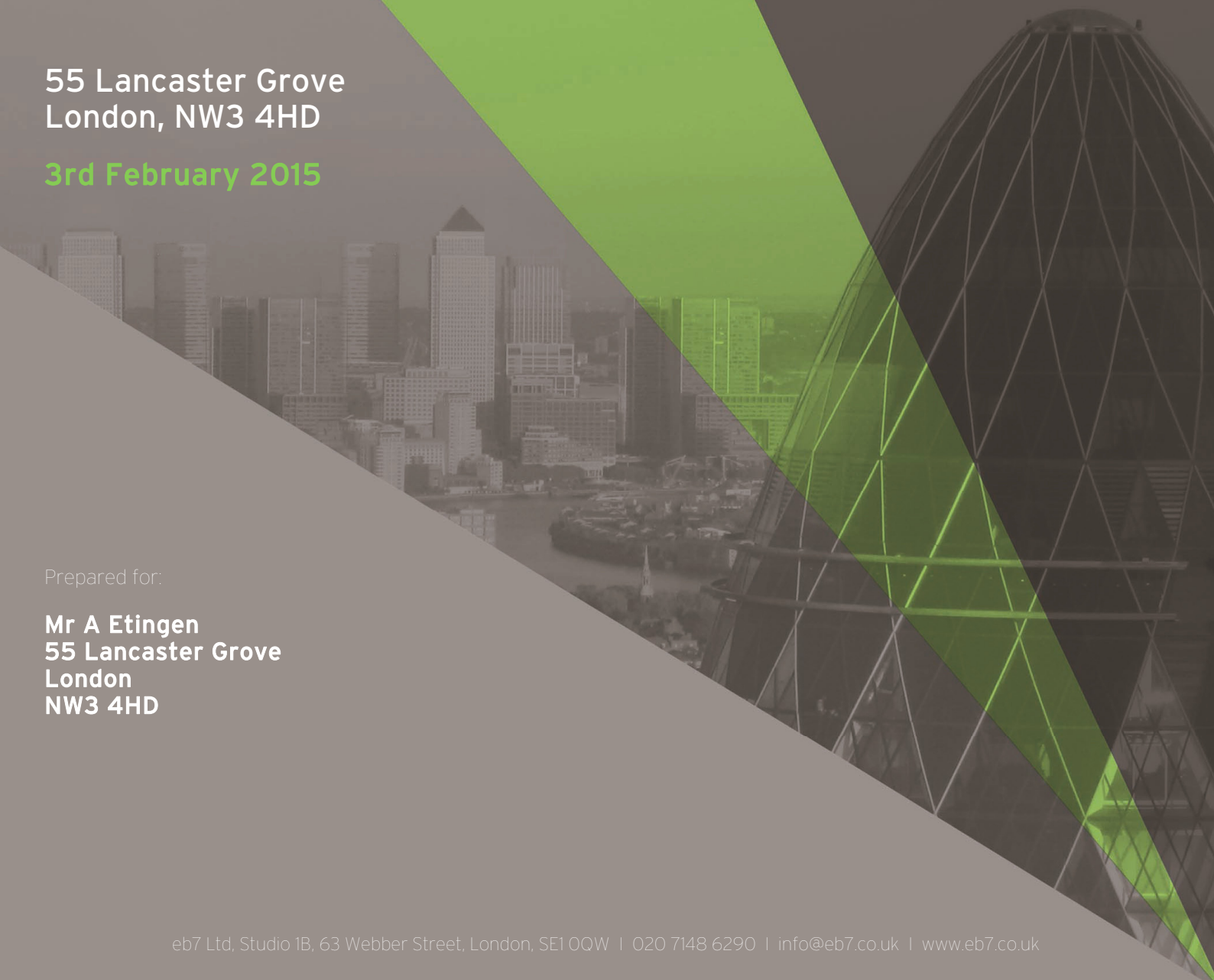
Sustainability

BREEAM Domestic Refurbishment
Pre-assessment Report

55 Lancaster Grove
London, NW3 4HD

3rd February 2015



Prepared for:

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Contents

Appendices

1.0 What is BREEAM Domestic Refurbishment?

Replacing Eco Homes in **July 2012**, the BREEAM Domestic Refurbishment scheme is used to assess the environmental life cycle impacts of refurbishment projects including existing dwelling undergoing refurbishment, extensions, domestic conversions and change of use projects in the UK only.

'Domestic Refurbishment' is classified under two categories:

1. Alterations to existing dwellings and extensions
2. Domestic conversions and change of use projects

BREEAM Domestic Refurbishment is a performance based assessment method and certification scheme for domestic buildings undergoing refurbishment. The primary aim of BREEAM Domestic Refurbishment is to improve the environmental performance of existing dwellings in a robust and cost effective manner.

This is achieved through integration and use of the scheme by clients and their project teams at key stages in the refurbishment process. This enables the client, through personnel qualified and licensed under the BREEAM Domestic Refurbishment Scheme and the BRE Global certification process, to measure, evaluate and reflect the performance of their refurbishment project against best practice in an independent and robust manner.

This performance is quantified by a number of individual measures and associated criteria stretching across a range of environmental issues as described in **Appendix A**

1.1 Advantages of Meeting the BREEAM standards

1. Reduced maintenance costs.
2. Reduced greenhouse gases.
3. Reduced impact on environment.
4. Provide affordable warmth.
5. Healthy and comfortable internal environment.
6. Improved sustainability credentials.
7. Increased level of occupant satisfaction.
8. Outperforms open market housing in terms of energy demand - increased sale-ability.
9. Demonstrates forward thinking and environmental awareness on the part of the Developers and Housing providers.

1.2 BREEAM Rating benchmarks

The BREEAM rating benchmarks for domestic refurbishment projects assessed using the 2014 version of BREEAM Domestic Refurbishment are as follows:

BREEAM Rating	% Score
Outstanding	>85
Excellent	>70
Very Good	>55
Good	>45
Pass	>30
Unclassified	<30

The BREEAM rating benchmark levels enable a client or other stakeholder to compare an individual building's performance with other BREEAM rated buildings and the typical sustainability performance of refurbished domestic buildings in the UK.

In this respect each BREEAM rating level broadly represents performance equivalent to:

- **Outstanding:** Less than top 1% of UK domestic refurbishments (innovator)
- **Excellent:** Top 10% of UK domestic refurbishments (best practice)
- **Very Good:** Top 25% of UK domestic refurbishments (advanced good practice)
- **Good:** Top 50% of UK domestic refurbishments (intermediate good practice)
- **Pass:** Top 75% of UK domestic refurbishments (standard good practice)

2.0 Site & Proposal

The development site consists of an existing 2 storey semi-detached dwelling with further accommodation within the roof space

The existing building is assumed to be of late Victorian era construction – and of solid brick construction with single glazed sash windows.

Planning permission is sought to create a basement level with a gym areas, study space and utility space, as well as a new ground floor extension to the rear providing a new kitchen and dining area.

The project sits within the Borough of Camden; Camden's adopted Local Development Framework expects that:-

"developments (except new build) of 500 sqm of residential floorspace or above or 5 or more dwellings to achieve "very good" in EcoHomes assessments prior to 2013 and encouraging "excellent" from 2013;

Camden Core Strategy Policy CS13, paragraph 13.9 expects "*development or alterations to existing buildings to include proportionate measures to be taken to improve their environmental sustainability, where possible.* "

"All buildings, whether being updated or refurbished, are expected to reduce their carbon emissions by making improvements to the existing building. Work involving a change of use or an extension to an existing property is included. As a guide, at least 10% of the project cost should be spent on the improvements."

This report takes into account these issues and although not specifically required as a non-major development, the developer has made the decision to demonstrate compliance with Camden Core Strategy Policy CS13 - "to include proportionate measures to improve their environmental sustainability, where possible. " – by undertaking a BREEAM Domestic Refurbishment assessment at formal design stage and post construction and achieve a "Very Good" standard.

It is expected that at least 10% of the project budget will be utilised in achieving improvements in overall energy efficiency for the dwelling and improved sustainability credentials:-

- New high efficiency boiler plant
- New super insulated DHW cylinder
- Upgraded boiler controls
- Upgraded insulation to existing roof structure
- Insulation levels to new build elements to go beyond the minimum requirements of the Building Regulations
- Cycle storage facilities
- Provision of new A rated white goods

3.0 Overall Score & BREEAM Performance

The proposed development should achieve **57.29%** which equates to a **'Very Good'** Rating

3.1 Detailed Breakdown

A detailed breakdown of the BREEAM categories, the recommendations to the developers and how the development will achieve the necessary credits for a Very Good rating is attached in **Appendix A.** This also includes the evidence that will be needed to be provided at the formal design stage assessment design/post construction stage.

3.2 Pre-assessment Estimator

The BREEAM Domestic Refurbishment pre-assessment estimator is attached at **Appendix B** which includes the indications of the percentage contribution of each section to the overall score

3.2 SAP Dwelling Emission Rate

In order to demonstrate the performance of the project under the critical Energy categories that relate to emissions standards and the improvements achieved through the refurbishment programme, SAP calculations have been undertaken based upon the following criteria which comply with the minimum standards of AD L1B:-

- Installation of new high efficiency condensing gas boiler to provide the heating.
- Domestic hot water provided via super insulated megaflow hot water cylinders
- All existing elements in original buildings to remain in situ and u values assumed from SAP2005 Appendix S
- New basement walls to achieve u value of 0.15, new external walls to achieve u=0.26
- New basement floor to achieve u=0.15
- New double glazing to be installed to new build elements – assumed u values at 1.6
- New flat roof structures to achieve a u value of 0.14
- Existing roof structure to be upgraded to meet a u value at 0.18

The pre-refurbishment model has been based upon SAP2009 Appendix S data assuming the standard features of the original building, including:-

- Solid brick walls - uninsulated
- Solid uninsulated floors
- Single glazing with hard wood frames
- Poorly insulated roof spaces
- Old gas boiler (65% efficient) with jacket insulated hot water tank

The data output from the SAP model has been input to the BREEAM Domestic Refurbishment Energy calculator tool which is attached at **Appendix C**

The SAP outputs for the dwellings before and after refurbishment are attached at **Appendix D & E**

4.0 CONCLUSION

The Developer and Principle Contractor will be committed to achieving the required score with the above recommendations incorporated into the specification. Occupiers of the dwelling will enjoy reduced operating and life cycle costs due to the enhancement over and above current Building Regulations and built in features designed to reduce environmental impact and greenhouse gases. Overall the carbon footprint of the scheme will be minimised and all stakeholders involved stand to benefit as a result of the assessment and recommendations.

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BREEAM Ref – Neil Ingham – NI03

Assessor  **Date:** 3rd February 2015

Checked  **Date:** 3rd February 2015

Appendix A

Project Performance Against Assessment Criteria

Appendix B

BREEAM Domestic Refurbishment - Pre-assessment Estimator

Appendix C

BREEAM Domestic Refurbishment – Energy Calculator Tool

Appendix D

SAP Worksheet & PEA Output – Before Refurbishment

Appendix E

SAP Worksheet & PEA Output – After Refurbishment

BREEAM®

BREEAM Domestic Refurbishment

55 Lancaster Gate, London, NW3 4HD

Category	Issue	Notes and Design Stage Evidence Requirements	Credits
Home User Guide	Man 1	Developer is committed to producing a home user guide in line with BREEAM requirements **Evidence** Letter confirming commitment to provide home user guide to BREEAM standards	3.00
Responsible Construction Practices	Man 2	The main contractor will be required to comply with CCS to "best practice", scoring at least 25 points and at least 5 points in each of the 5 sections **Evidence** Written confirmation of commitment to scheme, and score to be targeted	1.00
Construction Site Impacts	Man 3	The credits will not be sought under this section **Evidence** Completed and signed copies of the relevant checklists	0.00
Security	Man 4	Due to the introduction of basement level glazing and the existing single glazing in accessible windows, it is unlikely that compliance will be sought on this project **Evidence** A written commitment to undertake the liaison and comply with the recommendations and outcomes.	0.00

Protection/ Enhancement of Ecological Features	Man 5	The credits will not be sought under this section **Evidence** Site ecology report by a project team member highlighting site ecology and written commitment to protect any such ecological features	0.00
Project Management	Man 6	The project team will be assigned specific responsibilities by the project manager, to include planning, design, refurbishment, commissioning & handover and occupation. **Evidence** Minutes from design team meetings involving the full project team	1.00
Daylighting	Hea 1	Looking at layouts, the addition of the new glazing may affect existing daylighting levels. Prior to formal assessment, the credits are not awarded **Evidence** N/A	0.00
Sound Insulation	Hea 2	The credits will not be sought under this section – as existing party walls cannot be tested **Evidence** Written report and confirmation of the above from a suitably qualified acoustician	0.00
Volatile Organic Compounds	Hea 3	The developer has not committed to achieving credits under this section. **Evidence** A written commitment to use suitable certified products, and copies of the manufacturers literature confirming compliance with the relevant standard	0.00
Inclusive Design	Hea 4	Due to the historic nature of the buildings and the limitations placed upon the redevelopment accordingly – it unlikely that the unit would be compliant and no credits are awarded under this section **Evidence** N/A	0.00

Ventilation	Hea 5	The developer has confirmed that the ventilation strategy will be fully compliant with AD Part F Section 5 in terms of background, purge and mechanical ventilation **Evidence** A compliant specification/mechanical drawings showing ventilation provision	2.00
Safety	Hea 6	The development will incorporate carbon monoxide detection due to the use of fossil fuels as the primary heating source, and mains powered fire detection/alarm systems **Evidence** Written commitment to install systems certified to the relevant standards, followed by manufacturers specification as soon as available	1.00
Improvement in EER	Ene 1	SAP calculations have been undertaken in line with the requirements of AD L1B. The outcome of a post refurbishment EER of 76, as against an assumed EER of 28 based upon SAP2009 Appendix S criteria achieves 5.0 credits **Evidence** Copy of the draft EPC from SAP2009 and the Energy Efficiency calculator	5.00
EER Post Refurbishment	Ene 2	The EER rating of 76 as noted above achieves 3.0 credits and meets the minimum standard of BREEAM Excellent **Evidence** Copy of the draft EPC from SAP2009 and the Energy Efficiency calculator	3.00
Primary Energy Demand	Ene 3	The calculations have been undertaken for the refurbished property and a primary energy demand of <160Kwh/sqm/year has been achieved **Evidence** Copy of the SAP worksheet from SAP2009 and the Energy Efficiency calculator	6.00

Renewable Technologies	Ene 4	It is acknowledged that the conservation area status of the development would inhibit the ability to pursue credits under this section. Credits are therefore not sought **Evidence** N/A	0.00
Energy Labelled White Goods	Ene 5	The developer has committed to providing a copy of the EU labelling scheme as part of the Home User Guide **Evidence** Copy of the Home User Guide	1.00
Drying Space	Ene 6	An external drying line will be installed within the rear garden area **Evidence** Include in specification and show on plans.	1.00
Lighting	Ene 7	The developer has confirmed that a low energy lighting strategy will be adopted for external lighting which will ensure an overall lighting density <9w/sqm **Evidence** Layouts showing lighting locations and details. Manufacturers literature confirming efficacy minimum, wattage and controls for external lighting	2.00
Display Energy Devices	Ene 8	The credits will not be sought under this section **Evidence** Written commitment to supply the display energy devices and model specification	0.00
Cycle Storage	Ene 9	A bespoke cycle storage facility will be put in place in the rear grounds – with direct access to/from the public highway **Evidence** Full details of the storage facility and security measures	2.00

Home Office	Ene 10	The dwelling will be equipped with a study area in a well lit room. Developer confirms that it is equipped with telephone sockets, 2 x double power sockets and has access to broadband. The rooms will also be provide with adequate ventilation (see Hea 05) **Evidence** Show on plans and confirm above through specification	1.00
Internal Water Consumption	Wat 1	All new sanitary ware to be installed will be low flow/low flush/low capacity, including new white goods. Developer also to advise flow rates for all existing water consuming devices within property (taps, baths, shower etc.). Developer to target <117 litres/person/day **Evidence** Full details and locations of all water consuming devices	2.0
External Water Consumption	Wat 2	An external water butt will be installed to collect roof water for the upkeep of soft landscaped areas **Evidence** Written commitment to supply and type/make model of water butt to be installed	1.00
Water Meter	Wat 3	The credit will not be sought under this section **Evidence** Written commitment to supply the display energy devices and model specification	0.00
Environmental Impact of Materials	Mat 1	As majority of material left in situ, the project will score highly in this section. Developer to confirm specification of all new build elements – roof, internal walls, windows and internal floors **Evidence** Specification of new build elements and plans indicating elements left in situ	13.00

Responsible Sourcing	Mat 2	Developer wishes to pursue further credits and will provide EMS/FCS certs for new materials to demonstrate responsible sourcing and in addition will confirm that all new timber used in the project is sourced in accordance with the UK Government's Timber Procurement Policy. **Evidence** Specification and volume of new build materials used and responsible sourcing certification	8.00
Insulation	Mat 3	Developer will source insulation materials with a high Green Guide rating and thereby achieve a high overall insulation index demonstrating low embodied environmental impact Credits are also available if insulation is responsibly sourced, but the developer has not committed to this at the design stage **Evidence** Specification and volume of insulations used and responsible sourcing certification	4.00
Household Waste	Wst 1	The developer will provide 3 x internal bins at capacity 30litres for waste recycling in a fixed location, minimum bin size 7l within a fixed unit in the kitchen area. The developer is also to provide information on Local Authority kerbside recycling scheme. **Evidence** Full details of bins supplied and mark provision on plans Details of Local authority collection scheme	2.00
Refurbishment Site Waste Management	Wst 2	Main contractor will be required to produce SWMP and monitor, sort and recycle construction waste and meet good practice waste benchmarks in terms of waste generated per £100K value of construction contract **Evidence** Copy of SWMP and waste removal records/recycling records	2.00
NOx Emissions	Pol 1	The development will incorporate a replacement high efficiency gas fired boiler system to provide the heating and hot water to the dwelling. **Evidence** Manufacturers specification of relevant plant and NOx emission data	3.00

Surface Water Run-off	Pol 2	The development site is required to ensure that surface water run-off is no greater then pre-development in order to meet planning requirements – Core Strategy Policy 13, and LDF Policy DP27 **Evidence** Details/specification of attenuation measures accompanied by design team calculations.	1.00
Flooding	Pol 3	EA maps indicate Zone 1 - the developer has not indicated that a formal flood risk assessment will be undertaken **Evidence** Flood risk assessment report confirming level of flood risk	0.00
Innovation	Inn	At this early stage, Innovation credits have not been considered	0.00
		Total Weighted Credits (Target 55 – Very Good)	**57.29**

BREEAM Domestic Refurbishment 2012 Pre-Assessment Estimator

BREEAM

This assessment and indicative BREEAM rating is not a formal certified BREEAM assessment or rating and must not be communicated as such. The score presented is indicative of a dwelling's potential performance and is based on a simplified pre-formal BREEAM assessment and unverified commitments given at an early stage in the design process.

Building name	55 Lancaster Grove
Indicative building score (%)	57.29%
Indicative BREEAM rating	BREEAM Very Good
Indicative Minimum standards level achieved	BREEAM Very Good

Management | Health & Wellbeing | Energy | Water | Materials | Waste | Pollution

INNOVATION	Section Weighting: 10%	Indicative Section Score	0.00%

MANAGEMENT	Section Weighting: 12%	Indicative Section Score	5.45%

Man 01 Home Users Guide

No. of BREEAM credits available	3	Available contribution to overall score	3.27%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where a Home Users Guide be provided to all dwellings, covering all issues set out in the 'Users Guide Contents list', three credits may be awarded

Indicative Credits Achieved
3

Man 02 Responsible Construction Practices

No. of BREEAM credits available	2	Available contribution to overall score	2.18%
No. of BREEAM innovation credits	1	Minimum standards applicable	No

Assessment Criteria

Where a compliant considerate construction scheme will be used, credits are awarded depending the score achieved as outlined below:

Indicative Credits Achieved
1

Large Scale - project with more than 5 units

	One Credit	Two Credits
Considerate Constructors Scheme	Score of 24 - 31.5	Score of 32 - 35.5
Checklist A-3	50% of the optional items in Checklist A-3	80% of the optional items in Checklist A-3

Small Scale - project with 5 units or fewer

	One Credit	Two Credits
Considerate Constructors Scheme	24 - 31.5	32 - 35.5
Checklist A-3	50% of the optional items	80% of the optional items
Checklist A-4	50% of the optional items	80% of the optional items

Exemplary Credit

Considerate Constructors Scheme	Score of >36
Checklist A-3	All Items (Optional & Mandatory)
Checklist A-4*	All Items (Optional & Mandatory)

Indicative Innovation Credits Achieved
0

* Small Scale Project Only

Man 03 Construction Site Impacts

No. of BREEAM credits available	1	Available contribution to overall score	1.09%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria
Where evidence demonstrate that site impacts will be monitored, as detailed below:

Indicative Credits Achieved
0

Requirements

	One Credit
Large Scale	Where there is evidence to demonstrate that **2 or more** of the sections in **Checklist A-5** are completed
Small Scale	Where there is evidence to demonstrate that **2 or more** of the sections in **Checklist A-6** are completed

Sections of Checklist	
Large Scale - Checklist A-5	**Small Scale - Checklist A-6**
Monitor, report and set targets for CO2 production of energy use arising from site activities	Set objectives for reducing CO2 production from energy use arising from site activities
Monitor, report and set targets for water consumption arising from site activities	Set objectives for reducing water use arising from site activities
A main contractor with an environmental materials policy	Main contractor environmental materials statement
A main contractor that operates an Environmental Management System	80% of site timber is reclaimed, re-used or responsibly sourced
80% of site timber is reclaimed, re-used or responsibly sourced	

Same definition of small and large scale as in Man 02

Man 04 Security

No. of BREEAM credits available	2	Available contribution to overall score	2.18%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria
Where the following requirements will be met:

Indicative Credits Achieved
0

Requirements

One Credit Secure windows and doors	External doors and accessible windows meet minimum standards and appropriately certified
Two Credits Secured by design	Principles and guidance of Secured by Design Section 2 are complied with
	A suitably qualified security consultant is consulted at the design stage and their recommendations are incorporated into the refurbishment

Man 05 Protection and Enhancement of Ecological Features

No. of BREEAM credits available	1	Available contribution to overall score	1.09%
No. of BREEAM innovation credits	1	Minimum standards applicable	No

Assessment Criteria
Where the following requirements will be met:

Indicative Credits Achieved
0

Requirements

One Credit Protecting Ecological Features	Site survey carried out to determine presence of ecological features
	Statutory Nature Conservation Organisation notified of protected species
	Features of ecological value protected during refurbishment works

Requirements

Exemplary Credit Ecological enhancement	A suitably qualified ecologist recommends features to enhance ecology of the site	**Indicative Innovation Credits Achieved**
	adopts all general ecological recommendations	0
	adopts 30% of additional recommendations	

Man 06	Project Management			
No. of BREEAM credits available	2	Available contribution to overall score	2.18%	
No. of BREEAM innovation credits	2	Minimum standards applicable	No	

Assessment Criteria

Where the following requirements will be met:

Indicative Credits Achieved
1

	Requirements
One Credit Project Roles and Responsibilities	Where all of the project team are involved in the project decision making **Small Scale** - the project manager assigns individual and shared responsibilities amongst the project team including all trades on site **Large Scale** - the project manager assigns individual and shared responsibilities across the following key design and refurbishment stages: i. Planning and Building control notification ii. Design iii. Refurbishment iv. Commissioning and handover v. Occupation

Small Scale projects: five units or fewer or less than £100k

Large Scale projects: more than five units or more than £100k

	Requirements
One Credit Handover and Aftercare	Handover meeting arranged 2 or more of the following committed to: - A site inspection within 3 months of occupation - Conduct post occupancy interviews with building occupants or a survey via phone or posted information within 3 months of occupation - Longer term after care e.g. a helpline, nominated individual or other appropriate system to support building users for at least the first 12 months of occupation

Exemplary Credits

Indicative Credits Achieved
0

	Requirements
One Exemplary Credit Early Design Input	Where A BREEAM Accredited Professional has been appointed to oversee key stages within the project. OR Where a BREEAM Domestic Refurbishment Assessor has been appointed at an early stage of the project, prior to the production of a refurbishment specification

	Requirements
One Exemplary Credit Thermographic Surveying and Airtightness Testing	Where Thermographic surveying and Airtightness testing have been carried out at both pre and post refurbishment stages Where an improved air tightness target has been set at design stage and testing demonstrates that this has been achieved post refurbishment

HEALTH & WELLBEING

Section Weighting: 17% | Indicative Section Score 4.25%

Hea 01 Daylighting

No. of BREEAM credits available	2	Available contribution to overall score	2.83%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where the refurbishment results in a neutral impact on daylighting or where minimum daylighting standards are met, up to two credits may be awarded as follows:

Indicative Credits Achieved
0

For Existing Dwellings and Change of Use Projects

First Credit Maintaining Good Daylighting	The refurbishment results in a neutral impact on the dwellings daylighting levels in the kitchen, living room, dining room and study

Where the property is being extended

First Credit Maintaining Good Daylighting	New spaces achieve minimum daylighting levels
	The extension does not reduce daylighting levels in the kitchen, living room, dining room or study of neighbouring properties

For All Properties

Second Credit Minimum Daylighting	The dwelling achieves minimum daylighting levels in the kitchen, living room, dining room and study

Hea 02 Sound Insulation

No. of BREEAM credits available	4	Available contribution to overall score	5.67%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

To ensure the provision of acceptable sound insulation standards and so minimise the likelihood of noise complaints.

Indicative Credits Achieved
0

Properties where sound testing has been carried out:

Up to Four Credits	Four credits awarded according to the improvement over building regulations. See table in additional information in Technical Manual

Properties where sound testing is not feasible and not required by the appointed Building Control body

Two Credits	Where existing separating walls and floors are designed to meet the requirements of Building Regulations with compliant construction details
Up to Four Credits	Where a Suitably Qualified Acoustician (SQA) provides recommendations for the specification of all existing separating walls and floors
	SQA confirms in their professional opinion that they have the potential to meet or exceed the sound insulation credit requirements
	Where these recommendations are implemented
	See table in additional information in Technical Manual

Historic Buildings

Up to Four Credits	Where the dwelling is a Historic Building and sound testing results demonstrate existing separating walls and floor meet the Historic Building credit requirements
	See table in additional information in Technical Manual

Detached Properties

Four Credits	By Default

Properties with separating walls or floors only between non habitable rooms OR Testing not required by building control body

Four Credits	By Default

Hea 03	Volatile Organic Compounds			
No. of BREEAM credits available	1	Available contribution to overall score	1.41%	
No. of BREEAM innovation credits	0	Minimum standards applicable	No	

Assessment Criteria

Where the refurbishment avoids the use of VOCs with new products meeting the following requirements:

Indicative Credits Achieved
0

One Credit Avoiding the use of VOCs	Where all decorative paints and varnishes used in the refurbishment have met the requirement listed in table 5.4 in the Technical Manual
	Where at least five of the eight remaining product categories listed in table 5.4 have met the testing requirements and emission levels for Volatile Organic Compound (VOC) emissions against the relevant standards identified within table 5.4 in the Technical Manual
	Where five or less products are specified within the refurbishment, all must meet the requirements in order to achieve this credit.

Hea 04	Inclusive Design			
No. of BREEAM credits available	2	Available contribution to overall score	2.83%	
No. of BREEAM innovation credits	1	Minimum standards applicable	No	

Assessment Criteria

Where an access statement has been carried out using Checklist A-8 of the Technical Manual to optimise the accessibility of the home as follows:

Indicative Credits Achieved
0

	Checklist A-8 of the Technical Manual	
	Section 1	Section 2
One Credit Minimum Accessibility	Completed with Evidence	
Two Credits Advanced Accessibility	Completed with Evidence	Completed with Evidence

Exemplary Performance

Indicative Innovation Credits Achieved
0

One Credit	Where an access expert suitably qualified member of the design team has completed sections 1, 2 and 3 of Checklist A-8, access statement template with evidence provided of the measures implemented in the refurbishment

Hea 05	Ventilation			
No. of BREEAM credits available	2	Available contribution to overall score	2.83%	
No. of BREEAM innovation credits	0	Minimum standards applicable	Yes	

Assessment Criteria

Where the dwelling meets the following ventilation requirements:

Indicative Credits Achieved
2

One Credit Minimum Ventilation Requirements	A minimum level of background ventilation is provided for all habitable rooms, kitchens, utility rooms and bathrooms
	A minimum level of extract ventilation is provided in wet rooms (e.g. kitchen, utility and bathrooms) which comply with Building Regulations Approved Document Part F with the addition of heat recovery
	A minimum level of purge ventilation is provided in habitable rooms and wet rooms.
	It is an historic building and meets historic building requirements in compliance note 4 of the technical manual

Two Credits Advanced Requirements	Ventilation is provided for the dwelling that meets the requirements of Section 5 of Building Regulations Part F in full
	Where the building is a historic building and meets the requirements for Historic Buildings in compliance note 4 of the technical manual

Hea 06 Safety

No. of BREEAM credits available	1	Available contribution to overall score	1.41%
No. of BREEAM innovation credits	0	Minimum standards applicable	Yes

Assessment Criteria

Where a fire and carbon monoxide (CO) detection and alarm system is specified as follows:

Indicative Credits Achieved
1

One Credit Fire and Carbon Monoxide (CO) Detection and Alarm Systems	Carbon Monoxide detector installed if dwelling is supplied with mains gas or other fossil fuel
	Where a compliant fire detection and fire alarm system is provided
	Mains supplied fire detection and alarm system if project involves re-wiring
	Battery operated fire detection and alarm system if no re-wiring is to take place

ENERGY

Section Weighting: 43% **Indicative Section Score 31.14%**

Ene 01 Improvement in Energy Efficiency Rating

No. of BREEAM credits available	6	Available contribution to overall score	8.89%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where the following targets are met for the improvement in Energy Efficiency Rating achieved as a result of refurbishment:

Indicative Credits Achieved
5

Improvement in EER	Credits
≥ 5	0.5
≥ 9	1
≥ 13	1.5
≥ 17	2
≥ 21	2.5
≥ 26	3
≥ 31	3.5
≥ 36	4
≥ 42	4.5
≥ 48	5
≥ 54	5.5
≥ 60	6

Ene 02 Energy Efficiency Rating Post Refurbishment

No. of BREEAM credits available	4	Available contribution to overall score	5.93%
No. of BREEAM innovation credits	2	Minimum standards applicable	Yes

Assessment Criteria

Where the following Energy Efficiency Rating benchmarks will be met as a result of refurbishment:

Indicative Credits Achieved
3

EER post refurbishment	Credits	Minimum requirements
≥50	0.5	'Pass' level EER of 50
≥55	1	'Good' level EER of 58
≥60	1.5	
≥65	2	'Very Good level' EER of 65
≥70	2.5	'Excellent' level EER of 70
≥75	3	
≥80	3.5	'Outstanding' level EER of 81
≥85	4	

Exemplary	Credits
≥90	1
≥100	2

Indicative Innovation Credits Achieved
0

Ene 03 Primary energy demand

No. of BREEAM credits available	7	Available contribution to overall score	10.37%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where the following Primary Energy Demand benchmarks will be met as a result of refurbishment:

Indicative Credits Achieved
6

Primary Energy Demand Post Refurbishment (kWh/m^2/year)	Credits
≤ 400	0.5
≤ 370	1
≤ 340	1.5
≤ 320	2
≤ 300	2.5
≤ 280	3
≤ 260	3.5
≤ 240	4
≤ 220	4.5
≤ 200	5
≤ 180	5.5
≤ 160	6

≤ 140	6.5
≤ 120	7

Ene 04 Renewable Technologies

No. of BREEAM credits available	2	Available contribution to overall score	2.96%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where the dwelling will meet the following % contribution from renewables and primary energy demand targets as a result of refurbishment

Indicative Credits Achieved
0

Dwelling Type	Primary Energy Demand	Percentage from Renewables	
		1 Credit	2 Credits
Detached	≤ 250 kWh/m^2/year	≥10%	≥20%
Semi-Detached		≥10%	≥20%
Bungalow		≥10%	≥20%
End of Terrace		≥10%	≥20%
Mid Terrace	≤ 220 kWh/m^2/year	≥10%	≥20%
Low Rise Flat		≥10%	≥20%
Mid Rise Flat		≥10%	≥15%
High Rise Flat		≥10%	≥15%

Ene 05 Energy Labelled White Goods

No. of BREEAM credits available	2	Available contribution to overall score	2.96%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where Energy Efficiency White goods are to be provided as follows:

Indicative Credits Achieved
1

First Credit

Appliance	Appliance provided	Appliance not to be provided
Fridges, Freezers and Fridge-Freezers	Energy Saving Trust Recommended appliances specified	EU Energy Efficiency Labelling Scheme Information Leaflet provided to all dwellings

Second Credit

Appliance	Appliance provided	Appliance not to be provided
Washing Machines and Dishwashers	Energy Saving Trust Recommended appliances specified	Second credit not achieved
Washer-Dryers and Tumble Dryers	Appliances specified with B Rating under EU Energy Efficiency Labelling Scheme	EU Energy Efficiency Labelling Scheme Information Leaflet provided to all dwellings

Ene 06 Drying Space

No. of BREEAM credits available	1	Available contribution to overall score	1.48%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where adequate, secure internal or external space with posts and footings or fixings is provided with the following:

Indicative Credits Achieved
1

1 Credit

Number of bedrooms	Drying line required
1-2	4m+
3+	6m+

Ene 07 Lighting

No. of BREEAM credits available	2	Available contribution to overall score	2.96%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where energy efficient internal and external lighting is provided as follows:

Indicative Credits Achieved
2

External Lighting - 1 Credit

Energy Efficient Space Lighting and Energy Efficient Security Lighting OR
Where Energy Efficient Space Lighting is provided ONLY

Internal Lighting - 1 Credit

Maximum average wattage across the total floor area of the dwelling of 9 watts/m2

Ene 08 Display Energy Devices

No. of BREEAM credits available	2	Available contribution to overall score	2.96%
No. of BREEAM innovation credits	1	Minimum standards applicable	No

Assessment Criteria

Where consumption data is displayed to occupants by a compliant energy display device

Indicative Credits Achieved
0

Electricity usage data displayed	Primary Heating Fuel	
	Electricity	Other
Electricity usage data displayed	2 credits awarded	1 credit awarded
Primary Heating Fuel usage data displayed	N/A	1 credit awarded
Electricity & Primary Heating Fuel usage displayed	N/A	2 credits awarded

Exemplary Credits

		Indicative Innovation Credits Achieved
One credit Recording consumption data	Where any compliant Energy Display Device is capable of recording consumption data	0

Ene 09 Cycle Storage

No. of BREEAM credits available	2	Available contribution to overall score	2.96%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where individual or communal compliant cycle storage is provided as follows:

Indicative Credits Achieved
2

Dwelling Size	One Credit	Two Credits
Studios/ 1 bedroom	1 per two dwellings	1 per dwelling
2-3 bedrooms	1 per dwelling	2 per dwelling
4 bedrooms	2 per dwelling	4 per dwelling

Ene 10 Home Office

No. of BREEAM credits available	1	Available contribution to overall score	1.48%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where sufficient space and services will be provided to allow occupants to set up a home office in a suitable room with adequate ventilation

Indicative Credits Achieved
1

WATER

Section Weighting: 11% | Indicative Section Score: 6.60%

Wat 01 Internal Water Use

No. of BREEAM credits available	3	Available contribution to overall score	6.60%
No. of BREEAM innovation credits	1	Minimum standards applicable	Yes

Assessment Criteria

Where the dwellings water consumption meets the following consumption benchmarks, or where terminal fittings meet the following water consumption standards:

Indicative Credits Achieved
2

Calculated Water Consumption (litres/person/day)	Equivalent terminal fitting standards	Minimum Standard	Credits
>150	Typical baseline performance	N/A	0
140-150	All showers specified to 'Good' **OR** All taps and WC's to 'Good' **OR** Kitchen fittings specified to 'Excellent'	N/A	0.5
129-139	All showers specified to 'Excellent' **OR** All showers and bathroom taps to 'Good'	N/A	1
118-128	All bathroom and WC room fittings specified to 'Good' **OR** All bathroom fittings specified to 'Excellent'	N/A	1.5
107-117	All Bathroom and WC room fittings specified to 'Excellent' **OR** All Bathroom fittings Specified to 'Excellent' and WC room fitting specified to 'Good' **OR** All Bathroom fittings, kitchen and utility sittings specified to 'Good'	BREEAM Very Good	2
96-106	All kitchen, bathroom, utility room and WC room fittings specified to 'Good' **OR** All bathrooms, kitchens and utility rooms specified to 'Excellent'	BREEAM Excellent	2.5
<95	All bathroom fittings specified to 'Excellent' and WC room, kitchen and utility room fittings specified to 'Good'	BREEAM Outstanding	3

NOTE: 'Good' fittings are equivalent to good practice fittings with "excellent" fittings equivalent to best practice fittings (see the technical manual for full details.

Exemplary Credit	If the water consumption is less than 80l/person/day

Indicative Innovation Credits Achieved
0

Wat 02 External Water Use

No. of BREEAM credits available	1	Available contribution to overall score	2.20%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where the following requirements will be met:

Indicative Credits Achieved
1

Requirements:

One Credit	Where a compliant rainwater collection system for external/internal irrigation use has been provided to dwellings. **OR** Where dwellings have no individual or communal garden space.

Wat 03 Water Meter

No. of BREEAM credits available	1	Available contribution to overall score	2.20%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where an appropriate water meter for measuring usage of mains potable water meter has been provided to dwelling(s), one credit may be awarded

Indicative Credits Achieved
0

MATERIALS

Section Weighting: 8% | Indicative Section Score 4.44%

Mat 01 Environmental Impact of Materials

No. of BREEAM credits available	25	Available contribution to overall score	4.44%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Up to 25 credits can be awarded, with credits calculated using the Mat 01 calculator tool. The table below shows the maximum number of credits available for each element:

Indicative Credits Achieved
13

Elements	Green Guide Rating credits available	Thermal performance credits available*
Roof	5	3
External walls	5	3.8
Internal walls (including separating walls)	5	-
Upper and Ground Floor	5	1.2
Windows	5	2

The full 25 credits represents all of the elements containing refurbished or existing materials that meet the Green Guide Rating of A+(6)

GG Rating	Points for existing / refurbished elements	Points for new elements
A+ (6)	5	
A+ (5)	4.6	
A+ (4)	4.2	
A+ (3)	3.8	
A+ (2)	3.4	
A+	3	3
A	2	2
B	1	1
C	0.5	0.5
D	0.25	0.25
E	0	0

Where the full 25 credits cannot be achieved the score can be 'topped up' with thermal performance credits. The full number of thermal performance credits for each element can be achieved when achieving the minimum U-values shown below.

Elements	Minimum U-Value (W/m2K)
Roof	0.11
External walls	0.15
Internal walls (including separating walls)	-
Upper and Ground Floor	0.15
Windows	1.4

Mat 02 Responsible Sourcing of Materials

No. of BREEAM credits available	12	Available contribution to overall score	2.13%
No. of BREEAM innovation credits	0	Minimum standards applicable	Yes

Assessment Criteria

Indicative Credits Achieved
8

Where new materials are responsibly sourced, up to 12 credits may be awarded where 80% of new materials for an element are responsibly sourced. The credits achieved are dependent on % of point achieved which is based upon the responsible sourcing tier level of each material sourced as detailed below:

Table 1

Tier level	Points
1	4
2	3.5
3	3
4	2.5
5	2
6	1.5
7	1
8	0

Table 2

BREEAM credits	% of available points achieved
12	≥54%
10	≥45%
8	≥36%
6	≥ 27%
4	≥ 18%
2	≥ 9%

Mat 03	Insulation			
No. of BREEAM credits available	8	Available contribution to overall score	1.42%	
No. of BREEAM innovation credits	0	Minimum standards applicable	No	

Assessment Criteria

Where any new insulation specified for use within external walls, ground floor, roof and buildings services meet the following requirements:

Indicative Credits Achieved
4

	Requirements
4 Credits	Where the Insulation Index for new insulation used in the buildings is ≥2
	Where Green Guide ratings are determined using the Green Guide to specification tool

	Requirements
4 Credits	Where ≥ 80% of the new thermal insulation used in the building elements is responsibly sourced.

WASTE

Section Weighting: 3% | Indicative Section Score 2.40%

Was 01	Household Waste		
No. of BREEAM credits available	2	Available contribution to overall score	1.20%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Where compliant recycling and composting facilities are provided, up to two credits may be awarded as follows

Indicative Credits Achieved
2

First Credit - Recycling Facilities	
Scenario	**Internal recycling storage requirements**
Compliant collection scheme in place	3 internal recycling containers provided where recycling is not sorted post collection
	1 internal recycling container provided where recycling is sorted post collection
	Minimum 30 litre total capacity, no single container less than 7 litre capacity
	Dedicated position in accordance with compliance note 1
No compliant collection scheme in place No adequate external storage	3 internal recycling containers provided
	Minimum 60 litre total capacity
	Dedicated position in accordance with compliance note 1
No compliant collection scheme in place Adequate external storage provided	3 internal recycling containers provided
	Minimum 30 litre total capacity, no single container smaller than 7 litre capacity
	Dedicated position in accordance with compliance note 1

Second credit - Composting facilities	
With external space	**Without external space**
Where a composting service or facility is provided for green/garden waste	Where a composting service or facility is provided for kitchen waste
Where a composting service or facility is provided for kitchen waste	Where an interior container is provided for kitchen composting waste of at least
Where an interior container is provided for kitchen composting waste of at least 7 litres	

Was 02	Refurbishment Site Waste Management			
No. of BREEAM credits available	3	Available contribution to overall score	1.80%	
No. of BREEAM innovation credits	1	Minimum standards applicable	No	

Assessment Criteria

		Indicative Credits Achieved
Up to three credits are available depending on the site waste management plan to be implemented as follows		2

Projects up to £100k

		Indicative Innovation Credits Achieved
Three Credits	Where waste generated through the refurbishment process is managed in accordance with Checklist A-9	
Exemplary Credit	Where a compliant Level 1; Site Waste Management Plan (SWMP) is in place	0

Projects up to £300k

Three Credits	Where a compliant Level 1; Site Waste Management Plan (SWMP) is in place
Exemplary Credit	Where a compliant Level 2; Site Waste Management Plan (SWMP) is in place
	Non-hazardous construction waste generated by the dwellings refurbishment meets or exceeds the resource efficiency benchmark
	The percentage of non-hazardous construction waste and demolition waste generated by the project has been diverted from landfill and meets or exceeds the refurbishment & demolition waste diversion benchmarks

Projects over £300k

First Credit Management Plan	Where a compliant Level 2; Site Waste Management Plan (SWMP) is in place
Second Credit Good Practice Waste Benchmarks	First credit achieved
	Non-hazardous construction waste generated by the dwellings refurbishment meets or exceeds the resource efficiency benchmark
	Amount of waste generated against £100,000 of project value is recorded in the SWMP
	Pre-refurbishment audit of the existing building is completed
	If demolition is included as part of the refurbishment programme, then the audit should also cover demolition materials
Third Credit Best Practice Waste Benchmarks	Where the first two credits have been achieved achieved
	Where Non-hazardous demolition waste generated by the dwellings refurbishment meets or exceeds the refurbishment & demolition waste diversion benchmarks
Exemplary Credit	Where non-hazardous construction waste generated by the dwellings refurbishment meets or exceeds the *exemplary level resource efficiency benchmark*
	Where Non-hazardous demolition waste generated by the dwellings refurbishment meets or exceeds the exemplary level diversion benchmarks

POLLUTION

Section Weighting: 6% | Indicative Section Score: 3.00%

Pol 01 NOx Emissions

No. of BREEAM credits available	3	Available contribution to overall score	2.25%
No. of BREEAM innovation credits	0	Minimum standards applicable	No

Assessment Criteria

Credits are awarded on the basis of NOx emissions arising from the operation of space heating and hot water systems for each refurbished dwelling as follows:

Indicative Credits Achieved
3

	Dry NOx Emissions
One Credit	≤100 mg/kWh (NOx class 4 boiler)
Two Credits	≤70 mg/kWh (NOx class 5 boiler)
Three Credits	≤40 mg/kWh

Pol 02 Surface Water Runoff

No. of BREEAM credits available	3	Available contribution to overall score	2.25%
No. of BREEAM innovation credits	1	Minimum standards applicable	No

Assessment Criteria

Where impacts of the refurbishment on surface water runoff are neutralised or where runoff is reduced as a result of refurbishment, up to three credits can be awarded as follows:

Indicative Credits Achieved
1

	Requirements
First Credit Neutral Impact on Surface Water	New hard standing areas must be permeable
	If building on to previously permeable area additional run-off must be managed on site
	Calculations should be carried out by an appropriately qualified professional

	Requirements
Second Credit Reducing Run-Off From Site: Basic	Where all run-off from the roof for rainfall depths up to 5 mm, have been managed on site using source control methods
	Include runoff from all existing and new parts of the roof.
	An appropriately qualified professional should be used to design an appropriate drainage strategy for the site

	Requirements
Third Credit Reducing Run-Off From Site: Advanced	Where run-off as a result of the refurbishment is managed on site using source control
	An appropriately qualified professional should be used to design an appropriate drainage strategy for the site.
	The peak rate of run-off as a result of the refurbishment for the 1 in 100 year event has been reduced by 75% from the existing site.
	The total volume of run-off discharged into the watercourses and sewers as a result of the refurbishment, for a 1 in 100 year event of 6 hour duration has been reduced by 75%.
	An allowance for climate change must be included for all of the above calculations, in accordance with current best practice (PPS25, 2010).

	Requirements	Indicative Credits Achieved
Exemplary Credit	Where all run-off from the developed site is managed on site using source control	0
	The peak rate of run-off as a result of the refurbishment for the 1 in 1 year event is reduced to zero.	
	The peak rate of run-off as a result of the refurbishment for the 1 in 100 year event is reduced to zero.	
	There is no volume of run-off discharged into the watercourses and sewers as a result of the refurbishment, for a 1 in 100 year event of 6 hour duration.	
	An allowance for climate change must be included for all of the above calculations, in accordance with current best practice (PPS25, 2010).	

Pol 03	Flooding			
No. of BREEAM credits available	2	Available contribution to overall score	1.50%	
No. of BREEAM innovation credits	0	Minimum standards applicable	Yes	

Assessment Criteria

Indicative Credits Achieved
0

Where the dwelling is located in a low flood risk zone, or where in a medium to high flood risk zone and a flood resilience/resistance strategy has been implemented, up to two credits can be awarded as follows:

Minimum Standards	A minimum of two credits must be achieved for this issue at the Excellent and Outstanding levels

Option 1 - Low Flood Risk

Two Credits	Where a Flood Risk Assessment (FRA) has been carried out and the assessed dwellings are defined as having a low annual probability of flooding.

Option 2 - Medium / High Flood Risk

Two Credits	Where a Flood Risk Assessment (FRA) has been carried out and the assessed dwellings are defined as having a medium or high annual probability of flooding.
	Two credits are awarded where as a result of the dwellings floor level or measures to keep water away the dwelling is defined as achieving avoidance from flooding by following Checklist A-10; Decision Strategy Flow Chart.
	Where avoidance is not possible, two credits are achieved where a full flood resilience/resistance strategy is implemented for the dwellings in accordance with recommendations made by a Suitably Qualified Building Professional

BREEAM Domestic Refurbishment: Energy Calculator

Tool Version	V00.2
BREEAM Domestic Refurbishment Version	V00.2
Assessor Name	N Ingham
Assessment Reference Number	15211
Site Name	55 Lancaster Grove

	Summary	
	Credits	Exemplary
Ene 01	5	
Ene 02	3	0
Ene 03	6	
Ene 04	0	

Ene 01: Improvement in Energy Efficiency Rating

Dwelling Type	Single	
SAP Type used	Full SAP	
EER Pre-Refurbishment	28	
EER Post-refurbishment	76	
EER Improvement	48	

Ene 01 Credits Awarded 5

Ene 02: Energy Efficiency Post Refurbishment

Ene 02 Credits Awarded	3	
Ene 02 Exemplary Credits Awarded	0	
Ene 02 Standard	Excellent	

Ene 03: Primary Energy Demand

Primary Energy Demand	81597.8	kWh/yr	Box 265*+266*+267*+268*
Total Floor Area	571.07	m2	Box 4
Primary Energy Demand Post Refurbishment	142.89	kWh/m2/year	
Credits Awarded	6		

Ene 04: Renewable Technologies

Energy provided by renewable energy	0.00	kWh/year
Percentage of Primary Energy Demand	0.00%	
Dwelling type	Mid Terrace	
Credits Awarded	0	

SAP Input

Property Details: 55 Lancaster grove - pre-refurbishment

Address:	55 Lancaster Grove, LONDON, NW3 4HD
Located in:	England
Region:	Thames valley
UPRN:	7608799078
Date of assessment:	27 January 2015
Date of certificate:	26 January 2015
Assessment type:	New dwelling design stage
Transaction type:	None of the above
Tenure type:	Owner-occupied
Related party disclosure:	No related party
Thermal Mass Parameter:	Indicative Value Medium
Water use <= 125 litres/person/day:	True
PCDF Version:	372

Property description:

Dwelling type:	House
Detachment:	Semi-detached
Year Completed:	2015

Floor Location:	Floor area:	Storey height:
Basement floor	196.23 m²	3 m
Floor 1	153.44 m²	3.9 m
Floor 2	116.9 m²	3.3 m
Floor 3	104.5 m²	3.35 m

Living area:	67.84 m² (fraction 0.119)
Front of dwelling faces:	South West

Opening types:

Name:	Source:	Type:	Glazing:	Argon:	Frame:
D1	SAP 2012	Half glazed	Single-glazed	No	Wood
D2	SAP 2012	Half glazed	Single-glazed	No	Wood
W1	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W2	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W3	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W4	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W5	SAP 2012	Windows	Single-glazed	No	Wood
W6	SAP 2012	Windows	Single-glazed	No	Wood
W7	SAP 2012	Windows	Single-glazed	No	Wood
W8	SAP 2012	Windows	Single-glazed	No	Wood
W9	SAP 2012	Windows	Single-glazed	No	Wood
W10	SAP 2012	Windows	Single-glazed	No	Wood
W11	SAP 2012	Windows	Single-glazed	No	Wood
W12	SAP 2012	Windows	Single-glazed	No	Wood
W13	SAP 2012	Windows	Single-glazed	No	Wood
W14	SAP 2012	Windows	Single-glazed	No	Wood
W15	SAP 2012	Windows	Single-glazed	No	Wood
W16	SAP 2012	Windows	Single-glazed	No	Wood
W17	SAP 2012	Windows	Single-glazed	No	Wood
W18	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W19	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W20	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W21	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W22	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W23	SAP 2012	Windows	Single-glazed	No	Wood
W24	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W25	SAP 2012	Windows	Single-glazed	No	Wood

SAP Input

W26	SAP 2012	Windows	Single-glazed	No	Wood
W27	SAP 2012	Windows	Single-glazed	No	Wood
W28	SAP 2012	Windows	Single-glazed	No	Wood
RL1	Manufacturer	Roof Windows	low-E, En = 0.05, soft coat	Yes	Wood
RL2	SAP 2012	Roof Windows	low-E, En = 0.05, soft coat	Yes	Wood

Name:	Gap:	Frame Factor:	g-value:	U-value:	Area:	No. of Openings:
D1	mm	0.7	0.85	3.9	2.42	1
D2	mm	0.7	0.85	3.9	2.42	1
W1	16mm or more	0.7	0.63	4.8	2.39	2
W2	16mm or more	0.7	0.63	4.8	3.58	1
W3	16mm or more	0.7	0.63	4.8	1.72	1
W4	16mm or more	0.7	0.63	4.8	1.72	1
W5		0.7	0.85	4.8	2.03	2
W6		0.7	0.85	4.8	3.04	1
W7		0.7	0.85	4.8	1.46	1
W8		0.7	0.85	4.8	1.46	1
W9		0.7	0.85	4.8	2.7	1
W10		0.7	0.85	4.8	1.3	1
W11		0.7	0.85	4.8	1.3	1
W12		0.7	0.85	4.8	2.2	2
W13		0.7	0.85	4.8	2.19	1
W14		0.7	0.85	4.8	2.73	1
W15		0.7	0.85	4.8	1.5	4
W16		0.7	0.85	4.8	0.42	1
W17		0.7	0.85	4.8	0.79	1
W18	16mm or more	0.7	0.63	4.8	3.45	1
W19	16mm or more	0.7	0.63	4.8	0.58	1
W20	16mm or more	0.7	0.63	4.8	5.28	1
W21	16mm or more	0.7	0.63	4.8	5.76	1
W22	16mm or more	0.7	0.63	4.8	1.31	1
W23		0.7	0.85	4.8	1.7	5
W24	16mm or more	0.7	0.63	4.8	11.88	1
W25		0.7	0.85	4.8	1.56	1
W26		0.7	0.85	4.8	1.56	1
W27		0.7	0.85	4.8	0.4	1
W28		0.7	0.85	4.8	5.55	1
RL1	16mm or more	0.7	0.63	4.8	23.6	1
RL2	16mm or more	0.7	0.63	4.8	4.52	3

Name:	Type-Name:	Location:	Orient:	Width:	Height:
D1		External	South West	1.1	2.2
D2		External	North East	1.1	2.2
W1		New external	South West	0.9	2.65
W2		New external	South West	1.35	2.65
W3		New external	South	0.65	2.65
W4		New external	West	0.65	2.65
W5		External	South West	0.9	2.25
W6		External	South West	1.35	2.25
W7		External	South	0.65	2.25
W8		External	West	0.65	2.25
W9		External	South West	1.35	2
W10		External	South	0.65	2
W11		External	West	0.65	2
W12		External	South West	1.1	2
W13		External	South West	1.85	1.185
W14		Dormer	South West	1.3	2.1
W15		External	South East	1	1.5
W16		External	South East	0.65	0.65
W17		External	South East	0.35	2.25

SAP Input

W18	External	South East	1.5	2.3
W19	External	South East	0.55	1.05
W20	New external	South East	2.2	2.4
W21	New external	North West	2.4	2.4
W22	New external	North West	0.875	1.5
W23	External	North East	0.85	2
W24	New external	North East	4.75	2.5
W25	External	North	0.65	2.4
W26	External	East	0.65	2.4
W27	External	North East	0.895	0.45
W28	Dormer	North East	3.7	1.5
RL1	New flat	Horizontal	14.3	1.65
RL2	Basement	Horizontal	1.35	3.35

Overshading: Average or unknown

Opaque Elements:

Type:	Gross area:	Openings:	Net area:	U-value:	Ru value:	Curtain wall:	Kappa:
External Elements							
New external	91.67	36.03	55.64	2.1	0	False	N/A
External	232.64	50.01	182.63	2.1	0	False	N/A
Dormer	13	8.28	4.72	2.3	0	False	N/A
Basement	164.1	0	164.1	2.1	0	False	N/A
Ceiling	66.5	0	66.5	2.1	0		N/A
New flat	33.99	23.6	10.39	2.3	0		N/A
Basement	42.79	13.56	29.23	2.3	0		N/A
Old dormer and bays	15.11	0	15.11	2.3	0		N/A
Rafter roof	39.56	0	39.56	2.3	0		N/A
New Basement	196.23			0.56			N/A
Internal Elements							
Party Elements							

Thermal bridges:

Thermal bridges: No information on thermal bridging (y=0.15) (y =0.15)

Ventilation:

Pressure test: No (Assumed)
Ventilation: Natural ventilation (extract fans)
Number of chimneys: 0
Number of open flues: 0
Number of fans: 8
Number of passive stacks: 0
Number of sides sheltered: 4
Pressure test: 15

Main heating system:

Main heating system:
Boiler systems with radiators or underfloor heating
Gas boilers and oil boilers
Fuel: mains gas
Info Source: SAP Tables
SAP Table: 116
Floor mounted, pre 1979
Systems with radiators
Central heating pump : Unknown
Design flow temperature: Unknown
Open
Boiler interlock: No

SAP Input

Main heating Control:	
Main heating Control:	Room thermostat only Control code: 2103
Secondary heating system:	
Secondary heating system:	None
Water heating:	
Water heating:	From main heating system Water code: 901 Fuel :mains gas Hot water cylinder Cylinder volume: 250 litres Cylinder insulation: Jacket 35 mm Primary pipework insulation: False Cylinderstat: False Cylinder in heated space: True Solar panel: False
Others:	
Electricity tariff:	Standard Tariff
In Smoke Control Area:	Unknown
Conservatory:	No conservatory
Low energy lights:	0%
Terrain type:	Low rise urban / suburban
EPC language:	English
Wind turbine:	No
Photovoltaics:	None
Assess Zero Carbon Home:	No

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Neil Ingham	**Stroma Number:**	STRO002943
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.1.14

Property Address: 55 Lancaster grove - pre-refurbishment

Address : 55 Lancaster Grove, LONDON, NW3 4HD

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Basement	196.23	(1a) x	3	(2a) =	588.69	(3a)
Ground floor	153.44	(1b) x	3.9	(2b) =	598.42	(3b)
First floor	116.9	(1c) x	3.3	(2c) =	385.77	(3c)
Second floor	104.5	(1d) x	3.35	(2d) =	350.07	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	571.07	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		1922.95	(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							8	x 10 =	80	(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) = 80 ÷ (5) =	0.04	(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		15	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)		0.79	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		4	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.55	(21)

Infiltration rate modified for monthly wind speed

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

DER WorkSheet: New dwelling design stage

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.71	0.69	0.68	0.61	0.6	0.53	0.53	0.51	0.55	0.6	0.62	0.65

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=	0.75	0.74	0.73	0.69	0.68	0.64	0.64	0.63	0.65	0.68	0.69	0.71

(24d)

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

(25)m=	0.75	0.74	0.73	0.69	0.68	0.64	0.64	0.63	0.65	0.68	0.69	0.71

(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			2.42	x	3.9	=	9.438001			(26)
Doors Type 2			2.42	x	3.9	=	9.438001			(26)
Windows Type 1			2.39	x1/[1/(4.8)+ 0.04]		=	9.62			(27)
Windows Type 2			3.58	x1/[1/(4.8)+ 0.04]		=	14.42			(27)
Windows Type 3			1.72	x1/[1/(4.8)+ 0.04]		=	6.93			(27)
Windows Type 4			1.72	x1/[1/(4.8)+ 0.04]		=	6.93			(27)
Windows Type 5			2.03	x1/[1/(4.8)+ 0.04]		=	8.17			(27)
Windows Type 6			3.04	x1/[1/(4.8)+ 0.04]		=	12.24			(27)
Windows Type 7			1.46	x1/[1/(4.8)+ 0.04]		=	5.88			(27)
Windows Type 8			1.46	x1/[1/(4.8)+ 0.04]		=	5.88			(27)
Windows Type 9			2.7	x1/[1/(4.8)+ 0.04]		=	10.87			(27)
Windows Type 10			1.3	x1/[1/(4.8)+ 0.04]		=	5.23			(27)
Windows Type 11			1.3	x1/[1/(4.8)+ 0.04]		=	5.23			(27)
Windows Type 12			2.2	x1/[1/(4.8)+ 0.04]		=	8.86			(27)

DER WorkSheet: New dwelling design stage

Windows Type 13			2.19	x1/[1/(4.8)+ 0.04]	=	8.82			(27)
Windows Type 14			2.73	x1/[1/(4.8)+ 0.04]	=	10.99			(27)
Windows Type 15			1.5	x1/[1/(4.8)+ 0.04]	=	6.04			(27)
Windows Type 16			0.42	x1/[1/(4.8)+ 0.04]	=	1.69			(27)
Windows Type 17			0.79	x1/[1/(4.8)+ 0.04]	=	3.18			(27)
Windows Type 18			3.45	x1/[1/(4.8)+ 0.04]	=	13.89			(27)
Windows Type 19			0.58	x1/[1/(4.8)+ 0.04]	=	2.34			(27)
Windows Type 20			5.28	x1/[1/(4.8)+ 0.04]	=	21.26			(27)
Windows Type 21			5.76	x1/[1/(4.8)+ 0.04]	=	23.19			(27)
Windows Type 22			1.31	x1/[1/(4.8)+ 0.04]	=	5.28			(27)
Windows Type 23			1.7	x1/[1/(4.8)+ 0.04]	=	6.85			(27)
Windows Type 24			11.88	x1/[1/(4.8)+ 0.04]	=	47.84			(27)
Windows Type 25			1.56	x1/[1/(4.8)+ 0.04]	=	6.28			(27)
Windows Type 26			1.56	x1/[1/(4.8)+ 0.04]	=	6.28			(27)
Windows Type 27			0.4	x1/[1/(4.8)+ 0.04]	=	1.61			(27)
Windows Type 28			5.55	x1/[1/(4.8)+ 0.04]	=	22.35			(27)
Rooflights Type 1			23.6	x1/[1/(4.8) + 0.04]	=	113.28			(27b)
Rooflights Type 2			4.52	x1/[1/(4.8) + 0.04]	=	21.696			(27b)
Floor			196.23	x	0.56	=	109.8888			(28)
Walls Type1	91.67	36.03	55.64	x	2.1	=	116.84			(29)
Walls Type2	232.64	50.01	182.63	x	2.1	=	383.52			(29)
Walls Type3	13	8.28	4.72	x	2.3	=	10.86			(29)
Walls Type4	164.1	0	164.1	x	2.1	=	344.61			(29)
Roof Type1	66.5	0	66.5	x	2.1	=	139.65			(30)
Roof Type2	33.99	23.6	10.39	x	2.3	=	23.9			(30)
Roof Type3	42.79	13.56	29.23	x	2.3	=	67.23			(30)
Roof Type4	15.11	0	15.11	x	2.3	=	34.75			(30)
Roof Type5	39.56	0	39.56	x	2.3	=	90.99			(30)
Total area of elements, m²			895.59							(31)

** 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) = 1851.07 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 29533.86 (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 134.34 (36)

if details of thermal bridging are not known (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 1985.41 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	475.66	469.51	463.48	435.17	429.87	405.21	405.21	400.64	414.71	429.87	440.59	451.79	(38)

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

(39)m=	2461.07	2454.92	2448.9	2420.58	2415.28	2390.62	2390.62	2386.06	2400.12	2415.28	2426	2437.2	

Average = Sum(39)$_{1...12}$ /12= 2420.56 (39)

DER WorkSheet: New dwelling design stage

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

(40)m=	4.31	4.3	4.29	4.24	4.23	4.19	4.19	4.18	4.2	4.23	4.25	4.27

Average = Sum(40)$_{1...12}$ /12= 4.24 (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 3.48 (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) + 36 116.95 (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=	128.65	123.97	119.29	114.61	109.94	105.26	105.26	109.94	114.61	119.29	123.97	128.65

Total = Sum(44)$_{1...12}$ = 1403.43 (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=	190.78	166.86	172.18	150.11	144.04	124.29	115.18	132.17	133.74	155.87	170.14	184.76

Total = Sum(45)$_{1...12}$ = 1840.12 (45)

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

(46)m=	28.62	25.03	25.83	22.52	21.61	18.64	17.28	19.82	20.06	23.38	25.52	27.71

(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 250 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0 (48)

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 250 (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.04 (51)

If community heating see section 4.3

Volume factor from Table 2a 0.78 (52)

Temperature factor from Table 2b 0.78 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 6.39 (54)

Enter (50) or (54) in (55) 6.39 (55)

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

(56)m=	197.94	178.78	197.94	191.55	197.94	191.55	197.94	197.94	191.55	197.94	191.55	197.94

(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=	197.94	178.78	197.94	191.55	197.94	191.55	197.94	197.94	191.55	197.94	191.55	197.94

(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=	128.38	115.95	128.38	124.24	128.38	41.92	43.31	43.31	41.92	128.38	124.24	128.38

(59)

DER WorkSheet: New dwelling design stage

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=	517.1	461.59	498.5	465.9	470.35	357.76	356.43	373.42	367.21	482.18	485.93	511.08	(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=	517.1	461.59	498.5	465.9	470.35	357.76	356.43	373.42	367.21	482.18	485.93	511.08	

Output from water heater (annual)$_{1...12}$ 5347.45 (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=	324.49	291.27	318.3	302.54	308.94	228.1	231.3	236.95	231.24	312.88	309.2	322.48	(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=	174.22	174.22	174.22	174.22	174.22	174.22	174.22	174.22	174.22	174.22	174.22	174.22	(66)

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

(67)m=	98.93	87.86	71.46	54.1	40.44	34.14	36.89	47.95	64.36	81.72	95.38	101.67	(67)

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

(68)m=	652.73	659.5	642.43	606.1	560.23	517.12	488.32	481.55	498.61	534.95	580.82	623.93	(68)

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

(69)m=	40.42	40.42	40.42	40.42	40.42	40.42	40.42	40.42	40.42	40.42	40.42	40.42	(69)

Pumps and fans gains (Table 5a)

(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)

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

(71)m=	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	(71)

Water heating gains (Table 5)

(72)m=	436.14	433.44	427.83	420.2	415.25	316.81	310.88	318.48	321.17	420.53	429.45	433.45	(72)

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

(73)m=	1273.06	1266.07	1226.98	1165.66	1101.18	953.33	921.36	933.24	969.41	1122.47	1190.91	1244.32	(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	1.56	x	10.63	x	0.85	x	0.7	=	6.84	(74)
North	0.9x 0.77	x	1.56	x	20.32	x	0.85	x	0.7	=	13.07	(74)
North	0.9x 0.77	x	1.56	x	34.53	x	0.85	x	0.7	=	22.21	(74)
North	0.9x 0.77	x	1.56	x	55.46	x	0.85	x	0.7	=	35.68	(74)
North	0.9x 0.77	x	1.56	x	74.72	x	0.85	x	0.7	=	48.06	(74)

DER WorkSheet: New dwelling design stage

North	0.9x	0.77	x	1.56	x	79.99	x	0.85	x	0.7	=	51.45	(74)
North	0.9x	0.77	x	1.56	x	74.68	x	0.85	x	0.7	=	48.04	(74)
North	0.9x	0.77	x	1.56	x	59.25	x	0.85	x	0.7	=	38.11	(74)
North	0.9x	0.77	x	1.56	x	41.52	x	0.85	x	0.7	=	26.71	(74)
North	0.9x	0.77	x	1.56	x	24.19	x	0.85	x	0.7	=	15.56	(74)
North	0.9x	0.77	x	1.56	x	13.12	x	0.85	x	0.7	=	8.44	(74)
North	0.9x	0.77	x	1.56	x	8.86	x	0.85	x	0.7	=	5.7	(74)
Northeast	0.9x	0.77	x	1.7	x	11.28	x	0.85	x	0.7	=	39.54	(75)
Northeast	0.9x	0.77	x	11.88	x	11.28	x	0.63	x	0.7	=	40.96	(75)
Northeast	0.9x	0.77	x	0.4	x	11.28	x	0.85	x	0.7	=	1.86	(75)
Northeast	0.9x	0.77	x	5.55	x	11.28	x	0.85	x	0.7	=	25.82	(75)
Northeast	0.9x	0.77	x	1.7	x	22.97	x	0.85	x	0.7	=	80.49	(75)
Northeast	0.9x	0.77	x	11.88	x	22.97	x	0.63	x	0.7	=	83.38	(75)
Northeast	0.9x	0.77	x	0.4	x	22.97	x	0.85	x	0.7	=	3.79	(75)
Northeast	0.9x	0.77	x	5.55	x	22.97	x	0.85	x	0.7	=	52.56	(75)
Northeast	0.9x	0.77	x	1.7	x	41.38	x	0.85	x	0.7	=	145.03	(75)
Northeast	0.9x	0.77	x	11.88	x	41.38	x	0.63	x	0.7	=	150.23	(75)
Northeast	0.9x	0.77	x	0.4	x	41.38	x	0.85	x	0.7	=	6.82	(75)
Northeast	0.9x	0.77	x	5.55	x	41.38	x	0.85	x	0.7	=	94.69	(75)
Northeast	0.9x	0.77	x	1.7	x	67.96	x	0.85	x	0.7	=	238.17	(75)
Northeast	0.9x	0.77	x	11.88	x	67.96	x	0.63	x	0.7	=	246.73	(75)
Northeast	0.9x	0.77	x	0.4	x	67.96	x	0.85	x	0.7	=	11.21	(75)
Northeast	0.9x	0.77	x	5.55	x	67.96	x	0.85	x	0.7	=	155.51	(75)
Northeast	0.9x	0.77	x	1.7	x	91.35	x	0.85	x	0.7	=	320.15	(75)
Northeast	0.9x	0.77	x	11.88	x	91.35	x	0.63	x	0.7	=	331.65	(75)
Northeast	0.9x	0.77	x	0.4	x	91.35	x	0.85	x	0.7	=	15.07	(75)
Northeast	0.9x	0.77	x	5.55	x	91.35	x	0.85	x	0.7	=	209.04	(75)
Northeast	0.9x	0.77	x	1.7	x	97.38	x	0.85	x	0.7	=	341.32	(75)
Northeast	0.9x	0.77	x	11.88	x	97.38	x	0.63	x	0.7	=	353.57	(75)
Northeast	0.9x	0.77	x	0.4	x	97.38	x	0.85	x	0.7	=	16.06	(75)
Northeast	0.9x	0.77	x	5.55	x	97.38	x	0.85	x	0.7	=	222.86	(75)
Northeast	0.9x	0.77	x	1.7	x	91.1	x	0.85	x	0.7	=	319.3	(75)
Northeast	0.9x	0.77	x	11.88	x	91.1	x	0.63	x	0.7	=	330.76	(75)
Northeast	0.9x	0.77	x	0.4	x	91.1	x	0.85	x	0.7	=	15.03	(75)
Northeast	0.9x	0.77	x	5.55	x	91.1	x	0.85	x	0.7	=	208.48	(75)
Northeast	0.9x	0.77	x	1.7	x	72.63	x	0.85	x	0.7	=	254.55	(75)
Northeast	0.9x	0.77	x	11.88	x	72.63	x	0.63	x	0.7	=	263.69	(75)
Northeast	0.9x	0.77	x	0.4	x	72.63	x	0.85	x	0.7	=	11.98	(75)
Northeast	0.9x	0.77	x	5.55	x	72.63	x	0.85	x	0.7	=	166.2	(75)
Northeast	0.9x	0.77	x	1.7	x	50.42	x	0.85	x	0.7	=	176.72	(75)
Northeast	0.9x	0.77	x	11.88	x	50.42	x	0.63	x	0.7	=	183.06	(75)

DER WorkSheet: New dwelling design stage

Northeast	0.9x	0.77	x	0.4	x	50.42	x	0.85	x	0.7	=	8.32	(75)
Northeast	0.9x	0.77	x	5.55	x	50.42	x	0.85	x	0.7	=	115.39	(75)
Northeast	0.9x	0.77	x	1.7	x	28.07	x	0.85	x	0.7	=	98.37	(75)
Northeast	0.9x	0.77	x	11.88	x	28.07	x	0.63	x	0.7	=	101.9	(75)
Northeast	0.9x	0.77	x	0.4	x	28.07	x	0.85	x	0.7	=	4.63	(75)
Northeast	0.9x	0.77	x	5.55	x	28.07	x	0.85	x	0.7	=	64.23	(75)
Northeast	0.9x	0.77	x	1.7	x	14.2	x	0.85	x	0.7	=	49.76	(75)
Northeast	0.9x	0.77	x	11.88	x	14.2	x	0.63	x	0.7	=	51.54	(75)
Northeast	0.9x	0.77	x	0.4	x	14.2	x	0.85	x	0.7	=	2.34	(75)
Northeast	0.9x	0.77	x	5.55	x	14.2	x	0.85	x	0.7	=	32.49	(75)
Northeast	0.9x	0.77	x	1.7	x	9.21	x	0.85	x	0.7	=	32.29	(75)
Northeast	0.9x	0.77	x	11.88	x	9.21	x	0.63	x	0.7	=	33.45	(75)
Northeast	0.9x	0.77	x	0.4	x	9.21	x	0.85	x	0.7	=	1.52	(75)
Northeast	0.9x	0.77	x	5.55	x	9.21	x	0.85	x	0.7	=	21.09	(75)
East	0.9x	1	x	1.56	x	19.64	x	0.85	x	0.7	=	12.63	(76)
East	0.9x	1	x	1.56	x	38.42	x	0.85	x	0.7	=	24.71	(76)
East	0.9x	1	x	1.56	x	63.27	x	0.85	x	0.7	=	40.7	(76)
East	0.9x	1	x	1.56	x	92.28	x	0.85	x	0.7	=	59.36	(76)
East	0.9x	1	x	1.56	x	113.09	x	0.85	x	0.7	=	72.75	(76)
East	0.9x	1	x	1.56	x	115.77	x	0.85	x	0.7	=	74.47	(76)
East	0.9x	1	x	1.56	x	110.22	x	0.85	x	0.7	=	70.9	(76)
East	0.9x	1	x	1.56	x	94.68	x	0.85	x	0.7	=	60.9	(76)
East	0.9x	1	x	1.56	x	73.59	x	0.85	x	0.7	=	47.34	(76)
East	0.9x	1	x	1.56	x	45.59	x	0.85	x	0.7	=	29.32	(76)
East	0.9x	1	x	1.56	x	24.49	x	0.85	x	0.7	=	15.75	(76)
East	0.9x	1	x	1.56	x	16.15	x	0.85	x	0.7	=	10.39	(76)
Southeast	0.9x	0.77	x	1.5	x	36.79	x	0.85	x	0.7	=	91.03	(77)
Southeast	0.9x	0.77	x	0.42	x	36.79	x	0.85	x	0.7	=	6.37	(77)
Southeast	0.9x	0.77	x	0.79	x	36.79	x	0.85	x	0.7	=	11.99	(77)
Southeast	0.9x	0.77	x	3.45	x	36.79	x	0.63	x	0.7	=	38.79	(77)
Southeast	0.9x	0.77	x	0.58	x	36.79	x	0.63	x	0.7	=	6.52	(77)
Southeast	0.9x	0.77	x	5.28	x	36.79	x	0.63	x	0.7	=	59.37	(77)
Southeast	0.9x	0.77	x	1.5	x	62.67	x	0.85	x	0.7	=	155.05	(77)
Southeast	0.9x	0.77	x	0.42	x	62.67	x	0.85	x	0.7	=	10.85	(77)
Southeast	0.9x	0.77	x	0.79	x	62.67	x	0.85	x	0.7	=	20.42	(77)
Southeast	0.9x	0.77	x	3.45	x	62.67	x	0.63	x	0.7	=	66.08	(77)
Southeast	0.9x	0.77	x	0.58	x	62.67	x	0.63	x	0.7	=	11.11	(77)
Southeast	0.9x	0.77	x	5.28	x	62.67	x	0.63	x	0.7	=	101.13	(77)
Southeast	0.9x	0.77	x	1.5	x	85.75	x	0.85	x	0.7	=	212.15	(77)
Southeast	0.9x	0.77	x	0.42	x	85.75	x	0.85	x	0.7	=	14.85	(77)
Southeast	0.9x	0.77	x	0.79	x	85.75	x	0.85	x	0.7	=	27.93	(77)

DER WorkSheet: New dwelling design stage

Southeast	0.9x	0.77	x	3.45	x	85.75	x	0.63	x	0.7	=	90.41	(77)
Southeast	0.9x	0.77	x	0.58	x	85.75	x	0.63	x	0.7	=	15.2	(77)
Southeast	0.9x	0.77	x	5.28	x	85.75	x	0.63	x	0.7	=	138.37	(77)
Southeast	0.9x	0.77	x	1.5	x	106.25	x	0.85	x	0.7	=	262.87	(77)
Southeast	0.9x	0.77	x	0.42	x	106.25	x	0.85	x	0.7	=	18.4	(77)
Southeast	0.9x	0.77	x	0.79	x	106.25	x	0.85	x	0.7	=	34.61	(77)
Southeast	0.9x	0.77	x	3.45	x	106.25	x	0.63	x	0.7	=	112.03	(77)
Southeast	0.9x	0.77	x	0.58	x	106.25	x	0.63	x	0.7	=	18.83	(77)
Southeast	0.9x	0.77	x	5.28	x	106.25	x	0.63	x	0.7	=	171.45	(77)
Southeast	0.9x	0.77	x	1.5	x	119.01	x	0.85	x	0.7	=	294.43	(77)
Southeast	0.9x	0.77	x	0.42	x	119.01	x	0.85	x	0.7	=	20.61	(77)
Southeast	0.9x	0.77	x	0.79	x	119.01	x	0.85	x	0.7	=	38.77	(77)
Southeast	0.9x	0.77	x	3.45	x	119.01	x	0.63	x	0.7	=	125.48	(77)
Southeast	0.9x	0.77	x	0.58	x	119.01	x	0.63	x	0.7	=	21.1	(77)
Southeast	0.9x	0.77	x	5.28	x	119.01	x	0.63	x	0.7	=	192.04	(77)
Southeast	0.9x	0.77	x	1.5	x	118.15	x	0.85	x	0.7	=	292.3	(77)
Southeast	0.9x	0.77	x	0.42	x	118.15	x	0.85	x	0.7	=	20.46	(77)
Southeast	0.9x	0.77	x	0.79	x	118.15	x	0.85	x	0.7	=	38.49	(77)
Southeast	0.9x	0.77	x	3.45	x	118.15	x	0.63	x	0.7	=	124.57	(77)
Southeast	0.9x	0.77	x	0.58	x	118.15	x	0.63	x	0.7	=	20.94	(77)
Southeast	0.9x	0.77	x	5.28	x	118.15	x	0.63	x	0.7	=	190.65	(77)
Southeast	0.9x	0.77	x	1.5	x	113.91	x	0.85	x	0.7	=	281.81	(77)
Southeast	0.9x	0.77	x	0.42	x	113.91	x	0.85	x	0.7	=	19.73	(77)
Southeast	0.9x	0.77	x	0.79	x	113.91	x	0.85	x	0.7	=	37.11	(77)
Southeast	0.9x	0.77	x	3.45	x	113.91	x	0.63	x	0.7	=	120.1	(77)
Southeast	0.9x	0.77	x	0.58	x	113.91	x	0.63	x	0.7	=	20.19	(77)
Southeast	0.9x	0.77	x	5.28	x	113.91	x	0.63	x	0.7	=	183.81	(77)
Southeast	0.9x	0.77	x	1.5	x	104.39	x	0.85	x	0.7	=	258.26	(77)
Southeast	0.9x	0.77	x	0.42	x	104.39	x	0.85	x	0.7	=	18.08	(77)
Southeast	0.9x	0.77	x	0.79	x	104.39	x	0.85	x	0.7	=	34	(77)
Southeast	0.9x	0.77	x	3.45	x	104.39	x	0.63	x	0.7	=	110.07	(77)
Southeast	0.9x	0.77	x	0.58	x	104.39	x	0.63	x	0.7	=	18.5	(77)
Southeast	0.9x	0.77	x	5.28	x	104.39	x	0.63	x	0.7	=	168.45	(77)
Southeast	0.9x	0.77	x	1.5	x	92.85	x	0.85	x	0.7	=	229.72	(77)
Southeast	0.9x	0.77	x	0.42	x	92.85	x	0.85	x	0.7	=	16.08	(77)
Southeast	0.9x	0.77	x	0.79	x	92.85	x	0.85	x	0.7	=	30.25	(77)
Southeast	0.9x	0.77	x	3.45	x	92.85	x	0.63	x	0.7	=	97.9	(77)
Southeast	0.9x	0.77	x	0.58	x	92.85	x	0.63	x	0.7	=	16.46	(77)
Southeast	0.9x	0.77	x	5.28	x	92.85	x	0.63	x	0.7	=	149.83	(77)
Southeast	0.9x	0.77	x	1.5	x	69.27	x	0.85	x	0.7	=	171.37	(77)
Southeast	0.9x	0.77	x	0.42	x	69.27	x	0.85	x	0.7	=	12	(77)

DER WorkSheet: New dwelling design stage

Southeast	0.9x	0.77	x	0.79	x	69.27	x	0.85	x	0.7	=	22.56	(77)
Southeast	0.9x	0.77	x	3.45	x	69.27	x	0.63	x	0.7	=	73.03	(77)
Southeast	0.9x	0.77	x	0.58	x	69.27	x	0.63	x	0.7	=	12.28	(77)
Southeast	0.9x	0.77	x	5.28	x	69.27	x	0.63	x	0.7	=	111.77	(77)
Southeast	0.9x	0.77	x	1.5	x	44.07	x	0.85	x	0.7	=	109.03	(77)
Southeast	0.9x	0.77	x	0.42	x	44.07	x	0.85	x	0.7	=	7.63	(77)
Southeast	0.9x	0.77	x	0.79	x	44.07	x	0.85	x	0.7	=	14.36	(77)
Southeast	0.9x	0.77	x	3.45	x	44.07	x	0.63	x	0.7	=	46.47	(77)
Southeast	0.9x	0.77	x	0.58	x	44.07	x	0.63	x	0.7	=	7.81	(77)
Southeast	0.9x	0.77	x	5.28	x	44.07	x	0.63	x	0.7	=	71.11	(77)
Southeast	0.9x	0.77	x	1.5	x	31.49	x	0.85	x	0.7	=	77.9	(77)
Southeast	0.9x	0.77	x	0.42	x	31.49	x	0.85	x	0.7	=	5.45	(77)
Southeast	0.9x	0.77	x	0.79	x	31.49	x	0.85	x	0.7	=	10.26	(77)
Southeast	0.9x	0.77	x	3.45	x	31.49	x	0.63	x	0.7	=	33.2	(77)
Southeast	0.9x	0.77	x	0.58	x	31.49	x	0.63	x	0.7	=	5.58	(77)
Southeast	0.9x	0.77	x	5.28	x	31.49	x	0.63	x	0.7	=	50.81	(77)
South	0.9x	0.77	x	1.72	x	46.75	x	0.63	x	0.7	=	24.58	(78)
South	0.9x	0.77	x	1.46	x	46.75	x	0.85	x	0.7	=	28.15	(78)
South	0.9x	0.77	x	1.3	x	46.75	x	0.85	x	0.7	=	25.06	(78)
South	0.9x	0.77	x	1.72	x	76.57	x	0.63	x	0.7	=	40.25	(78)
South	0.9x	0.77	x	1.46	x	76.57	x	0.85	x	0.7	=	46.09	(78)
South	0.9x	0.77	x	1.3	x	76.57	x	0.85	x	0.7	=	41.04	(78)
South	0.9x	0.77	x	1.72	x	97.53	x	0.63	x	0.7	=	51.27	(78)
South	0.9x	0.77	x	1.46	x	97.53	x	0.85	x	0.7	=	58.72	(78)
South	0.9x	0.77	x	1.3	x	97.53	x	0.85	x	0.7	=	52.28	(78)
South	0.9x	0.77	x	1.72	x	110.23	x	0.63	x	0.7	=	57.95	(78)
South	0.9x	0.77	x	1.46	x	110.23	x	0.85	x	0.7	=	66.36	(78)
South	0.9x	0.77	x	1.3	x	110.23	x	0.85	x	0.7	=	59.09	(78)
South	0.9x	0.77	x	1.72	x	114.87	x	0.63	x	0.7	=	60.38	(78)
South	0.9x	0.77	x	1.46	x	114.87	x	0.85	x	0.7	=	69.15	(78)
South	0.9x	0.77	x	1.3	x	114.87	x	0.85	x	0.7	=	61.57	(78)
South	0.9x	0.77	x	1.72	x	110.55	x	0.63	x	0.7	=	58.11	(78)
South	0.9x	0.77	x	1.46	x	110.55	x	0.85	x	0.7	=	66.55	(78)
South	0.9x	0.77	x	1.3	x	110.55	x	0.85	x	0.7	=	59.26	(78)
South	0.9x	0.77	x	1.72	x	108.01	x	0.63	x	0.7	=	56.78	(78)
South	0.9x	0.77	x	1.46	x	108.01	x	0.85	x	0.7	=	65.02	(78)
South	0.9x	0.77	x	1.3	x	108.01	x	0.85	x	0.7	=	57.9	(78)
South	0.9x	0.77	x	1.72	x	104.89	x	0.63	x	0.7	=	55.14	(78)
South	0.9x	0.77	x	1.46	x	104.89	x	0.85	x	0.7	=	63.15	(78)
South	0.9x	0.77	x	1.3	x	104.89	x	0.85	x	0.7	=	56.23	(78)
South	0.9x	0.77	x	1.72	x	101.89	x	0.63	x	0.7	=	53.56	(78)

DER WorkSheet: New dwelling design stage

South	0.9x	0.77	x	1.46	x	101.89	x	0.85	x	0.7	=	61.34	(78)
South	0.9x	0.77	x	1.3	x	101.89	x	0.85	x	0.7	=	54.61	(78)
South	0.9x	0.77	x	1.72	x	82.59	x	0.63	x	0.7	=	43.41	(78)
South	0.9x	0.77	x	1.46	x	82.59	x	0.85	x	0.7	=	49.72	(78)
South	0.9x	0.77	x	1.3	x	82.59	x	0.85	x	0.7	=	44.27	(78)
South	0.9x	0.77	x	1.72	x	55.42	x	0.63	x	0.7	=	29.13	(78)
South	0.9x	0.77	x	1.46	x	55.42	x	0.85	x	0.7	=	33.36	(78)
South	0.9x	0.77	x	1.3	x	55.42	x	0.85	x	0.7	=	29.71	(78)
South	0.9x	0.77	x	1.72	x	40.4	x	0.63	x	0.7	=	21.24	(78)
South	0.9x	0.77	x	1.46	x	40.4	x	0.85	x	0.7	=	24.32	(78)
South	0.9x	0.77	x	1.3	x	40.4	x	0.85	x	0.7	=	21.65	(78)
Southwest	0.9x	0.77	x	2.39	x	36.79		0.63	x	0.7	=	53.75	(79)
Southwest	0.9x	0.77	x	3.58	x	36.79		0.63	x	0.7	=	40.26	(79)
Southwest	0.9x	0.77	x	2.03	x	36.79		0.85	x	0.7	=	61.6	(79)
Southwest	0.9x	0.77	x	3.04	x	36.79		0.85	x	0.7	=	46.12	(79)
Southwest	0.9x	0.77	x	2.7	x	36.79		0.85	x	0.7	=	40.96	(79)
Southwest	0.9x	0.77	x	2.2	x	36.79		0.85	x	0.7	=	66.75	(79)
Southwest	0.9x	0.77	x	2.19	x	36.79		0.85	x	0.7	=	33.23	(79)
Southwest	0.9x	0.77	x	2.73	x	36.79		0.85	x	0.7	=	41.42	(79)
Southwest	0.9x	0.77	x	2.39	x	62.67		0.63	x	0.7	=	91.56	(79)
Southwest	0.9x	0.77	x	3.58	x	62.67		0.63	x	0.7	=	68.57	(79)
Southwest	0.9x	0.77	x	2.03	x	62.67		0.85	x	0.7	=	104.92	(79)
Southwest	0.9x	0.77	x	3.04	x	62.67		0.85	x	0.7	=	78.56	(79)
Southwest	0.9x	0.77	x	2.7	x	62.67		0.85	x	0.7	=	69.77	(79)
Southwest	0.9x	0.77	x	2.2	x	62.67		0.85	x	0.7	=	113.71	(79)
Southwest	0.9x	0.77	x	2.19	x	62.67		0.85	x	0.7	=	56.6	(79)
Southwest	0.9x	0.77	x	2.73	x	62.67		0.85	x	0.7	=	70.55	(79)
Southwest	0.9x	0.77	x	2.39	x	85.75		0.63	x	0.7	=	125.27	(79)
Southwest	0.9x	0.77	x	3.58	x	85.75		0.63	x	0.7	=	93.82	(79)
Southwest	0.9x	0.77	x	2.03	x	85.75		0.85	x	0.7	=	143.56	(79)
Southwest	0.9x	0.77	x	3.04	x	85.75		0.85	x	0.7	=	107.49	(79)
Southwest	0.9x	0.77	x	2.7	x	85.75		0.85	x	0.7	=	95.47	(79)
Southwest	0.9x	0.77	x	2.2	x	85.75		0.85	x	0.7	=	155.58	(79)
Southwest	0.9x	0.77	x	2.19	x	85.75		0.85	x	0.7	=	77.44	(79)
Southwest	0.9x	0.77	x	2.73	x	85.75		0.85	x	0.7	=	96.53	(79)
Southwest	0.9x	0.77	x	2.39	x	106.25		0.63	x	0.7	=	155.22	(79)
Southwest	0.9x	0.77	x	3.58	x	106.25		0.63	x	0.7	=	116.25	(79)
Southwest	0.9x	0.77	x	2.03	x	106.25		0.85	x	0.7	=	177.87	(79)
Southwest	0.9x	0.77	x	3.04	x	106.25		0.85	x	0.7	=	133.19	(79)
Southwest	0.9x	0.77	x	2.7	x	106.25		0.85	x	0.7	=	118.29	(79)
Southwest	0.9x	0.77	x	2.2	x	106.25		0.85	x	0.7	=	192.77	(79)

DER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	2.19	x	106.25	0.85	x	0.7	=	95.95	(79)
Southwest	0.9x	0.77	x	2.73	x	106.25	0.85	x	0.7	=	119.6	(79)
Southwest	0.9x	0.77	x	2.39	x	119.01	0.63	x	0.7	=	173.85	(79)
Southwest	0.9x	0.77	x	3.58	x	119.01	0.63	x	0.7	=	130.21	(79)
Southwest	0.9x	0.77	x	2.03	x	119.01	0.85	x	0.7	=	199.23	(79)
Southwest	0.9x	0.77	x	3.04	x	119.01	0.85	x	0.7	=	149.18	(79)
Southwest	0.9x	0.77	x	2.7	x	119.01	0.85	x	0.7	=	132.5	(79)
Southwest	0.9x	0.77	x	2.2	x	119.01	0.85	x	0.7	=	215.92	(79)
Southwest	0.9x	0.77	x	2.19	x	119.01	0.85	x	0.7	=	107.47	(79)
Southwest	0.9x	0.77	x	2.73	x	119.01	0.85	x	0.7	=	133.97	(79)
Southwest	0.9x	0.77	x	2.39	x	118.15	0.63	x	0.7	=	172.6	(79)
Southwest	0.9x	0.77	x	3.58	x	118.15	0.63	x	0.7	=	129.27	(79)
Southwest	0.9x	0.77	x	2.03	x	118.15	0.85	x	0.7	=	197.79	(79)
Southwest	0.9x	0.77	x	3.04	x	118.15	0.85	x	0.7	=	148.1	(79)
Southwest	0.9x	0.77	x	2.7	x	118.15	0.85	x	0.7	=	131.54	(79)
Southwest	0.9x	0.77	x	2.2	x	118.15	0.85	x	0.7	=	214.36	(79)
Southwest	0.9x	0.77	x	2.19	x	118.15	0.85	x	0.7	=	106.69	(79)
Southwest	0.9x	0.77	x	2.73	x	118.15	0.85	x	0.7	=	133	(79)
Southwest	0.9x	0.77	x	2.39	x	113.91	0.63	x	0.7	=	166.4	(79)
Southwest	0.9x	0.77	x	3.58	x	113.91	0.63	x	0.7	=	124.63	(79)
Southwest	0.9x	0.77	x	2.03	x	113.91	0.85	x	0.7	=	190.69	(79)
Southwest	0.9x	0.77	x	3.04	x	113.91	0.85	x	0.7	=	142.79	(79)
Southwest	0.9x	0.77	x	2.7	x	113.91	0.85	x	0.7	=	126.82	(79)
Southwest	0.9x	0.77	x	2.2	x	113.91	0.85	x	0.7	=	206.66	(79)
Southwest	0.9x	0.77	x	2.19	x	113.91	0.85	x	0.7	=	102.86	(79)
Southwest	0.9x	0.77	x	2.73	x	113.91	0.85	x	0.7	=	128.22	(79)
Southwest	0.9x	0.77	x	2.39	x	104.39	0.63	x	0.7	=	152.5	(79)
Southwest	0.9x	0.77	x	3.58	x	104.39	0.63	x	0.7	=	114.21	(79)
Southwest	0.9x	0.77	x	2.03	x	104.39	0.85	x	0.7	=	174.76	(79)
Southwest	0.9x	0.77	x	3.04	x	104.39	0.85	x	0.7	=	130.85	(79)
Southwest	0.9x	0.77	x	2.7	x	104.39	0.85	x	0.7	=	116.22	(79)
Southwest	0.9x	0.77	x	2.2	x	104.39	0.85	x	0.7	=	189.39	(79)
Southwest	0.9x	0.77	x	2.19	x	104.39	0.85	x	0.7	=	94.27	(79)
Southwest	0.9x	0.77	x	2.73	x	104.39	0.85	x	0.7	=	117.51	(79)
Southwest	0.9x	0.77	x	2.39	x	92.85	0.63	x	0.7	=	135.64	(79)
Southwest	0.9x	0.77	x	3.58	x	92.85	0.63	x	0.7	=	101.59	(79)
Southwest	0.9x	0.77	x	2.03	x	92.85	0.85	x	0.7	=	155.44	(79)
Southwest	0.9x	0.77	x	3.04	x	92.85	0.85	x	0.7	=	116.39	(79)
Southwest	0.9x	0.77	x	2.7	x	92.85	0.85	x	0.7	=	103.37	(79)
Southwest	0.9x	0.77	x	2.2	x	92.85	0.85	x	0.7	=	168.46	(79)
Southwest	0.9x	0.77	x	2.19	x	92.85	0.85	x	0.7	=	83.85	(79)

DER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	2.73	x	92.85		0.85	x	0.7	=	104.52	(79)
Southwest	0.9x	0.77	x	2.39	x	69.27		0.63	x	0.7	=	101.19	(79)
Southwest	0.9x	0.77	x	3.58	x	69.27		0.63	x	0.7	=	75.79	(79)
Southwest	0.9x	0.77	x	2.03	x	69.27		0.85	x	0.7	=	115.96	(79)
Southwest	0.9x	0.77	x	3.04	x	69.27		0.85	x	0.7	=	86.83	(79)
Southwest	0.9x	0.77	x	2.7	x	69.27		0.85	x	0.7	=	77.12	(79)
Southwest	0.9x	0.77	x	2.2	x	69.27		0.85	x	0.7	=	125.67	(79)
Southwest	0.9x	0.77	x	2.19	x	69.27		0.85	x	0.7	=	62.55	(79)
Southwest	0.9x	0.77	x	2.73	x	69.27		0.85	x	0.7	=	77.97	(79)
Southwest	0.9x	0.77	x	2.39	x	44.07		0.63	x	0.7	=	64.38	(79)
Southwest	0.9x	0.77	x	3.58	x	44.07		0.63	x	0.7	=	48.22	(79)
Southwest	0.9x	0.77	x	2.03	x	44.07		0.85	x	0.7	=	73.78	(79)
Southwest	0.9x	0.77	x	3.04	x	44.07		0.85	x	0.7	=	55.24	(79)
Southwest	0.9x	0.77	x	2.7	x	44.07		0.85	x	0.7	=	49.06	(79)
Southwest	0.9x	0.77	x	2.2	x	44.07		0.85	x	0.7	=	79.96	(79)
Southwest	0.9x	0.77	x	2.19	x	44.07		0.85	x	0.7	=	39.8	(79)
Southwest	0.9x	0.77	x	2.73	x	44.07		0.85	x	0.7	=	49.61	(79)
Southwest	0.9x	0.77	x	2.39	x	31.49		0.63	x	0.7	=	46	(79)
Southwest	0.9x	0.77	x	3.58	x	31.49		0.63	x	0.7	=	34.45	(79)
Southwest	0.9x	0.77	x	2.03	x	31.49		0.85	x	0.7	=	52.71	(79)
Southwest	0.9x	0.77	x	3.04	x	31.49		0.85	x	0.7	=	39.47	(79)
Southwest	0.9x	0.77	x	2.7	x	31.49		0.85	x	0.7	=	35.06	(79)
Southwest	0.9x	0.77	x	2.2	x	31.49		0.85	x	0.7	=	57.13	(79)
Southwest	0.9x	0.77	x	2.19	x	31.49		0.85	x	0.7	=	28.43	(79)
Southwest	0.9x	0.77	x	2.73	x	31.49		0.85	x	0.7	=	35.45	(79)
West	0.9x	0.77	x	1.72	x	19.64	x	0.63	x	0.7	=	10.32	(80)
West	0.9x	0.77	x	1.46	x	19.64	x	0.85	x	0.7	=	11.82	(80)
West	0.9x	0.77	x	1.3	x	19.64	x	0.85	x	0.7	=	10.53	(80)
West	0.9x	0.77	x	1.72	x	38.42	x	0.63	x	0.7	=	20.2	(80)
West	0.9x	0.77	x	1.46	x	38.42	x	0.85	x	0.7	=	23.13	(80)
West	0.9x	0.77	x	1.3	x	38.42	x	0.85	x	0.7	=	20.59	(80)
West	0.9x	0.77	x	1.72	x	63.27	x	0.63	x	0.7	=	33.26	(80)
West	0.9x	0.77	x	1.46	x	63.27	x	0.85	x	0.7	=	38.09	(80)
West	0.9x	0.77	x	1.3	x	63.27	x	0.85	x	0.7	=	33.92	(80)
West	0.9x	0.77	x	1.72	x	92.28	x	0.63	x	0.7	=	48.51	(80)
West	0.9x	0.77	x	1.46	x	92.28	x	0.85	x	0.7	=	55.55	(80)
West	0.9x	0.77	x	1.3	x	92.28	x	0.85	x	0.7	=	49.47	(80)
West	0.9x	0.77	x	1.72	x	113.09	x	0.63	x	0.7	=	59.45	(80)
West	0.9x	0.77	x	1.46	x	113.09	x	0.85	x	0.7	=	68.08	(80)
West	0.9x	0.77	x	1.3	x	113.09	x	0.85	x	0.7	=	60.62	(80)
West	0.9x	0.77	x	1.72	x	115.77	x	0.63	x	0.7	=	60.86	(80)

DER WorkSheet: New dwelling design stage

West	0.9x	0.77	x	1.46	x	115.77	x	0.85	x	0.7	=	69.69	(80)
West	0.9x	0.77	x	1.3	x	115.77	x	0.85	x	0.7	=	62.06	(80)
West	0.9x	0.77	x	1.72	x	110.22	x	0.63	x	0.7	=	57.94	(80)
West	0.9x	0.77	x	1.46	x	110.22	x	0.85	x	0.7	=	66.35	(80)
West	0.9x	0.77	x	1.3	x	110.22	x	0.85	x	0.7	=	59.08	(80)
West	0.9x	0.77	x	1.72	x	94.68	x	0.63	x	0.7	=	49.77	(80)
West	0.9x	0.77	x	1.46	x	94.68	x	0.85	x	0.7	=	57	(80)
West	0.9x	0.77	x	1.3	x	94.68	x	0.85	x	0.7	=	50.75	(80)
West	0.9x	0.77	x	1.72	x	73.59	x	0.63	x	0.7	=	38.68	(80)
West	0.9x	0.77	x	1.46	x	73.59	x	0.85	x	0.7	=	44.3	(80)
West	0.9x	0.77	x	1.3	x	73.59	x	0.85	x	0.7	=	39.45	(80)
West	0.9x	0.77	x	1.72	x	45.59	x	0.63	x	0.7	=	23.96	(80)
West	0.9x	0.77	x	1.46	x	45.59	x	0.85	x	0.7	=	27.45	(80)
West	0.9x	0.77	x	1.3	x	45.59	x	0.85	x	0.7	=	24.44	(80)
West	0.9x	0.77	x	1.72	x	24.49	x	0.63	x	0.7	=	12.87	(80)
West	0.9x	0.77	x	1.46	x	24.49	x	0.85	x	0.7	=	14.74	(80)
West	0.9x	0.77	x	1.3	x	24.49	x	0.85	x	0.7	=	13.13	(80)
West	0.9x	0.77	x	1.72	x	16.15	x	0.63	x	0.7	=	8.49	(80)
West	0.9x	0.77	x	1.46	x	16.15	x	0.85	x	0.7	=	9.72	(80)
West	0.9x	0.77	x	1.3	x	16.15	x	0.85	x	0.7	=	8.66	(80)
Northwest	0.9x	0.77	x	5.76	x	11.28	x	0.63	x	0.7	=	19.86	(81)
Northwest	0.9x	0.77	x	1.31	x	11.28	x	0.63	x	0.7	=	4.52	(81)
Northwest	0.9x	0.77	x	5.76	x	22.97	x	0.63	x	0.7	=	40.43	(81)
Northwest	0.9x	0.77	x	1.31	x	22.97	x	0.63	x	0.7	=	9.19	(81)
Northwest	0.9x	0.77	x	5.76	x	41.38	x	0.63	x	0.7	=	72.84	(81)
Northwest	0.9x	0.77	x	1.31	x	41.38	x	0.63	x	0.7	=	16.57	(81)
Northwest	0.9x	0.77	x	5.76	x	67.96	x	0.63	x	0.7	=	119.62	(81)
Northwest	0.9x	0.77	x	1.31	x	67.96	x	0.63	x	0.7	=	27.21	(81)
Northwest	0.9x	0.77	x	5.76	x	91.35	x	0.63	x	0.7	=	160.8	(81)
Northwest	0.9x	0.77	x	1.31	x	91.35	x	0.63	x	0.7	=	36.57	(81)
Northwest	0.9x	0.77	x	5.76	x	97.38	x	0.63	x	0.7	=	171.43	(81)
Northwest	0.9x	0.77	x	1.31	x	97.38	x	0.63	x	0.7	=	38.99	(81)
Northwest	0.9x	0.77	x	5.76	x	91.1	x	0.63	x	0.7	=	160.37	(81)
Northwest	0.9x	0.77	x	1.31	x	91.1	x	0.63	x	0.7	=	36.47	(81)
Northwest	0.9x	0.77	x	5.76	x	72.63	x	0.63	x	0.7	=	127.85	(81)
Northwest	0.9x	0.77	x	1.31	x	72.63	x	0.63	x	0.7	=	29.08	(81)
Northwest	0.9x	0.77	x	5.76	x	50.42	x	0.63	x	0.7	=	88.76	(81)
Northwest	0.9x	0.77	x	1.31	x	50.42	x	0.63	x	0.7	=	20.19	(81)
Northwest	0.9x	0.77	x	5.76	x	28.07	x	0.63	x	0.7	=	49.41	(81)
Northwest	0.9x	0.77	x	1.31	x	28.07	x	0.63	x	0.7	=	11.24	(81)
Northwest	0.9x	0.77	x	5.76	x	14.2	x	0.63	x	0.7	=	24.99	(81)

DER WorkSheet: New dwelling design stage

Northwest 0.9x	0.77	x	1.31	x	14.2	x	0.63	x	0.7	=	5.68	(81)
Northwest 0.9x	0.77	x	5.76	x	9.21	x	0.63	x	0.7	=	16.22	(81)
Northwest 0.9x	0.77	x	1.31	x	9.21	x	0.63	x	0.7	=	3.69	(81)
Rooflights 0.9x	1	x	23.6	x	26	x	0.63	x	0.7	=	243.54	(82)
Rooflights 0.9x	1	x	4.52	x	26	x	0.63	x	0.7	=	139.93	(82)
Rooflights 0.9x	1	x	23.6	x	54	x	0.63	x	0.7	=	505.81	(82)
Rooflights 0.9x	1	x	4.52	x	54	x	0.63	x	0.7	=	290.63	(82)
Rooflights 0.9x	1	x	23.6	x	96	x	0.63	x	0.7	=	899.22	(82)
Rooflights 0.9x	1	x	4.52	x	96	x	0.63	x	0.7	=	516.67	(82)
Rooflights 0.9x	1	x	23.6	x	150	x	0.63	x	0.7	=	1405.03	(82)
Rooflights 0.9x	1	x	4.52	x	150	x	0.63	x	0.7	=	807.29	(82)
Rooflights 0.9x	1	x	23.6	x	192	x	0.63	x	0.7	=	1798.43	(82)
Rooflights 0.9x	1	x	4.52	x	192	x	0.63	x	0.7	=	1033.34	(82)
Rooflights 0.9x	1	x	23.6	x	200	x	0.63	x	0.7	=	1873.37	(82)
Rooflights 0.9x	1	x	4.52	x	200	x	0.63	x	0.7	=	1076.39	(82)
Rooflights 0.9x	1	x	23.6	x	189	x	0.63	x	0.7	=	1770.33	(82)
Rooflights 0.9x	1	x	4.52	x	189	x	0.63	x	0.7	=	1017.19	(82)
Rooflights 0.9x	1	x	23.6	x	157	x	0.63	x	0.7	=	1470.59	(82)
Rooflights 0.9x	1	x	4.52	x	157	x	0.63	x	0.7	=	844.97	(82)
Rooflights 0.9x	1	x	23.6	x	115	x	0.63	x	0.7	=	1077.19	(82)
Rooflights 0.9x	1	x	4.52	x	115	x	0.63	x	0.7	=	618.93	(82)
Rooflights 0.9x	1	x	23.6	x	66	x	0.63	x	0.7	=	618.21	(82)
Rooflights 0.9x	1	x	4.52	x	66	x	0.63	x	0.7	=	355.21	(82)
Rooflights 0.9x	1	x	23.6	x	33	x	0.63	x	0.7	=	309.11	(82)
Rooflights 0.9x	1	x	4.52	x	33	x	0.63	x	0.7	=	177.6	(82)
Rooflights 0.9x	1	x	23.6	x	21	x	0.63	x	0.7	=	196.7	(82)
Rooflights 0.9x	1	x	4.52	x	21	x	0.63	x	0.7	=	113.02	(82)

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

(83)m=	1244.12	2314.26	3626.59	5170.06	6339.87	6517.19	6191.75	5297.01	4164	2687.41	1527.1	1040.06	(83)

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

(84)m=	2517.18	3580.33	4853.57	6335.72	7441.05	7470.53	7113.1	6230.24	5133.41	3809.88	2718.01	2284.37	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.99	0.97	0.93	0.87	0.8	0.84	0.94	0.98	1	1	(86)

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

(87)m=	16.97	17.24	17.79	18.56	19.36	20.07	20.49	20.39	19.76	18.75	17.74	16.94	(87)

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

(88)m=	18.85	18.85	18.86	18.88	18.89	18.91	18.91	18.91	18.9	18.89	18.88	18.87	(88)

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

(89)m=	1	0.99	0.98	0.95	0.9	0.78	0.59	0.66	0.89	0.97	0.99	1	(89)

DER WorkSheet: New dwelling design stage

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

(90)m=	15.37	15.64	16.19	16.97	17.76	18.43	18.77	18.71	18.16	17.17	16.16	15.36	(90)

fLA = Living area ÷ (4) = 0.12 (91)

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

(92)m=	15.56	15.83	16.38	17.16	17.95	18.63	18.97	18.91	18.35	17.36	16.34	15.54	(92)

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

(93)m=	15.56	15.83	16.38	17.16	17.95	18.63	18.97	18.91	18.35	17.36	16.34	15.54	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.99	0.97	0.94	0.87	0.76	0.6	0.67	0.87	0.96	0.99	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	2501.37	3532.94	4715.14	5933.58	6475.33	5670.99	4257.41	4145.26	4450.68	3669.59	2688.94	2272.79	(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=	27713.14	26837.84	24189.42	20001.55	15094.34	9627.36	5667.67	5999.07	10208.91	16317.36	22426.89	27648.72	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	18757.55	15660.89	14488.87	10128.94	6412.54	0	0	0	0	9409.94	14211.33	18879.7	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 107949.75 (98)

Space heating requirement in kWh/m²/year 189.03 (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 51 (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)													
	18757.55	15660.89	14488.87	10128.94	6412.54	0	0	0	0	9409.94	14211.33	18879.7	
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)													(211)
	36779.51	30707.63	28409.54	19860.66	12573.6	0	0	0	0	18450.87	27865.34	37019.01	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 211666.17 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] + (214) m } 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)

	517.1	461.59	498.5	465.9	470.35	357.76	356.43	373.42	367.21	482.18	485.93	511.08

Efficiency of water heater 41 (216)

DER WorkSheet: New dwelling design stage

(217)m=	50.67	50.65	50.59	50.46	50.16	41	41	41	41	50.4	50.59	50.67	(217)

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

(219)m=	1020.55	911.41	985.38	923.33	937.63	872.59	869.33	910.77	895.64	956.69	960.48	1008.55

Total = Sum(219a)$_{1...12}$ = 11252.36 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		211666.17	
Water heating fuel used		11252.36	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	120		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =	120	(231)
Electricity for lighting		1747.05	(232)

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

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x		0.216	=	45719.89	(261)
Space heating (secondary)	(215) x		0.519	=	0	(263)
Water heating	(219) x		0.216	=	2430.51	(264)
Space and water heating	(261) + (262) + (263) + (264) =				48150.4	(265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	62.28	(267)
Electricity for lighting	(232) x		0.519	=	906.72	(268)
Total CO2, kg/year		sum of (265)…(271) =			49119.4	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =			86.01	(273)
EI rating (section 14)					19	(274)

SAP Input

Property Details: 55 Lancaster Grove - as designed

Address:	55 Lancaster Grove, LONDON, NW3 4HD
Located in:	England
Region:	Thames valley
UPRN:	7608799078
Date of assessment:	27 January 2015
Date of certificate:	26 January 2015
Assessment type:	New dwelling design stage
Transaction type:	None of the above
Tenure type:	Owner-occupied
Related party disclosure:	No related party
Thermal Mass Parameter:	Indicative Value Medium
Water use <= 125 litres/person/day:	True
PCDF Version:	372

Property description:

Dwelling type:	House
Detachment:	Semi-detached
Year Completed:	2014

Floor Location:	Floor area:	Storey height:
Basement floor	196.23 m²	3 m
Floor 1	153.44 m²	3.9 m
Floor 2	116.9 m²	3.3 m
Floor 3	104.5 m²	3.35 m

Living area:	67.84 m² (fraction 0.119)
Front of dwelling faces:	South West

Opening types:

Name:	Source:	Type:	Glazing:	Argon:	Frame:
D1	SAP 2012	Half glazed	Single-glazed	No	Wood
D2	SAP 2012	Half glazed	Single-glazed	No	Wood
W1	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W2	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W3	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W4	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W5	SAP 2012	Windows	Single-glazed	No	Wood
W6	SAP 2012	Windows	Single-glazed	No	Wood
W7	SAP 2012	Windows	Single-glazed	No	Wood
W8	SAP 2012	Windows	Single-glazed	No	Wood
W9	SAP 2012	Windows	Single-glazed	No	Wood
W10	SAP 2012	Windows	Single-glazed	No	Wood
W11	SAP 2012	Windows	Single-glazed	No	Wood
W12	SAP 2012	Windows	Single-glazed	No	Wood
W13	SAP 2012	Windows	Single-glazed	No	Wood
W14	SAP 2012	Windows	Single-glazed	No	Wood
W15	SAP 2012	Windows	Single-glazed	No	Wood
W16	SAP 2012	Windows	Single-glazed	No	Wood
W17	SAP 2012	Windows	Single-glazed	No	Wood
W18	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W19	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W20	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W21	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W22	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W23	SAP 2012	Windows	Single-glazed	No	Wood
W24	SAP 2012	Windows	low-E, En = 0.05, soft coat	Yes	Wood
W25	SAP 2012	Windows	Single-glazed	No	Wood

SAP Input

W26	SAP 2012	Windows	Single-glazed	No	Wood
W27	SAP 2012	Windows	Single-glazed	No	Wood
W28	SAP 2012	Windows	Single-glazed	No	Wood
RL1	SAP 2012	Roof Windows	low-E, En = 0.05, soft coat	Yes	Wood
RL2	SAP 2012	Roof Windows	low-E, En = 0.05, soft coat	Yes	Wood

Name:	Gap:	Frame Factor:	g-value:	U-value:	Area:	No. of Openings:
D1	mm	0.7	0.85	3.9	2.42	1
D2	mm	0.7	0.85	3.9	2.42	1
W1	16mm or more	0.7	0.63	1.6	2.39	2
W2	16mm or more	0.7	0.63	1.6	3.58	1
W3	16mm or more	0.7	0.63	1.6	1.72	1
W4	16mm or more	0.7	0.63	1.6	1.72	1
W5		0.7	0.85	4.8	2.03	2
W6		0.7	0.85	4.8	3.04	1
W7		0.7	0.85	4.8	1.46	1
W8		0.7	0.85	4.8	1.46	1
W9		0.7	0.85	4.8	2.7	1
W10		0.7	0.85	4.8	1.3	1
W11		0.7	0.85	4.8	1.3	1
W12		0.7	0.85	4.8	2.2	2
W13		0.7	0.85	4.8	2.19	1
W14		0.7	0.85	4.8	2.73	1
W15		0.7	0.85	4.8	1.5	4
W16		0.7	0.85	4.8	0.42	1
W17		0.7	0.85	4.8	0.79	1
W18	16mm or more	0.7	0.63	4.8	3.45	1
W19	16mm or more	0.7	0.63	1.6	0.58	1
W20	16mm or more	0.7	0.63	1.6	5.28	1
W21	16mm or more	0.7	0.63	1.6	5.76	1
W22	16mm or more	0.7	0.63	1.6	1.31	1
W23		0.7	0.85	4.8	1.7	5
W24	16mm or more	0.7	0.63	1.6	11.88	1
W25		0.7	0.85	4.8	1.56	1
W26		0.7	0.85	4.8	1.56	1
W27		0.7	0.85	4.8	0.4	1
W28		0.7	0.85	4.8	5.55	1
RL1	16mm or more	0.7	0.63	2	23.6	1
RL2	16mm or more	0.7	0.63	2	4.52	3

Name:	Type-Name:	Location:	Orient:	Width:	Height:
D1		External	South West	1.1	2.2
D2		External	North East	1.1	2.2
W1		New external	South West	0.9	2.65
W2		New external	South West	1.35	2.65
W3		New external	South	0.65	2.65
W4		New external	West	0.65	2.65
W5		External	South West	0.9	2.25
W6		External	South West	1.35	2.25
W7		External	South	0.65	2.25
W8		External	West	0.65	2.25
W9		External	South West	1.35	2
W10		External	South	0.65	2
W11		External	West	0.65	2
W12		External	South West	1.1	2
W13		External	South West	1.85	1.185
W14		Dormer	South West	1.3	2.1
W15		External	South East	1	1.5
W16		External	South East	0.65	0.65
W17		External	South East	0.35	2.25

SAP Input

W18	External	South East	1.5	2.3
W19	External	South East	0.55	1.05
W20	New external	South East	2.2	2.4
W21	New external	North West	2.4	2.4
W22	New external	North West	0.875	1.5
W23	External	North East	0.85	2
W24	New external	North East	4.75	2.5
W25	External	North	0.65	2.4
W26	External	East	0.65	2.4
W27	External	North East	0.895	0.45
W28	Dormer	North East	3.7	1.5
RL1	New flat	Horizontal	14.3	1.65
RL2	Basement	Horizontal	1.35	3.35

Overshading: Average or unknown

Opaque Elements:

Type:	Gross area:	Openings:	Net area:	U-value:	Ru value:	Curtain wall:	Kappa:
External Elements							
New external	91.67	36.03	55.64	0.26	0	False	N/A
External	232.64	50.01	182.63	2.1	0	False	N/A
Dormer	13	8.28	4.72	2.1	0	False	N/A
Basement	164.1	0	164.1	0.2	0	False	N/A
Ceiling	66.5	0	66.5	0.11	0		N/A
New flat	33.99	23.6	10.39	0.14	0		N/A
Basement	42.79	13.56	29.23	0.18	0		N/A
Old dormer and bays	15.11	0	15.11	2.3	0		N/A
Rafter roof	39.56	0	39.56	0.18	0		N/A
New Basement	196.23			0.15			N/A
Internal Elements							
Party Elements							

Thermal bridges:

Thermal bridges: No information on thermal bridging (y=0.15) (y =0.15)

Ventilation:

Pressure test: No (Assumed)
Ventilation: Natural ventilation (extract fans)
Number of chimneys: 0
Number of open flues: 0
Number of fans: 8
Number of passive stacks: 0
Number of sides sheltered: 4
Pressure test: 15

Main heating system:

Main heating system:
Boiler systems with radiators or underfloor heating
Gas boilers and oil boilers
Fuel: mains gas
Info Source: Manufacturer Declaration
Manufacturer's data
Efficiency: 89.3% (SEDBUK2009)
Regular condensing with automatic ignition
Fuel Burning Type: Modulation
Systems with radiators
Central heating pump : 2013 or later
Design flow temperature: Design flow temperature >45°C

SAP Input

	Room-sealed Boiler interlock: Yes Delayed start
Main heating Control:	
Main heating Control:	Time and temperature zone control by suitable arrangement of plumbing and electrical services Control code: 2110
Secondary heating system:	
Secondary heating system:	None
Water heating:	
Water heating:	From main heating system Water code: 901 Fuel :mains gas Hot water cylinder Cylinder volume: 250 litres Cylinder insulation: Measured loss, 1.75kWh/day Primary pipework insulation: True Cylinderstat: True Cylinder in heated space: True Solar panel: False
Others:	
Electricity tariff:	Standard Tariff
In Smoke Control Area:	Unknown
Conservatory:	No conservatory
Low energy lights:	75%
Terrain type:	Low rise urban / suburban
EPC language:	English
Wind turbine:	No
Photovoltaics:	None
Assess Zero Carbon Home:	No

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Neil Ingham	**Stroma Number:**	STRO002943
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.1.14

Property Address: 55 Lancaster Grove - as designed

Address : 55 Lancaster Grove, LONDON, NW3 4HD

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Basement	196.23	(1a) x	3	(2a) =	588.69	(3a)
Ground floor	153.44	(1b) x	3.9	(2b) =	598.42	(3b)
First floor	116.9	(1c) x	3.3	(2c) =	385.77	(3c)
Second floor	104.5	(1d) x	3.35	(2d) =	350.07	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	571.07	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		1922.95	(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							8	x 10 =	80	(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) =	80	÷ (5) =	0.04 (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			15 (17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.79 (18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered			4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =		0.7 (20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =		0.55 (21)

Infiltration rate modified for monthly wind speed

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

DER WorkSheet: New dwelling design stage

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

Wind Factor (22a)m = (22)m ÷ 4

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

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

0.71	0.69	0.68	0.61	0.6	0.53	0.53	0.51	0.55	0.6	0.62	0.65

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=	0.75	0.74	0.73	0.69	0.68	0.64	0.64	0.63	0.65	0.68	0.69	0.71

(24d)

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

(25)m=	0.75	0.74	0.73	0.69	0.68	0.64	0.64	0.63	0.65	0.68	0.69	0.71

(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			2.42	x	3.9	=	9.438001			(26)
Doors Type 2			2.42	x	3.9	=	9.438001			(26)
Windows Type 1			2.39	x1/[1/(1.6)+ 0.04]		=	3.59			(27)
Windows Type 2			3.58	x1/[1/(1.6)+ 0.04]		=	5.38			(27)
Windows Type 3			1.72	x1/[1/(1.6)+ 0.04]		=	2.59			(27)
Windows Type 4			1.72	x1/[1/(1.6)+ 0.04]		=	2.59			(27)
Windows Type 5			2.03	x1/[1/(4.8)+ 0.04]		=	8.17			(27)
Windows Type 6			3.04	x1/[1/(4.8)+ 0.04]		=	12.24			(27)
Windows Type 7			1.46	x1/[1/(4.8)+ 0.04]		=	5.88			(27)
Windows Type 8			1.46	x1/[1/(4.8)+ 0.04]		=	5.88			(27)
Windows Type 9			2.7	x1/[1/(4.8)+ 0.04]		=	10.87			(27)
Windows Type 10			1.3	x1/[1/(4.8)+ 0.04]		=	5.23			(27)
Windows Type 11			1.3	x1/[1/(4.8)+ 0.04]		=	5.23			(27)
Windows Type 12			2.2	x1/[1/(4.8)+ 0.04]		=	8.86			(27)

DER WorkSheet: New dwelling design stage

Windows Type 13			2.19	x1/[1/(4.8)+ 0.04]	=	8.82			(27)
Windows Type 14			2.73	x1/[1/(4.8)+ 0.04]	=	10.99			(27)
Windows Type 15			1.5	x1/[1/(4.8)+ 0.04]	=	6.04			(27)
Windows Type 16			0.42	x1/[1/(4.8)+ 0.04]	=	1.69			(27)
Windows Type 17			0.79	x1/[1/(4.8)+ 0.04]	=	3.18			(27)
Windows Type 18			3.45	x1/[1/(4.8)+ 0.04]	=	13.89			(27)
Windows Type 19			0.58	x1/[1/(1.6)+ 0.04]	=	0.87			(27)
Windows Type 20			5.28	x1/[1/(1.6)+ 0.04]	=	7.94			(27)
Windows Type 21			5.76	x1/[1/(1.6)+ 0.04]	=	8.66			(27)
Windows Type 22			1.31	x1/[1/(1.6)+ 0.04]	=	1.97			(27)
Windows Type 23			1.7	x1/[1/(4.8)+ 0.04]	=	6.85			(27)
Windows Type 24			11.88	x1/[1/(1.6)+ 0.04]	=	17.86			(27)
Windows Type 25			1.56	x1/[1/(4.8)+ 0.04]	=	6.28			(27)
Windows Type 26			1.56	x1/[1/(4.8)+ 0.04]	=	6.28			(27)
Windows Type 27			0.4	x1/[1/(4.8)+ 0.04]	=	1.61			(27)
Windows Type 28			5.55	x1/[1/(4.8)+ 0.04]	=	22.35			(27)
Rooflights Type 1			23.6	x 1/[1/(2) + 0.04]	=	47.2			(27b)
Rooflights Type 2			4.52	x 1/[1/(2) + 0.04]	=	9.04			(27b)
Floor			196.23	x	0.15	=	29.4345			(28)
Walls Type1	91.67	36.03	55.64	x	0.26	=	14.47			(29)
Walls Type2	232.64	50.01	182.63	x	2.1	=	383.52			(29)
Walls Type3	13	8.28	4.72	x	2.1	=	9.91			(29)
Walls Type4	164.1	0	164.1	x	0.2	=	32.82			(29)
Roof Type1	66.5	0	66.5	x	0.11	=	7.31			(30)
Roof Type2	33.99	23.6	10.39	x	0.14	=	1.45			(30)
Roof Type3	42.79	13.56	29.23	x	0.18	=	5.26			(30)
Roof Type4	15.11	0	15.11	x	2.3	=	34.75			(30)
Roof Type5	39.56	0	39.56	x	0.18	=	7.12			(30)
Total area of elements, m²			895.59							(31)

** 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) =	881.7	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	29533.86	(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		134.34	(36)
if details of thermal bridging are not known (36) = 0.15 x (31)			
Total fabric heat loss	(33) + (36) =	1016.04	(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=	475.66	469.51	463.48	435.17	429.87	405.21	405.21	400.64	414.71	429.87	440.59	451.79	(38)

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

(39)m=	1491.7	1485.55	1479.52	1451.21	1445.91	1421.25	1421.25	1416.69	1430.75	1445.91	1456.63	1467.83	
Average = Sum(39)$_{1...12}$ /12=												1451.19	(39)

DER WorkSheet: New dwelling design stage

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

(40)m=	2.61	2.6	2.59	2.54	2.53	2.49	2.49	2.48	2.51	2.53	2.55	2.57

Average = Sum(40)$_{1...12}$ /12= 2.54 (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 3.48 (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) + 36 116.95 (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
(44)m=	128.65	123.97	119.29	114.61	109.94	105.26	105.26	109.94	114.61	119.29	123.97	128.65

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

Total = Sum(44)$_{1...12}$ = 1403.43 (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=	190.78	166.86	172.18	150.11	144.04	124.29	115.18	132.17	133.74	155.87	170.14	184.76

Total = Sum(45)$_{1...12}$ = 1840.12 (45)

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

(46)m=	28.62	25.03	25.83	22.52	21.61	18.64	17.28	19.82	20.06	23.38	25.52	27.71

(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 250 (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): 1.75 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.94 (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) 0.94 (55)

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

(56)m=	29.3	26.46	29.3	28.35	29.3	28.35	29.3	29.3	28.35	29.3	28.35	29.3

(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=	29.3	26.46	29.3	28.35	29.3	28.35	29.3	29.3	28.35	29.3	28.35	29.3

(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=	43.31	39.12	43.31	41.92	43.31	41.92	43.31	43.31	41.92	43.31	41.92	43.31

(59)

DER WorkSheet: New dwelling design stage

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=	263.39	232.44	244.79	220.38	216.65	194.56	187.78	204.77	204.01	228.47	240.41	257.37	(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=	263.39	232.44	244.79	220.38	216.65	194.56	187.78	204.77	204.01	228.47	240.41	257.37	

Output from water heater (annual)$_{1...12}$ 2695.02 (64)

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

(65)m=	121.52	107.95	115.34	106.13	105.98	97.54	96.38	102.03	100.68	109.91	112.78	119.52	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	174.22	174.22	174.22	174.22	174.22	174.22	174.22	174.22	174.22	174.22	174.22	174.22	(66)

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

(67)m=	72.74	64.61	52.54	39.78	29.73	25.1	27.12	35.26	47.32	60.09	70.13	74.76	(67)

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

(68)m=	652.73	659.5	642.43	606.1	560.23	517.12	488.32	481.55	498.61	534.95	580.82	623.93	(68)

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

(69)m=	40.42	40.42	40.42	40.42	40.42	40.42	40.42	40.42	40.42	40.42	40.42	40.42	(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=	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	-139.37	(71)

Water heating gains (Table 5)

(72)m=	163.34	160.63	155.02	147.4	142.44	135.47	129.55	137.14	139.84	147.73	156.65	160.64	(72)

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

(73)m=	967.07	963.01	928.26	871.54	810.67	755.96	723.25	732.21	764.04	821.03	885.86	937.6	(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	1.56	x	10.63	x	0.85	x	0.7	=	6.84	(74)
North	0.9x 0.77	x	1.56	x	20.32	x	0.85	x	0.7	=	13.07	(74)
North	0.9x 0.77	x	1.56	x	34.53	x	0.85	x	0.7	=	22.21	(74)
North	0.9x 0.77	x	1.56	x	55.46	x	0.85	x	0.7	=	35.68	(74)
North	0.9x 0.77	x	1.56	x	74.72	x	0.85	x	0.7	=	48.06	(74)

DER WorkSheet: New dwelling design stage

North	0.9x	0.77	x	1.56	x	79.99	x	0.85	x	0.7	=	51.45	(74)
North	0.9x	0.77	x	1.56	x	74.68	x	0.85	x	0.7	=	48.04	(74)
North	0.9x	0.77	x	1.56	x	59.25	x	0.85	x	0.7	=	38.11	(74)
North	0.9x	0.77	x	1.56	x	41.52	x	0.85	x	0.7	=	26.71	(74)
North	0.9x	0.77	x	1.56	x	24.19	x	0.85	x	0.7	=	15.56	(74)
North	0.9x	0.77	x	1.56	x	13.12	x	0.85	x	0.7	=	8.44	(74)
North	0.9x	0.77	x	1.56	x	8.86	x	0.85	x	0.7	=	5.7	(74)
Northeast	0.9x	0.77	x	1.7	x	11.28	x	0.85	x	0.7	=	39.54	(75)
Northeast	0.9x	0.77	x	11.88	x	11.28	x	0.63	x	0.7	=	40.96	(75)
Northeast	0.9x	0.77	x	0.4	x	11.28	x	0.85	x	0.7	=	1.86	(75)
Northeast	0.9x	0.77	x	5.55	x	11.28	x	0.85	x	0.7	=	25.82	(75)
Northeast	0.9x	0.77	x	1.7	x	22.97	x	0.85	x	0.7	=	80.49	(75)
Northeast	0.9x	0.77	x	11.88	x	22.97	x	0.63	x	0.7	=	83.38	(75)
Northeast	0.9x	0.77	x	0.4	x	22.97	x	0.85	x	0.7	=	3.79	(75)
Northeast	0.9x	0.77	x	5.55	x	22.97	x	0.85	x	0.7	=	52.56	(75)
Northeast	0.9x	0.77	x	1.7	x	41.38	x	0.85	x	0.7	=	145.03	(75)
Northeast	0.9x	0.77	x	11.88	x	41.38	x	0.63	x	0.7	=	150.23	(75)
Northeast	0.9x	0.77	x	0.4	x	41.38	x	0.85	x	0.7	=	6.82	(75)
Northeast	0.9x	0.77	x	5.55	x	41.38	x	0.85	x	0.7	=	94.69	(75)
Northeast	0.9x	0.77	x	1.7	x	67.96	x	0.85	x	0.7	=	238.17	(75)
Northeast	0.9x	0.77	x	11.88	x	67.96	x	0.63	x	0.7	=	246.73	(75)
Northeast	0.9x	0.77	x	0.4	x	67.96	x	0.85	x	0.7	=	11.21	(75)
Northeast	0.9x	0.77	x	5.55	x	67.96	x	0.85	x	0.7	=	155.51	(75)
Northeast	0.9x	0.77	x	1.7	x	91.35	x	0.85	x	0.7	=	320.15	(75)
Northeast	0.9x	0.77	x	11.88	x	91.35	x	0.63	x	0.7	=	331.65	(75)
Northeast	0.9x	0.77	x	0.4	x	91.35	x	0.85	x	0.7	=	15.07	(75)
Northeast	0.9x	0.77	x	5.55	x	91.35	x	0.85	x	0.7	=	209.04	(75)
Northeast	0.9x	0.77	x	1.7	x	97.38	x	0.85	x	0.7	=	341.32	(75)
Northeast	0.9x	0.77	x	11.88	x	97.38	x	0.63	x	0.7	=	353.57	(75)
Northeast	0.9x	0.77	x	0.4	x	97.38	x	0.85	x	0.7	=	16.06	(75)
Northeast	0.9x	0.77	x	5.55	x	97.38	x	0.85	x	0.7	=	222.86	(75)
Northeast	0.9x	0.77	x	1.7	x	91.1	x	0.85	x	0.7	=	319.3	(75)
Northeast	0.9x	0.77	x	11.88	x	91.1	x	0.63	x	0.7	=	330.76	(75)
Northeast	0.9x	0.77	x	0.4	x	91.1	x	0.85	x	0.7	=	15.03	(75)
Northeast	0.9x	0.77	x	5.55	x	91.1	x	0.85	x	0.7	=	208.48	(75)
Northeast	0.9x	0.77	x	1.7	x	72.63	x	0.85	x	0.7	=	254.55	(75)
Northeast	0.9x	0.77	x	11.88	x	72.63	x	0.63	x	0.7	=	263.69	(75)
Northeast	0.9x	0.77	x	0.4	x	72.63	x	0.85	x	0.7	=	11.98	(75)
Northeast	0.9x	0.77	x	5.55	x	72.63	x	0.85	x	0.7	=	166.2	(75)
Northeast	0.9x	0.77	x	1.7	x	50.42	x	0.85	x	0.7	=	176.72	(75)
Northeast	0.9x	0.77	x	11.88	x	50.42	x	0.63	x	0.7	=	183.06	(75)

DER WorkSheet: New dwelling design stage

Northeast	0.9x	0.77	x	0.4	x	50.42	x	0.85	x	0.7	=	8.32	(75)
Northeast	0.9x	0.77	x	5.55	x	50.42	x	0.85	x	0.7	=	115.39	(75)
Northeast	0.9x	0.77	x	1.7	x	28.07	x	0.85	x	0.7	=	98.37	(75)
Northeast	0.9x	0.77	x	11.88	x	28.07	x	0.63	x	0.7	=	101.9	(75)
Northeast	0.9x	0.77	x	0.4	x	28.07	x	0.85	x	0.7	=	4.63	(75)
Northeast	0.9x	0.77	x	5.55	x	28.07	x	0.85	x	0.7	=	64.23	(75)
Northeast	0.9x	0.77	x	1.7	x	14.2	x	0.85	x	0.7	=	49.76	(75)
Northeast	0.9x	0.77	x	11.88	x	14.2	x	0.63	x	0.7	=	51.54	(75)
Northeast	0.9x	0.77	x	0.4	x	14.2	x	0.85	x	0.7	=	2.34	(75)
Northeast	0.9x	0.77	x	5.55	x	14.2	x	0.85	x	0.7	=	32.49	(75)
Northeast	0.9x	0.77	x	1.7	x	9.21	x	0.85	x	0.7	=	32.29	(75)
Northeast	0.9x	0.77	x	11.88	x	9.21	x	0.63	x	0.7	=	33.45	(75)
Northeast	0.9x	0.77	x	0.4	x	9.21	x	0.85	x	0.7	=	1.52	(75)
Northeast	0.9x	0.77	x	5.55	x	9.21	x	0.85	x	0.7	=	21.09	(75)
East	0.9x	1	x	1.56	x	19.64	x	0.85	x	0.7	=	12.63	(76)
East	0.9x	1	x	1.56	x	38.42	x	0.85	x	0.7	=	24.71	(76)
East	0.9x	1	x	1.56	x	63.27	x	0.85	x	0.7	=	40.7	(76)
East	0.9x	1	x	1.56	x	92.28	x	0.85	x	0.7	=	59.36	(76)
East	0.9x	1	x	1.56	x	113.09	x	0.85	x	0.7	=	72.75	(76)
East	0.9x	1	x	1.56	x	115.77	x	0.85	x	0.7	=	74.47	(76)
East	0.9x	1	x	1.56	x	110.22	x	0.85	x	0.7	=	70.9	(76)
East	0.9x	1	x	1.56	x	94.68	x	0.85	x	0.7	=	60.9	(76)
East	0.9x	1	x	1.56	x	73.59	x	0.85	x	0.7	=	47.34	(76)
East	0.9x	1	x	1.56	x	45.59	x	0.85	x	0.7	=	29.32	(76)
East	0.9x	1	x	1.56	x	24.49	x	0.85	x	0.7	=	15.75	(76)
East	0.9x	1	x	1.56	x	16.15	x	0.85	x	0.7	=	10.39	(76)
Southeast	0.9x	0.77	x	1.5	x	36.79	x	0.85	x	0.7	=	91.03	(77)
Southeast	0.9x	0.77	x	0.42	x	36.79	x	0.85	x	0.7	=	6.37	(77)
Southeast	0.9x	0.77	x	0.79	x	36.79	x	0.85	x	0.7	=	11.99	(77)
Southeast	0.9x	0.77	x	3.45	x	36.79	x	0.63	x	0.7	=	38.79	(77)
Southeast	0.9x	0.77	x	0.58	x	36.79	x	0.63	x	0.7	=	6.52	(77)
Southeast	0.9x	0.77	x	5.28	x	36.79	x	0.63	x	0.7	=	59.37	(77)
Southeast	0.9x	0.77	x	1.5	x	62.67	x	0.85	x	0.7	=	155.05	(77)
Southeast	0.9x	0.77	x	0.42	x	62.67	x	0.85	x	0.7	=	10.85	(77)
Southeast	0.9x	0.77	x	0.79	x	62.67	x	0.85	x	0.7	=	20.42	(77)
Southeast	0.9x	0.77	x	3.45	x	62.67	x	0.63	x	0.7	=	66.08	(77)
Southeast	0.9x	0.77	x	0.58	x	62.67	x	0.63	x	0.7	=	11.11	(77)
Southeast	0.9x	0.77	x	5.28	x	62.67	x	0.63	x	0.7	=	101.13	(77)
Southeast	0.9x	0.77	x	1.5	x	85.75	x	0.85	x	0.7	=	212.15	(77)
Southeast	0.9x	0.77	x	0.42	x	85.75	x	0.85	x	0.7	=	14.85	(77)
Southeast	0.9x	0.77	x	0.79	x	85.75	x	0.85	x	0.7	=	27.93	(77)

DER WorkSheet: New dwelling design stage

Southeast	0.9x	0.77	x	3.45	x	85.75	x	0.63	x	0.7	=	90.41	(77)
Southeast	0.9x	0.77	x	0.58	x	85.75	x	0.63	x	0.7	=	15.2	(77)
Southeast	0.9x	0.77	x	5.28	x	85.75	x	0.63	x	0.7	=	138.37	(77)
Southeast	0.9x	0.77	x	1.5	x	106.25	x	0.85	x	0.7	=	262.87	(77)
Southeast	0.9x	0.77	x	0.42	x	106.25	x	0.85	x	0.7	=	18.4	(77)
Southeast	0.9x	0.77	x	0.79	x	106.25	x	0.85	x	0.7	=	34.61	(77)
Southeast	0.9x	0.77	x	3.45	x	106.25	x	0.63	x	0.7	=	112.03	(77)
Southeast	0.9x	0.77	x	0.58	x	106.25	x	0.63	x	0.7	=	18.83	(77)
Southeast	0.9x	0.77	x	5.28	x	106.25	x	0.63	x	0.7	=	171.45	(77)
Southeast	0.9x	0.77	x	1.5	x	119.01	x	0.85	x	0.7	=	294.43	(77)
Southeast	0.9x	0.77	x	0.42	x	119.01	x	0.85	x	0.7	=	20.61	(77)
Southeast	0.9x	0.77	x	0.79	x	119.01	x	0.85	x	0.7	=	38.77	(77)
Southeast	0.9x	0.77	x	3.45	x	119.01	x	0.63	x	0.7	=	125.48	(77)
Southeast	0.9x	0.77	x	0.58	x	119.01	x	0.63	x	0.7	=	21.1	(77)
Southeast	0.9x	0.77	x	5.28	x	119.01	x	0.63	x	0.7	=	192.04	(77)
Southeast	0.9x	0.77	x	1.5	x	118.15	x	0.85	x	0.7	=	292.3	(77)
Southeast	0.9x	0.77	x	0.42	x	118.15	x	0.85	x	0.7	=	20.46	(77)
Southeast	0.9x	0.77	x	0.79	x	118.15	x	0.85	x	0.7	=	38.49	(77)
Southeast	0.9x	0.77	x	3.45	x	118.15	x	0.63	x	0.7	=	124.57	(77)
Southeast	0.9x	0.77	x	0.58	x	118.15	x	0.63	x	0.7	=	20.94	(77)
Southeast	0.9x	0.77	x	5.28	x	118.15	x	0.63	x	0.7	=	190.65	(77)
Southeast	0.9x	0.77	x	1.5	x	113.91	x	0.85	x	0.7	=	281.81	(77)
Southeast	0.9x	0.77	x	0.42	x	113.91	x	0.85	x	0.7	=	19.73	(77)
Southeast	0.9x	0.77	x	0.79	x	113.91	x	0.85	x	0.7	=	37.11	(77)
Southeast	0.9x	0.77	x	3.45	x	113.91	x	0.63	x	0.7	=	120.1	(77)
Southeast	0.9x	0.77	x	0.58	x	113.91	x	0.63	x	0.7	=	20.19	(77)
Southeast	0.9x	0.77	x	5.28	x	113.91	x	0.63	x	0.7	=	183.81	(77)
Southeast	0.9x	0.77	x	1.5	x	104.39	x	0.85	x	0.7	=	258.26	(77)
Southeast	0.9x	0.77	x	0.42	x	104.39	x	0.85	x	0.7	=	18.08	(77)
Southeast	0.9x	0.77	x	0.79	x	104.39	x	0.85	x	0.7	=	34	(77)
Southeast	0.9x	0.77	x	3.45	x	104.39	x	0.63	x	0.7	=	110.07	(77)
Southeast	0.9x	0.77	x	0.58	x	104.39	x	0.63	x	0.7	=	18.5	(77)
Southeast	0.9x	0.77	x	5.28	x	104.39	x	0.63	x	0.7	=	168.45	(77)
Southeast	0.9x	0.77	x	1.5	x	92.85	x	0.85	x	0.7	=	229.72	(77)
Southeast	0.9x	0.77	x	0.42	x	92.85	x	0.85	x	0.7	=	16.08	(77)
Southeast	0.9x	0.77	x	0.79	x	92.85	x	0.85	x	0.7	=	30.25	(77)
Southeast	0.9x	0.77	x	3.45	x	92.85	x	0.63	x	0.7	=	97.9	(77)
Southeast	0.9x	0.77	x	0.58	x	92.85	x	0.63	x	0.7	=	16.46	(77)
Southeast	0.9x	0.77	x	5.28	x	92.85	x	0.63	x	0.7	=	149.83	(77)
Southeast	0.9x	0.77	x	1.5	x	69.27	x	0.85	x	0.7	=	171.37	(77)
Southeast	0.9x	0.77	x	0.42	x	69.27	x	0.85	x	0.7	=	12	(77)

DER WorkSheet: New dwelling design stage

Southeast	0.9x	0.77	x	0.79	x	69.27	x	0.85	x	0.7	=	22.56	(77)
Southeast	0.9x	0.77	x	3.45	x	69.27	x	0.63	x	0.7	=	73.03	(77)
Southeast	0.9x	0.77	x	0.58	x	69.27	x	0.63	x	0.7	=	12.28	(77)
Southeast	0.9x	0.77	x	5.28	x	69.27	x	0.63	x	0.7	=	111.77	(77)
Southeast	0.9x	0.77	x	1.5	x	44.07	x	0.85	x	0.7	=	109.03	(77)
Southeast	0.9x	0.77	x	0.42	x	44.07	x	0.85	x	0.7	=	7.63	(77)
Southeast	0.9x	0.77	x	0.79	x	44.07	x	0.85	x	0.7	=	14.36	(77)
Southeast	0.9x	0.77	x	3.45	x	44.07	x	0.63	x	0.7	=	46.47	(77)
Southeast	0.9x	0.77	x	0.58	x	44.07	x	0.63	x	0.7	=	7.81	(77)
Southeast	0.9x	0.77	x	5.28	x	44.07	x	0.63	x	0.7	=	71.11	(77)
Southeast	0.9x	0.77	x	1.5	x	31.49	x	0.85	x	0.7	=	77.9	(77)
Southeast	0.9x	0.77	x	0.42	x	31.49	x	0.85	x	0.7	=	5.45	(77)
Southeast	0.9x	0.77	x	0.79	x	31.49	x	0.85	x	0.7	=	10.26	(77)
Southeast	0.9x	0.77	x	3.45	x	31.49	x	0.63	x	0.7	=	33.2	(77)
Southeast	0.9x	0.77	x	0.58	x	31.49	x	0.63	x	0.7	=	5.58	(77)
Southeast	0.9x	0.77	x	5.28	x	31.49	x	0.63	x	0.7	=	50.81	(77)
South	0.9x	0.77	x	1.72	x	46.75	x	0.63	x	0.7	=	24.58	(78)
South	0.9x	0.77	x	1.46	x	46.75	x	0.85	x	0.7	=	28.15	(78)
South	0.9x	0.77	x	1.3	x	46.75	x	0.85	x	0.7	=	25.06	(78)
South	0.9x	0.77	x	1.72	x	76.57	x	0.63	x	0.7	=	40.25	(78)
South	0.9x	0.77	x	1.46	x	76.57	x	0.85	x	0.7	=	46.09	(78)
South	0.9x	0.77	x	1.3	x	76.57	x	0.85	x	0.7	=	41.04	(78)
South	0.9x	0.77	x	1.72	x	97.53	x	0.63	x	0.7	=	51.27	(78)
South	0.9x	0.77	x	1.46	x	97.53	x	0.85	x	0.7	=	58.72	(78)
South	0.9x	0.77	x	1.3	x	97.53	x	0.85	x	0.7	=	52.28	(78)
South	0.9x	0.77	x	1.72	x	110.23	x	0.63	x	0.7	=	57.95	(78)
South	0.9x	0.77	x	1.46	x	110.23	x	0.85	x	0.7	=	66.36	(78)
South	0.9x	0.77	x	1.3	x	110.23	x	0.85	x	0.7	=	59.09	(78)
South	0.9x	0.77	x	1.72	x	114.87	x	0.63	x	0.7	=	60.38	(78)
South	0.9x	0.77	x	1.46	x	114.87	x	0.85	x	0.7	=	69.15	(78)
South	0.9x	0.77	x	1.3	x	114.87	x	0.85	x	0.7	=	61.57	(78)
South	0.9x	0.77	x	1.72	x	110.55	x	0.63	x	0.7	=	58.11	(78)
South	0.9x	0.77	x	1.46	x	110.55	x	0.85	x	0.7	=	66.55	(78)
South	0.9x	0.77	x	1.3	x	110.55	x	0.85	x	0.7	=	59.26	(78)
South	0.9x	0.77	x	1.72	x	108.01	x	0.63	x	0.7	=	56.78	(78)
South	0.9x	0.77	x	1.46	x	108.01	x	0.85	x	0.7	=	65.02	(78)
South	0.9x	0.77	x	1.3	x	108.01	x	0.85	x	0.7	=	57.9	(78)
South	0.9x	0.77	x	1.72	x	104.89	x	0.63	x	0.7	=	55.14	(78)
South	0.9x	0.77	x	1.46	x	104.89	x	0.85	x	0.7	=	63.15	(78)
South	0.9x	0.77	x	1.3	x	104.89	x	0.85	x	0.7	=	56.23	(78)
South	0.9x	0.77	x	1.72	x	101.89	x	0.63	x	0.7	=	53.56	(78)

DER WorkSheet: New dwelling design stage

South	0.9x	0.77	x	1.46	x	101.89	x	0.85	x	0.7	=	61.34	(78)
South	0.9x	0.77	x	1.3	x	101.89	x	0.85	x	0.7	=	54.61	(78)
South	0.9x	0.77	x	1.72	x	82.59	x	0.63	x	0.7	=	43.41	(78)
South	0.9x	0.77	x	1.46	x	82.59	x	0.85	x	0.7	=	49.72	(78)
South	0.9x	0.77	x	1.3	x	82.59	x	0.85	x	0.7	=	44.27	(78)
South	0.9x	0.77	x	1.72	x	55.42	x	0.63	x	0.7	=	29.13	(78)
South	0.9x	0.77	x	1.46	x	55.42	x	0.85	x	0.7	=	33.36	(78)
South	0.9x	0.77	x	1.3	x	55.42	x	0.85	x	0.7	=	29.71	(78)
South	0.9x	0.77	x	1.72	x	40.4	x	0.63	x	0.7	=	21.24	(78)
South	0.9x	0.77	x	1.46	x	40.4	x	0.85	x	0.7	=	24.32	(78)
South	0.9x	0.77	x	1.3	x	40.4	x	0.85	x	0.7	=	21.65	(78)
Southwest	0.9x	0.77	x	2.39	x	36.79		0.63	x	0.7	=	53.75	(79)
Southwest	0.9x	0.77	x	3.58	x	36.79		0.63	x	0.7	=	40.26	(79)
Southwest	0.9x	0.77	x	2.03	x	36.79		0.85	x	0.7	=	61.6	(79)
Southwest	0.9x	0.77	x	3.04	x	36.79		0.85	x	0.7	=	46.12	(79)
Southwest	0.9x	0.77	x	2.7	x	36.79		0.85	x	0.7	=	40.96	(79)
Southwest	0.9x	0.77	x	2.2	x	36.79		0.85	x	0.7	=	66.75	(79)
Southwest	0.9x	0.77	x	2.19	x	36.79		0.85	x	0.7	=	33.23	(79)
Southwest	0.9x	0.77	x	2.73	x	36.79		0.85	x	0.7	=	41.42	(79)
Southwest	0.9x	0.77	x	2.39	x	62.67		0.63	x	0.7	=	91.56	(79)
Southwest	0.9x	0.77	x	3.58	x	62.67		0.63	x	0.7	=	68.57	(79)
Southwest	0.9x	0.77	x	2.03	x	62.67		0.85	x	0.7	=	104.92	(79)
Southwest	0.9x	0.77	x	3.04	x	62.67		0.85	x	0.7	=	78.56	(79)
Southwest	0.9x	0.77	x	2.7	x	62.67		0.85	x	0.7	=	69.77	(79)
Southwest	0.9x	0.77	x	2.2	x	62.67		0.85	x	0.7	=	113.71	(79)
Southwest	0.9x	0.77	x	2.19	x	62.67		0.85	x	0.7	=	56.6	(79)
Southwest	0.9x	0.77	x	2.73	x	62.67		0.85	x	0.7	=	70.55	(79)
Southwest	0.9x	0.77	x	2.39	x	85.75		0.63	x	0.7	=	125.27	(79)
Southwest	0.9x	0.77	x	3.58	x	85.75		0.63	x	0.7	=	93.82	(79)
Southwest	0.9x	0.77	x	2.03	x	85.75		0.85	x	0.7	=	143.56	(79)
Southwest	0.9x	0.77	x	3.04	x	85.75		0.85	x	0.7	=	107.49	(79)
Southwest	0.9x	0.77	x	2.7	x	85.75		0.85	x	0.7	=	95.47	(79)
Southwest	0.9x	0.77	x	2.2	x	85.75		0.85	x	0.7	=	155.58	(79)
Southwest	0.9x	0.77	x	2.19	x	85.75		0.85	x	0.7	=	77.44	(79)
Southwest	0.9x	0.77	x	2.73	x	85.75		0.85	x	0.7	=	96.53	(79)
Southwest	0.9x	0.77	x	2.39	x	106.25		0.63	x	0.7	=	155.22	(79)
Southwest	0.9x	0.77	x	3.58	x	106.25		0.63	x	0.7	=	116.25	(79)
Southwest	0.9x	0.77	x	2.03	x	106.25		0.85	x	0.7	=	177.87	(79)
Southwest	0.9x	0.77	x	3.04	x	106.25		0.85	x	0.7	=	133.19	(79)
Southwest	0.9x	0.77	x	2.7	x	106.25		0.85	x	0.7	=	118.29	(79)
Southwest	0.9x	0.77	x	2.2	x	106.25		0.85	x	0.7	=	192.77	(79)

DER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	2.19	x	106.25	0.85	x	0.7	=	95.95	(79)
Southwest	0.9x	0.77	x	2.73	x	106.25	0.85	x	0.7	=	119.6	(79)
Southwest	0.9x	0.77	x	2.39	x	119.01	0.63	x	0.7	=	173.85	(79)
Southwest	0.9x	0.77	x	3.58	x	119.01	0.63	x	0.7	=	130.21	(79)
Southwest	0.9x	0.77	x	2.03	x	119.01	0.85	x	0.7	=	199.23	(79)
Southwest	0.9x	0.77	x	3.04	x	119.01	0.85	x	0.7	=	149.18	(79)
Southwest	0.9x	0.77	x	2.7	x	119.01	0.85	x	0.7	=	132.5	(79)
Southwest	0.9x	0.77	x	2.2	x	119.01	0.85	x	0.7	=	215.92	(79)
Southwest	0.9x	0.77	x	2.19	x	119.01	0.85	x	0.7	=	107.47	(79)
Southwest	0.9x	0.77	x	2.73	x	119.01	0.85	x	0.7	=	133.97	(79)
Southwest	0.9x	0.77	x	2.39	x	118.15	0.63	x	0.7	=	172.6	(79)
Southwest	0.9x	0.77	x	3.58	x	118.15	0.63	x	0.7	=	129.27	(79)
Southwest	0.9x	0.77	x	2.03	x	118.15	0.85	x	0.7	=	197.79	(79)
Southwest	0.9x	0.77	x	3.04	x	118.15	0.85	x	0.7	=	148.1	(79)
Southwest	0.9x	0.77	x	2.7	x	118.15	0.85	x	0.7	=	131.54	(79)
Southwest	0.9x	0.77	x	2.2	x	118.15	0.85	x	0.7	=	214.36	(79)
Southwest	0.9x	0.77	x	2.19	x	118.15	0.85	x	0.7	=	106.69	(79)
Southwest	0.9x	0.77	x	2.73	x	118.15	0.85	x	0.7	=	133	(79)
Southwest	0.9x	0.77	x	2.39	x	113.91	0.63	x	0.7	=	166.4	(79)
Southwest	0.9x	0.77	x	3.58	x	113.91	0.63	x	0.7	=	124.63	(79)
Southwest	0.9x	0.77	x	2.03	x	113.91	0.85	x	0.7	=	190.69	(79)
Southwest	0.9x	0.77	x	3.04	x	113.91	0.85	x	0.7	=	142.79	(79)
Southwest	0.9x	0.77	x	2.7	x	113.91	0.85	x	0.7	=	126.82	(79)
Southwest	0.9x	0.77	x	2.2	x	113.91	0.85	x	0.7	=	206.66	(79)
Southwest	0.9x	0.77	x	2.19	x	113.91	0.85	x	0.7	=	102.86	(79)
Southwest	0.9x	0.77	x	2.73	x	113.91	0.85	x	0.7	=	128.22	(79)
Southwest	0.9x	0.77	x	2.39	x	104.39	0.63	x	0.7	=	152.5	(79)
Southwest	0.9x	0.77	x	3.58	x	104.39	0.63	x	0.7	=	114.21	(79)
Southwest	0.9x	0.77	x	2.03	x	104.39	0.85	x	0.7	=	174.76	(79)
Southwest	0.9x	0.77	x	3.04	x	104.39	0.85	x	0.7	=	130.85	(79)
Southwest	0.9x	0.77	x	2.7	x	104.39	0.85	x	0.7	=	116.22	(79)
Southwest	0.9x	0.77	x	2.2	x	104.39	0.85	x	0.7	=	189.39	(79)
Southwest	0.9x	0.77	x	2.19	x	104.39	0.85	x	0.7	=	94.27	(79)
Southwest	0.9x	0.77	x	2.73	x	104.39	0.85	x	0.7	=	117.51	(79)
Southwest	0.9x	0.77	x	2.39	x	92.85	0.63	x	0.7	=	135.64	(79)
Southwest	0.9x	0.77	x	3.58	x	92.85	0.63	x	0.7	=	101.59	(79)
Southwest	0.9x	0.77	x	2.03	x	92.85	0.85	x	0.7	=	155.44	(79)
Southwest	0.9x	0.77	x	3.04	x	92.85	0.85	x	0.7	=	116.39	(79)
Southwest	0.9x	0.77	x	2.7	x	92.85	0.85	x	0.7	=	103.37	(79)
Southwest	0.9x	0.77	x	2.2	x	92.85	0.85	x	0.7	=	168.46	(79)
Southwest	0.9x	0.77	x	2.19	x	92.85	0.85	x	0.7	=	83.85	(79)

DER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	2.73	x	92.85		0.85	x	0.7	=	104.52	(79)
Southwest	0.9x	0.77	x	2.39	x	69.27		0.63	x	0.7	=	101.19	(79)
Southwest	0.9x	0.77	x	3.58	x	69.27		0.63	x	0.7	=	75.79	(79)
Southwest	0.9x	0.77	x	2.03	x	69.27		0.85	x	0.7	=	115.96	(79)
Southwest	0.9x	0.77	x	3.04	x	69.27		0.85	x	0.7	=	86.83	(79)
Southwest	0.9x	0.77	x	2.7	x	69.27		0.85	x	0.7	=	77.12	(79)
Southwest	0.9x	0.77	x	2.2	x	69.27		0.85	x	0.7	=	125.67	(79)
Southwest	0.9x	0.77	x	2.19	x	69.27		0.85	x	0.7	=	62.55	(79)
Southwest	0.9x	0.77	x	2.73	x	69.27		0.85	x	0.7	=	77.97	(79)
Southwest	0.9x	0.77	x	2.39	x	44.07		0.63	x	0.7	=	64.38	(79)
Southwest	0.9x	0.77	x	3.58	x	44.07		0.63	x	0.7	=	48.22	(79)
Southwest	0.9x	0.77	x	2.03	x	44.07		0.85	x	0.7	=	73.78	(79)
Southwest	0.9x	0.77	x	3.04	x	44.07		0.85	x	0.7	=	55.24	(79)
Southwest	0.9x	0.77	x	2.7	x	44.07		0.85	x	0.7	=	49.06	(79)
Southwest	0.9x	0.77	x	2.2	x	44.07		0.85	x	0.7	=	79.96	(79)
Southwest	0.9x	0.77	x	2.19	x	44.07		0.85	x	0.7	=	39.8	(79)
Southwest	0.9x	0.77	x	2.73	x	44.07		0.85	x	0.7	=	49.61	(79)
Southwest	0.9x	0.77	x	2.39	x	31.49		0.63	x	0.7	=	46	(79)
Southwest	0.9x	0.77	x	3.58	x	31.49		0.63	x	0.7	=	34.45	(79)
Southwest	0.9x	0.77	x	2.03	x	31.49		0.85	x	0.7	=	52.71	(79)
Southwest	0.9x	0.77	x	3.04	x	31.49		0.85	x	0.7	=	39.47	(79)
Southwest	0.9x	0.77	x	2.7	x	31.49		0.85	x	0.7	=	35.06	(79)
Southwest	0.9x	0.77	x	2.2	x	31.49		0.85	x	0.7	=	57.13	(79)
Southwest	0.9x	0.77	x	2.19	x	31.49		0.85	x	0.7	=	28.43	(79)
Southwest	0.9x	0.77	x	2.73	x	31.49		0.85	x	0.7	=	35.45	(79)
West	0.9x	0.77	x	1.72	x	19.64	x	0.63	x	0.7	=	10.32	(80)
West	0.9x	0.77	x	1.46	x	19.64	x	0.85	x	0.7	=	11.82	(80)
West	0.9x	0.77	x	1.3	x	19.64	x	0.85	x	0.7	=	10.53	(80)
West	0.9x	0.77	x	1.72	x	38.42	x	0.63	x	0.7	=	20.2	(80)
West	0.9x	0.77	x	1.46	x	38.42	x	0.85	x	0.7	=	23.13	(80)
West	0.9x	0.77	x	1.3	x	38.42	x	0.85	x	0.7	=	20.59	(80)
West	0.9x	0.77	x	1.72	x	63.27	x	0.63	x	0.7	=	33.26	(80)
West	0.9x	0.77	x	1.46	x	63.27	x	0.85	x	0.7	=	38.09	(80)
West	0.9x	0.77	x	1.3	x	63.27	x	0.85	x	0.7	=	33.92	(80)
West	0.9x	0.77	x	1.72	x	92.28	x	0.63	x	0.7	=	48.51	(80)
West	0.9x	0.77	x	1.46	x	92.28	x	0.85	x	0.7	=	55.55	(80)
West	0.9x	0.77	x	1.3	x	92.28	x	0.85	x	0.7	=	49.47	(80)
West	0.9x	0.77	x	1.72	x	113.09	x	0.63	x	0.7	=	59.45	(80)
West	0.9x	0.77	x	1.46	x	113.09	x	0.85	x	0.7	=	68.08	(80)
West	0.9x	0.77	x	1.3	x	113.09	x	0.85	x	0.7	=	60.62	(80)
West	0.9x	0.77	x	1.72	x	115.77	x	0.63	x	0.7	=	60.86	(80)

DER WorkSheet: New dwelling design stage

West	0.9x	0.77	x	1.46	x	115.77	x	0.85	x	0.7	=	69.69	(80)
West	0.9x	0.77	x	1.3	x	115.77	x	0.85	x	0.7	=	62.06	(80)
West	0.9x	0.77	x	1.72	x	110.22	x	0.63	x	0.7	=	57.94	(80)
West	0.9x	0.77	x	1.46	x	110.22	x	0.85	x	0.7	=	66.35	(80)
West	0.9x	0.77	x	1.3	x	110.22	x	0.85	x	0.7	=	59.08	(80)
West	0.9x	0.77	x	1.72	x	94.68	x	0.63	x	0.7	=	49.77	(80)
West	0.9x	0.77	x	1.46	x	94.68	x	0.85	x	0.7	=	57	(80)
West	0.9x	0.77	x	1.3	x	94.68	x	0.85	x	0.7	=	50.75	(80)
West	0.9x	0.77	x	1.72	x	73.59	x	0.63	x	0.7	=	38.68	(80)
West	0.9x	0.77	x	1.46	x	73.59	x	0.85	x	0.7	=	44.3	(80)
West	0.9x	0.77	x	1.3	x	73.59	x	0.85	x	0.7	=	39.45	(80)
West	0.9x	0.77	x	1.72	x	45.59	x	0.63	x	0.7	=	23.96	(80)
West	0.9x	0.77	x	1.46	x	45.59	x	0.85	x	0.7	=	27.45	(80)
West	0.9x	0.77	x	1.3	x	45.59	x	0.85	x	0.7	=	24.44	(80)
West	0.9x	0.77	x	1.72	x	24.49	x	0.63	x	0.7	=	12.87	(80)
West	0.9x	0.77	x	1.46	x	24.49	x	0.85	x	0.7	=	14.74	(80)
West	0.9x	0.77	x	1.3	x	24.49	x	0.85	x	0.7	=	13.13	(80)
West	0.9x	0.77	x	1.72	x	16.15	x	0.63	x	0.7	=	8.49	(80)
West	0.9x	0.77	x	1.46	x	16.15	x	0.85	x	0.7	=	9.72	(80)
West	0.9x	0.77	x	1.3	x	16.15	x	0.85	x	0.7	=	8.66	(80)
Northwest	0.9x	0.77	x	5.76	x	11.28	x	0.63	x	0.7	=	19.86	(81)
Northwest	0.9x	0.77	x	1.31	x	11.28	x	0.63	x	0.7	=	4.52	(81)
Northwest	0.9x	0.77	x	5.76	x	22.97	x	0.63	x	0.7	=	40.43	(81)
Northwest	0.9x	0.77	x	1.31	x	22.97	x	0.63	x	0.7	=	9.19	(81)
Northwest	0.9x	0.77	x	5.76	x	41.38	x	0.63	x	0.7	=	72.84	(81)
Northwest	0.9x	0.77	x	1.31	x	41.38	x	0.63	x	0.7	=	16.57	(81)
Northwest	0.9x	0.77	x	5.76	x	67.96	x	0.63	x	0.7	=	119.62	(81)
Northwest	0.9x	0.77	x	1.31	x	67.96	x	0.63	x	0.7	=	27.21	(81)
Northwest	0.9x	0.77	x	5.76	x	91.35	x	0.63	x	0.7	=	160.8	(81)
Northwest	0.9x	0.77	x	1.31	x	91.35	x	0.63	x	0.7	=	36.57	(81)
Northwest	0.9x	0.77	x	5.76	x	97.38	x	0.63	x	0.7	=	171.43	(81)
Northwest	0.9x	0.77	x	1.31	x	97.38	x	0.63	x	0.7	=	38.99	(81)
Northwest	0.9x	0.77	x	5.76	x	91.1	x	0.63	x	0.7	=	160.37	(81)
Northwest	0.9x	0.77	x	1.31	x	91.1	x	0.63	x	0.7	=	36.47	(81)
Northwest	0.9x	0.77	x	5.76	x	72.63	x	0.63	x	0.7	=	127.85	(81)
Northwest	0.9x	0.77	x	1.31	x	72.63	x	0.63	x	0.7	=	29.08	(81)
Northwest	0.9x	0.77	x	5.76	x	50.42	x	0.63	x	0.7	=	88.76	(81)
Northwest	0.9x	0.77	x	1.31	x	50.42	x	0.63	x	0.7	=	20.19	(81)
Northwest	0.9x	0.77	x	5.76	x	28.07	x	0.63	x	0.7	=	49.41	(81)
Northwest	0.9x	0.77	x	1.31	x	28.07	x	0.63	x	0.7	=	11.24	(81)
Northwest	0.9x	0.77	x	5.76	x	14.2	x	0.63	x	0.7	=	24.99	(81)

DER WorkSheet: New dwelling design stage

Northwest 0.9x	0.77	x	1.31	x	14.2	x	0.63	x	0.7	=	5.68	(81)
Northwest 0.9x	0.77	x	5.76	x	9.21	x	0.63	x	0.7	=	16.22	(81)
Northwest 0.9x	0.77	x	1.31	x	9.21	x	0.63	x	0.7	=	3.69	(81)
Rooflights 0.9x	1	x	23.6	x	26	x	0.63	x	0.7	=	243.54	(82)
Rooflights 0.9x	1	x	4.52	x	26	x	0.63	x	0.7	=	139.93	(82)
Rooflights 0.9x	1	x	23.6	x	54	x	0.63	x	0.7	=	505.81	(82)
Rooflights 0.9x	1	x	4.52	x	54	x	0.63	x	0.7	=	290.63	(82)
Rooflights 0.9x	1	x	23.6	x	96	x	0.63	x	0.7	=	899.22	(82)
Rooflights 0.9x	1	x	4.52	x	96	x	0.63	x	0.7	=	516.67	(82)
Rooflights 0.9x	1	x	23.6	x	150	x	0.63	x	0.7	=	1405.03	(82)
Rooflights 0.9x	1	x	4.52	x	150	x	0.63	x	0.7	=	807.29	(82)
Rooflights 0.9x	1	x	23.6	x	192	x	0.63	x	0.7	=	1798.43	(82)
Rooflights 0.9x	1	x	4.52	x	192	x	0.63	x	0.7	=	1033.34	(82)
Rooflights 0.9x	1	x	23.6	x	200	x	0.63	x	0.7	=	1873.37	(82)
Rooflights 0.9x	1	x	4.52	x	200	x	0.63	x	0.7	=	1076.39	(82)
Rooflights 0.9x	1	x	23.6	x	189	x	0.63	x	0.7	=	1770.33	(82)
Rooflights 0.9x	1	x	4.52	x	189	x	0.63	x	0.7	=	1017.19	(82)
Rooflights 0.9x	1	x	23.6	x	157	x	0.63	x	0.7	=	1470.59	(82)
Rooflights 0.9x	1	x	4.52	x	157	x	0.63	x	0.7	=	844.97	(82)
Rooflights 0.9x	1	x	23.6	x	115	x	0.63	x	0.7	=	1077.19	(82)
Rooflights 0.9x	1	x	4.52	x	115	x	0.63	x	0.7	=	618.93	(82)
Rooflights 0.9x	1	x	23.6	x	66	x	0.63	x	0.7	=	618.21	(82)
Rooflights 0.9x	1	x	4.52	x	66	x	0.63	x	0.7	=	355.21	(82)
Rooflights 0.9x	1	x	23.6	x	33	x	0.63	x	0.7	=	309.11	(82)
Rooflights 0.9x	1	x	4.52	x	33	x	0.63	x	0.7	=	177.6	(82)
Rooflights 0.9x	1	x	23.6	x	21	x	0.63	x	0.7	=	196.7	(82)
Rooflights 0.9x	1	x	4.52	x	21	x	0.63	x	0.7	=	113.02	(82)

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

(83)m=	1244.12	2314.26	3626.59	5170.06	6339.87	6517.19	6191.75	5297.01	4164	2687.41	1527.1	1040.06	(83)

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

(84)m=	2211.19	3277.26	4554.86	6041.6	7150.54	7273.15	6915	6029.21	4928.04	3508.44	2412.96	1977.66	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	0.99	0.97	0.91	0.82	0.7	0.77	0.93	0.99	1	1	(86)

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

(87)m=	18.05	18.31	18.79	19.46	20.09	20.58	20.82	20.75	20.3	19.48	18.66	18.04	(87)

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

(88)m=	18.96	18.96	18.97	19	19	19.03	19.03	19.03	19.02	19	18.99	18.98	(88)

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

(89)m=	1	1	0.98	0.95	0.86	0.69	0.46	0.55	0.85	0.98	1	1	(89)

DER WorkSheet: New dwelling design stage

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

(90)m=	15.22	15.6	16.3	17.28	18.16	18.77	18.98	18.95	18.47	17.33	16.13	15.21	(90)

fLA = Living area ÷ (4) = 0.12 (91)

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

(92)m=	15.55	15.93	16.6	17.54	18.39	18.99	19.2	19.16	18.69	17.58	16.43	15.54	(92)

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

(93)m=	15.4	15.78	16.45	17.39	18.24	18.84	19.05	19.01	18.54	17.43	16.28	15.39	(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=	1	0.99	0.97	0.93	0.83	0.67	0.47	0.55	0.83	0.96	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	2203.98	3246.2	4433.81	5600.77	5945.57	4856.48	3216.82	3286.28	4067.76	3385.01	2396.99	1973.03	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	16564.45	16156.73	14721.35	12325.02	9450.7	6024.44	3477.09	3702.78	6350.99	9877.11	13371.61	16429.12	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	10684.19	8675.87	7653.93	4841.46	2607.82	0	0	0	0	4830.12	7901.73	10755.33	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 57950.45 (98)

Space heating requirement in kWh/m²/year 101.48 (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 93.3 (206)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)													
	10684.19	8675.87	7653.93	4841.46	2607.82	0	0	0	0	4830.12	7901.73	10755.33	
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)													(211)
	11451.44	9298.9	8203.57	5189.13	2795.09	0	0	0	0	5176.98	8469.16	11527.68	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 62111.95 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] + (214) m } 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)

	263.39	232.44	244.79	220.38	216.65	194.56	187.78	204.77	204.01	228.47	240.41	257.37

Efficiency of water heater 79.6 (216)

DER WorkSheet: New dwelling design stage

(217)m=	90.01	89.98	89.93	89.77	89.38	79.6	79.6	79.6	79.6	89.76	89.94	90.02

(217)

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

(219)m=	292.63	258.31	272.22	245.48	242.39	244.42	235.91	257.25	256.29	254.55	267.29	285.91

Total = Sum(219a)$_{1...12}$ = 3112.66 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		62111.95	
Water heating fuel used		3112.66	
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		1284.6	(232)

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

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x		0.216	=	13416.18	(261)
Space heating (secondary)	(215) x		0.519	=	0	(263)
Water heating	(219) x		0.216	=	672.33	(264)
Space and water heating	(261) + (262) + (263) + (264) =				14088.52	(265)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	38.93	(267)
Electricity for lighting	(232) x		0.519	=	666.71	(268)
Total CO2, kg/year		sum of (265)…(271) =			14794.15	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =			25.91	(273)
EI rating (section 14)					68	(274)