2.16	x	129.88	x	0.63	x	0.7	=	111.35	(82)
Rooflights	0.9x	1	x	2.16	x	143.74	x	0.63	x	0.7	=	123.22	(82)
Rooflights	0.9x	1	x	2.16	x	132.31	x	0.63	x	0.7	=	113.43	(82)
Rooflights	0.9x	1	x	2.16	x	98.56	x	0.63	x	0.7	=	84.5	(82)
Rooflights	0.9x	1	x	2.16	x	62.62	x	0.63	x	0.7	=	53.69	(82)
Rooflights	0.9x	1	x	2.16	x	34.05	x	0.63	x	0.7	=	29.19	(82)
Rooflights	0.9x	1	x	2.16	x	18.64	x	0.63	x	0.7	=	15.98	(82)
Rooflights	0.9x	1	x	2.16	x	12.94	x	0.63	x	0.7	=	11.1	(82)

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

(83)m=	235.48	411.88	600.26	818.49	994.56	1024.14	971.89	833.22	673.79	464.33	283.82	200.49	(83)

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

(84)m=	845.65	1019.7	1187.56	1372.05	1512.6	1508.95	1435.74	1303.83	1162.29	986.81	845.4	792.62	(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	1	0.99	0.95	0.83	0.67	0.75	0.94	0.99	1	1	(86)

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

(87)m=	19.56	19.71	19.96	20.31	20.65	20.89	20.97	20.95	20.76	20.32	19.88	19.53	(87)

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

(88)m=	19.94	19.95	19.95	19.95	19.96	19.96	19.96	19.96	19.96	19.96	19.95	19.95	(88)

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

(89)m=	1	1	1	0.98	0.92	0.75	0.54	0.61	0.9	0.99	1	1	(89)

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

(90)m=	18	18.22	18.59	19.1	19.58	19.88	19.95	19.94	19.73	19.13	18.47	17.97	(90)

fLA = Living area ÷ (4) = 0.11 (91)

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

(92)m=	18.18	18.39	18.74	19.24	19.7	19.99	20.07	20.06	19.85	19.26	18.63	18.15	(92)

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

(93)m=	18.18	18.39	18.74	19.24	19.7	19.99	20.07	20.06	19.85	19.26	18.63	18.15	(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	1	0.99	0.97	0.91	0.75	0.55	0.63	0.89	0.99	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	844.92	1017.37	1179.43	1337.43	1378.11	1135.94	791.75	817.52	1034.49	973.34	843.72	792.13	(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=	3319.22	3220.18	2918.51	2444.44	1889.02	1264.06	812.49	855.74	1351.49	2045.16	2731.26	3313.15	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1840.88	1480.28	1293.87	797.05	380.12	0	0	0	0	797.44	1359.03	1875.64	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 9824.3 (98)

Space heating requirement in kWh/m²/year 48.09 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(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)													
	1840.88	1480.28	1293.87	797.05	380.12	0	0	0	0	797.44	1359.03	1875.64	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	1968.85	1583.19	1383.82	852.45	406.54	0	0	0	0	852.87	1453.5	2006.03	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 10507.27 (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)

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Water heating

Output from water heater (calculated above)

	221.55	195.18	204.75	183.23	179.33	159.91	153.27	168.61	168.45	190.02	201.32	216.11		
Efficiency of water heater													79.8	(216)
(217)m=	89.21	89.11	88.87	88.29	86.77	79.8	79.8	79.8	79.8	88.22	88.96	89.26		(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	248.33	219.04	230.39	207.54	206.67	200.39	192.06	211.29	211.09	215.38	226.3	242.11		
Total = Sum(219a)$_{1...12}$ =													2610.59	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			10507.27	
Water heating fuel used			2610.59	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		75	(231)
Electricity for lighting			600.52	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =			13793.39	(338)

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	=	2269.57	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	563.89	(264)
Space and water heating	(261) + (262) + (263) + (264) =			2833.46	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	311.67	(268)
Total CO2, kg/year		sum of (265)…(271) =		3184.05	(272)

TER = 15.59 (273)

TER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matt Fitzpatrick	**Stroma Number:**	STRO003572
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.41

Property Address: Plot 4

Address : Plot 4, Widdington, TBC

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	144.43	(1a)	x	2.5	(2a)	=	361.07	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	144.43	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			361.07	(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							4	x 10 =	40	(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) =	40	÷ (5) =	0.11	(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		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.36	(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) =	0.31	(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

TER WorkSheet: New dwelling design stage

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

0.39	0.38	0.38	0.34	0.33	0.29	0.29	0.28	0.31	0.33	0.34	0.36

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=	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(24d)

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

(25)m=	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(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 Type 1			2.55	x	1.2	=	3.06			(26)
Doors Type 2			2.1	x	1.2	=	2.52			(26)
Windows Type 1			15.74	x1/[1/(1.4)+ 0.04]		=	20.87			(27)
Windows Type 2			1.8	x1/[1/(1.4)+ 0.04]		=	2.39			(27)
Windows Type 3			3.18	x1/[1/(1.4)+ 0.04]		=	4.22			(27)
Windows Type 4			4.2	x1/[1/(1.4)+ 0.04]		=	5.57			(27)
Floor			144.43	x	0.13	=	18.7759			(28)
Walls	172.48	29.57	142.91	x	0.18	=	25.72			(29)
Roof	144.43	0	144.43	x	0.13	=	18.78			(30)
Total area of elements, m²			461.34							(31)
Internal wall **			248.99							(32c)

** 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) = 101.89 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 22947.63 (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 19.07 (36)

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

Total fabric heat loss (33) + (36) = 120.97 (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=	68.69	68.33	67.99	66.36	66.05	64.63	64.63	64.37	65.18	66.05	66.67	67.31	(38)

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

(39)m=	189.65	189.3	188.95	187.32	187.02	185.6	185.6	185.34	186.15	187.02	187.64	188.28	

Average = $Sum(39)_{1…12}$ /12= 187.32 (39)

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

(40)m=	1.31	1.31	1.31	1.3	1.29	1.29	1.29	1.28	1.29	1.29	1.3	1.3	

Average = $Sum(40)_{1…12}$ /12= 1.3 (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 2.93 (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) + 36 103.67 (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=	114.04	109.89	105.74	101.6	97.45	93.3	93.3	97.45	101.6	105.74	109.89	114.04	

Total = $Sum(44)_{1…12}$ = 1244.05 (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=	169.11	147.91	152.63	133.07	127.68	110.18	102.1	117.16	118.56	138.17	150.82	163.78	

Total = $Sum(45)_{1…12}$ = 1631.15 (45)

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

(46)m=	25.37	22.19	22.89	19.96	19.15	16.53	15.31	17.57	17.78	20.72	22.62	24.57	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 150 (47)

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

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

Water storage loss:

a) If manufacturer’s declared loss factor is known (kWh/day): 1.55 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.84 (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) 0.84 (55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	25.98	23.47	25.98	25.14	25.98	25.14	25.98	25.98	25.14	25.98	25.14	25.98	(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=	25.98	23.47	25.98	25.14	25.98	25.14	25.98	25.98	25.14	25.98	25.14	25.98	(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	218.36	192.39	201.87	180.72	176.92	157.83	151.34	166.4	166.21	187.41	198.47	213.02	(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=	218.36	192.39	201.87	180.72	176.92	157.83	151.34	166.4	166.21	187.41	198.47	213.02

Output from water heater (annual)$_{1...12}$ — 2210.94 (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=	95.62	84.76	90.14	82.37	81.85	74.76	73.34	78.35	77.54	85.33	88.27	93.85	(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=	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	(66)

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

(67)m=	28.16	25.01	20.34	15.4	11.51	9.72	10.5	13.65	18.32	23.26	27.15	28.94	(67)

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

(68)m=	314.4	317.66	309.44	291.93	269.84	249.08	235.2	231.94	240.16	257.67	279.76	300.52	(68)

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

(69)m=	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	(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=	-117	-117	-117	-117	-117	-117	-117	-117	-117	-117	-117	-117	(71)

Water heating gains (Table 5)

(72)m=	128.53	126.13	121.16	114.4	110.01	103.83	98.58	105.31	107.7	114.7	122.6	126.14	(72)

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

(73)m=	540.96	538.68	520.82	491.61	461.24	432.5	414.16	420.78	436.06	465.5	499.38	525.49	(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)

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North	0.9x	0.77	x	15.74	x	10.63	x	0.63	x	0.7	=	51.15	(74)
North	0.9x	0.77	x	15.74	x	20.32	x	0.63	x	0.7	=	97.75	(74)
North	0.9x	0.77	x	15.74	x	34.53	x	0.63	x	0.7	=	166.1	(74)
North	0.9x	0.77	x	15.74	x	55.46	x	0.63	x	0.7	=	266.8	(74)
North	0.9x	0.77	x	15.74	x	74.72	x	0.63	x	0.7	=	359.41	(74)
North	0.9x	0.77	x	15.74	x	79.99	x	0.63	x	0.7	=	384.76	(74)
North	0.9x	0.77	x	15.74	x	74.68	x	0.63	x	0.7	=	359.22	(74)
North	0.9x	0.77	x	15.74	x	59.25	x	0.63	x	0.7	=	285	(74)
North	0.9x	0.77	x	15.74	x	41.52	x	0.63	x	0.7	=	199.71	(74)
North	0.9x	0.77	x	15.74	x	24.19	x	0.63	x	0.7	=	116.36	(74)
North	0.9x	0.77	x	15.74	x	13.12	x	0.63	x	0.7	=	63.1	(74)
North	0.9x	0.77	x	15.74	x	8.86	x	0.63	x	0.7	=	42.64	(74)
East	0.9x	0.77	x	1.8	x	19.64	x	0.63	x	0.7	=	10.8	(76)
East	0.9x	0.77	x	1.8	x	38.42	x	0.63	x	0.7	=	21.14	(76)
East	0.9x	0.77	x	1.8	x	63.27	x	0.63	x	0.7	=	34.81	(76)
East	0.9x	0.77	x	1.8	x	92.28	x	0.63	x	0.7	=	50.76	(76)
East	0.9x	0.77	x	1.8	x	113.09	x	0.63	x	0.7	=	62.21	(76)
East	0.9x	0.77	x	1.8	x	115.77	x	0.63	x	0.7	=	63.69	(76)
East	0.9x	0.77	x	1.8	x	110.22	x	0.63	x	0.7	=	60.63	(76)
East	0.9x	0.77	x	1.8	x	94.68	x	0.63	x	0.7	=	52.08	(76)
East	0.9x	0.77	x	1.8	x	73.59	x	0.63	x	0.7	=	40.48	(76)
East	0.9x	0.77	x	1.8	x	45.59	x	0.63	x	0.7	=	25.08	(76)
East	0.9x	0.77	x	1.8	x	24.49	x	0.63	x	0.7	=	13.47	(76)
East	0.9x	0.77	x	1.8	x	16.15	x	0.63	x	0.7	=	8.88	(76)
South	0.9x	0.77	x	4.2	x	46.75	x	0.63	x	0.7	=	60.01	(78)
South	0.9x	0.77	x	4.2	x	76.57	x	0.63	x	0.7	=	98.28	(78)
South	0.9x	0.77	x	4.2	x	97.53	x	0.63	x	0.7	=	125.19	(78)
South	0.9x	0.77	x	4.2	x	110.23	x	0.63	x	0.7	=	141.49	(78)
South	0.9x	0.77	x	4.2	x	114.87	x	0.63	x	0.7	=	147.45	(78)
South	0.9x	0.77	x	4.2	x	110.55	x	0.63	x	0.7	=	141.9	(78)
South	0.9x	0.77	x	4.2	x	108.01	x	0.63	x	0.7	=	138.64	(78)
South	0.9x	0.77	x	4.2	x	104.89	x	0.63	x	0.7	=	134.64	(78)
South	0.9x	0.77	x	4.2	x	101.89	x	0.63	x	0.7	=	130.78	(78)
South	0.9x	0.77	x	4.2	x	82.59	x	0.63	x	0.7	=	106	(78)
South	0.9x	0.77	x	4.2	x	55.42	x	0.63	x	0.7	=	71.13	(78)
South	0.9x	0.77	x	4.2	x	40.4	x	0.63	x	0.7	=	51.85	(78)
West	0.9x	0.77	x	3.18	x	19.64	x	0.63	x	0.7	=	19.09	(80)
West	0.9x	0.77	x	3.18	x	38.42	x	0.63	x	0.7	=	37.34	(80)
West	0.9x	0.77	x	3.18	x	63.27	x	0.63	x	0.7	=	61.49	(80)
West	0.9x	0.77	x	3.18	x	92.28	x	0.63	x	0.7	=	89.68	(80)
West	0.9x	0.77	x	3.18	x	113.09	x	0.63	x	0.7	=	109.91	(80)

West	0.9x	0.77	x	3.18	x	115.77	x	0.63	x	0.7	=	112.51	(80)
West	0.9x	0.77	x	3.18	x	110.22	x	0.63	x	0.7	=	107.12	(80)
West	0.9x	0.77	x	3.18	x	94.68	x	0.63	x	0.7	=	92.01	(80)
West	0.9x	0.77	x	3.18	x	73.59	x	0.63	x	0.7	=	71.52	(80)
West	0.9x	0.77	x	3.18	x	45.59	x	0.63	x	0.7	=	44.31	(80)
West	0.9x	0.77	x	3.18	x	24.49	x	0.63	x	0.7	=	23.8	(80)
West	0.9x	0.77	x	3.18	x	16.15	x	0.63	x	0.7	=	15.7	(80)

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

(83)m=	141.05	254.51	387.59	548.74	678.98	702.85	665.61	563.73	442.49	291.75	171.5	119.08	(83)

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

(84)m=	682.01	793.19	908.41	1040.35	1140.22	1135.35	1079.77	984.5	878.55	757.25	670.89	644.56	(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	1	0.98	0.94	0.84	0.69	0.76	0.94	0.99	1	1	(86)

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

(87)m=	19.43	19.57	19.84	20.21	20.58	20.85	20.96	20.93	20.71	20.24	19.77	19.41	(87)

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

(88)m=	19.83	19.83	19.83	19.84	19.84	19.85	19.85	19.85	19.85	19.84	19.84	19.84	(88)

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

(89)m=	1	1	0.99	0.98	0.92	0.75	0.54	0.62	0.89	0.99	1	1	(89)

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

(90)m=	17.74	17.95	18.34	18.88	19.4	19.74	19.83	19.82	19.58	18.93	18.25	17.71	(90)

fLA = Living area ÷ (4) = 0.2 (91)

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

(92)m=	18.08	18.27	18.64	19.15	19.64	19.96	20.06	20.04	19.81	19.2	18.55	18.05	(92)

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

(93)m=	18.08	18.27	18.64	19.15	19.64	19.96	20.06	20.04	19.81	19.2	18.55	18.05	(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	1	0.99	0.97	0.91	0.76	0.57	0.64	0.89	0.98	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	680.86	790.35	900.16	1010.39	1037.54	867.03	616.85	632.95	781.5	744.27	668.61	643.72	(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=	2612.49	2531.73	2293.51	1920.15	1484.37	995.51	641.99	675.46	1062.53	1607.6	2148.59	2607.06	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1437.14	1170.2	1036.65	655.02	332.44	0	0	0	0	642.32	1065.59	1460.72	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 7800.08 (98)

Space heating requirement in kWh/m²/year 54.01 (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 93.5 (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)	1437.14	1170.2	1036.65	655.02	332.44	0	0	0	0	642.32	1065.59	1460.72		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	1537.04	1251.55	1108.71	700.56	355.55	0	0	0	0	686.97	1139.67	1562.27		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													8342.34	(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)	218.36	192.39	201.87	180.72	176.92	157.83	151.34	166.4	166.21	187.41	198.47	213.02		
Efficiency of water heater													79.8	(216)
(217)m=	88.93	88.82	88.56	87.95	86.47	79.8	79.8	79.8	79.8	87.84	88.63	88.98		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	245.55	216.61	227.94	205.48	204.6	197.78	189.65	208.52	208.28	213.35	223.92	239.4		
Total = Sum(219a)$_{1...12}$ =													2581.08	(219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		8342.34	
Water heating fuel used		2581.08	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		75	(231)
Electricity for lighting		497.35	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =		11495.77	(338)

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

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

TER WorkSheet: New dwelling design stage

Space heating (main system 1)	(211) x	0.216	=	1801.94	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	557.51	(264)
Space and water heating	(261) + (262) + (263) + (264) =			2359.46	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	258.13	(268)
Total CO2, kg/year		sum of (265)…(271) =		2656.51	(272)

TER =	18.39 (273)

Be Lean SAP Sheets

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matt Fitzpatrick	**Stroma Number:**	STRO003572
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.41

Property Address: Plot 1

Address : Plot 1, Widdington, TBC

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	119.31	(1a)	x	2.5	(2a)	=	298.27	(3a)
First floor	84.97	(1b)	x	2.56	(2b)	=	217.61	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	204.28	(4)						
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	=	515.88	(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							0	x 10 =	0	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)

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		4.65000009536743	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.23	(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) =	0.2	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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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

0.25	0.25	0.24	0.22	0.21	0.19	0.19	0.18	0.2	0.21	0.22	0.23

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(24c)

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

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

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

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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 Type 1			2.21	x	1.4	=	3.094			(26)
Doors Type 2			1.89	x	1.4	=	2.646			(26)
Windows Type 1			16.92	x1/[1/(1.4)+ 0.04]		=	22.43			(27)
Windows Type 2			3.6	x1/[1/(1.4)+ 0.04]		=	4.77			(27)
Windows Type 3			0.72	x1/[1/(1.4)+ 0.04]		=	0.95			(27)
Windows Type 4			9.9	x1/[1/(1.4)+ 0.04]		=	13.12			(27)
Rooflights			2.16	x1/[1/(1.4) + 0.04]		=	3.024			(27b)
Floor			119.31	x	0.12	=	14.3172	75	8948.25	(28)
Walls Type1	170.21	35.24	134.97	x	0.19	=	25.64	60	8098.2	(29)
Walls Type2	82.85	0	82.85	x	0.17	=	14.38	9	745.65	(29)
Roof Type1	58.74	0	58.74	x	0.11	=	6.46	9	528.66	(30)
Roof Type2	18.64	0	18.64	x	0.11	=	2.05	9	167.76	(30)
Roof Type3	16.35	0	16.35	x	0.1	=	1.7	9	147.15	(30)
Roof Type4	37.1	2.16	34.94	x	0.15	=	5.24	9	314.46	(30)
Total area of elements, m²			503.2							(31)
Internal wall **			29.96					75	2247	(32c)
Internal wall **			304.16					9	2737.44	(32c)

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Internal floor	84.97	18	1529.46	(32d)
Internal ceiling	84.97	9	764.73	(32e)

** 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) =	119.68	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	26228.76	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	= (34) ÷ (4) =	128.4	(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		26.11	(36)

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

Total fabric heat loss	(33) + (36) =	145.79	(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=	85.46	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	(38)

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

(39)m=	231.25	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	

Average = $Sum(39)_{1…12}$ /12= 230.94 (39)

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

(40)m=	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	

Average = $Sum(40)_{1…12}$ /12= 1.13 (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 3.01 (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) + 36 105.63 (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=	116.19	111.97	107.74	103.52	99.29	95.07	95.07	99.29	103.52	107.74	111.97	116.19

Total = $Sum(44)_{1…12}$ = 1267.53 (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=	172.31	150.7	155.51	135.58	130.09	112.26	104.02	119.37	120.79	140.77	153.67	166.87

Total = $Sum(45)_{1…12}$ = 1661.94 (45)

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

(46)m=	25.85	22.61	23.33	20.34	19.51	16.84	15.6	17.91	18.12	21.12	23.05	25.03	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 180 (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:

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a) If manufacturer's declared loss factor is known (kWh/day):		1.32	(48)
Temperature factor from Table 2b		0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0.71	(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)		0.71	(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	217.67	191.67	200.87	179.47	175.45	156.15	149.38	164.73	164.69	186.13	197.56	212.23	(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=	217.67	191.67	200.87	179.47	175.45	156.15	149.38	164.73	164.69	186.13	197.56	212.23

Output from water heater (annual)$_{1...12}$ — 2196.01 (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=	93.58	82.88	87.99	80.2	79.54	72.44	70.88	75.98	75.28	83.09	86.21	91.77	(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=	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	(66)

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

(67)m=	34	30.2	24.56	18.59	13.9	11.73	12.68	16.48	22.12	28.09	32.78	34.95	(67)

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

(68)m=	375.1	378.99	369.18	348.3	321.94	297.17	280.62	276.72	286.53	307.41	333.77	358.54	(68)

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

(69)m=	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	(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=	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	(71)

Water heating gains (Table 5)

(72)m=	125.78	123.34	118.27	111.38	106.91	100.61	95.26	102.12	104.56	111.69	119.74	123.35	(72)

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

(73)m=	605.99	603.64	583.13	549.39	513.86	480.63	459.67	466.44	484.32	518.3	557.4	587.96	(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)	
North	0.9x	0.77	x	16.92	x	10.63	x	0.63	x	0.7	=	54.98	(74)
North	0.9x	0.77	x	16.92	x	20.32	x	0.63	x	0.7	=	105.08	(74)
North	0.9x	0.77	x	16.92	x	34.53	x	0.63	x	0.7	=	178.56	(74)
North	0.9x	0.77	x	16.92	x	55.46	x	0.63	x	0.7	=	286.81	(74)
North	0.9x	0.77	x	16.92	x	74.72	x	0.63	x	0.7	=	386.35	(74)
North	0.9x	0.77	x	16.92	x	79.99	x	0.63	x	0.7	=	413.6	(74)
North	0.9x	0.77	x	16.92	x	74.68	x	0.63	x	0.7	=	386.15	(74)
North	0.9x	0.77	x	16.92	x	59.25	x	0.63	x	0.7	=	306.36	(74)
North	0.9x	0.77	x	16.92	x	41.52	x	0.63	x	0.7	=	214.68	(74)
North	0.9x	0.77	x	16.92	x	24.19	x	0.63	x	0.7	=	125.08	(74)
North	0.9x	0.77	x	16.92	x	13.12	x	0.63	x	0.7	=	67.83	(74)
North	0.9x	0.77	x	16.92	x	8.86	x	0.63	x	0.7	=	45.84	(74)
East	0.9x	0.77	x	3.6	x	19.64	x	0.63	x	0.7	=	21.61	(76)
East	0.9x	0.77	x	3.6	x	38.42	x	0.63	x	0.7	=	42.27	(76)
East	0.9x	0.77	x	3.6	x	63.27	x	0.63	x	0.7	=	69.61	(76)
East	0.9x	0.77	x	3.6	x	92.28	x	0.63	x	0.7	=	101.53	(76)
East	0.9x	0.77	x	3.6	x	113.09	x	0.63	x	0.7	=	124.43	(76)
East	0.9x	0.77	x	3.6	x	115.77	x	0.63	x	0.7	=	127.37	(76)
East	0.9x	0.77	x	3.6	x	110.22	x	0.63	x	0.7	=	121.26	(76)
East	0.9x	0.77	x	3.6	x	94.68	x	0.63	x	0.7	=	104.16	(76)
East	0.9x	0.77	x	3.6	x	73.59	x	0.63	x	0.7	=	80.96	(76)
East	0.9x	0.77	x	3.6	x	45.59	x	0.63	x	0.7	=	50.16	(76)
East	0.9x	0.77	x	3.6	x	24.49	x	0.63	x	0.7	=	26.94	(76)
East	0.9x	0.77	x	3.6	x	16.15	x	0.63	x	0.7	=	17.77	(76)
South	0.9x	0.77	x	9.9	x	46.75	x	0.63	x	0.7	=	141.45	(78)
South	0.9x	0.77	x	9.9	x	76.57	x	0.63	x	0.7	=	231.66	(78)
South	0.9x	0.77	x	9.9	x	97.53	x	0.63	x	0.7	=	295.1	(78)
South	0.9x	0.77	x	9.9	x	110.23	x	0.63	x	0.7	=	333.52	(78)
South	0.9x	0.77	x	9.9	x	114.87	x	0.63	x	0.7	=	347.55	(78)
South	0.9x	0.77	x	9.9	x	110.55	x	0.63	x	0.7	=	334.47	(78)

DER WorkSheet: New dwelling design stage

South	0.9x	0.77	x	9.9	x	108.01	x	0.63	x	0.7	=	326.8	(78)
South	0.9x	0.77	x	9.9	x	104.89	x	0.63	x	0.7	=	317.37	(78)
South	0.9x	0.77	x	9.9	x	101.89	x	0.63	x	0.7	=	308.26	(78)
South	0.9x	0.77	x	9.9	x	82.59	x	0.63	x	0.7	=	249.87	(78)
South	0.9x	0.77	x	9.9	x	55.42	x	0.63	x	0.7	=	167.67	(78)
South	0.9x	0.77	x	9.9	x	40.4	x	0.63	x	0.7	=	122.23	(78)
West	0.9x	0.77	x	0.72	x	19.64	x	0.63	x	0.7	=	4.32	(80)
West	0.9x	0.77	x	0.72	x	38.42	x	0.63	x	0.7	=	8.45	(80)
West	0.9x	0.77	x	0.72	x	63.27	x	0.63	x	0.7	=	13.92	(80)
West	0.9x	0.77	x	0.72	x	92.28	x	0.63	x	0.7	=	20.31	(80)
West	0.9x	0.77	x	0.72	x	113.09	x	0.63	x	0.7	=	24.89	(80)
West	0.9x	0.77	x	0.72	x	115.77	x	0.63	x	0.7	=	25.47	(80)
West	0.9x	0.77	x	0.72	x	110.22	x	0.63	x	0.7	=	24.25	(80)
West	0.9x	0.77	x	0.72	x	94.68	x	0.63	x	0.7	=	20.83	(80)
West	0.9x	0.77	x	0.72	x	73.59	x	0.63	x	0.7	=	16.19	(80)
West	0.9x	0.77	x	0.72	x	45.59	x	0.63	x	0.7	=	10.03	(80)
West	0.9x	0.77	x	0.72	x	24.49	x	0.63	x	0.7	=	5.39	(80)
West	0.9x	0.77	x	0.72	x	16.15	x	0.63	x	0.7	=	3.55	(80)
Rooflights	0.9x	1	x	2.16	x	15.3	x	0.63	x	0.7	=	13.11	(82)
Rooflights	0.9x	1	x	2.16	x	28.48	x	0.63	x	0.7	=	24.41	(82)
Rooflights	0.9x	1	x	2.16	x	50.24	x	0.63	x	0.7	=	43.07	(82)
Rooflights	0.9x	1	x	2.16	x	89.03	x	0.63	x	0.7	=	76.33	(82)
Rooflights	0.9x	1	x	2.16	x	129.88	x	0.63	x	0.7	=	111.35	(82)
Rooflights	0.9x	1	x	2.16	x	143.74	x	0.63	x	0.7	=	123.22	(82)
Rooflights	0.9x	1	x	2.16	x	132.31	x	0.63	x	0.7	=	113.43	(82)
Rooflights	0.9x	1	x	2.16	x	98.56	x	0.63	x	0.7	=	84.5	(82)
Rooflights	0.9x	1	x	2.16	x	62.62	x	0.63	x	0.7	=	53.69	(82)
Rooflights	0.9x	1	x	2.16	x	34.05	x	0.63	x	0.7	=	29.19	(82)
Rooflights	0.9x	1	x	2.16	x	18.64	x	0.63	x	0.7	=	15.98	(82)
Rooflights	0.9x	1	x	2.16	x	12.94	x	0.63	x	0.7	=	11.1	(82)

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

(83)m=	235.48	411.88	600.26	818.49	994.56	1024.14	971.89	833.22	673.79	464.33	283.82	200.49	(83)

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

(84)m=	841.47	1015.52	1183.38	1367.88	1508.43	1504.77	1431.56	1299.66	1158.11	982.63	841.22	788.44	(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	0.97	0.94	0.87	0.75	0.62	0.68	0.86	0.96	0.99	0.99	(86)

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

(87)m=	18.73	18.96	19.35	19.87	20.37	20.74	20.9	20.86	20.55	19.91	19.21	18.67	(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=	19.97	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98		(88)

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

(89)m=	0.99	0.98	0.97	0.93	0.84	0.68	0.5	0.57	0.81	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=	16.91	17.25	17.81	18.56	19.26	19.74	19.91	19.88	19.52	18.62	17.62	16.83		(90)

fLA = Living area ÷ (4) = 0.11 (91)

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

(92)m=	17.11	17.44	17.99	18.71	19.39	19.85	20.02	19.99	19.64	18.77	17.8	17.04		(92)

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

(93)m=	16.96	17.29	17.84	18.56	19.24	19.7	19.87	19.84	19.49	18.62	17.65	16.89		(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=	0.98	0.97	0.95	0.9	0.81	0.66	0.49	0.55	0.78	0.93	0.98	0.99		(94)
Useful gains, hmGm , W = (94)m x (84)m														
(95)m=	828.84	988.82	1126.01	1233.78	1218.06	988.87	702.89	717.32	906.27	912.88	820.63	778.59		(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=	2928.17	2860.98	2617.98	2229.88	1740.81	1177.37	755.91	794.68	1243.64	1851.39	2435.63	2929.93		(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m														
(98)m=	1561.91	1258.09	1110.03	717.19	388.93	0	0	0	0	698.25	1162.8	1600.59		

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 8497.78 (98)

Space heating requirement in kWh/m²/year 41.6 (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		90.6	(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)														
	1561.91	1258.09	1110.03	717.19	388.93	0	0	0	0	698.25	1162.8	1600.59		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	1723.96	1388.62	1225.19	791.6	429.28	0	0	0	0	770.69	1283.44	1766.66		

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 9379.45 (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)

DER WorkSheet: New dwelling design stage

Water heating

Output from water heater (calculated above)

	217.67	191.67	200.87	179.47	175.45	156.15	149.38	164.73	164.69	186.13	197.56	212.23

Efficiency of water heater 79.9 (216)

(217)m=	89.14	89.02	88.78	88.23	86.98	79.9	79.9	79.9	79.9	88.12	88.87	89.2	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	244.19	215.3	226.26	203.4	201.71	195.44	186.96	206.17	206.12	211.23	222.3	237.92

Total = $Sum(219a)_{1...12}$ = 2557.01 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		9379.45	
Water heating fuel used		2557.01	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	94.73		(230a)
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		169.73	(231)
Electricity for lighting		600.52	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =		12706.7	(338)

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	=	2025.96	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	552.31	(264)
Space and water heating	(261) + (262) + (263) + (264) =			2578.27	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	88.09	(267)
Electricity for lighting	(232) x	0.519	=	311.67	(268)
Total CO2, kg/year		sum of (265)…(271) =		2978.03	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		14.58	(273)
EI rating (section 14)				84	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matt Fitzpatrick	**Stroma Number:**	STRO003572
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.41

Property Address: Plot 2

Address : Plot 2, Widdington, TBC

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	119.31	(1a)	x	2.5	(2a)	=	298.27	(3a)
First floor	84.97	(1b)	x	2.56	(2b)	=	217.61	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	204.28	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	515.88	(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							0	x 10 =	0	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)
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			4.65000009536743	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.23	(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) =		0.2	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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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

0.25	0.25	0.24	0.22	0.21	0.19	0.19	0.18	0.2	0.21	0.22	0.23

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(24c)

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

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

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

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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 Type 1			2.21	x	1.4	=	3.094			(26)
Doors Type 2			1.89	x	1.4	=	2.646			(26)
Windows Type 1			16.92	x1/[1/(1.4)+ 0.04]		=	22.43			(27)
Windows Type 2			3.6	x1/[1/(1.4)+ 0.04]		=	4.77			(27)
Windows Type 3			0.72	x1/[1/(1.4)+ 0.04]		=	0.95			(27)
Windows Type 4			9.9	x1/[1/(1.4)+ 0.04]		=	13.12			(27)
Rooflights			2.16	x1/[1/(1.4) + 0.04]		=	3.024			(27b)
Floor			119.31	x	0.12	=	14.3172	75	8948.25	(28)
Walls Type1	170.21	35.24	134.97	x	0.19	=	25.64	60	8098.2	(29)
Walls Type2	82.85	0	82.85	x	0.17	=	14.38	9	745.65	(29)
Roof Type1	58.74	0	58.74	x	0.11	=	6.46	9	528.66	(30)
Roof Type2	18.64	0	18.64	x	0.11	=	2.05	9	167.76	(30)
Roof Type3	16.35	0	16.35	x	0.1	=	1.7	9	147.15	(30)
Roof Type4	37.1	2.16	34.94	x	0.15	=	5.24	9	314.46	(30)
Total area of elements, m²			503.2							(31)
Internal wall **			29.96					75	2247	(32c)
Internal wall **			304.16					9	2737.44	(32c)

DER WorkSheet: New dwelling design stage

Internal floor	84.97	18	1529.46	(32d)
Internal ceiling	84.97	9	764.73	(32e)

** 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) =	119.68	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	26228.76	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	= (34) ÷ (4) =	128.4	(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 — 26.11 (36)

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

Total fabric heat loss — (33) + (36) = — 145.79 (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=	85.46	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	(38)

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

(39)m=	231.25	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	

Average = $Sum(39)_{1…12}$ /12= 230.94 (39)

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

(40)m=	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13

Average = $Sum(40)_{1…12}$ /12= 1.13 (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 — 3.01 (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 — 105.63 (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=	116.19	111.97	107.74	103.52	99.29	95.07	95.07	99.29	103.52	107.74	111.97	116.19	
										Total = $Sum(44)_{1…12}$ =		1267.53	(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=	172.31	150.7	155.51	135.58	130.09	112.26	104.02	119.37	120.79	140.77	153.67	166.87	
										Total = $Sum(45)_{1…12}$ =		1661.94	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	25.85	22.61	23.33	20.34	19.51	16.84	15.6	17.91	18.12	21.12	23.05	25.03	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 180 (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:

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a) If manufacturer's declared loss factor is known (kWh/day):		1.32	(48)
Temperature factor from Table 2b		0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0.71	(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)		0.71	(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	217.67	191.67	200.87	179.47	175.45	156.15	149.38	164.73	164.69	186.13	197.56	212.23	(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=	217.67	191.67	200.87	179.47	175.45	156.15	149.38	164.73	164.69	186.13	197.56	212.23

Output from water heater (annual)1…12 — 2196.01 (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=	93.58	82.88	87.99	80.2	79.54	72.44	70.88	75.98	75.28	83.09	86.21	91.77	(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=	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	(66)

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

(67)m=	34	30.2	24.56	18.59	13.9	11.73	12.68	16.48	22.12	28.09	32.78	34.95	(67)

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

(68)m=	375.1	378.99	369.18	348.3	321.94	297.17	280.62	276.72	286.53	307.41	333.77	358.54	(68)

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

(69)m=	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	(71)

Water heating gains (Table 5)

(72)m=	125.78	123.34	118.27	111.38	106.91	100.61	95.26	102.12	104.56	111.69	119.74	123.35	(72)

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

(73)m=	605.99	603.64	583.13	549.39	513.86	480.63	459.67	466.44	484.32	518.3	557.4	587.96	(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)	
North	0.9x	0.77	x	16.92	x	10.63	x	0.63	x	0.7	=	54.98	(74)
North	0.9x	0.77	x	16.92	x	20.32	x	0.63	x	0.7	=	105.08	(74)
North	0.9x	0.77	x	16.92	x	34.53	x	0.63	x	0.7	=	178.56	(74)
North	0.9x	0.77	x	16.92	x	55.46	x	0.63	x	0.7	=	286.81	(74)
North	0.9x	0.77	x	16.92	x	74.72	x	0.63	x	0.7	=	386.35	(74)
North	0.9x	0.77	x	16.92	x	79.99	x	0.63	x	0.7	=	413.6	(74)
North	0.9x	0.77	x	16.92	x	74.68	x	0.63	x	0.7	=	386.15	(74)
North	0.9x	0.77	x	16.92	x	59.25	x	0.63	x	0.7	=	306.36	(74)
North	0.9x	0.77	x	16.92	x	41.52	x	0.63	x	0.7	=	214.68	(74)
North	0.9x	0.77	x	16.92	x	24.19	x	0.63	x	0.7	=	125.08	(74)
North	0.9x	0.77	x	16.92	x	13.12	x	0.63	x	0.7	=	67.83	(74)
North	0.9x	0.77	x	16.92	x	8.86	x	0.63	x	0.7	=	45.84	(74)
East	0.9x	0.77	x	3.6	x	19.64	x	0.63	x	0.7	=	21.61	(76)
East	0.9x	0.77	x	3.6	x	38.42	x	0.63	x	0.7	=	42.27	(76)
East	0.9x	0.77	x	3.6	x	63.27	x	0.63	x	0.7	=	69.61	(76)
East	0.9x	0.77	x	3.6	x	92.28	x	0.63	x	0.7	=	101.53	(76)
East	0.9x	0.77	x	3.6	x	113.09	x	0.63	x	0.7	=	124.43	(76)
East	0.9x	0.77	x	3.6	x	115.77	x	0.63	x	0.7	=	127.37	(76)
East	0.9x	0.77	x	3.6	x	110.22	x	0.63	x	0.7	=	121.26	(76)
East	0.9x	0.77	x	3.6	x	94.68	x	0.63	x	0.7	=	104.16	(76)
East	0.9x	0.77	x	3.6	x	73.59	x	0.63	x	0.7	=	80.96	(76)
East	0.9x	0.77	x	3.6	x	45.59	x	0.63	x	0.7	=	50.16	(76)
East	0.9x	0.77	x	3.6	x	24.49	x	0.63	x	0.7	=	26.94	(76)
East	0.9x	0.77	x	3.6	x	16.15	x	0.63	x	0.7	=	17.77	(76)
South	0.9x	0.77	x	9.9	x	46.75	x	0.63	x	0.7	=	141.45	(78)
South	0.9x	0.77	x	9.9	x	76.57	x	0.63	x	0.7	=	231.66	(78)
South	0.9x	0.77	x	9.9	x	97.53	x	0.63	x	0.7	=	295.1	(78)
South	0.9x	0.77	x	9.9	x	110.23	x	0.63	x	0.7	=	333.52	(78)
South	0.9x	0.77	x	9.9	x	114.87	x	0.63	x	0.7	=	347.55	(78)
South	0.9x	0.77	x	9.9	x	110.55	x	0.63	x	0.7	=	334.47	(78)

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South	0.9x	0.77	x	9.9	x	108.01	x	0.63	x	0.7	=	326.8	(78)
South	0.9x	0.77	x	9.9	x	104.89	x	0.63	x	0.7	=	317.37	(78)
South	0.9x	0.77	x	9.9	x	101.89	x	0.63	x	0.7	=	308.26	(78)
South	0.9x	0.77	x	9.9	x	82.59	x	0.63	x	0.7	=	249.87	(78)
South	0.9x	0.77	x	9.9	x	55.42	x	0.63	x	0.7	=	167.67	(78)
South	0.9x	0.77	x	9.9	x	40.4	x	0.63	x	0.7	=	122.23	(78)
West	0.9x	0.77	x	0.72	x	19.64	x	0.63	x	0.7	=	4.32	(80)
West	0.9x	0.77	x	0.72	x	38.42	x	0.63	x	0.7	=	8.45	(80)
West	0.9x	0.77	x	0.72	x	63.27	x	0.63	x	0.7	=	13.92	(80)
West	0.9x	0.77	x	0.72	x	92.28	x	0.63	x	0.7	=	20.31	(80)
West	0.9x	0.77	x	0.72	x	113.09	x	0.63	x	0.7	=	24.89	(80)
West	0.9x	0.77	x	0.72	x	115.77	x	0.63	x	0.7	=	25.47	(80)
West	0.9x	0.77	x	0.72	x	110.22	x	0.63	x	0.7	=	24.25	(80)
West	0.9x	0.77	x	0.72	x	94.68	x	0.63	x	0.7	=	20.83	(80)
West	0.9x	0.77	x	0.72	x	73.59	x	0.63	x	0.7	=	16.19	(80)
West	0.9x	0.77	x	0.72	x	45.59	x	0.63	x	0.7	=	10.03	(80)
West	0.9x	0.77	x	0.72	x	24.49	x	0.63	x	0.7	=	5.39	(80)
West	0.9x	0.77	x	0.72	x	16.15	x	0.63	x	0.7	=	3.55	(80)
Rooflights	0.9x	1	x	2.16	x	15.3	x	0.63	x	0.7	=	13.11	(82)
Rooflights	0.9x	1	x	2.16	x	28.48	x	0.63	x	0.7	=	24.41	(82)
Rooflights	0.9x	1	x	2.16	x	50.24	x	0.63	x	0.7	=	43.07	(82)
Rooflights	0.9x	1	x	2.16	x	89.03	x	0.63	x	0.7	=	76.33	(82)
Rooflights	0.9x	1	x	2.16	x	129.88	x	0.63	x	0.7	=	111.35	(82)
Rooflights	0.9x	1	x	2.16	x	143.74	x	0.63	x	0.7	=	123.22	(82)
Rooflights	0.9x	1	x	2.16	x	132.31	x	0.63	x	0.7	=	113.43	(82)
Rooflights	0.9x	1	x	2.16	x	98.56	x	0.63	x	0.7	=	84.5	(82)
Rooflights	0.9x	1	x	2.16	x	62.62	x	0.63	x	0.7	=	53.69	(82)
Rooflights	0.9x	1	x	2.16	x	34.05	x	0.63	x	0.7	=	29.19	(82)
Rooflights	0.9x	1	x	2.16	x	18.64	x	0.63	x	0.7	=	15.98	(82)
Rooflights	0.9x	1	x	2.16	x	12.94	x	0.63	x	0.7	=	11.1	(82)

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

(83)m=	235.48	411.88	600.26	818.49	994.56	1024.14	971.89	833.22	673.79	464.33	283.82	200.49	(83)

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

(84)m=	841.47	1015.52	1183.38	1367.88	1508.43	1504.77	1431.56	1299.66	1158.11	982.63	841.22	788.44	(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	0.97	0.94	0.87	0.75	0.62	0.68	0.86	0.96	0.99	0.99	(86)

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

(87)m=	18.73	18.96	19.35	19.87	20.37	20.74	20.9	20.86	20.55	19.91	19.21	18.67	(87)

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

(88)m=	19.97	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	(88)

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

(89)m=	0.99	0.98	0.97	0.93	0.84	0.68	0.5	0.57	0.81	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=	16.91	17.25	17.81	18.56	19.26	19.74	19.91	19.88	19.52	18.62	17.62	16.83	(90)

fLA = Living area ÷ (4) = 0.11 (91)

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

(92)m=	17.11	17.44	17.99	18.71	19.39	19.85	20.02	19.99	19.64	18.77	17.8	17.04	(92)

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

(93)m=	16.96	17.29	17.84	18.56	19.24	19.7	19.87	19.84	19.49	18.62	17.65	16.89	(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=	0.98	0.97	0.95	0.9	0.81	0.66	0.49	0.55	0.78	0.93	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	828.84	988.82	1126.01	1233.78	1218.06	988.87	702.89	717.32	906.27	912.88	820.63	778.59	(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=	2928.17	2860.98	2617.98	2229.88	1740.81	1177.37	755.91	794.68	1243.64	1851.39	2435.63	2929.93	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1561.91	1258.09	1110.03	717.19	388.93	0	0	0	0	698.25	1162.8	1600.59	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 8497.78 (98)

Space heating requirement in kWh/m²/year 41.6 (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		90.6	(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)													
	1561.91	1258.09	1110.03	717.19	388.93	0	0	0	0	698.25	1162.8	1600.59	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	1723.96	1388.62	1225.19	791.6	429.28	0	0	0	0	770.69	1283.44	1766.66	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 9379.45 (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)

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Water heating

Output from water heater (calculated above)

	217.67	191.67	200.87	179.47	175.45	156.15	149.38	164.73	164.69	186.13	197.56	212.23		
Efficiency of water heater													79.9	(216)
(217)m=	89.14	89.02	88.78	88.23	86.98	79.9	79.9	79.9	79.9	88.12	88.87	89.2		(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	244.19	215.3	226.26	203.4	201.71	195.44	186.96	206.17	206.12	211.23	222.3	237.92		
								Total = Sum(219a)$_{1...12}$ =					2557.01	(219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		9379.45	
Water heating fuel used		2557.01	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	94.73		(230a)
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		169.73	(231)
Electricity for lighting		600.52	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =		12706.7	(338)

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	=	2025.96	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	552.31	(264)
Space and water heating	(261) + (262) + (263) + (264) =				2578.27	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	88.09	(267)
Electricity for lighting	(232)	x	0.519	=	311.67	(268)
Total CO2, kg/year			sum of (265)…(271) =		2978.03	(272)
Dwelling CO2 Emission Rate			(272) ÷ (4) =		14.58	(273)
EI rating (section 14)					84	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matt Fitzpatrick	**Stroma Number:**	STRO003572
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.41

Property Address: Plot 3

Address : Plot 3, Widdington, TBC

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	119.31	(1a) x	2.5	(2a) =	298.27	(3a)
First floor	84.97	(1b) x	2.56	(2b) =	217.61	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	204.28	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	515.88	(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							0	x 10 =	0	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)

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		4.65000009536743	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.23	(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) =	0.2	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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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

0.25	0.25	0.24	0.22	0.21	0.19	0.19	0.18	0.2	0.21	0.22	0.23

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(24c)

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

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

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

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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 Type 1			2.21	x	1.4	=	3.094			(26)
Doors Type 2			1.89	x	1.4	=	2.646			(26)
Windows Type 1			16.92	x1/[1/(1.4)+ 0.04]		=	22.43			(27)
Windows Type 2			3.6	x1/[1/(1.4)+ 0.04]		=	4.77			(27)
Windows Type 3			0.72	x1/[1/(1.4)+ 0.04]		=	0.95			(27)
Windows Type 4			9.9	x1/[1/(1.4)+ 0.04]		=	13.12			(27)
Rooflights			2.16	x1/[1/(1.4) + 0.04]		=	3.024			(27b)
Floor			119.31	x	0.12	=	14.3172	75	8948.25	(28)
Walls Type1	170.21	35.24	134.97	x	0.19	=	25.64	60	8098.2	(29)
Walls Type2	82.85	0	82.85	x	0.17	=	14.38	9	745.65	(29)
Roof Type1	58.74	0	58.74	x	0.11	=	6.46	9	528.66	(30)
Roof Type2	18.64	0	18.64	x	0.11	=	2.05	9	167.76	(30)
Roof Type3	16.35	0	16.35	x	0.1	=	1.7	9	147.15	(30)
Roof Type4	37.1	2.16	34.94	x	0.15	=	5.24	9	314.46	(30)
Total area of elements, m²			503.2							(31)
Internal wall **			29.96					75	2247	(32c)
Internal wall **			304.16					9	2737.44	(32c)

Internal floor	84.97	18	1529.46	(32d)
Internal ceiling	84.97	9	764.73	(32e)

** 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) =	119.68	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	26228.76	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	= (34) ÷ (4) =	128.4	(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		26.11	(36)

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

Total fabric heat loss	(33) + (36) =	145.79	(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=	85.46	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	(38)

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

(39)m=	231.25	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	

Average = $Sum(39)_{1…12}$ /12= 230.94 (39)

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

(40)m=	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	

Average = $Sum(40)_{1…12}$ /12= 1.13 (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 3.01 (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) + 36 105.63 (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=	116.19	111.97	107.74	103.52	99.29	95.07	95.07	99.29	103.52	107.74	111.97	116.19	

Total = $Sum(44)_{1…12}$ = 1267.53 (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=	172.31	150.7	155.51	135.58	130.09	112.26	104.02	119.37	120.79	140.77	153.67	166.87	

Total = $Sum(45)_{1…12}$ = 1661.94 (45)

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

(46)m=	25.85	22.61	23.33	20.34	19.51	16.84	15.6	17.91	18.12	21.12	23.05	25.03	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 180 (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:

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a) If manufacturer's declared loss factor is known (kWh/day):		1.32	(48)
Temperature factor from Table 2b		0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0.71	(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)		0.71	(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	217.67	191.67	200.87	179.47	175.45	156.15	149.38	164.73	164.69	186.13	197.56	212.23	(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=	217.67	191.67	200.87	179.47	175.45	156.15	149.38	164.73	164.69	186.13	197.56	212.23

Output from water heater (annual)$_{1…12}$ — 2196.01 (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=	93.58	82.88	87.99	80.2	79.54	72.44	70.88	75.98	75.28	83.09	86.21	91.77	(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):

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m=	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	34	30.2	24.56	18.59	13.9	11.73	12.68	16.48	22.12	28.09	32.78	34.95	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	375.1	378.99	369.18	348.3	321.94	297.17	280.62	276.72	286.53	307.41	333.77	358.54	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	(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=	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	(71)

Water heating gains (Table 5)

(72)m=	125.78	123.34	118.27	111.38	106.91	100.61	95.26	102.12	104.56	111.69	119.74	123.35	(72)

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

(73)m=	605.99	603.64	583.13	549.39	513.86	480.63	459.67	466.44	484.32	518.3	557.4	587.96	(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)	
North	0.9x	0.77	x	16.92	x	10.63	x	0.63	x	0.7	=	54.98	(74)
North	0.9x	0.77	x	16.92	x	20.32	x	0.63	x	0.7	=	105.08	(74)
North	0.9x	0.77	x	16.92	x	34.53	x	0.63	x	0.7	=	178.56	(74)
North	0.9x	0.77	x	16.92	x	55.46	x	0.63	x	0.7	=	286.81	(74)
North	0.9x	0.77	x	16.92	x	74.72	x	0.63	x	0.7	=	386.35	(74)
North	0.9x	0.77	x	16.92	x	79.99	x	0.63	x	0.7	=	413.6	(74)
North	0.9x	0.77	x	16.92	x	74.68	x	0.63	x	0.7	=	386.15	(74)
North	0.9x	0.77	x	16.92	x	59.25	x	0.63	x	0.7	=	306.36	(74)
North	0.9x	0.77	x	16.92	x	41.52	x	0.63	x	0.7	=	214.68	(74)
North	0.9x	0.77	x	16.92	x	24.19	x	0.63	x	0.7	=	125.08	(74)
North	0.9x	0.77	x	16.92	x	13.12	x	0.63	x	0.7	=	67.83	(74)
North	0.9x	0.77	x	16.92	x	8.86	x	0.63	x	0.7	=	45.84	(74)
East	0.9x	0.77	x	3.6	x	19.64	x	0.63	x	0.7	=	21.61	(76)
East	0.9x	0.77	x	3.6	x	38.42	x	0.63	x	0.7	=	42.27	(76)
East	0.9x	0.77	x	3.6	x	63.27	x	0.63	x	0.7	=	69.61	(76)
East	0.9x	0.77	x	3.6	x	92.28	x	0.63	x	0.7	=	101.53	(76)
East	0.9x	0.77	x	3.6	x	113.09	x	0.63	x	0.7	=	124.43	(76)
East	0.9x	0.77	x	3.6	x	115.77	x	0.63	x	0.7	=	127.37	(76)
East	0.9x	0.77	x	3.6	x	110.22	x	0.63	x	0.7	=	121.26	(76)
East	0.9x	0.77	x	3.6	x	94.68	x	0.63	x	0.7	=	104.16	(76)
East	0.9x	0.77	x	3.6	x	73.59	x	0.63	x	0.7	=	80.96	(76)
East	0.9x	0.77	x	3.6	x	45.59	x	0.63	x	0.7	=	50.16	(76)
East	0.9x	0.77	x	3.6	x	24.49	x	0.63	x	0.7	=	26.94	(76)
East	0.9x	0.77	x	3.6	x	16.15	x	0.63	x	0.7	=	17.77	(76)
South	0.9x	0.77	x	9.9	x	46.75	x	0.63	x	0.7	=	141.45	(78)
South	0.9x	0.77	x	9.9	x	76.57	x	0.63	x	0.7	=	231.66	(78)
South	0.9x	0.77	x	9.9	x	97.53	x	0.63	x	0.7	=	295.1	(78)
South	0.9x	0.77	x	9.9	x	110.23	x	0.63	x	0.7	=	333.52	(78)
South	0.9x	0.77	x	9.9	x	114.87	x	0.63	x	0.7	=	347.55	(78)
South	0.9x	0.77	x	9.9	x	110.55	x	0.63	x	0.7	=	334.47	(78)

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South	0.9x	0.77	x	9.9	x	108.01	x	0.63	x	0.7	=	326.8	(78)
South	0.9x	0.77	x	9.9	x	104.89	x	0.63	x	0.7	=	317.37	(78)
South	0.9x	0.77	x	9.9	x	101.89	x	0.63	x	0.7	=	308.26	(78)
South	0.9x	0.77	x	9.9	x	82.59	x	0.63	x	0.7	=	249.87	(78)
South	0.9x	0.77	x	9.9	x	55.42	x	0.63	x	0.7	=	167.67	(78)
South	0.9x	0.77	x	9.9	x	40.4	x	0.63	x	0.7	=	122.23	(78)
West	0.9x	0.77	x	0.72	x	19.64	x	0.63	x	0.7	=	4.32	(80)
West	0.9x	0.77	x	0.72	x	38.42	x	0.63	x	0.7	=	8.45	(80)
West	0.9x	0.77	x	0.72	x	63.27	x	0.63	x	0.7	=	13.92	(80)
West	0.9x	0.77	x	0.72	x	92.28	x	0.63	x	0.7	=	20.31	(80)
West	0.9x	0.77	x	0.72	x	113.09	x	0.63	x	0.7	=	24.89	(80)
West	0.9x	0.77	x	0.72	x	115.77	x	0.63	x	0.7	=	25.47	(80)
West	0.9x	0.77	x	0.72	x	110.22	x	0.63	x	0.7	=	24.25	(80)
West	0.9x	0.77	x	0.72	x	94.68	x	0.63	x	0.7	=	20.83	(80)
West	0.9x	0.77	x	0.72	x	73.59	x	0.63	x	0.7	=	16.19	(80)
West	0.9x	0.77	x	0.72	x	45.59	x	0.63	x	0.7	=	10.03	(80)
West	0.9x	0.77	x	0.72	x	24.49	x	0.63	x	0.7	=	5.39	(80)
West	0.9x	0.77	x	0.72	x	16.15	x	0.63	x	0.7	=	3.55	(80)
Rooflights	0.9x	1	x	2.16	x	15.3	x	0.63	x	0.7	=	13.11	(82)
Rooflights	0.9x	1	x	2.16	x	28.48	x	0.63	x	0.7	=	24.41	(82)
Rooflights	0.9x	1	x	2.16	x	50.24	x	0.63	x	0.7	=	43.07	(82)
Rooflights	0.9x	1	x	2.16	x	89.03	x	0.63	x	0.7	=	76.33	(82)
Rooflights	0.9x	1	x	2.16	x	129.88	x	0.63	x	0.7	=	111.35	(82)
Rooflights	0.9x	1	x	2.16	x	143.74	x	0.63	x	0.7	=	123.22	(82)
Rooflights	0.9x	1	x	2.16	x	132.31	x	0.63	x	0.7	=	113.43	(82)
Rooflights	0.9x	1	x	2.16	x	98.56	x	0.63	x	0.7	=	84.5	(82)
Rooflights	0.9x	1	x	2.16	x	62.62	x	0.63	x	0.7	=	53.69	(82)
Rooflights	0.9x	1	x	2.16	x	34.05	x	0.63	x	0.7	=	29.19	(82)
Rooflights	0.9x	1	x	2.16	x	18.64	x	0.63	x	0.7	=	15.98	(82)
Rooflights	0.9x	1	x	2.16	x	12.94	x	0.63	x	0.7	=	11.1	(82)

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

(83)m=	235.48	411.88	600.26	818.49	994.56	1024.14	971.89	833.22	673.79	464.33	283.82	200.49	(83)

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

(84)m=	841.47	1015.52	1183.38	1367.88	1508.43	1504.77	1431.56	1299.66	1158.11	982.63	841.22	788.44	(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	0.97	0.94	0.87	0.75	0.62	0.68	0.86	0.96	0.99	0.99	(86)

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

(87)m=	18.73	18.96	19.35	19.87	20.37	20.74	20.9	20.86	20.55	19.91	19.21	18.67	(87)

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

(88)m=	19.97	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	(88)

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

(89)m=	0.99	0.98	0.97	0.93	0.84	0.68	0.5	0.57	0.81	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=	16.91	17.25	17.81	18.56	19.26	19.74	19.91	19.88	19.52	18.62	17.62	16.83	(90)

fLA = Living area ÷ (4) = 0.11 (91)

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

(92)m=	17.11	17.44	17.99	18.71	19.39	19.85	20.02	19.99	19.64	18.77	17.8	17.04	(92)

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

(93)m=	16.96	17.29	17.84	18.56	19.24	19.7	19.87	19.84	19.49	18.62	17.65	16.89	(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=	0.98	0.97	0.95	0.9	0.81	0.66	0.49	0.55	0.78	0.93	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	828.84	988.82	1126.01	1233.78	1218.06	988.87	702.89	717.32	906.27	912.88	820.63	778.59	(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=	2928.17	2860.98	2617.98	2229.88	1740.81	1177.37	755.91	794.68	1243.64	1851.39	2435.63	2929.93	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1561.91	1258.09	1110.03	717.19	388.93	0	0	0	0	698.25	1162.8	1600.59	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 8497.78 (98)

Space heating requirement in kWh/m²/year 41.6 (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		90.6	(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)													
	1561.91	1258.09	1110.03	717.19	388.93	0	0	0	0	698.25	1162.8	1600.59	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	1723.96	1388.62	1225.19	791.6	429.28	0	0	0	0	770.69	1283.44	1766.66	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 9379.45 (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)

DER WorkSheet: New dwelling design stage

Water heating

Output from water heater (calculated above)

	217.67	191.67	200.87	179.47	175.45	156.15	149.38	164.73	164.69	186.13	197.56	212.23		
Efficiency of water heater													79.9	(216)
(217)m=	89.14	89.02	88.78	88.23	86.98	79.9	79.9	79.9	79.9	88.12	88.87	89.2		(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	244.19	215.3	226.26	203.4	201.71	195.44	186.96	206.17	206.12	211.23	222.3	237.92		
								Total = Sum(219a)$_{1...12}$ =					2557.01	(219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		9379.45	
Water heating fuel used		2557.01	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	94.73		(230a)
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year — sum of (230a)…(230g) =		169.73	(231)
Electricity for lighting		600.52	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =		12706.7	(338)

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	=	2025.96	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	552.31	(264)
Space and water heating	(261) + (262) + (263) + (264) =			2578.27	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	88.09	(267)
Electricity for lighting	(232) x	0.519	=	311.67	(268)
Total CO2, kg/year		sum of (265)…(271) =		2978.03	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		14.58	(273)
EI rating (section 14)				84	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matt Fitzpatrick	**Stroma Number:**	STRO003572
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.41

Property Address: Plot 4

Address : Plot 4, Widdington, TBC

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	144.43	(1a) x	2.5	(2a) =	361.07	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	144.43	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	361.07	(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							0	x 10 =	0	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues and fans =	(6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)

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		4.65000009536743	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.23	(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) =	0.2	(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

0.25	0.25	0.24	0.22	0.21	0.19	0.19	0.18	0.2	0.21	0.22	0.23

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(24c)

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

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

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

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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 Type 1			2.55	x	1.4	=	3.57			(26)
Doors Type 2			2.1	x	1.4	=	2.94			(26)
Windows Type 1			15.74	x1/[1/(1.4)+ 0.04]		=	20.87			(27)
Windows Type 2			1.8	x1/[1/(1.4)+ 0.04]		=	2.39			(27)
Windows Type 3			3.18	x1/[1/(1.4)+ 0.04]		=	4.22			(27)
Windows Type 4			4.2	x1/[1/(1.4)+ 0.04]		=	5.57			(27)
Floor			144.43	x	0.12	=	17.3316	75	10832.25	(28)
Walls	172.48	29.57	142.91	x	0.19	=	27.15	60	8574.6	(29)
Roof	144.43	0	144.43	x	0.11	=	15.89	9	1299.87	(30)
Total area of elements, m²			461.34							(31)
Internal wall **			248.99					9	2240.91	(32c)

** 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) = 99.92 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 22947.63 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K = (34) ÷ (4) = 158.88 (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 20.7 (36)

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

Total fabric heat loss (33) + (36) = 120.62 (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=	59.81	59.58	59.58	59.58	59.58	59.58	59.58	59.58	59.58	59.58	59.58	59.58	(38)

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

(39)m=	180.43	180.2	180.2	180.2	180.2	180.2	180.2	180.2	180.2	180.2	180.2	180.2	

Average = Sum(39)$_{1...12}$ /12= 180.22 (39)

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

(40)m=	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	

Average = Sum(40)$_{1...12}$ /12= 1.25 (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 2.93 (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) + 36 103.67 (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=	114.04	109.89	105.74	101.6	97.45	93.3	93.3	97.45	101.6	105.74	109.89	114.04	

Total = Sum(44)$_{1...12}$ = 1244.05 (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=	169.11	147.91	152.63	133.07	127.68	110.18	102.1	117.16	118.56	138.17	150.82	163.78	

Total = Sum(45)$_{1...12}$ = 1631.15 (45)

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

(46)m=	25.37	22.19	22.89	19.96	19.15	16.53	15.31	17.57	17.78	20.72	22.62	24.57	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 180 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.32 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.71 (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) 0.71 (55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	214.47	188.88	197.99	176.96	173.04	154.07	147.46	162.52	162.45	183.52	194.71	209.14	(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=	214.47	188.88	197.99	176.96	173.04	154.07	147.46	162.52	162.45	183.52	194.71	209.14

Output from water heater (annual)$_{1...12}$ — 2165.21 (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=	92.52	81.96	87.04	79.36	78.74	71.75	70.23	75.24	74.54	82.23	85.26	90.74	(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=	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	(66)

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

(67)m=	28.16	25.01	20.34	15.4	11.51	9.72	10.5	13.65	18.32	23.26	27.15	28.94	(67)

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

(68)m=	314.4	317.66	309.44	291.93	269.84	249.08	235.2	231.94	240.16	257.67	279.76	300.52	(68)

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

(69)m=	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	(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=	-117	-117	-117	-117	-117	-117	-117	-117	-117	-117	-117	-117	(71)

Water heating gains (Table 5)

(72)m=	124.35	121.96	116.98	110.22	105.83	99.65	94.4	101.13	103.52	110.52	118.42	121.97	(72)

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

(73)m=	536.79	534.5	516.64	487.43	457.06	428.33	409.98	416.6	431.88	461.33	495.21	521.31	(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)

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North	0.9x	0.77	x	15.74	x	10.63	x	0.63	x	0.7	=	51.15	(74)
North	0.9x	0.77	x	15.74	x	20.32	x	0.63	x	0.7	=	97.75	(74)
North	0.9x	0.77	x	15.74	x	34.53	x	0.63	x	0.7	=	166.1	(74)
North	0.9x	0.77	x	15.74	x	55.46	x	0.63	x	0.7	=	266.8	(74)
North	0.9x	0.77	x	15.74	x	74.72	x	0.63	x	0.7	=	359.41	(74)
North	0.9x	0.77	x	15.74	x	79.99	x	0.63	x	0.7	=	384.76	(74)
North	0.9x	0.77	x	15.74	x	74.68	x	0.63	x	0.7	=	359.22	(74)
North	0.9x	0.77	x	15.74	x	59.25	x	0.63	x	0.7	=	285	(74)
North	0.9x	0.77	x	15.74	x	41.52	x	0.63	x	0.7	=	199.71	(74)
North	0.9x	0.77	x	15.74	x	24.19	x	0.63	x	0.7	=	116.36	(74)
North	0.9x	0.77	x	15.74	x	13.12	x	0.63	x	0.7	=	63.1	(74)
North	0.9x	0.77	x	15.74	x	8.86	x	0.63	x	0.7	=	42.64	(74)
East	0.9x	0.77	x	1.8	x	19.64	x	0.63	x	0.7	=	10.8	(76)
East	0.9x	0.77	x	1.8	x	38.42	x	0.63	x	0.7	=	21.14	(76)
East	0.9x	0.77	x	1.8	x	63.27	x	0.63	x	0.7	=	34.81	(76)
East	0.9x	0.77	x	1.8	x	92.28	x	0.63	x	0.7	=	50.76	(76)
East	0.9x	0.77	x	1.8	x	113.09	x	0.63	x	0.7	=	62.21	(76)
East	0.9x	0.77	x	1.8	x	115.77	x	0.63	x	0.7	=	63.69	(76)
East	0.9x	0.77	x	1.8	x	110.22	x	0.63	x	0.7	=	60.63	(76)
East	0.9x	0.77	x	1.8	x	94.68	x	0.63	x	0.7	=	52.08	(76)
East	0.9x	0.77	x	1.8	x	73.59	x	0.63	x	0.7	=	40.48	(76)
East	0.9x	0.77	x	1.8	x	45.59	x	0.63	x	0.7	=	25.08	(76)
East	0.9x	0.77	x	1.8	x	24.49	x	0.63	x	0.7	=	13.47	(76)
East	0.9x	0.77	x	1.8	x	16.15	x	0.63	x	0.7	=	8.88	(76)
South	0.9x	0.77	x	4.2	x	46.75	x	0.63	x	0.7	=	60.01	(78)
South	0.9x	0.77	x	4.2	x	76.57	x	0.63	x	0.7	=	98.28	(78)
South	0.9x	0.77	x	4.2	x	97.53	x	0.63	x	0.7	=	125.19	(78)
South	0.9x	0.77	x	4.2	x	110.23	x	0.63	x	0.7	=	141.49	(78)
South	0.9x	0.77	x	4.2	x	114.87	x	0.63	x	0.7	=	147.45	(78)
South	0.9x	0.77	x	4.2	x	110.55	x	0.63	x	0.7	=	141.9	(78)
South	0.9x	0.77	x	4.2	x	108.01	x	0.63	x	0.7	=	138.64	(78)
South	0.9x	0.77	x	4.2	x	104.89	x	0.63	x	0.7	=	134.64	(78)
South	0.9x	0.77	x	4.2	x	101.89	x	0.63	x	0.7	=	130.78	(78)
South	0.9x	0.77	x	4.2	x	82.59	x	0.63	x	0.7	=	106	(78)
South	0.9x	0.77	x	4.2	x	55.42	x	0.63	x	0.7	=	71.13	(78)
South	0.9x	0.77	x	4.2	x	40.4	x	0.63	x	0.7	=	51.85	(78)
West	0.9x	0.77	x	3.18	x	19.64	x	0.63	x	0.7	=	19.09	(80)
West	0.9x	0.77	x	3.18	x	38.42	x	0.63	x	0.7	=	37.34	(80)
West	0.9x	0.77	x	3.18	x	63.27	x	0.63	x	0.7	=	61.49	(80)
West	0.9x	0.77	x	3.18	x	92.28	x	0.63	x	0.7	=	89.68	(80)
West	0.9x	0.77	x	3.18	x	113.09	x	0.63	x	0.7	=	109.91	(80)

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West	0.9x	0.77	x	3.18	x	115.77	x	0.63	x	0.7	=	112.51	(80)
West	0.9x	0.77	x	3.18	x	110.22	x	0.63	x	0.7	=	107.12	(80)
West	0.9x	0.77	x	3.18	x	94.68	x	0.63	x	0.7	=	92.01	(80)
West	0.9x	0.77	x	3.18	x	73.59	x	0.63	x	0.7	=	71.52	(80)
West	0.9x	0.77	x	3.18	x	45.59	x	0.63	x	0.7	=	44.31	(80)
West	0.9x	0.77	x	3.18	x	24.49	x	0.63	x	0.7	=	23.8	(80)
West	0.9x	0.77	x	3.18	x	16.15	x	0.63	x	0.7	=	15.7	(80)

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

(83)m=	141.05	254.51	387.59	548.74	678.98	702.85	665.61	563.73	442.49	291.75	171.5	119.08	(83)

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

(84)m=	677.84	789.01	904.23	1036.18	1136.04	1131.18	1075.59	980.33	874.37	753.07	666.71	640.39	(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	0.89	0.78	0.64	0.7	0.88	0.97	0.99	1	(86)

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

(87)m=	18.92	19.11	19.46	19.94	20.41	20.76	20.91	20.87	20.58	19.98	19.36	18.87	(87)

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

(88)m=	19.88	19.88	19.88	19.88	19.88	19.88	19.88	19.88	19.88	19.88	19.88	19.88	(88)

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

(89)m=	0.99	0.99	0.98	0.94	0.86	0.7	0.51	0.58	0.83	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=	17.09	17.38	17.89	18.57	19.23	19.67	19.83	19.81	19.47	18.64	17.74	17.03	(90)

fLA = Living area ÷ (4) = 0.2 (91)

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

(92)m=	17.46	17.72	18.2	18.85	19.47	19.89	20.05	20.02	19.69	18.91	18.06	17.39	(92)

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

(93)m=	17.31	17.57	18.05	18.7	19.32	19.74	19.9	19.87	19.54	18.76	17.91	17.24	(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	0.92	0.84	0.69	0.52	0.58	0.81	0.95	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	670.33	774.31	872.3	956.89	951.31	778.75	554.96	566.95	710.64	712.03	654.63	634.45	(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=	2346.8	2283.7	2081.66	1765.32	1372.64	926.22	594.15	625.12	981.05	1470.64	1948.01	2350.52	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1247.3	1014.31	899.77	582.07	313.47	0	0	0	0	564.4	931.23	1276.75	

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Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ =	6829.3	(98)
Space heating requirement in kWh/m²/year	47.28	(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		90.6	(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)	1247.3	1014.31	899.77	582.07	313.47	0	0	0	0	564.4	931.23	1276.75		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	1376.71	1119.55	993.12	642.46	345.99	0	0	0	0	622.96	1027.85	1409.22		(211)
Total (kWh/year) =Sum(211)$_{1...5,10...12}$=													7537.86	(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)	214.47	188.88	197.99	176.96	173.04	154.07	147.46	162.52	162.45	183.52	194.71	209.14		
Efficiency of water heater													79.9	(216)
(217)m=	88.85	88.73	88.46	87.86	86.48	79.9	79.9	79.9	79.9	87.72	88.55	88.92		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	241.38	212.86	223.81	201.42	200.09	192.83	184.55	203.4	203.32	209.22	219.89	235.19		
Total = Sum(219a)$_{1...12}$ =													2527.96	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			7537.86	
Water heating fuel used			2527.96	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		67.02		(230a)
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		142.02	(231)
Electricity for lighting			497.35	(232)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =			10705.19	(338)

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

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	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211)	x	0.216	=	1628.18	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	546.04	(264)
Space and water heating	(261) + (262) + (263) + (264) =				2174.22	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	73.71	(267)
Electricity for lighting	(232)	x	0.519	=	258.13	(268)
Total CO2, kg/year			sum of (265)…(271) =		2506.05	(272)
Dwelling CO2 Emission Rate			(272) ÷ (4) =		17.35	(273)
EI rating (section 14)					82	(274)

Be Green SAP Sheets

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matt Fitzpatrick	**Stroma Number:**	STRO003572
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.41

Property Address: Plot 1

Address : Plot 1, Widdington, TBC

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	119.31	(1a) x	2.5	(2a) =	298.27	(3a)
First floor	84.97	(1b) x	2.56	(2b) =	217.61	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	204.28	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	515.88	(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							0	x 10 =	0	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)

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		4.65000009536743	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.23	(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) =	0.2	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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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

0.25	0.25	0.24	0.22	0.21	0.19	0.19	0.18	0.2	0.21	0.22	0.23

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(24c)

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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 Type 1			2.21	x	1.4	=	3.094			(26)
Doors Type 2			1.89	x	1.4	=	2.646			(26)
Windows Type 1			16.92	x1/[1/(1.4)+ 0.04]		=	22.43			(27)
Windows Type 2			3.6	x1/[1/(1.4)+ 0.04]		=	4.77			(27)
Windows Type 3			0.72	x1/[1/(1.4)+ 0.04]		=	0.95			(27)
Windows Type 4			9.9	x1/[1/(1.4)+ 0.04]		=	13.12			(27)
Rooflights			2.16	x1/[1/(1.4) + 0.04]		=	3.024			(27b)
Floor			119.31	x	0.12	=	14.3172	75	8948.25	(28)
Walls Type1	170.21	35.24	134.97	x	0.19	=	25.64	60	8098.2	(29)
Walls Type2	82.85	0	82.85	x	0.17	=	14.38	9	745.65	(29)
Roof Type1	58.74	0	58.74	x	0.11	=	6.46	9	528.66	(30)
Roof Type2	18.64	0	18.64	x	0.11	=	2.05	9	167.76	(30)
Roof Type3	16.35	0	16.35	x	0.1	=	1.7	9	147.15	(30)
Roof Type4	37.1	2.16	34.94	x	0.15	=	5.24	9	314.46	(30)
Total area of elements, m²			503.2							(31)
Internal wall **			29.96					75	2247	(32c)
Internal wall **			304.16					9	2737.44	(32c)

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Internal floor	84.97	18	1529.46	(32d)
Internal ceiling	84.97	9	764.73	(32e)

** 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) =	119.68	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	26228.76	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	= (34) ÷ (4) =	128.4	(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		26.11	(36)

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

Total fabric heat loss	(33) + (36) =	145.79	(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=	85.46	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	(38)

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

(39)m=	231.25	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	

Average = Sum(39)$_{1…12}$ /12= 230.94 (39)

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

(40)m=	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	

Average = Sum(40)$_{1…12}$ /12= 1.13 (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 3.01 (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) + 36 105.63 (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=	116.19	111.97	107.74	103.52	99.29	95.07	95.07	99.29	103.52	107.74	111.97	116.19	

Total = Sum(44)$_{1…12}$ = 1267.53 (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=	172.31	150.7	155.51	135.58	130.09	112.26	104.02	119.37	120.79	140.77	153.67	166.87	

Total = Sum(45)$_{1…12}$ = 1661.94 (45)

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

(46)m=	25.85	22.61	23.33	20.34	19.51	16.84	15.6	17.91	18.12	21.12	23.05	25.03	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 180 (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:

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a) If manufacturer's declared loss factor is known (kWh/day):		1.32	(48)
Temperature factor from Table 2b		0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0.71	(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)		0.71	(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	23.26	21.01	23.26	22.51	23.26	0	0	0	0	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	217.67	191.67	200.87	179.47	175.45	133.64	126.12	141.46	142.18	186.13	197.56	212.23	(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=	217.67	191.67	200.87	179.47	175.45	0	0	0	0	186.13	197.56	212.23

Output from water heater (annual)$_{1...12}$ — 1561.05 (64)

Output immersion

(64)m=	0	0	0	0	0	133.64	126.12	141.46	142.18	0	0	0

Output from immersion (annual)$_{1...12}$ — 543.404137853139 (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=	93.58	82.88	87.99	80.2	79.54	54.43	52.27	57.37	57.27	83.09	86.21	91.77	(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=	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	(66)

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

(67)m=	34	30.2	24.56	18.59	13.9	11.73	12.68	16.48	22.12	28.09	32.78	34.95	(67)

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

(68)m=	375.1	378.99	369.18	348.3	321.94	297.17	280.62	276.72	286.53	307.41	333.77	358.54	(68)

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

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(69)m=	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	(69)

Pumps and fans gains (Table 5a)

(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

(71)m=	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	(71)

Water heating gains (Table 5)

(72)m=	125.78	123.34	118.27	111.38	106.91	75.6	70.25	77.11	79.54	111.69	119.74	123.35	(72)

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

(73)m=	602.99	600.64	580.13	546.39	510.86	452.61	431.66	438.42	456.31	515.3	554.4	584.96	(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)	
North	0.9x	0.77	x	16.92	x	10.63	x	0.63	x	0.7	=	54.98	(74)
North	0.9x	0.77	x	16.92	x	20.32	x	0.63	x	0.7	=	105.08	(74)
North	0.9x	0.77	x	16.92	x	34.53	x	0.63	x	0.7	=	178.56	(74)
North	0.9x	0.77	x	16.92	x	55.46	x	0.63	x	0.7	=	286.81	(74)
North	0.9x	0.77	x	16.92	x	74.72	x	0.63	x	0.7	=	386.35	(74)
North	0.9x	0.77	x	16.92	x	79.99	x	0.63	x	0.7	=	413.6	(74)
North	0.9x	0.77	x	16.92	x	74.68	x	0.63	x	0.7	=	386.15	(74)
North	0.9x	0.77	x	16.92	x	59.25	x	0.63	x	0.7	=	306.36	(74)
North	0.9x	0.77	x	16.92	x	41.52	x	0.63	x	0.7	=	214.68	(74)
North	0.9x	0.77	x	16.92	x	24.19	x	0.63	x	0.7	=	125.08	(74)
North	0.9x	0.77	x	16.92	x	13.12	x	0.63	x	0.7	=	67.83	(74)
North	0.9x	0.77	x	16.92	x	8.86	x	0.63	x	0.7	=	45.84	(74)
East	0.9x	0.77	x	3.6	x	19.64	x	0.63	x	0.7	=	21.61	(76)
East	0.9x	0.77	x	3.6	x	38.42	x	0.63	x	0.7	=	42.27	(76)
East	0.9x	0.77	x	3.6	x	63.27	x	0.63	x	0.7	=	69.61	(76)
East	0.9x	0.77	x	3.6	x	92.28	x	0.63	x	0.7	=	101.53	(76)
East	0.9x	0.77	x	3.6	x	113.09	x	0.63	x	0.7	=	124.43	(76)
East	0.9x	0.77	x	3.6	x	115.77	x	0.63	x	0.7	=	127.37	(76)
East	0.9x	0.77	x	3.6	x	110.22	x	0.63	x	0.7	=	121.26	(76)
East	0.9x	0.77	x	3.6	x	94.68	x	0.63	x	0.7	=	104.16	(76)
East	0.9x	0.77	x	3.6	x	73.59	x	0.63	x	0.7	=	80.96	(76)
East	0.9x	0.77	x	3.6	x	45.59	x	0.63	x	0.7	=	50.16	(76)
East	0.9x	0.77	x	3.6	x	24.49	x	0.63	x	0.7	=	26.94	(76)
East	0.9x	0.77	x	3.6	x	16.15	x	0.63	x	0.7	=	17.77	(76)
South	0.9x	0.77	x	9.9	x	46.75	x	0.63	x	0.7	=	141.45	(78)
South	0.9x	0.77	x	9.9	x	76.57	x	0.63	x	0.7	=	231.66	(78)
South	0.9x	0.77	x	9.9	x	97.53	x	0.63	x	0.7	=	295.1	(78)
South	0.9x	0.77	x	9.9	x	110.23	x	0.63	x	0.7	=	333.52	(78)

South	0.9x	0.77	x	9.9	x	114.87	x	0.63	x	0.7	=	347.55	(78)
South	0.9x	0.77	x	9.9	x	110.55	x	0.63	x	0.7	=	334.47	(78)
South	0.9x	0.77	x	9.9	x	108.01	x	0.63	x	0.7	=	326.8	(78)
South	0.9x	0.77	x	9.9	x	104.89	x	0.63	x	0.7	=	317.37	(78)
South	0.9x	0.77	x	9.9	x	101.89	x	0.63	x	0.7	=	308.26	(78)
South	0.9x	0.77	x	9.9	x	82.59	x	0.63	x	0.7	=	249.87	(78)
South	0.9x	0.77	x	9.9	x	55.42	x	0.63	x	0.7	=	167.67	(78)
South	0.9x	0.77	x	9.9	x	40.4	x	0.63	x	0.7	=	122.23	(78)
West	0.9x	0.77	x	0.72	x	19.64	x	0.63	x	0.7	=	4.32	(80)
West	0.9x	0.77	x	0.72	x	38.42	x	0.63	x	0.7	=	8.45	(80)
West	0.9x	0.77	x	0.72	x	63.27	x	0.63	x	0.7	=	13.92	(80)
West	0.9x	0.77	x	0.72	x	92.28	x	0.63	x	0.7	=	20.31	(80)
West	0.9x	0.77	x	0.72	x	113.09	x	0.63	x	0.7	=	24.89	(80)
West	0.9x	0.77	x	0.72	x	115.77	x	0.63	x	0.7	=	25.47	(80)
West	0.9x	0.77	x	0.72	x	110.22	x	0.63	x	0.7	=	24.25	(80)
West	0.9x	0.77	x	0.72	x	94.68	x	0.63	x	0.7	=	20.83	(80)
West	0.9x	0.77	x	0.72	x	73.59	x	0.63	x	0.7	=	16.19	(80)
West	0.9x	0.77	x	0.72	x	45.59	x	0.63	x	0.7	=	10.03	(80)
West	0.9x	0.77	x	0.72	x	24.49	x	0.63	x	0.7	=	5.39	(80)
West	0.9x	0.77	x	0.72	x	16.15	x	0.63	x	0.7	=	3.55	(80)
Rooflights	0.9x	1	x	2.16	x	15.3	x	0.63	x	0.7	=	13.11	(82)
Rooflights	0.9x	1	x	2.16	x	28.48	x	0.63	x	0.7	=	24.41	(82)
Rooflights	0.9x	1	x	2.16	x	50.24	x	0.63	x	0.7	=	43.07	(82)
Rooflights	0.9x	1	x	2.16	x	89.03	x	0.63	x	0.7	=	76.33	(82)
Rooflights	0.9x	1	x	2.16	x	129.88	x	0.63	x	0.7	=	111.35	(82)
Rooflights	0.9x	1	x	2.16	x	143.74	x	0.63	x	0.7	=	123.22	(82)
Rooflights	0.9x	1	x	2.16	x	132.31	x	0.63	x	0.7	=	113.43	(82)
Rooflights	0.9x	1	x	2.16	x	98.56	x	0.63	x	0.7	=	84.5	(82)
Rooflights	0.9x	1	x	2.16	x	62.62	x	0.63	x	0.7	=	53.69	(82)
Rooflights	0.9x	1	x	2.16	x	34.05	x	0.63	x	0.7	=	29.19	(82)
Rooflights	0.9x	1	x	2.16	x	18.64	x	0.63	x	0.7	=	15.98	(82)
Rooflights	0.9x	1	x	2.16	x	12.94	x	0.63	x	0.7	=	11.1	(82)

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

(83)m=	235.48	411.88	600.26	818.49	994.56	1024.14	971.89	833.22	673.79	464.33	283.82	200.49	(83)

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

(84)m=	838.47	1012.52	1180.38	1364.88	1505.43	1476.76	1403.55	1271.64	1130.1	979.63	838.22	785.44	(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	0.97	0.94	0.87	0.76	0.62	0.68	0.87	0.96	0.99	0.99	(86)

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

(87)m=	18.73	18.96	19.35	19.86	20.37	20.73	20.89	20.86	20.54	19.91	19.19	18.68	(87)

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

(88)m=	19.97	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	(88)

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

(89)m=	0.99	0.98	0.97	0.93	0.84	0.69	0.51	0.58	0.82	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=	16.9	17.24	17.81	18.56	19.26	19.73	19.91	19.88	19.5	18.62	17.61	16.83	(90)

fLA = Living area ÷ (4) = 0.11 (91)

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

(92)m=	17.11	17.44	17.99	18.7	19.39	19.84	20.02	19.99	19.62	18.77	17.79	17.04	(92)

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

(93)m=	17.11	17.44	17.99	18.7	19.39	19.84	20.02	19.99	19.62	18.77	17.79	17.04	(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	0.97	0.95	0.91	0.81	0.68	0.52	0.58	0.8	0.93	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	826.39	986.91	1125.28	1235.98	1226.36	999.19	725.8	736.05	903.81	913.43	818.62	776.04	(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=	2962.28	2894.92	2652.06	2263.67	1775.09	1210.16	789.84	828.26	1274.74	1885.48	2469.13	2963.99	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1589.1	1282.19	1135.92	739.94	408.26	0	0	0	0	723.2	1188.37	1627.84	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 8694.81 (98)

Space heating requirement in kWh/m²/year 42.56 (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		280.83	(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)												
1589.1	1282.19	1135.92	739.94	408.26	0	0	0	0	723.2	1188.37	1627.84	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)												(211)
565.87	456.58	404.49	263.49	145.38	0	0	0	0	257.52	423.17	579.66	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 3096.15 (211)

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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)

217.67	191.67	200.87	179.47	175.45	0	0	0	0	186.13	197.56	212.23

Efficiency of water heater 281.39 (216)

(217)m=	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	(217)

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

(219)m=	77.35	68.12	71.38	63.78	62.35	0	0	0	0	66.15	70.21	75.42

Total = Sum(219a)$_{1...12}$ = 554.76 (219)

Water heating requirement (immersion)

0	0	0	0	0	133.64	126.12	141.46	142.18	0	0	0

Efficiency of water heater (Immersion) 100 (216)

(217)m=	0	0	0	0	0	100	100	100	100	0	0	0	(217)

Fuel for water heating (Immersion), kWh/month
(219)m = [(64)m + (218) m] x 100 ÷ (217)m

(219)m=	0	0	0	0	0	133.64	126.12	141.46	142.18	0	0	0

Total = Sum(219a)$_{1...12}$ = 543.4 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			3096.15	
Water heating fuel used			554.76	
Water heating fuel used (Immersion)			543.4	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		94.73		(230a)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		94.73	(231)
Electricity for lighting			600.52	(232)
Electricity generated by PVs			-614.18	(233)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =			3731.98	(338)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.519	=	1606.9	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.519	=	287.92	(264)
Water heating (Immersion)	(219) x	0.519	=	282.03	(264)
Space and water heating	(261) + (262) + (263) + (264) =			2176.85	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	49.16	(267)

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Electricity for lighting	(232) x	0.519	=	311.67	(268)
Energy saving/generation technologies					
Item 1		0.519	=	-318.76	(269)
Total CO2, kg/year		sum of (265)…(271) =		2218.92	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		10.86	(273)
EI rating (section 14)				88	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matt Fitzpatrick	**Stroma Number:**	STRO003572
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.41

Property Address: Plot 2

Address : Plot 2, Widdington, TBC

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	119.31	(1a) x	2.5	(2a) =	298.27	(3a)
First floor	84.97	(1b) x	2.56	(2b) =	217.61	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	204.28	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	515.88	(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							0	x 10 =	0	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)

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		4.65000009536743	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.23	(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) =	0.2	(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

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

0.25	0.25	0.24	0.22	0.21	0.19	0.19	0.18	0.2	0.21	0.22	0.23

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(24c)

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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 Type 1			2.21	x	1.4	=	3.094			(26)
Doors Type 2			1.89	x	1.4	=	2.646			(26)
Windows Type 1			16.92	x1/[1/(1.4)+ 0.04]		=	22.43			(27)
Windows Type 2			3.6	x1/[1/(1.4)+ 0.04]		=	4.77			(27)
Windows Type 3			0.72	x1/[1/(1.4)+ 0.04]		=	0.95			(27)
Windows Type 4			9.9	x1/[1/(1.4)+ 0.04]		=	13.12			(27)
Rooflights			2.16	x1/[1/(1.4) + 0.04]		=	3.024			(27b)
Floor			119.31	x	0.12	=	14.3172	75	8948.25	(28)
Walls Type1	170.21	35.24	134.97	x	0.19	=	25.64	60	8098.2	(29)
Walls Type2	82.85	0	82.85	x	0.17	=	14.38	9	745.65	(29)
Roof Type1	58.74	0	58.74	x	0.11	=	6.46	9	528.66	(30)
Roof Type2	18.64	0	18.64	x	0.11	=	2.05	9	167.76	(30)
Roof Type3	16.35	0	16.35	x	0.1	=	1.7	9	147.15	(30)
Roof Type4	37.1	2.16	34.94	x	0.15	=	5.24	9	314.46	(30)
Total area of elements, m²			503.2							(31)
Internal wall **			29.96					75	2247	(32c)
Internal wall **			304.16					9	2737.44	(32c)

DER WorkSheet: New dwelling design stage

Internal floor	84.97	18	1529.46	(32d)
Internal ceiling	84.97	9	764.73	(32e)

** 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) =	119.68	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	26228.76	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	= (34) ÷ (4) =	128.4	(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		26.11	(36)

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

Total fabric heat loss	(33) + (36) =	145.79	(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=	85.46	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	(38)

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

(39)m=	231.25	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	

Average = $Sum(39)_{1…12}$ /12= 230.94 (39)

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

(40)m=	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	

Average = $Sum(40)_{1…12}$ /12= 1.13 (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 3.01 (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) + 36 105.63 (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=	116.19	111.97	107.74	103.52	99.29	95.07	95.07	99.29	103.52	107.74	111.97	116.19

Total = $Sum(44)_{1…12}$ = 1267.53 (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=	172.31	150.7	155.51	135.58	130.09	112.26	104.02	119.37	120.79	140.77	153.67	166.87

Total = $Sum(45)_{1…12}$ = 1661.94 (45)

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

(46)m=	25.85	22.61	23.33	20.34	19.51	16.84	15.6	17.91	18.12	21.12	23.05	25.03	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 180 (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:

DER WorkSheet: New dwelling design stage

a) If manufacturer's declared loss factor is known (kWh/day):		1.32	(48)
Temperature factor from Table 2b		0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0.71	(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)		0.71	(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	23.26	21.01	23.26	22.51	23.26	0	0	0	0	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	217.67	191.67	200.87	179.47	175.45	133.64	126.12	141.46	142.18	186.13	197.56	212.23	(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=	217.67	191.67	200.87	179.47	175.45	0	0	0	0	186.13	197.56	212.23	

Output from water heater (annual)$_{1...12}$ — 1561.05 (64)

Output immersion

(64)m=	0	0	0	0	0	133.64	126.12	141.46	142.18	0	0	0	

Output from immersion (annual)$_{1...12}$ — 543.404137853139 (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=	93.58	82.88	87.99	80.2	79.54	54.43	52.27	57.37	57.27	83.09	86.21	91.77	(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=	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	(66)

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

(67)m=	34	30.2	24.56	18.59	13.9	11.73	12.68	16.48	22.12	28.09	32.78	34.95	(67)

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

(68)m=	375.1	378.99	369.18	348.3	321.94	297.17	280.62	276.72	286.53	307.41	333.77	358.54	(68)

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

(69)m=	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	(69)

Pumps and fans gains (Table 5a)

(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

(71)m=	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	(71)

Water heating gains (Table 5)

(72)m=	125.78	123.34	118.27	111.38	106.91	75.6	70.25	77.11	79.54	111.69	119.74	123.35	(72)

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

(73)m=	602.99	600.64	580.13	546.39	510.86	452.61	431.66	438.42	456.31	515.3	554.4	584.96	(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)	
North	0.9x	0.77	x	16.92	x	10.63	x	0.63	x	0.7	=	54.98	(74)
North	0.9x	0.77	x	16.92	x	20.32	x	0.63	x	0.7	=	105.08	(74)
North	0.9x	0.77	x	16.92	x	34.53	x	0.63	x	0.7	=	178.56	(74)
North	0.9x	0.77	x	16.92	x	55.46	x	0.63	x	0.7	=	286.81	(74)
North	0.9x	0.77	x	16.92	x	74.72	x	0.63	x	0.7	=	386.35	(74)
North	0.9x	0.77	x	16.92	x	79.99	x	0.63	x	0.7	=	413.6	(74)
North	0.9x	0.77	x	16.92	x	74.68	x	0.63	x	0.7	=	386.15	(74)
North	0.9x	0.77	x	16.92	x	59.25	x	0.63	x	0.7	=	306.36	(74)
North	0.9x	0.77	x	16.92	x	41.52	x	0.63	x	0.7	=	214.68	(74)
North	0.9x	0.77	x	16.92	x	24.19	x	0.63	x	0.7	=	125.08	(74)
North	0.9x	0.77	x	16.92	x	13.12	x	0.63	x	0.7	=	67.83	(74)
North	0.9x	0.77	x	16.92	x	8.86	x	0.63	x	0.7	=	45.84	(74)
East	0.9x	0.77	x	3.6	x	19.64	x	0.63	x	0.7	=	21.61	(76)
East	0.9x	0.77	x	3.6	x	38.42	x	0.63	x	0.7	=	42.27	(76)
East	0.9x	0.77	x	3.6	x	63.27	x	0.63	x	0.7	=	69.61	(76)
East	0.9x	0.77	x	3.6	x	92.28	x	0.63	x	0.7	=	101.53	(76)
East	0.9x	0.77	x	3.6	x	113.09	x	0.63	x	0.7	=	124.43	(76)
East	0.9x	0.77	x	3.6	x	115.77	x	0.63	x	0.7	=	127.37	(76)
East	0.9x	0.77	x	3.6	x	110.22	x	0.63	x	0.7	=	121.26	(76)
East	0.9x	0.77	x	3.6	x	94.68	x	0.63	x	0.7	=	104.16	(76)
East	0.9x	0.77	x	3.6	x	73.59	x	0.63	x	0.7	=	80.96	(76)
East	0.9x	0.77	x	3.6	x	45.59	x	0.63	x	0.7	=	50.16	(76)
East	0.9x	0.77	x	3.6	x	24.49	x	0.63	x	0.7	=	26.94	(76)
East	0.9x	0.77	x	3.6	x	16.15	x	0.63	x	0.7	=	17.77	(76)
South	0.9x	0.77	x	9.9	x	46.75	x	0.63	x	0.7	=	141.45	(78)
South	0.9x	0.77	x	9.9	x	76.57	x	0.63	x	0.7	=	231.66	(78)
South	0.9x	0.77	x	9.9	x	97.53	x	0.63	x	0.7	=	295.1	(78)
South	0.9x	0.77	x	9.9	x	110.23	x	0.63	x	0.7	=	333.52	(78)

South	0.9x	0.77	x	9.9	x	114.87	x	0.63	x	0.7	=	347.55	(78)
South	0.9x	0.77	x	9.9	x	110.55	x	0.63	x	0.7	=	334.47	(78)
South	0.9x	0.77	x	9.9	x	108.01	x	0.63	x	0.7	=	326.8	(78)
South	0.9x	0.77	x	9.9	x	104.89	x	0.63	x	0.7	=	317.37	(78)
South	0.9x	0.77	x	9.9	x	101.89	x	0.63	x	0.7	=	308.26	(78)
South	0.9x	0.77	x	9.9	x	82.59	x	0.63	x	0.7	=	249.87	(78)
South	0.9x	0.77	x	9.9	x	55.42	x	0.63	x	0.7	=	167.67	(78)
South	0.9x	0.77	x	9.9	x	40.4	x	0.63	x	0.7	=	122.23	(78)
West	0.9x	0.77	x	0.72	x	19.64	x	0.63	x	0.7	=	4.32	(80)
West	0.9x	0.77	x	0.72	x	38.42	x	0.63	x	0.7	=	8.45	(80)
West	0.9x	0.77	x	0.72	x	63.27	x	0.63	x	0.7	=	13.92	(80)
West	0.9x	0.77	x	0.72	x	92.28	x	0.63	x	0.7	=	20.31	(80)
West	0.9x	0.77	x	0.72	x	113.09	x	0.63	x	0.7	=	24.89	(80)
West	0.9x	0.77	x	0.72	x	115.77	x	0.63	x	0.7	=	25.47	(80)
West	0.9x	0.77	x	0.72	x	110.22	x	0.63	x	0.7	=	24.25	(80)
West	0.9x	0.77	x	0.72	x	94.68	x	0.63	x	0.7	=	20.83	(80)
West	0.9x	0.77	x	0.72	x	73.59	x	0.63	x	0.7	=	16.19	(80)
West	0.9x	0.77	x	0.72	x	45.59	x	0.63	x	0.7	=	10.03	(80)
West	0.9x	0.77	x	0.72	x	24.49	x	0.63	x	0.7	=	5.39	(80)
West	0.9x	0.77	x	0.72	x	16.15	x	0.63	x	0.7	=	3.55	(80)
Rooflights	0.9x	1	x	2.16	x	15.3	x	0.63	x	0.7	=	13.11	(82)
Rooflights	0.9x	1	x	2.16	x	28.48	x	0.63	x	0.7	=	24.41	(82)
Rooflights	0.9x	1	x	2.16	x	50.24	x	0.63	x	0.7	=	43.07	(82)
Rooflights	0.9x	1	x	2.16	x	89.03	x	0.63	x	0.7	=	76.33	(82)
Rooflights	0.9x	1	x	2.16	x	129.88	x	0.63	x	0.7	=	111.35	(82)
Rooflights	0.9x	1	x	2.16	x	143.74	x	0.63	x	0.7	=	123.22	(82)
Rooflights	0.9x	1	x	2.16	x	132.31	x	0.63	x	0.7	=	113.43	(82)
Rooflights	0.9x	1	x	2.16	x	98.56	x	0.63	x	0.7	=	84.5	(82)
Rooflights	0.9x	1	x	2.16	x	62.62	x	0.63	x	0.7	=	53.69	(82)
Rooflights	0.9x	1	x	2.16	x	34.05	x	0.63	x	0.7	=	29.19	(82)
Rooflights	0.9x	1	x	2.16	x	18.64	x	0.63	x	0.7	=	15.98	(82)
Rooflights	0.9x	1	x	2.16	x	12.94	x	0.63	x	0.7	=	11.1	(82)

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

(83)m=	235.48	411.88	600.26	818.49	994.56	1024.14	971.89	833.22	673.79	464.33	283.82	200.49	(83)

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

(84)m=	838.47	1012.52	1180.38	1364.88	1505.43	1476.76	1403.55	1271.64	1130.1	979.63	838.22	785.44	(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	0.97	0.94	0.87	0.76	0.62	0.68	0.87	0.96	0.99	0.99	(86)

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

(87)m=	18.73	18.96	19.35	19.86	20.37	20.73	20.89	20.86	20.54	19.91	19.19	18.68	(87)

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

(88)m=	19.97	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	(88)

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

(89)m=	0.99	0.98	0.97	0.93	0.84	0.69	0.51	0.58	0.82	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=	16.9	17.24	17.81	18.56	19.26	19.73	19.91	19.88	19.5	18.62	17.61	16.83	(90)

fLA = Living area ÷ (4) = 0.11 (91)

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

(92)m=	17.11	17.44	17.99	18.7	19.39	19.84	20.02	19.99	19.62	18.77	17.79	17.04	(92)

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

(93)m=	17.11	17.44	17.99	18.7	19.39	19.84	20.02	19.99	19.62	18.77	17.79	17.04	(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	0.97	0.95	0.91	0.81	0.68	0.52	0.58	0.8	0.93	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	826.39	986.91	1125.28	1235.98	1226.36	999.19	725.8	736.05	903.81	913.43	818.62	776.04	(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=	2962.28	2894.92	2652.06	2263.67	1775.09	1210.16	789.84	828.26	1274.74	1885.48	2469.13	2963.99	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1589.1	1282.19	1135.92	739.94	408.26	0	0	0	0	723.2	1188.37	1627.84	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 8694.81 (98)

Space heating requirement in kWh/m²/year 42.56 (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		280.83	(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)													
	1589.1	1282.19	1135.92	739.94	408.26	0	0	0	0	723.2	1188.37	1627.84	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	565.87	456.58	404.49	263.49	145.38	0	0	0	0	257.52	423.17	579.66	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 3096.15 (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)

	217.67	191.67	200.87	179.47	175.45	0	0	0	0	186.13	197.56	212.23		
Efficiency of water heater													281.39	(216)
(217)m=	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39		(217)

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

(219)m=	77.35	68.12	71.38	63.78	62.35	0	0	0	0	66.15	70.21	75.42		
								Total = Sum(219a)$_{1...12}$ =					554.76	(219)

Water heating requirement (immersion)

	0	0	0	0	0	133.64	126.12	141.46	142.18	0	0	0		
Efficiency of water heater (Immersion)													100	(216)
(217)m=	0	0	0	0	0	100	100	100	100	0	0	0		(217)

Fuel for water heating (Immersion), kWh/month
(219)m = [(64)m + (218) m] x 100 ÷ (217)m

(219)m=	0	0	0	0	0	133.64	126.12	141.46	142.18	0	0	0		
								Total = Sum(219a)$_{1...12}$ =					543.4	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			3096.15	
Water heating fuel used			554.76	
Water heating fuel used (Immersion)			543.4	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		94.73		(230a)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		94.73	(231)
Electricity for lighting			600.52	(232)
Electricity generated by PVs			-614.18	(233)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =			3731.98	(338)

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

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211)	x	0.519	=	1606.9	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.519	=	287.92	(264)
Water heating (Immersion)	(219)	x	0.519	=	282.03	(264)
Space and water heating	(261) + (262) + (263) + (264) =				2176.85	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	49.16	(267)

DER WorkSheet: New dwelling design stage

Electricity for lighting	(232) x	0.519	=	311.67	(268)
Energy saving/generation technologies					
Item 1		0.519	=	-318.76	(269)
Total CO2, kg/year		sum of (265)…(271) =		2218.92	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		10.86	(273)
EI rating (section 14)				88	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matt Fitzpatrick	**Stroma Number:**	STRO003572
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.41

Property Address: Plot 3

Address : Plot 3, Widdington, TBC

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	119.31	(1a)	x	2.5	(2a)	=	298.27	(3a)
First floor	84.97	(1b)	x	2.56	(2b)	=	217.61	(3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	204.28	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	515.88	(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							0	x 10 =	0	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)

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		4.65000009536743	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.23	(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) =	0.2	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

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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

0.25	0.25	0.24	0.22	0.21	0.19	0.19	0.18	0.2	0.21	0.22	0.23

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(24c)

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

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

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

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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 Type 1			2.21	x	1.4	=	3.094			(26)
Doors Type 2			1.89	x	1.4	=	2.646			(26)
Windows Type 1			16.92	x1/[1/(1.4)+ 0.04]		=	22.43			(27)
Windows Type 2			3.6	x1/[1/(1.4)+ 0.04]		=	4.77			(27)
Windows Type 3			0.72	x1/[1/(1.4)+ 0.04]		=	0.95			(27)
Windows Type 4			9.9	x1/[1/(1.4)+ 0.04]		=	13.12			(27)
Rooflights			2.16	x1/[1/(1.4) + 0.04]		=	3.024			(27b)
Floor			119.31	x	0.12	=	14.3172	75	8948.25	(28)
Walls Type1	170.21	35.24	134.97	x	0.19	=	25.64	60	8098.2	(29)
Walls Type2	82.85	0	82.85	x	0.17	=	14.38	9	745.65	(29)
Roof Type1	58.74	0	58.74	x	0.11	=	6.46	9	528.66	(30)
Roof Type2	18.64	0	18.64	x	0.11	=	2.05	9	167.76	(30)
Roof Type3	16.35	0	16.35	x	0.1	=	1.7	9	147.15	(30)
Roof Type4	37.1	2.16	34.94	x	0.15	=	5.24	9	314.46	(30)
Total area of elements, m²			503.2							(31)
Internal wall **			29.96					75	2247	(32c)
Internal wall **			304.16					9	2737.44	(32c)

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Internal floor	84.97	18	1529.46	(32d)
Internal ceiling	84.97	9	764.73	(32e)

** 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) =	119.68	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	26228.76	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	= (34) ÷ (4) =	128.4	(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		26.11	(36)

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

Total fabric heat loss	(33) + (36) =	145.79	(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=	85.46	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	85.12	(38)

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

(39)m=	231.25	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	230.91	

Average = Sum(39)$_{1…12}$ /12= 230.94 (39)

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

(40)m=	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	

Average = Sum(40)$_{1…12}$ /12= 1.13 (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 3.01 (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) + 36 105.63 (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=	116.19	111.97	107.74	103.52	99.29	95.07	95.07	99.29	103.52	107.74	111.97	116.19

Total = Sum(44)$_{1…12}$ = 1267.53 (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=	172.31	150.7	155.51	135.58	130.09	112.26	104.02	119.37	120.79	140.77	153.67	166.87

Total = Sum(45)$_{1…12}$ = 1661.94 (45)

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

(46)m=	25.85	22.61	23.33	20.34	19.51	16.84	15.6	17.91	18.12	21.12	23.05	25.03	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 180 (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:

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a) If manufacturer's declared loss factor is known (kWh/day):		1.32	(48)
Temperature factor from Table 2b		0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	0.71	(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)		0.71	(55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	23.26	21.01	23.26	22.51	23.26	0	0	0	0	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	217.67	191.67	200.87	179.47	175.45	133.64	126.12	141.46	142.18	186.13	197.56	212.23	(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=	217.67	191.67	200.87	179.47	175.45	0	0	0	0	186.13	197.56	212.23	

Output from water heater (annual)1…12 — 1561.05 (64)

Output immersion

(64)m=	0	0	0	0	0	133.64	126.12	141.46	142.18	0	0	0	

Output from immersion (annual)1…12 — 543.404137853139 (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=	93.58	82.88	87.99	80.2	79.54	54.43	52.27	57.37	57.27	83.09	86.21	91.77	(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=	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	150.37	(66)

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

(67)m=	34	30.2	24.56	18.59	13.9	11.73	12.68	16.48	22.12	28.09	32.78	34.95	(67)

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

(68)m=	375.1	378.99	369.18	348.3	321.94	297.17	280.62	276.72	286.53	307.41	333.77	358.54	(68)

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

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(69)m=	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	38.04	(69)
Pumps and fans gains (Table 5a)													
(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	-120.3	(71)
Water heating gains (Table 5)													
(72)m=	125.78	123.34	118.27	111.38	106.91	75.6	70.25	77.11	79.54	111.69	119.74	123.35	(72)
Total internal gains =						(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m							
(73)m=	602.99	600.64	580.13	546.39	510.86	452.61	431.66	438.42	456.31	515.3	554.4	584.96	(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)	
North	0.9x	0.77	x	16.92	x	10.63	x	0.63	x	0.7	=	54.98	(74)
North	0.9x	0.77	x	16.92	x	20.32	x	0.63	x	0.7	=	105.08	(74)
North	0.9x	0.77	x	16.92	x	34.53	x	0.63	x	0.7	=	178.56	(74)
North	0.9x	0.77	x	16.92	x	55.46	x	0.63	x	0.7	=	286.81	(74)
North	0.9x	0.77	x	16.92	x	74.72	x	0.63	x	0.7	=	386.35	(74)
North	0.9x	0.77	x	16.92	x	79.99	x	0.63	x	0.7	=	413.6	(74)
North	0.9x	0.77	x	16.92	x	74.68	x	0.63	x	0.7	=	386.15	(74)
North	0.9x	0.77	x	16.92	x	59.25	x	0.63	x	0.7	=	306.36	(74)
North	0.9x	0.77	x	16.92	x	41.52	x	0.63	x	0.7	=	214.68	(74)
North	0.9x	0.77	x	16.92	x	24.19	x	0.63	x	0.7	=	125.08	(74)
North	0.9x	0.77	x	16.92	x	13.12	x	0.63	x	0.7	=	67.83	(74)
North	0.9x	0.77	x	16.92	x	8.86	x	0.63	x	0.7	=	45.84	(74)
East	0.9x	0.77	x	3.6	x	19.64	x	0.63	x	0.7	=	21.61	(76)
East	0.9x	0.77	x	3.6	x	38.42	x	0.63	x	0.7	=	42.27	(76)
East	0.9x	0.77	x	3.6	x	63.27	x	0.63	x	0.7	=	69.61	(76)
East	0.9x	0.77	x	3.6	x	92.28	x	0.63	x	0.7	=	101.53	(76)
East	0.9x	0.77	x	3.6	x	113.09	x	0.63	x	0.7	=	124.43	(76)
East	0.9x	0.77	x	3.6	x	115.77	x	0.63	x	0.7	=	127.37	(76)
East	0.9x	0.77	x	3.6	x	110.22	x	0.63	x	0.7	=	121.26	(76)
East	0.9x	0.77	x	3.6	x	94.68	x	0.63	x	0.7	=	104.16	(76)
East	0.9x	0.77	x	3.6	x	73.59	x	0.63	x	0.7	=	80.96	(76)
East	0.9x	0.77	x	3.6	x	45.59	x	0.63	x	0.7	=	50.16	(76)
East	0.9x	0.77	x	3.6	x	24.49	x	0.63	x	0.7	=	26.94	(76)
East	0.9x	0.77	x	3.6	x	16.15	x	0.63	x	0.7	=	17.77	(76)
South	0.9x	0.77	x	9.9	x	46.75	x	0.63	x	0.7	=	141.45	(78)
South	0.9x	0.77	x	9.9	x	76.57	x	0.63	x	0.7	=	231.66	(78)
South	0.9x	0.77	x	9.9	x	97.53	x	0.63	x	0.7	=	295.1	(78)
South	0.9x	0.77	x	9.9	x	110.23	x	0.63	x	0.7	=	333.52	(78)

South	0.9x	0.77	x	9.9	x	114.87	x	0.63	x	0.7	=	347.55	(78)
South	0.9x	0.77	x	9.9	x	110.55	x	0.63	x	0.7	=	334.47	(78)
South	0.9x	0.77	x	9.9	x	108.01	x	0.63	x	0.7	=	326.8	(78)
South	0.9x	0.77	x	9.9	x	104.89	x	0.63	x	0.7	=	317.37	(78)
South	0.9x	0.77	x	9.9	x	101.89	x	0.63	x	0.7	=	308.26	(78)
South	0.9x	0.77	x	9.9	x	82.59	x	0.63	x	0.7	=	249.87	(78)
South	0.9x	0.77	x	9.9	x	55.42	x	0.63	x	0.7	=	167.67	(78)
South	0.9x	0.77	x	9.9	x	40.4	x	0.63	x	0.7	=	122.23	(78)
West	0.9x	0.77	x	0.72	x	19.64	x	0.63	x	0.7	=	4.32	(80)
West	0.9x	0.77	x	0.72	x	38.42	x	0.63	x	0.7	=	8.45	(80)
West	0.9x	0.77	x	0.72	x	63.27	x	0.63	x	0.7	=	13.92	(80)
West	0.9x	0.77	x	0.72	x	92.28	x	0.63	x	0.7	=	20.31	(80)
West	0.9x	0.77	x	0.72	x	113.09	x	0.63	x	0.7	=	24.89	(80)
West	0.9x	0.77	x	0.72	x	115.77	x	0.63	x	0.7	=	25.47	(80)
West	0.9x	0.77	x	0.72	x	110.22	x	0.63	x	0.7	=	24.25	(80)
West	0.9x	0.77	x	0.72	x	94.68	x	0.63	x	0.7	=	20.83	(80)
West	0.9x	0.77	x	0.72	x	73.59	x	0.63	x	0.7	=	16.19	(80)
West	0.9x	0.77	x	0.72	x	45.59	x	0.63	x	0.7	=	10.03	(80)
West	0.9x	0.77	x	0.72	x	24.49	x	0.63	x	0.7	=	5.39	(80)
West	0.9x	0.77	x	0.72	x	16.15	x	0.63	x	0.7	=	3.55	(80)
Rooflights	0.9x	1	x	2.16	x	15.3	x	0.63	x	0.7	=	13.11	(82)
Rooflights	0.9x	1	x	2.16	x	28.48	x	0.63	x	0.7	=	24.41	(82)
Rooflights	0.9x	1	x	2.16	x	50.24	x	0.63	x	0.7	=	43.07	(82)
Rooflights	0.9x	1	x	2.16	x	89.03	x	0.63	x	0.7	=	76.33	(82)
Rooflights	0.9x	1	x	2.16	x	129.88	x	0.63	x	0.7	=	111.35	(82)
Rooflights	0.9x	1	x	2.16	x	143.74	x	0.63	x	0.7	=	123.22	(82)
Rooflights	0.9x	1	x	2.16	x	132.31	x	0.63	x	0.7	=	113.43	(82)
Rooflights	0.9x	1	x	2.16	x	98.56	x	0.63	x	0.7	=	84.5	(82)
Rooflights	0.9x	1	x	2.16	x	62.62	x	0.63	x	0.7	=	53.69	(82)
Rooflights	0.9x	1	x	2.16	x	34.05	x	0.63	x	0.7	=	29.19	(82)
Rooflights	0.9x	1	x	2.16	x	18.64	x	0.63	x	0.7	=	15.98	(82)
Rooflights	0.9x	1	x	2.16	x	12.94	x	0.63	x	0.7	=	11.1	(82)

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

(83)m=	235.48	411.88	600.26	818.49	994.56	1024.14	971.89	833.22	673.79	464.33	283.82	200.49	(83)

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

(84)m=	838.47	1012.52	1180.38	1364.88	1505.43	1476.76	1403.55	1271.64	1130.1	979.63	838.22	785.44	(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	0.97	0.94	0.87	0.76	0.62	0.68	0.87	0.96	0.99	0.99	(86)

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

(87)m=	18.73	18.96	19.35	19.86	20.37	20.73	20.89	20.86	20.54	19.91	19.19	18.68	(87)

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

(88)m=	19.97	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	19.98	(88)

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

(89)m=	0.99	0.98	0.97	0.93	0.84	0.69	0.51	0.58	0.82	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=	16.9	17.24	17.81	18.56	19.26	19.73	19.91	19.88	19.5	18.62	17.61	16.83	(90)

fLA = Living area ÷ (4) = 0.11 (91)

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

(92)m=	17.11	17.44	17.99	18.7	19.39	19.84	20.02	19.99	19.62	18.77	17.79	17.04	(92)

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

(93)m=	17.11	17.44	17.99	18.7	19.39	19.84	20.02	19.99	19.62	18.77	17.79	17.04	(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	0.97	0.95	0.91	0.81	0.68	0.52	0.58	0.8	0.93	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	826.39	986.91	1125.28	1235.98	1226.36	999.19	725.8	736.05	903.81	913.43	818.62	776.04	(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=	2962.28	2894.92	2652.06	2263.67	1775.09	1210.16	789.84	828.26	1274.74	1885.48	2469.13	2963.99	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1589.1	1282.19	1135.92	739.94	408.26	0	0	0	0	723.2	1188.37	1627.84	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 8694.81 (98)

Space heating requirement in kWh/m²/year 42.56 (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		280.83	(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)													
	1589.1	1282.19	1135.92	739.94	408.26	0	0	0	0	723.2	1188.37	1627.84	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	565.87	456.58	404.49	263.49	145.38	0	0	0	0	257.52	423.17	579.66	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 3096.15 (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)

	217.67	191.67	200.87	179.47	175.45	0	0	0	0	186.13	197.56	212.23		
Efficiency of water heater													281.39	(216)
(217)m=	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39		(217)

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

(219)m=	77.35	68.12	71.38	63.78	62.35	0	0	0	0	66.15	70.21	75.42		
								Total = Sum(219a)$_{1...12}$ =					554.76	(219)

Water heating requirement (immersion)

	0	0	0	0	0	133.64	126.12	141.46	142.18	0	0	0		
Efficiency of water heater (Immersion)													100	(216)
(217)m=	0	0	0	0	0	100	100	100	100	0	0	0		(217)

Fuel for water heating (Immersion), kWh/month
(219)m = [(64)m + (218) m] x 100 ÷ (217)m

(219)m=	0	0	0	0	0	133.64	126.12	141.46	142.18	0	0	0		
								Total = Sum(219a)$_{1...12}$ =					543.4	(219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		3096.15	
Water heating fuel used		554.76	
Water heating fuel used (Immersion)		543.4	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	94.73		(230a)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		94.73	(231)
Electricity for lighting		600.52	(232)
Electricity generated by PVs		-1433.09	(233)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =		2913.07	(338)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.519	=	1606.9	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.519	=	287.92	(264)
Water heating (Immersion)	(219) x	0.519	=	282.03	(264)
Space and water heating	(261) + (262) + (263) + (264) =			2176.85	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	49.16	(267)

DER WorkSheet: New dwelling design stage

Electricity for lighting	(232) x	0.519	=	311.67	(268)
Energy saving/generation technologies					
Item 1		0.519	=	-743.77	(269)
Total CO2, kg/year		sum of (265)…(271) =		1793.91	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		8.78	(273)
EI rating (section 14)				90	(274)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Matt Fitzpatrick	**Stroma Number:**	STRO003572
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.41

Property Address: Plot 4

Address : Plot 4, Widdington, TBC

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	144.43	(1a) x	2.5	(2a) =	361.07	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	144.43	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	361.07	(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							0	x 10 =	0	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

Air changes per hour

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)

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		4.65000009536743	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.23	(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) =	0.2	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

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

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

0.25	0.25	0.24	0.22	0.21	0.19	0.19	0.18	0.2	0.21	0.22	0.23

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 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=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(24c)

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

(25)m=	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	(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 Type 1			2.55	x	1.4	=	3.57			(26)
Doors Type 2			2.1	x	1.4	=	2.94			(26)
Windows Type 1			15.74	x1/[1/(1.4)+ 0.04]		=	20.87			(27)
Windows Type 2			1.8	x1/[1/(1.4)+ 0.04]		=	2.39			(27)
Windows Type 3			3.18	x1/[1/(1.4)+ 0.04]		=	4.22			(27)
Windows Type 4			4.2	x1/[1/(1.4)+ 0.04]		=	5.57			(27)
Floor			144.43	x	0.12	=	17.3316	75	10832.25	(28)
Walls	172.48	29.57	142.91	x	0.19	=	27.15	60	8574.6	(29)
Roof	144.43	0	144.43	x	0.11	=	15.89	9	1299.87	(30)
Total area of elements, m²			461.34							(31)
Internal wall **			248.99					9	2240.91	(32c)

** 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) =	99.92	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	22947.63	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	= (34) ÷ (4) =	158.88	(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 20.7 (36)

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

Total fabric heat loss (33) + (36) = 120.62 (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=	59.81	59.58	59.58	59.58	59.58	59.58	59.58	59.58	59.58	59.58	59.58	59.58	(38)

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

(39)m=	180.43	180.2	180.2	180.2	180.2	180.2	180.2	180.2	180.2	180.2	180.2	180.2	

Average = $Sum(39)_{1...12}$ /12= 180.22 (39)

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

(40)m=	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	

Average = $Sum(40)_{1...12}$ /12= 1.25 (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 2.93 (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) + 36 103.67 (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=	114.04	109.89	105.74	101.6	97.45	93.3	93.3	97.45	101.6	105.74	109.89	114.04

Total = $Sum(44)_{1...12}$ = 1244.05 (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=	169.11	147.91	152.63	133.07	127.68	110.18	102.1	117.16	118.56	138.17	150.82	163.78

Total = $Sum(45)_{1...12}$ = 1631.15 (45)

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

(46)m=	25.37	22.19	22.89	19.96	19.15	16.53	15.31	17.57	17.78	20.72	22.62	24.57	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 180 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.32 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.71 (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) 0.71 (55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	22.1	19.96	22.1	21.38	22.1	21.38	22.1	22.1	21.38	22.1	21.38	22.1	(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=	23.26	21.01	23.26	22.51	23.26	0	0	0	0	23.26	22.51	23.26	(59)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(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=	214.47	188.88	197.99	176.96	173.04	131.56	124.19	139.25	139.94	183.52	194.71	209.14	(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=	214.47	188.88	197.99	176.96	173.04	0	0	0	0	183.52	194.71	209.14

Output from water heater (annual)$_{1\ldots12}$ — 1538.72 (64)

Output immersion

(64)m=	0	0	0	0	0	131.56	124.19	139.25	139.94	0	0	0

Output from immersion (annual)$_{1\ldots12}$ — 534.947209287422 (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=	92.52	81.96	87.04	79.36	78.74	53.74	51.62	56.63	56.53	82.23	85.26	90.74	(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=	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	146.25	(66)

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

(67)m=	28.16	25.01	20.34	15.4	11.51	9.72	10.5	13.65	18.32	23.26	27.15	28.94	(67)

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

(68)m=	314.4	317.66	309.44	291.93	269.84	249.08	235.2	231.94	240.16	257.67	279.76	300.52	(68)

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

(69)m=	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63	(69)

Pumps and fans gains (Table 5a)

(70)m=	0	0	0	0	0	0	0	0	0	0	0	0	(70)

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

(71)m=	-117	-117	-117	-117	-117	-117	-117	-117	-117	-117	-117	-117	(71)

Water heating gains (Table 5)

(72)m=	124.35	121.96	116.98	110.22	105.83	74.64	69.39	76.12	78.51	110.52	118.42	121.97	(72)

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

(73)m=	533.79	531.5	513.64	484.43	454.06	400.31	381.97	388.59	403.87	458.33	492.21	518.31	(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)	
North	0.9x	0.77	x	15.74	x	10.63	x	0.63	x	0.7	=	51.15	(74)
North	0.9x	0.77	x	15.74	x	20.32	x	0.63	x	0.7	=	97.75	(74)
North	0.9x	0.77	x	15.74	x	34.53	x	0.63	x	0.7	=	166.1	(74)
North	0.9x	0.77	x	15.74	x	55.46	x	0.63	x	0.7	=	266.8	(74)
North	0.9x	0.77	x	15.74	x	74.72	x	0.63	x	0.7	=	359.41	(74)
North	0.9x	0.77	x	15.74	x	79.99	x	0.63	x	0.7	=	384.76	(74)
North	0.9x	0.77	x	15.74	x	74.68	x	0.63	x	0.7	=	359.22	(74)
North	0.9x	0.77	x	15.74	x	59.25	x	0.63	x	0.7	=	285	(74)
North	0.9x	0.77	x	15.74	x	41.52	x	0.63	x	0.7	=	199.71	(74)
North	0.9x	0.77	x	15.74	x	24.19	x	0.63	x	0.7	=	116.36	(74)
North	0.9x	0.77	x	15.74	x	13.12	x	0.63	x	0.7	=	63.1	(74)
North	0.9x	0.77	x	15.74	x	8.86	x	0.63	x	0.7	=	42.64	(74)
East	0.9x	0.77	x	1.8	x	19.64	x	0.63	x	0.7	=	10.8	(76)
East	0.9x	0.77	x	1.8	x	38.42	x	0.63	x	0.7	=	21.14	(76)
East	0.9x	0.77	x	1.8	x	63.27	x	0.63	x	0.7	=	34.81	(76)
East	0.9x	0.77	x	1.8	x	92.28	x	0.63	x	0.7	=	50.76	(76)
East	0.9x	0.77	x	1.8	x	113.09	x	0.63	x	0.7	=	62.21	(76)
East	0.9x	0.77	x	1.8	x	115.77	x	0.63	x	0.7	=	63.69	(76)
East	0.9x	0.77	x	1.8	x	110.22	x	0.63	x	0.7	=	60.63	(76)
East	0.9x	0.77	x	1.8	x	94.68	x	0.63	x	0.7	=	52.08	(76)
East	0.9x	0.77	x	1.8	x	73.59	x	0.63	x	0.7	=	40.48	(76)
East	0.9x	0.77	x	1.8	x	45.59	x	0.63	x	0.7	=	25.08	(76)
East	0.9x	0.77	x	1.8	x	24.49	x	0.63	x	0.7	=	13.47	(76)
East	0.9x	0.77	x	1.8	x	16.15	x	0.63	x	0.7	=	8.88	(76)
South	0.9x	0.77	x	4.2	x	46.75	x	0.63	x	0.7	=	60.01	(78)
South	0.9x	0.77	x	4.2	x	76.57	x	0.63	x	0.7	=	98.28	(78)
South	0.9x	0.77	x	4.2	x	97.53	x	0.63	x	0.7	=	125.19	(78)
South	0.9x	0.77	x	4.2	x	110.23	x	0.63	x	0.7	=	141.49	(78)
South	0.9x	0.77	x	4.2	x	114.87	x	0.63	x	0.7	=	147.45	(78)
South	0.9x	0.77	x	4.2	x	110.55	x	0.63	x	0.7	=	141.9	(78)
South	0.9x	0.77	x	4.2	x	108.01	x	0.63	x	0.7	=	138.64	(78)
South	0.9x	0.77	x	4.2	x	104.89	x	0.63	x	0.7	=	134.64	(78)
South	0.9x	0.77	x	4.2	x	101.89	x	0.63	x	0.7	=	130.78	(78)
South	0.9x	0.77	x	4.2	x	82.59	x	0.63	x	0.7	=	106	(78)
South	0.9x	0.77	x	4.2	x	55.42	x	0.63	x	0.7	=	71.13	(78)
South	0.9x	0.77	x	4.2	x	40.4	x	0.63	x	0.7	=	51.85	(78)
West	0.9x	0.77	x	3.18	x	19.64	x	0.63	x	0.7	=	19.09	(80)
West	0.9x	0.77	x	3.18	x	38.42	x	0.63	x	0.7	=	37.34	(80)
West	0.9x	0.77	x	3.18	x	63.27	x	0.63	x	0.7	=	61.49	(80)

West	0.9x	0.77	x	3.18	x	92.28	x	0.63	x	0.7	=	89.68	(80)
West	0.9x	0.77	x	3.18	x	113.09	x	0.63	x	0.7	=	109.91	(80)
West	0.9x	0.77	x	3.18	x	115.77	x	0.63	x	0.7	=	112.51	(80)
West	0.9x	0.77	x	3.18	x	110.22	x	0.63	x	0.7	=	107.12	(80)
West	0.9x	0.77	x	3.18	x	94.68	x	0.63	x	0.7	=	92.01	(80)
West	0.9x	0.77	x	3.18	x	73.59	x	0.63	x	0.7	=	71.52	(80)
West	0.9x	0.77	x	3.18	x	45.59	x	0.63	x	0.7	=	44.31	(80)
West	0.9x	0.77	x	3.18	x	24.49	x	0.63	x	0.7	=	23.8	(80)
West	0.9x	0.77	x	3.18	x	16.15	x	0.63	x	0.7	=	15.7	(80)

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

(83)m=	141.05	254.51	387.59	548.74	678.98	702.85	665.61	563.73	442.49	291.75	171.5	119.08	(83)

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

(84)m=	674.84	786.01	901.23	1033.18	1133.04	1103.16	1047.58	952.31	846.36	750.07	663.71	637.39	(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	0.89	0.79	0.65	0.71	0.89	0.97	0.99	1	(86)

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

(87)m=	18.92	19.11	19.46	19.93	20.41	20.75	20.9	20.87	20.56	19.98	19.34	18.87	(87)

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

(88)m=	19.88	19.88	19.88	19.88	19.88	19.88	19.88	19.88	19.88	19.88	19.88	19.88	(88)

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

(89)m=	0.99	0.99	0.98	0.94	0.86	0.71	0.53	0.59	0.84	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=	17.09	17.37	17.88	18.57	19.23	19.66	19.83	19.8	19.45	18.64	17.73	17.02	(90)

fLA = Living area ÷ (4) = 0.2 (91)

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

(92)m=	17.45	17.72	18.2	18.84	19.47	19.88	20.04	20.01	19.68	18.91	18.05	17.39	(92)

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

(93)m=	17.45	17.72	18.2	18.84	19.47	19.88	20.04	20.01	19.68	18.91	18.05	17.39	(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	0.84	0.71	0.55	0.61	0.83	0.95	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	667.71	772	870.75	957.42	956.6	783.93	571.98	580.16	703.89	711.43	652.28	631.76	(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=	2373.4	2310.1	2108.22	1791.46	1399.34	951.47	620.51	651.15	1004.62	1497.18	1973.84	2377.08	(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=	1269.03	1033.6	920.67	600.51	329.39	0	0	0	0	584.6	951.53	1298.52		

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 6987.86 (98)

Space heating requirement in kWh/m²/year 48.38 (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		282.19	(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)	1269.03	1033.6	920.67	600.51	329.39	0	0	0	0	584.6	951.53	1298.52		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	449.71	366.28	326.26	212.8	116.73	0	0	0	0	207.16	337.19	460.15		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													2476.28	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	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)	214.47	188.88	197.99	176.96	173.04	0	0	0	0	183.52	194.71	209.14		
Efficiency of water heater													281.39	(216)
(217)m=	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39	281.39		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	76.22	67.12	70.36	62.89	61.49	0	0	0	0	65.22	69.2	74.32		
Total = Sum(219a)$_{1...12}$ =													546.83	(219)
Water heating requirement (immersion)	0	0	0	0	0	131.56	124.19	139.25	139.94	0	0	0		
Efficiency of water heater (Immersion)													100	(216)
(217)m=	0	0	0	0	0	100	100	100	100	0	0	0		(217)
Fuel for water heating (Immersion), kWh/month (219)m = [(64)m + (218) m] x 100 ÷ (217)m														
(219)m=	0	0	0	0	0	131.56	124.19	139.25	139.94	0	0	0		
Total = Sum(219a)$_{1...12}$ =													534.95	(219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		2476.28
Water heating fuel used		546.83
Water heating fuel used (Immersion)		534.95

Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		67.02		(230a)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		67.02	(231)
Electricity for lighting			497.35	(232)
Electricity generated by PVs			-2456.73	(233)
Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) =			1130.75	(338)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.519	=	1285.19	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.519	=	283.8	(264)
Water heating (Immersion)	(219) x	0.519	=	277.64	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1846.63	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	34.78	(267)
Electricity for lighting	(232) x	0.519	=	258.13	(268)
Energy saving/generation technologies Item 1		0.519	=	-1275.04	(269)
Total CO2, kg/year		sum of (265)…(271) =		864.5	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		5.99	(273)
EI rating (section 14)				94	(274)