



**Reading Borough Council
Wensley Road: New Build
& Estate Improvements
Phase 2**

Energy Statement

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Author **VKO**

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View from Lesford Road

1. Executive summary

HTA Design LLP has been appointed by Reading Borough Council (RBC) to prepare an Energy and Sustainability Statement to support the submission of the planning application for the refurbishment of the Phase 2 Coley Rise development.

The assessment has been undertaken based on the existing site and accommodation layout information provided by HTA Design LLP.

A detailed appraisal has been conducted to review the most appropriate solution to maximise the energy efficiency of the units.

A fabric first approach has been adopted with the intention of minimising the energy demand before relying on mechanical systems.

Fabric specifications in line with the specifications of Phase 1 have been investigated and proposed. The Phase 1 development consists of 46 new dwellings (28 houses and 18 flats) which have been designed to be zero carbon. The development will be a flagship in terms of sustainability. The proposed strategies in Phase 2 intend to adopt a similar approach to reduce carbon emissions to the lowest levels possible, reduce energy demand and tackle fuel poverty.

The scheme is expected to improve energy efficiency by 24% through fabric measures alone.

Tenants will see an ongoing impact as a result of these improvements with reduced annual heating demand and energy bills.

The following table summarises the carbon and energy savings potential of different options compared to the current configuration. The results demonstrate that Option 4 would reduce energy demand more than the other options.

The specifications of Option 4 are aligned with the specifications of Phase 1 and confirm that adopting a fabric first approach would have a beneficial effect on both energy and carbon reductions.

In addition, a highly performing Mechanical Ventilation and Heat recovery system and full reprovision of lighting fittings with low energy appliances has been provided. These further improvements provide a carbon reduction of 30.7% above current Building Regulations. The reprovision of the heating and hot water system is not part of the current proposal.

Table 1: Results of fabric improvement options

	Average Carbon Emissions (kgCO ₂ /m ²)	Savings (%)	Average Fabric Energy Efficiency (kWh/m ² /year)	Savings (%)
BASELINE	77.40	-	119.61	-
OPTION 1 Improved windows and doors	73.82	4.63%	111.39	6.87%
OPTION 2 Improved windows, doors and walls	69.84	9.77%	101.10	15.48%
OPTION 3 Improved windows, doors, walls and roofs	68.22	11.86%	99.55	16.77%
OPTION 4 Improved windows, doors, walls and roofs. Improved air permeability	58.60	24.29%	85.27	28.71%

Table 2: Carbon and energy savings

	Average Carbon Emissions (kgCO ₂ /m ²)	Savings (%)	Average Fabric Energy Efficiency (kWh/m ² /year)	Savings (%)
Coley Rise	53.64	30.70%	84.62	29.25%

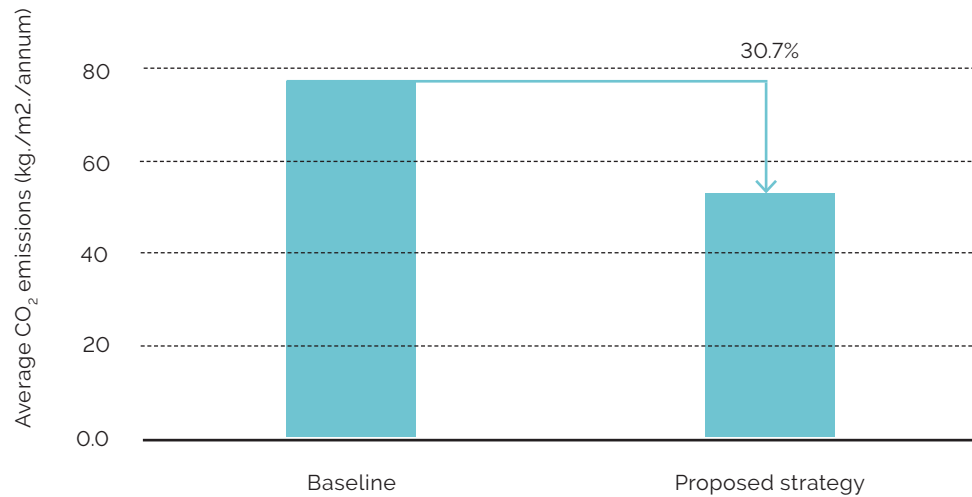


Figure 1 -Aerial view of the site, which includes Phase 1

2. Background and site location

Coley Rise Refurbishment project is the second phase of the Wensley Road regeneration. Phase 1 received planning approval in August 2020 for the construction of 46 new dwellings. It includes a masterplan for the whole site to serve both the new dwellings and the existing 267 flats within the three blocks.

The project

The proposed development area being submitted for planning approval consists of three sites, 193 Wensley Court, 203 Irving Court and 205 Riversley Court.

Location

The site is located to the south west of Reading Town centre, with the ward of Minister. The site is easily accessible from Reading Town Centre and Reading Central Railway Station via public transport, with the number 11 bronze bus directly serving the site. The town centre can be reached on foot within 30-40 minutes and Reading West Train Station can also be reached within a 30-minute walk.

The A33 to the east of site the provides direct vehicular connection to the city centre to the north and the M4 to the south. Within the immediate vicinity of the site are a number of amenities including Coley Park Community Centre, Royal Berkshire Independent Hospital, as well as a number of local shops and schools.

A number of recreation and green spaces are in close proximity to the site. These include Coley Park located 5-10 minutes' walk to the east of the site and Courage Park, which can be accessed via a pedestrian footpath, just to the north-west of the site. Coley Park allotments are situated only 200-300m east of the site, off Lesford Road and to the south are footpaths to Holy Brook, connecting to the wider Fobney meadow nature reserve.



Figure 2 - Local context



Figure 3 - Site context



Figure 4 - Existing aerial photo from the South

The energy assessment has been conducted following the following stages:

- Assessment of the predicted energy performance of the current configuration. The analysis has been conducted using Part L 1 approved software. Both the regulated energy and carbon emissions have been calculated.
- Assessment of different fabric specifications aimed at improving the energy efficiency of the dwellings. Four options have been tested with Option 1 representing the less performing scenario and Option 4 representing the best one.
- Assessment of the predicted energy performance of the proposed configuration. The analysis has been conducted using Part L1 approved software and improving upon Option 4 of the preliminary appraisal. Both the regulated energy and carbon emissions have been calculated.

Minimum Energy Efficiency Standards (MEES)

The refurbishment works will be required to meet the requirements of Part L1B. The document does not set any specific carbon reduction target and the requirement is to meet the minimum energy efficiency standards.

These minimum requirements came into force on 1 April 2018 and apply to England and Wales. They are aimed at encouraging landlords and property owners to improve the energy efficiency of their properties by a restriction on the granting and continuation of existing tenancies where the property has an energy Performance Certificate rating of F and G.

The strategies proposed at Coley Rise intend to exceed the minimum standards to the highest degree possible. The specifications are aligned with the specifications used for the Phase 1 buildings, which are designed to be zero carbon.

The proposed improvements include:

- Improvement of the fabric specifications of the external walls
- Improvement of the fabric specifications of the roofs
- Provision of triple glazing
- Provision of a Mechanical Ventilation with Heat recovery system
- Provision of low energy lighting fittings

The proposal does not include:

- Changes to the heating system
- Changes to the hot water system

The proposed refurbishment work aims at improving the energy performance, with the aspiration of exceeding the minimum requirements as much as possible.

Carbon Emission Factors

In 2018 the BRE released an update to the Standard Assessment Procedure (SAP) for consultation. The updates include a revision of the carbon emission factors to reflect the decarbonisation of the grid and other national infrastructure change.

The current Building Regulations Part L still refer to the previous carbon factors. The new Part L is expected to be released in October 2021 to come into effect in April 2022. The changes to the carbon factors influence the specification of the proposed heating and hot water systems.

The proposal intends to improve the fabric specifications to the greatest degree while keeping the current HVAC systems. The changes to the carbon factors mainly attain to the specifications of the systems, i.e. whether they use gas or electricity. Since there is no change to the systems, the application of carbon factors is not relevant for this assessment.

The proposed changes to Part L do, however, include an improvement in the minimum specifications of the fabric elements. The proposed improvements exceed both the current and future minimum standards detailed in the Part L documents. Detailed information on the specification of the elements applied at Coley Rise are summarised in Table 7.

3. Responding to the environmental targets

The UK aims to achieve an 80% reduction in greenhouse gas emissions by 2050 (against a 1990 baseline) in order to meet the world's first legally binding climate change target established in the 2008 Climate Change Act.

Buildings in the UK account for over 40% of all energy use and CO₂ emissions. Therefore, there is an increasing need for building regulations to become more demanding in terms of energy performance targets.

Sustainability has been placed at the heart of National, Regional and Local Policy setting performance targets for best practice in design, construction and operation.

This section outlines the relevant policies that are used to inform and guide the sustainable design at Coley Rise.

National policies

National Planning Policy Framework (NPPF) (February 2019)

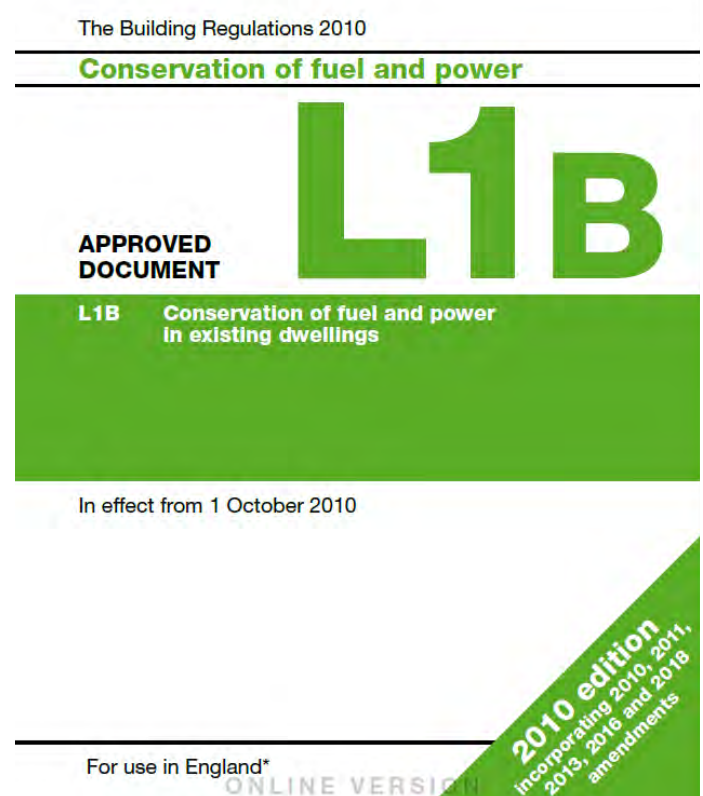
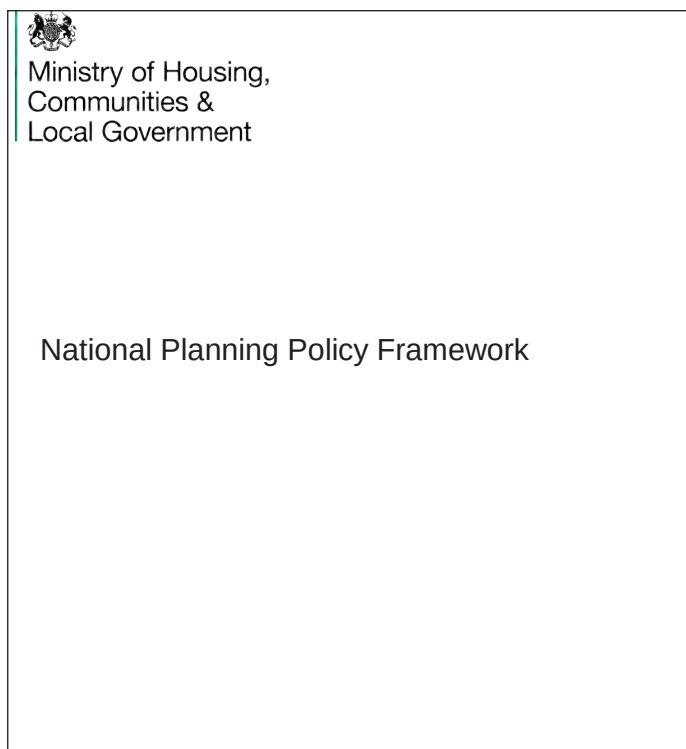
The National Planning Policy Framework states that 'achieving sustainable development means that the planning system has three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways (so that opportunities can be taken to secure net gains across each of the different objectives):

a) an **economic** objective - to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure;

b) a **social** objective - to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering a well-designed and safe built environment, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and

c) an **environmental** objective - to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.

The NPPF goes on to state that 'Plans and decisions should apply a presumption in favour of sustainable development'.



Part L1B 2013 of the Building Regulations

The Part L1B document provide guidance on the conservation of fuel and power for existing dwellings.

Guidance provided includes insulation regulations, boiler productivity, lighting and storage techniques for hot water. Further information covered includes fixed standards for solar emissions, heating and ventilation systems, space heating controls and air conditioning systems, amongst other fuel and power systems.

SAP 12 and SAP 10

The current Government's Standard Assessment Procedure for Energy Rating of dwelling is version 12. A new version (SAP 10.0) was released in July 2018. SAP 10.1 was published in October 2020 to coincide with the publication of the UK Government's Future Homes Standard consultation, which discusses proposed changes to Building Regulations Approved Documents, making reference to SAP. The BRE anticipates that there will be a further update to SAP (to version 10.2) following this consultation, prior to its official use.

SAP 2012 must continue to be used for Building Regulation compliance and for producing Energy Performance Certificates until further notice, in conjunction with the 2006 edition of BR443.

Local policies

Reading Borough Council Local Plan, November 2019

The Local Plan has been carefully developed to address some of the key issues facing Reading. In particular, this Council declared a Climate Emergency in 2019, and set out its commitment to work towards achieving a carbon neutral Reading by 2030.

The Local Plan contains sustainability policies that put it at the cutting edge of authorities across the country. The Local Plan plays a major part in putting Reading in the top 5% of local authorities in Britain for cutting carbon emissions.

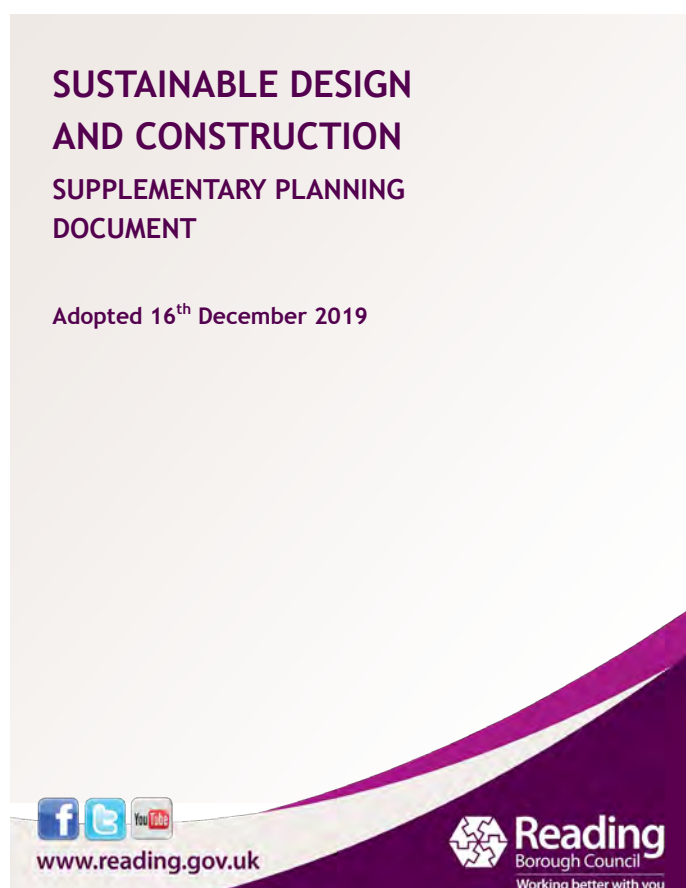
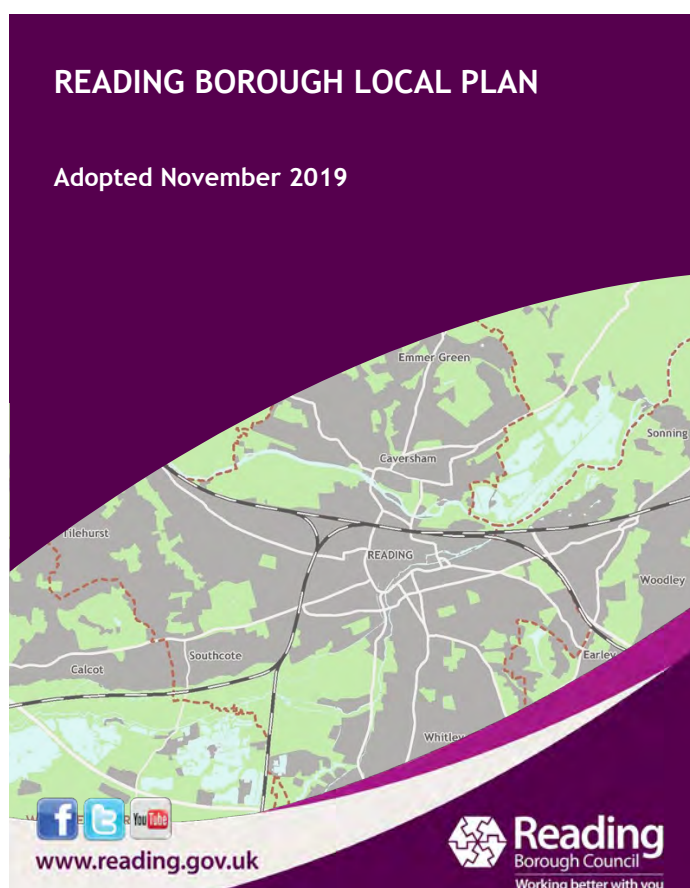
Policy CC2: sustainable Design and Construction states that:

Proposals for new development, including the construction of new buildings and the redevelopment and refurbishment of existing building stock, will be acceptable where the design of buildings and site layouts use energy, water, minerals, materials and other natural resources appropriately, efficiently and with care and take account of the effects of climate change

Supplementary Planning Document (SPD) - Revised Sustainable Design and Construction, December 2019

This Supplementary Planning Document (SPD) therefore explains planning requirements with regard to energy, climate change, water management and waste reduction. It is intended to supplement the policies of the Local Plan, particularly:

CC2: Sustainable Design and Construction
CC3: Adaptation to Climate Change
CC4: Decentralised Energy
CC5: Waste Minimisation and Storage
EN18: Flooding and Drainage
H5: Housing Standards



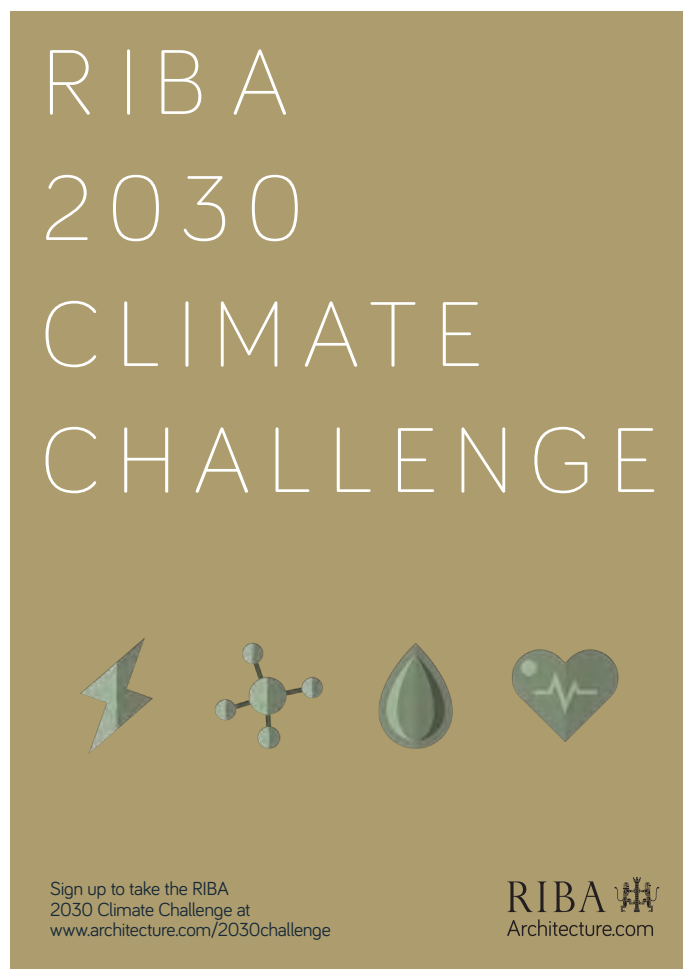
Guides

RIBA 2030 Climate Challenge

Reading Borough Council intends to reduce carbon emissions as much as possible to tackle Climate Change. The RIBA Climate Challenge, to which HTA is committed, sets targets for 2020, 2025 and 2030 for energy use, embodied carbon, and water. Other metrics include daylight, overheating and other factors related to the health and wellbeing of people. These metrics have to be factored in to design proposals as they emerge in order to be effective. It should be noted that RIBA 2030 it is neither a mandatory standard nor a document developed for refurbishment projects. With reference to the LETI guidance the project has begun with the RIBA 2030 targets. Recognising this may not be possible with a refurbishment project they have been adopted to guide and motivate to reach as close to its measures as possible. Measures include materials specification and services strategy but also justifications on why choices have been made to ensure the high quality design solutions that are being developed are carried through to use.

To achieve the embodied carbon targets requires use of systems/products with a high recyclable/recycled content; the decision to retain as much of the existing fabric of the blocks as possible is already a step in the right direction.

Everyone involved was encouraged to give thought to possible solutions to the sustainability challenges throughout the programme.



RIBA 2030 Climate Challenge target metrics for domestic buildings

RIBA Sustainable Outcome Metrics	Current Benchmarks	2020 Targets	2025 Targets	2030 Targets	Notes
Operational Energy kWh/m ² /y 	146 kWh/m ² /y (Ofgem benchmark)	< 105 kWh/m ² /y	< 70 kWh/m ² /y	< 0 to 35 kWh/m ² /y	UKGBC Net Zero Framework 1. Fabric First 2. Efficient services, and low-carbon heat 3. Maximise onsite renewables 4. Minimum offsetting using UK schemes (CCC)
Embodied Carbon kgCO ₂ e/m ² 	1000 kgCO ₂ e/m ² (M4i benchmark)	< 600 kgCO ₂ e/m ²	< 450 kgCO ₂ e/m ²	< 300 kgCO ₂ e/m ²	RICS Whole Life Carbon (A-C) 1. Whole Life Carbon Analysis 2. Using circular economy Strategies 3. Minimum offsetting using UK schemes (CCC)
Potable Water Use Litres/person/day 	125 l/p/day (Building Regulations England and Wales)	< 110 l/p/day	< 95 l/p/day	< 75 l/p/day	CIBSE Guide G

Guides

LETI Design Guidance Net Zero Housing

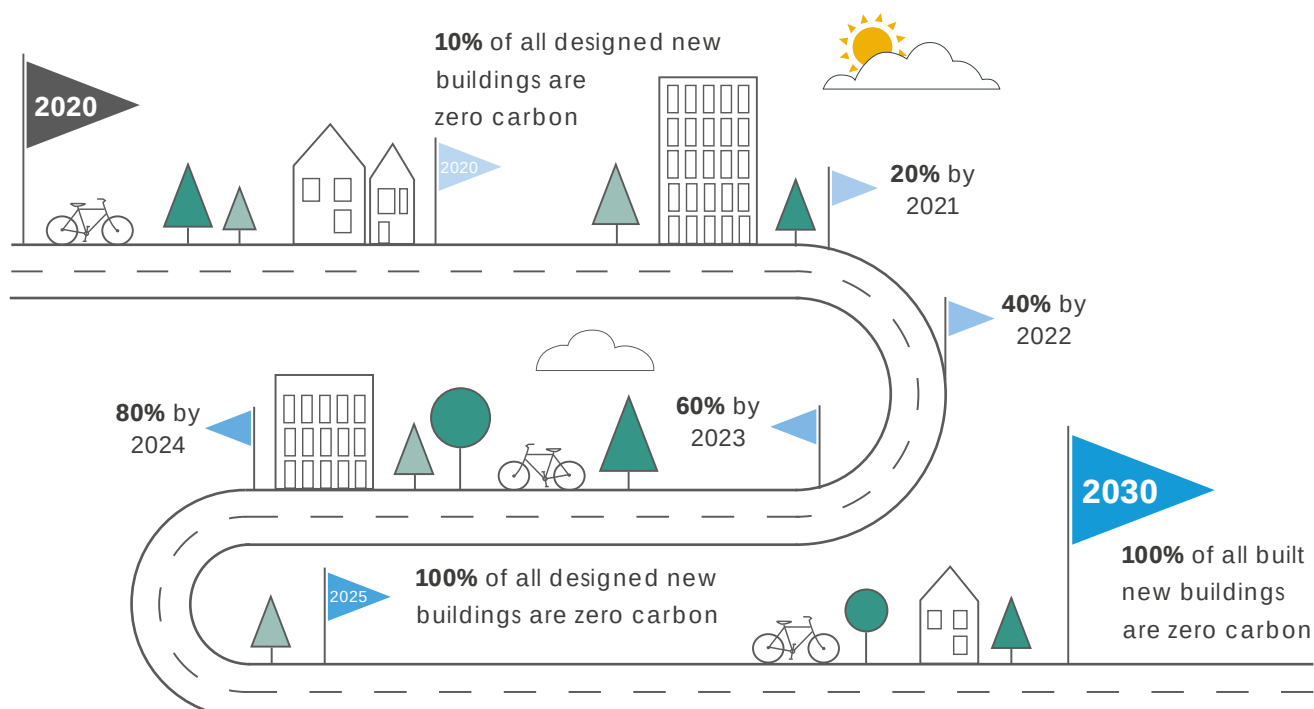
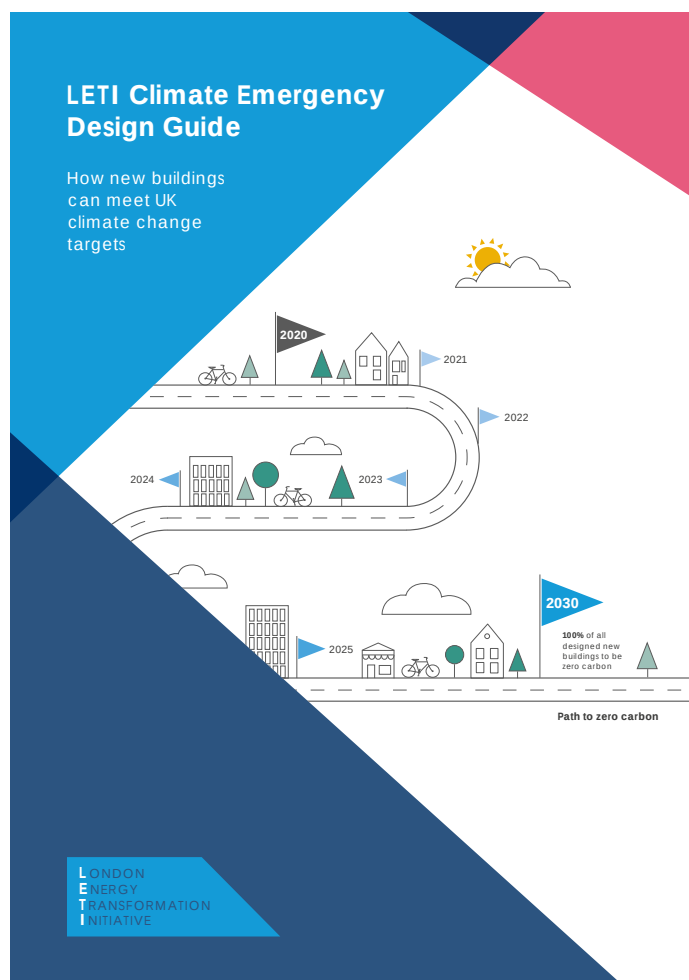
The Committee on Climate Change (CCC) report 'UK housing - fit for the future?' highlights that we need to build buildings with 'ultra-low' levels of energy use. The report makes specific reference to space heating demand and recommends a maximum of 15-20 kWh/m²/yr for new homes.

The transition to low-carbon and zero-carbon housing needs to consider the impact on heating costs for residents.

The LETI guide focuses on new buildings only. However, many of the principles described in the report apply to refurbishment works, as well.

Targets suggested in the guide cannot be achieved without the specification of a new heating system. However, the passive strategies described in the report should be suggested and applied where possible.

The energy strategy described in this report focuses on the operational energy. This is the energy consumed by a building during its lifetime. It accounts for the energy consumed by the heating and hot water systems, ventilation and lighting systems. The operational energy also includes the energy consumed by equipment such as fridges, washing machines, TVs, computers, lifts and cooking. This is called 'unregulated energy' as it is not accounted for in the SAP calculations.



4. Energy Statement

Reading Borough Council is committed to significantly improving the energy efficiency of all the existing housing stock throughout the borough, by considering the most appropriate solutions for each of the sites.

As the replacement of the external insulation and windows is required on the existing blocks, this provides an ideal opportunity for adopting a fabric first approach to improving the thermal performance of the buildings and as result reducing energy demand.

A series of comparison studies were prepared by HTA Sustainability to consider the combined effect of different improvements in terms of the external wall insulation and window specification.

These ranged from the minimum requirement under approved document L1B (2018) of the building regulations to U-values equivalent to EnerPHit standard (Retrofit equivalent for PassivHaus), with variations to demonstrate the impact of improved air tightness.

In line with the PassivHaus principles adopted for new build homes within Phase 1 and with the intention of maximising potential energy saving for residents, U-values of walls, roofs and windows have been improved to the greatest extent. In addition, a low air permeability rate of $3\text{m}^3/\text{hm}^2$ @ 50 Pa and new mechanical ventilation system have been specified.

Energy and sustainability principles

According to Part L building Regulations, there are no specific targets that need to be met other than the ones related to the minimum energy performance standards. The proposed works at Coley Rise intend to exceed the minimum requirements and adopt a fabric-first approach. The measures proposed are in line with the one detailed for buildings in Phase 1 which are designed to be zero carbon following PassivHaus principles.

In addition, the proposal aims at improving the quality of the area and adopts the following sustainable principles:

- Fabric first approach to the building envelope, aspiring to achieve EnerPHit standards for thermal performance.
- Supporting active travel through increased provision of safe, secure and easily accessible cycle storage, combined with improved connections to the green travel network provided as part of Phase 1 works.

- Encouraging and supporting residents to improve recycling habits by providing new user-friendly refuse, recycling and food waste facilities.
- Providing enhanced external landscape with increased biodiversity value, creating a key link with existing rich natural habitats in the surrounding area.
- Make effective use of resources by re-using materials on-site where possible, reducing waste and specifying materials with low embodied carbon, minimising waste and reducing material transportation.
- Holistic approach to improving the environment for existing residents leading to a positive impact on mental health and personal wellbeing

The energy calculations have been conducted comparing the predicted energy performance of the dwelling with the current configuration.

Baseline modelling

The baseline model has been created to measure the carbon and energy reductions from the proposed improvements.

The specifications used for the baseline model are detailed in Table 3.

Improving the fabric first

Before looking at mechanical systems, an initial appraisal was conducted to assess the energy and carbon improvement from different fabric specifications.

Four options were assessed against the baseline condition. Table 4 summarises the fabric specifications of each scenario while Table 5 summarises the results of the analysis. A graphic representation of the results is also provided.

The results demonstrate that the regulated carbon emissions of Option 4 are approximately 24% below that of the baseline configuration. This reduction is achieved through fabric improvement measures alone.

It should be noted that the specifications adopted in Option 4 are in line with the specifications of the new dwellings at Phase 1 with the exception of the air permeability value.

Table 3: Baseline specifications - Existing building

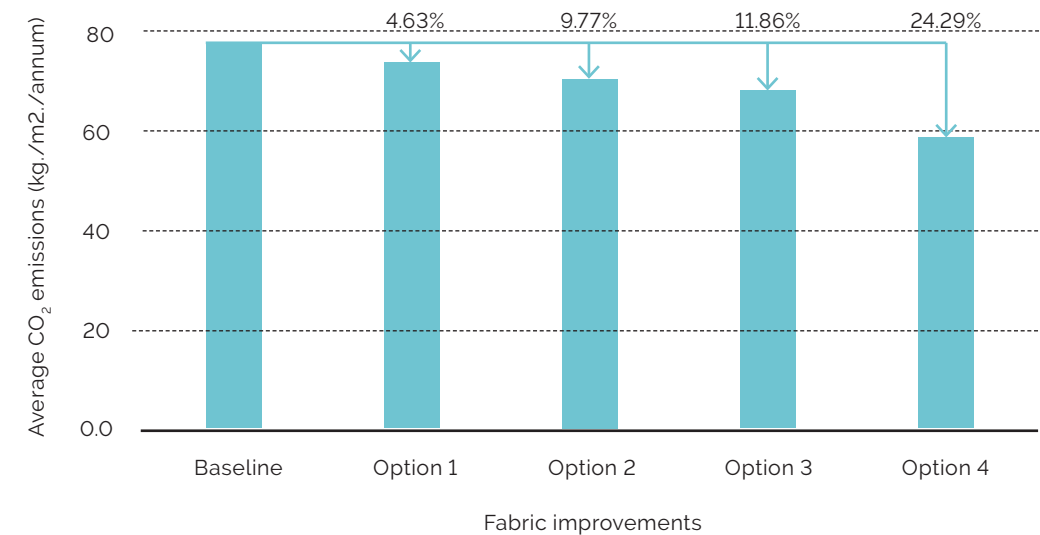
	Description	Value	Notes/Evidence
External Fabric	External Wall U-value (W/m ² K)	0.55 W/m ² K	Appendix S, SAP 12 Document & 40mm of polystyrene insulation
	Ground Floor U-value	1.20 W/m ² K	Appendix S, SAP 12 Document
	Roof U-value	0.68 W/m ² K	Appendix S, SAP 12 Document & 50mm of insulation
	Glazing U-value and g-value	U: 2.80 W/m ² K, g: 0.76	Appendix S, SAP 12 Document
Internal Fabric	Sheltered Walls	1.10 W/m ² K	Appendix S, SAP 12 Document, calculation carried out
	Door	1.40 W/m ² K	Appendix S, SAP 12 Document
Thermal bridging	Default values		As per Table 6
Air permeability	15 m ³ /h·m ² at 50 Pa		Default value assumed
Mechanical ventilation	Extract fan: Nuaire - Model: Faith (minimum whole dwelling ventilation rate: 13L/s for 1 bed, 17L/s for 2 bed, 21L/s for 3 bed)		As per actual survey
Artificial lighting	75% Low Energy Lighting fittings		As per actual survey
Space heating: Three & Two bed units	<u>Living room:</u> Creda Model No. 79153 / Combination Storage Heater 2.5kW <u>Main bedroom:</u> Creda Model No. 79141 / Automatic Storage Heater 1.7kW <u>Other bedrooms:</u> Creda Model No. 85304 / 15kW Panel Heater <u>Kitchen and bathroom:</u> Dimplex Model No. FX20V Downflow Fan Heater		As per actual survey
Space heating: Studio units	<u>Bedroom:</u> Creda Model No. 79153 / Combination Storage Heater 2.5kW <u>Kitchen and bathroom:</u> Dimplex Model No. FX20V downflow fan heater		As per actual survey
Water heating All units	Gledhill Stainless ES D170		As per actual survey
Comfort cooling	None		As per actual survey
Renewables	None		As per actual survey

Table 4: Summary of fabric improvement options

	Specifications that change from Baseline
OPTION 1	Triple glazed windows: U-value: 0.71, g value: 0.37 Doors U value: 1.00 W/m²K
OPTION 2	Same as Option 1 + External Wall U-value 0.15 W/m²K
OPTION 3	Same as Option 2 + Roof U-value 0.15 W/m²K
OPTION 4	Same as Option 3 + air permeability: 3 m³/h·m² at 50 Pa

Table 5: Results of fabric improvement options

	Average Carbon Emissions (kgCO ₂ /m²)	Savings (%)	Average Fabric Energy Efficiency (kWh/m²/year)	Savings (%)
BASELINE	77.40		119.61	
OPTION 1	73.82	4.63%	111.39	6.87%
OPTION 2	69.84	9.77%	101.10	15.48%
OPTION 3	68.22	11.86%	99.55	16.77%
OPTION 4	58.60	24.29%	85.27	28.71%



Proposed strategies at Coley Rise

The results from the comparative exercise demonstrate that in order to reduce the energy demand through passive strategies only, the specifications highlighted in Option 4 should be used.

In summary, the following specifications are applied:

Windows: triple glazing, U-value: 0.71 W/m²K, g-value: 0.37, vt: 0.65

Doors: U-value: 1.0 W/m²K

External walls: U-value: 0.15 W/m²K

Roofs: U-value: 0.15 W/m²K

Air permeability: 3 m³/h·m² at 50 Pa

In addition to the above measures, a highly efficient mechanical system is proposed. Mechanical ventilation alone would provide additional ventilation. However, a more efficient system would recover the excess heat from the environment to reduce energy demand. A Mechanical Ventilation with Heat recovery system is proposed within the dwellings.

All light fittings will be low energy.

With these additional measures in place, the scheme achieves an improvement of 30.7% on current Building Regulations.

It is expected that the performance at the linear junctions will also improve. At the time of the assessment no detailed information is available to define the psi-value associated with junctions as they will be developed at detailed design. It is expected that the performance of the junctions will improve and that additional savings will be found in terms of energy efficiency.

Overall, the proposed strategies will significantly reduce the energy demand from the current conditions. The units can further improve their energy efficiency with a highly efficient fully electric system, such as a Air-Source Heat Pump, which combined with the upcoming changes to the regulations, would make the dwelling exceed the current and future standards for energy and carbon emissions.

Tables 3 and 7 show the specifications applied to the current and the proposed configurations.

Table 6: Summary of final improved option

FINAL IMPROVED OPTION	Same as Option 4 + MVHR installed + 100% Low Energy Lighting Fittings (details in Table 4)
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Figure 5: Riversley Court Entrance

Table 7: Specifications of refurbished building - Final improved option

	Description	Value	Notes/Evidence
External Fabric	External Wall U-value (W/m ² K) - Ground floor	0.15 W/m ² K	Detailed U-value calculation has been carried out
	External Wall U-value (W/m ² K) - Upper floors	0.15 W/m ² K	Detailed U-value calculation has been carried out
	Ground Floor U-value	1.20 W/m ² K	As per existing
	Roof U-value	0.15 W/m ² K	U-value calculation
	Glazing U-value and g-value	U: 0.71. W/m ² K, g: 0.37, frame factor: 72.9%	Nordan NTech Passive model
Internal Fabric	Sheltered Walls	1.10 W/m ² K	As per existing
	Door	1.00 W/m ² K	
Thermal bridging	Default values		Any improvements will be examined during Stage 3 - Results of structural and opening-up surveys will provide more information
Air permeability	3 m ³ /h.m ² at 50 Pa		Estimated based on the improved fabric
Mechanical ventilation	Mechanical ventilation with heat recovery, Vent Axia Sentinel Kinetic FH, sfp:0.53 for 1 wet room		Same model selected as per Phase 1
Artificial lighting	100% Low Energy Lighting fittings		
Space heating: Three & Two bed units	<u>Living room:</u> Creda Model No. 79153 / Combination Storage Heater 2.5kW <u>Main bedroom:</u> Creda Model No. 79141 / Automatic Storage Heater 1.7kW <u>Other bedrooms:</u> Creda Model No. 85304 / 15kW Panel Heater <u>Kitchen and bathroom:</u> Dimplex Model No. FX20V Downflow Fan Heater		As per existing
Space heating: Studio units	<u>Bedroom:</u> Creda Model No. 79153 / Combination Storage Heater 2.5kW <u>Kitchen and bathroom:</u> Dimplex Model No. FX20V downflow fan heater		As per existing
Water heating	Gledhill Stainless ES D170		As per existing
Comfort cooling	None		As per existing
Renewables	None		As per existing

Table 8: Thermal bridging values

SAP Ref	Bridge type	Source Type	SAP Default Psi (W/mK)
E2	Other lintels (including steel lintels)	Table K1 - Default	1.000
E3	Sill	Table K1 - Default	0.080
E4	Jamb	Table K1 - Default	0.100
E5	Ground floor (normal)	Table K1 - Default	0.320
E7	Party floor between dwellings (in blocks of flats)	Table K1 - Default	0.140
E15	Flat roof with parapet	Table K1 - Default	0.560
E16	Corner (normal)	Table K1 - Default	0.180
E17	Corner (inverted - internal area greater than external area)	Table K1 - Default	0.000
E18	Party wall between dwellings	Table K1 - Default	0.120
E25	Staggered party wall between dwellings	Table K1 - Default	0.120
P1	Party wall - Ground floor	Table K1 - Default	0.160
P3	Party wall - Intermediate floor between dwellings (in blocks of flats)	Table K1 - Default	0.000
P4	Party wall - Roof (insulation at ceiling level)	Table K1 - Default	0.240

Table 9: Results of final improved option

	Average Carbon Emissions (kgCO ₂ /m ²)	Savings (%)	Average Fabric Energy Efficiency (kWh/m ² /year)	Savings (%)
FINAL IMPROVED OPTION	53.64	30.70%	84.62	29.25%

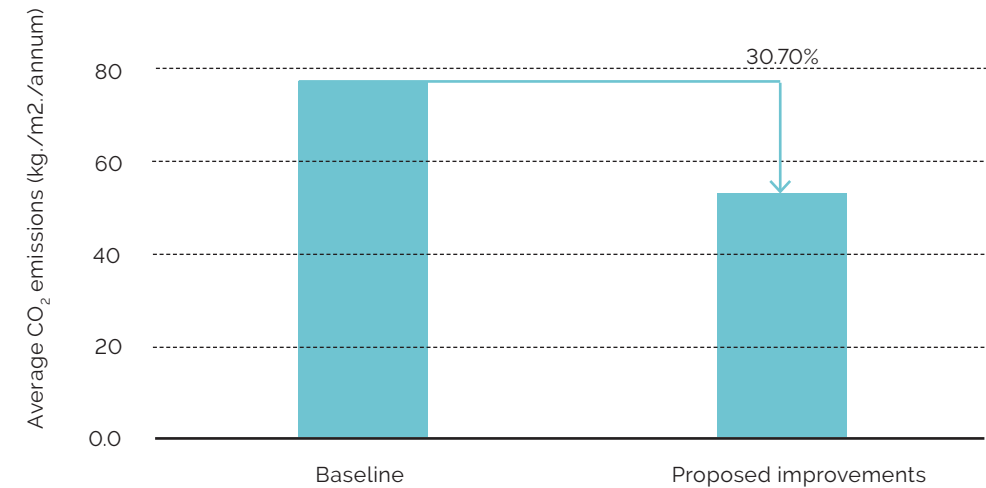


Figure 6: Proposed Development Regulated Carbon Dioxide Emissions

Appendix A - Fabric specifications of existing building

S2 Age bands

A set of age bands is defined according to Table S1 for the purposes of assigning U-values and other data.

Table S1 : Age bands

Age band	Years of construction			
	England & Wales	Scotland	Northern Ireland	Park home (UK)
A	before 1900	before 1919	before 1919	-
B	1900-1929	1919-1929	1919-1929	-
C	1930-1949	1930-1949	1930-1949	-
D	1950-1966	1950-1964	1950-1973	-
E	1967-1975	1965-1975	1974-1977	-
F	1976-1982	1976-1983	1978-1985	before 1983
G	1983-1990	1984-1991	1986-1991	1983-1995
H	1991-1995	1992-1998	1992-1999	(not applicable)
I	1996-2002	1999-2002	2000-2006	1996-2005
J	2003-2006	2003-2007	(not applicable)	(not applicable)
K	2007-2011	2008-2011	2007-2013	2006 onwards
L	2012 onwards	2012 onwards	2014 onwards	(not applicable)

From the 1960s, constructional changes have been caused primarily by amendments to building regulations for the conservation of fuel and power, which have called for increasing levels of thermal insulation. The dates in Table S1 are generally one year after a change in regulations, to allow for completion of dwellings approved under the previous regulations.

For a conversion which was a change of use (e.g. barn converted to dwelling) or where a dwelling has been sub-divided (e.g. house to flats) use the original construction date, unless there is documentary evidence that all thermal elements have been upgraded to the building regulation standards applicable at the conversion date. Enter insulation levels only for those elements for which evidence is available.

Age band L can apply to extensions added to an older property.

Table S6 : Wall U-values – England and Wales

Age band	A	B	C	D	E	F	G	H	I	J	K	L
Wall type												
Stone: granite or whinstone as built	a	a	a	a	1.7 b	1.0	0.60	0.60	0.45	0.35	0.30	0.28
Stone: sandstone or limestone as built	a	a	a	a	1.7 b	1.0	0.60	0.60	0.45	0.35	0.30	0.28
Solid brick as built	2.1	2.1	2.1	2.1	1.7	1.0	0.60	0.60	0.45	0.35	0.30	0.28
Stone/solid brick with 50 mm external or internal insulation	0.60	0.60	0.60	0.60	0.55	0.45*	0.35*	0.35*	0.30*	0.25*	0.21*	0.21*
Stone/solid brick with 100 mm external or internal insulation	0.35	0.35	0.35	0.35	0.35	0.32*	0.24*	0.24*	0.21*	0.19*	0.17*	0.16*
Stone/solid brick with 150 mm external or internal insulation	0.25	0.25	0.25	0.25	0.25	0.21*	0.18*	0.18*	0.17*	0.15*	0.14*	0.14*
Stone/solid brick with 200 mm external or internal insulation	0.18	0.18	0.18	0.18	0.18	0.17*	0.15*	0.15*	0.14*	0.13*	0.12*	0.12*
Cob (as built)	0.80	0.80	0.80	0.80	0.80	0.80	0.60	0.60	0.45	0.35	0.30	0.28
Cob with 50 mm external or internal insulation	0.40	0.40	0.40	0.40	0.40	0.40	0.35*	0.35*	0.30*	0.25*	0.21*	0.21*
Cob with 100 mm external or internal insulation	0.26	0.26	0.26	0.26	0.26	0.26	0.24*	0.24*	0.21*	0.19*	0.17*	0.16*
Cob with 150 mm external or internal insulation	0.20	0.20	0.20	0.20	0.20	0.20	0.18*	0.18*	0.17*	0.15*	0.14*	0.14*
Cob with 200 mm external or internal insulation	0.16	0.16	0.16	0.16	0.16	0.16	0.15*	0.15*	0.14*	0.13*	0.12*	0.12*
Cavity as built	2.1	1.6	1.6	1.6	1.6	1.0	0.60	0.60	0.45	0.35	0.30	0.28
Unfilled cavity with 50 mm external or internal insulation	0.60	0.53	0.53	0.53	0.53	0.45	0.35*	0.35*	0.30*	0.25*	0.21*	0.21*
Unfilled cavity with 100 mm external or internal insulation	0.35	0.32	0.32	0.32	0.32	0.30	0.24*	0.24*	0.21*	0.19*	0.17*	0.16*
Unfilled cavity with 150 mm external or internal insulation	0.25	0.23	0.23	0.23	0.23	0.21	0.18*	0.18*	0.17*	0.15*	0.14*	0.14*
Unfilled cavity with 200 mm external or internal insulation	0.18	0.18	0.18	0.18	0.18	0.17*	0.15*	0.15*	0.14*	0.13*	0.12*	0.12*
Filled cavity	0.50	0.50	0.50	0.50	0.50	0.40	0.35	0.35	0.45 [†]	0.35 [†]	0.30 [†]	0.28 [†]
Filled cavity with 50 mm external or internal insulation	0.31	0.31	0.31	0.31	0.31	0.27	0.25*	0.25*	0.25*	0.25*	0.21*	0.21*
Filled cavity with 100 mm external or internal insulation	0.22	0.22	0.22	0.22	0.22	0.20	0.19*	0.19*	0.19*	0.19*	0.17*	0.16*
Filled cavity with 150 mm external or internal insulation	0.17	0.17	0.17	0.17	0.17	0.16	0.15*	0.15*	0.15*	0.15*	0.14*	0.14*
Filled cavity with 200 mm external or internal insulation	0.14	0.14	0.14	0.14	0.14	0.13	0.13*	0.13*	0.13*	0.13*	0.12*	0.12*
Timber frame as built	2.5	1.9	1.9	1.0	0.80	0.45	0.40	0.40	0.40	0.35	0.30	0.28
Timber frame with internal insulation	0.60	0.55	0.55	0.40	0.40	0.40	0.40 [†]	0.40 [†]	0.40 [†]	0.35 [†]	0.30 [†]	0.28 [†]
System build as built	2.0	2.0	2.0	2.0	1.7	1.0	0.60	0.60	0.45	0.35	0.30	0.28
System build with 50 mm external or internal insulation	0.60	0.60	0.60	0.60	0.55	0.45	0.35*	0.35*	0.30*	0.25*	0.21*	0.21*
System build with 100 mm external or internal insulation	0.35	0.35	0.35	0.35	0.35	0.32*	0.24*	0.24*	0.21*	0.19*	0.17*	0.16*
System build with 150 mm external or internal insulation	0.25	0.25	0.25	0.25	0.25	0.21*	0.18*	0.18*	0.17*	0.15*	0.14*	0.14*
System build with 200 mm external or internal insulation	0.18	0.18	0.18	0.18	0.18	0.17*	0.15*	0.15*	0.14*	0.13*	0.12*	0.12*

a See equations in S5.1.1

b Or from equations in S5.1.1 if that is less.

* wall may have had internal or external insulation when originally built; this applies only if insulation is known to have been increased subsequently (otherwise 'as built' applies)

[†] assumed as built

If a wall is known to have additional insulation but the insulation thickness is unknown, use the row in the table for 50 mm insulation

Table S12 : Exposed/Semi-exposed floor U-values

Age band	U-value (W/m ² K)			
	Insulation unknown or as built	Insulated 50 mm	Insulated 100 mm	Insulated 150 mm
A to G	1.20	0.50 ⁽¹⁾	0.30	0.22
H or I	0.51	0.50 ⁽¹⁾	0.30	0.22
J	0.25	0.25	0.25	0.22
K	0.22	0.22	0.22	0.22
L	0.22 ⁽²⁾	0.22 ⁽²⁾	0.22 ⁽²⁾	0.22 ⁽²⁾
⁽¹⁾ Use these values if known to be insulated but insulation thickness not known				
⁽²⁾ 0.18 W/m ² K in Scotland				

Table S10 : Assumed roof U-values when Table S9 does not apply

Age band	Assumed Roof U-value (W/m ² K) ^(a)						
	Pitched, slates or tiles, insulation between joists or unknown	Pitched, slates or tiles, insulation at rafters	Flat roof ^(b)	Room-in-roof, slates or tiles	Thatched roof ^(c)	Thatched roof, room-in-roof	Park home
A, B, C, D	2.3 (none)	2.3 ⁽¹⁾	2.3 ⁽¹⁾	2.3 ⁽¹⁾	0.35	0.25	-
E	1.5 (12 mm)	1.5 ⁽¹⁾	1.5 ⁽¹⁾	1.5 ⁽¹⁾	0.35	0.25	-
F	0.68 (50 mm)	0.68 ⁽¹⁾	0.68 ⁽¹⁾	0.80 ⁽¹⁾	0.35	0.25	1.7
G	0.40 (100 mm)	0.40 ⁽¹⁾	0.40 ⁽¹⁾	0.50 ⁽¹⁾	0.35	0.25	0.6
H	0.30 (150 mm)	0.35 ⁽¹⁾	0.35 ⁽¹⁾	0.35 ⁽¹⁾	0.35	0.25	-
I	0.26 (150 mm)	0.35 ⁽¹⁾	0.35 ⁽¹⁾	0.35 ⁽¹⁾	0.35	0.25	0.35
J	0.16 (270 mm)	0.20	0.25	0.30	0.30	0.25	-
K	0.16 (270 mm)	0.20	0.25 ⁽²⁾	0.25 ⁽²⁾	0.25 ⁽²⁾	0.25 ⁽²⁾	0.30
L	0.16 ⁽³⁾ (270 mm)	0.18	0.18	0.18	0.18	0.18	-
^(a) If the roof insulation is "none" use U = 2.3 (all roof types). ^(b) Applies also to roof with sloping ceiling ^(c) If there is also retro-fitted insulation between the rafters reduce the U-value to 1/(1/U _{table} + R _{ins}) where R _{ins} is 0.7 m ² K/W for 50 mm, 1.4 m ² K/W for 100 mm and 2.1 m ² K/W for 150 mm. If retro-fit insulation present of unknown thickness use 50 mm. ⁽¹⁾ The value from the table applies for unknown and as built. If the roof is known to have more insulation than would normally be expected for the age band, either observed or on the basis of documentary evidence, use the lower of the value in the table and: 50 mm insulation: 0.68 100 mm insulation: 0.40 150 mm or more insulation: 0.30 ⁽²⁾ 0.20 W/m ² K in Scotland ⁽³⁾ 0.15 W/m ² K in Scotland							

Note: These U-values take account of joists. They may differ from Elemental U-values in regulations applicable at the time of construction, where the Elemental U-values in regulations (up to age band H) were set on the basis of ignoring joists in U-value calculations.

Table S14 : Window characteristics

Glazing	Installed	Glazing gap	U-value (window)	U-value** (roof window)	g-value
Single	any	-	4.8	5.1	0.85
Double glazed unit*	England & Wales: before 2002, Scotland: before 2003 N. Ireland: before 2006	6 mm in PVC frame, or any in non-PVC frame	3.1	3.3	
		12 mm in PVC frame	2.8	3.0	0.76
		16 mm or more in PVC frame	2.6	2.8	
Double glazed unit	England & Wales: 2002 or later, Scotland: 2003 or later N. Ireland: 2006 or later	any	2.0	2.2	0.72
Secondary glazing	any	any	2.4	2.6	0.76
Triple glazing	any	any	1.8	2.0	0.68
Double or triple, known data	any	any	As provided in RdSAP data set		

* Use this row for conservatories and for other double glazing whose installation date is unknown.

** Roof pitch 45° (unless horizontal). Applies only where all windows are measured individually (otherwise all glazing is assigned to windows).

Frame factor is 0.7 for all window types (not applied if data source is BFRG)

Frame type is wood for single glazing and secondary glazing, PVC for other types

U-values are adjusted for curtains (section 3.2 of the SAP specification).

S5.2 U-values of sheltered walls

For sheltered walls of flats and maisonettes (between the dwelling and an unheated corridor or stairwell), the U-value for the applicable wall area is adjusted as described in Section 3.3 using $R_u = 0.4 \text{ m}^2\text{K/W}$.

3.3 U-values of elements adjacent to an unheated space

The procedure for treatment of U-values of elements adjacent to unheated space is described in BS EN ISO 6946 and BS EN ISO 13789.

The following procedure may be used for typical structures (no measurements are needed of the construction providing an unheated space, just select the appropriate R_u from Tables 3.1 to 3.3 below).

$$U = \frac{1}{\frac{1}{U_0} + R_u} \quad (4)$$

where: U = resultant U-value of element adjacent to unheated space, $\text{W/m}^2\text{K}$;
 U_0 = U-value of the element between heated and unheated spaces calculated as if there were no unheated space adjacent to the element, $\text{W/m}^2\text{K}$;
 R_u = effective thermal resistance of unheated space from the appropriate table below.

S8.3 Door U-values

The RdSAP data set contains the total number of external doors and the number of those doors that are insulated. The U-value of insulated doors is part of the data set; the U-value of other external doors is taken from Table 15A.

Table S15A : Doors

Door opens to	Age band	Door U-value
Outside	A to J	3.0
	K	2.0
	L	E&W and N.I: 1.8 Scotland: 1.6
Unheated corridor or stairwell	any	1.4
Heated corridor or stairwell		(omitted from data collection)

Appendix B - Details of the current systems and specifications

A vertical advertisement for the Gledhill Stainless ES unvented cylinder. The background is dark blue with a diagonal split. On the left, the Gledhill logo is at the top, followed by the product name 'STAINLESS ES' in large white letters. Below it, the text 'THE NEW UNVENTED CYLINDER RANGE FROM GLEDHILL' is in smaller white letters. Further down, a large circular graphic contains the number '25' and the word 'YEAR', with '25 YEAR WARRANTY' written below it. At the bottom left, the slogan 'ONE NAME. EVERY SOLUTION.' is in red. On the right, a tall, silver, cylindrical water heater is shown. It has a black top and bottom. A label near the top says 'G STAINLESS ES'. Another label further down says 'G GLEDHILL'. There are several ports and valves on the cylinder, including a red and yellow gas valve at the top right and a white pressure relief valve near the bottom.

G GLEDHILL

STAINLESS ES

THE NEW UNVENTED CYLINDER
RANGE FROM GLEDHILL

25
YEAR

**25 YEAR
WARRANTY**

ONE NAME. EVERY SOLUTION.

G STAINLESS ES

G GLEDHILL

WWW.GLEDHILL.NET

STAINLESS ES

DIRECT AND INDIRECT

90 | 120 | 150 | 170 | 200 | 250 | 300 LITRES



KEY FEATURES

- Gledhill proven technologies and quality manufacturing at a competitive price
- Manufactured from highly corrosion-resistant duplex stainless steel
- Delivers mains pressure hot water, enabling high flow rates for showers and baths, without the need for a boost pump
- 40mm insulation to reduce heat loss
- Supplied with full NSF WRC and WRAS independent approvals



25 YEAR
WARRANTY

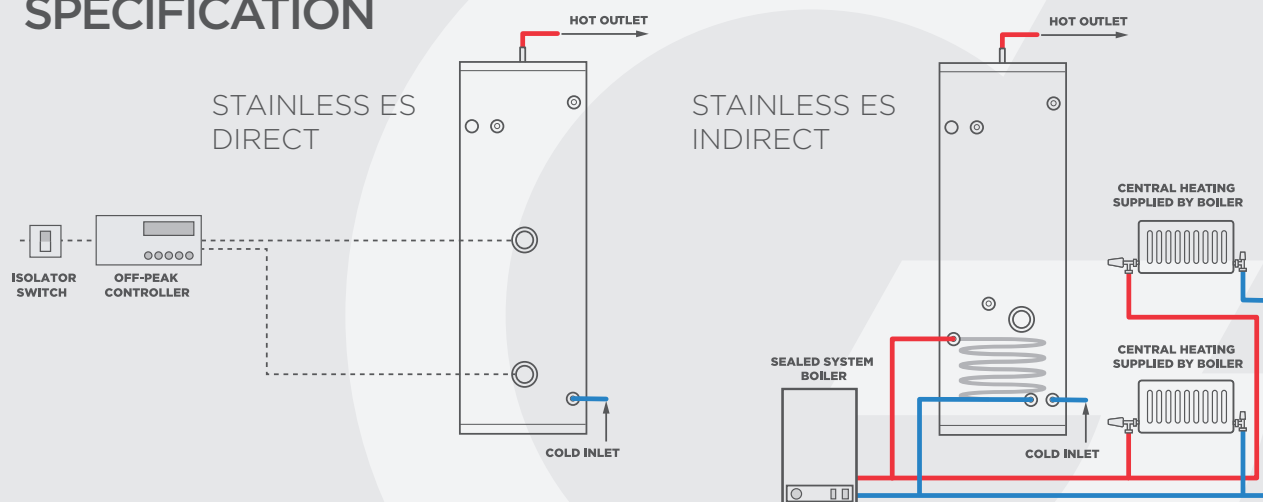


GAS OR OIL
BOILERS



IMMERSION
HEATER

TECHNICAL SPECIFICATION



STAINLESS ES DIRECT

Description		D90	D120	D150	D170	D200	D250
Product stock code		SESINPDR090	SESINPDR120	SESINPDR150	SESINPDR170	SESINPDR200	SESINPDR250
ErP rating		C	C	C	C	C	C
Heat loss	watts	36	43	52	57	65	79
Capacity	litres	93	118	149	169	198	248
Height	mm	658	832	1012	1131	1305	1603
Overall diameter	mm	530	530	530	530	530	530
Weight (empty)	kg	15	19	22	24	27	33
Weight (full)	kg	108	137	171	193	225	281
Pressure regulator	bar	3	3	3	3	3	3
Expansion vessel size	litres	12	12	18	18	24	24
kW rating of primary coil	kW	n/a	n/a	n/a	n/a	n/a	n/a

STAINLESS ES INDIRECT

Description		IND90	IND120	IND150	IND170	IND200	IND250	IND300
Product stock code		SESINPIN090	SESINPIN120	SESINPIN150	SESINPIN170	SESINPIN200	SESINPIN250	SESINPIN300
ErP rating		B	B	B	B	C	C	C
Heat loss	watts	36	43	52	57	65	79	92
Capacity	litres	93	118	149	169	198	248	295
Height	mm	658	832	1012	1131	1305	1603	1895
Overall diameter	mm	530	530	530	530	530	530	530
Weight (empty)	kg	17	20	23	26	29	35	41
Weight (full)	kg	110	138	172	195	227	283	336
Pressure regulator	bar	3	3	3	3	3	3	3
Expansion vessel size	litres	12	12	18	18	24	24	35
kW rating of primary coil	kW	13.4	14.6	14.0	16.2	16.0	16.7	18.3

NOTES:

- 1 Heat up time from 15°C to 60°C (applies to primary heat source only)
- 2 For further ErP information, please refer to the installation manual at www.gledhill.net
- 3 The schematics shown above are representational, please refer to the installation manual for full technical requirements

**PermaRock Products Ltd**

Jubilee Drive
Loughborough
Leicestershire, LE11 5TW
T: 01509 262924 F: 01509 230063
permarock@permarock.com

Project Information

Reference 61/1336
Date 21 September 2020
Client Ruth Heyes HTA
78 Chamber Street
London
E1 8BL
Tel: 020 7485 8555
Email: Ruth.Heyes@hta.co.uk

Project Wensley Court, Irvine Court & Riversley Court
Coley Park
Reading

Construction Type

Element : Wall - 300mm NFC + PermaRock 250 mm Mineral Fibre EWI U=0.15

No-fines Concrete + External Wall Insulation

Internal surface emissivity : High External surface emissivity : High

	Thickness (mm)	Thermal Conductivity (W/mK)	Thermal Resistance (m ² K/W)	Pitch (°)	Bridge details Air gaps (Level, Delta U")
Outside surface resistance	-	-	0.040		
PermaRock K-Finish (1.5mm SiliconeULTRA)	1.5	1.000	0.002		
PermaRock K and R Primer	0.1	1.000	0.000		L:0 0.000W/m ² K
PermaRock Bedding Mortar and Reinforcement	5.0	1.000	0.005		
PermaRock Mineral Fibre Insulation (DD)	250.0	0.036	6.944		L:0 0.000W/m ² K
PermaRock Adhesive zone (40%)	5.0	-	0.100		40.005% Mortar (5.0mm)
Render, cement-sand	15.0	1.000	0.015		
No-Fines Concrete (CIBSE Guide A Table 3.38)	300.0	0.960	0.313		L:0 0.000W/m ² K
Gypsum plastering (1000 kg/m ³)	13.0	0.400	0.032		
Inside surface resistance	-	-	0.130		

Total thickness 589.6mm

U-value = 0.15W/m²K

U-value, Combined Method : 0.151W/m²K (upper/lower limit 7.543 / 7.493m²K/W, dUf 0.0180, dUg 0.0000, dUp0.0000, dUr0.0000, dUrc1 0.0000, dUrc2 0.0000)

Correction factors

Mechanical fasteners :-

Point thermal transmittance : 0.0020W/K nf : 9.000 per m²

PPxxPM/WKT-S - Plastic Screw-in Insulation Anchor - (ABCDE)

Delta Uf for PermaRock Mineral Fibre Insulation (DD) : 0.0180

nf = fasteners per m² Af = fasteners cross-sectional area

Air gaps, Delta Ug = 0.000W/m²K

(Based on the combined method for determining U-values of structures containing repeating thermal bridges)

	Thickness (mm)	Thermal Conductivity (W/mK)	Thermal Resistance (m ² K/W)	Vapour Resistivity (MNs/gm)	Vapour Resistance (MNs/g)
Outside surface resistance	-	-	0.040	-	-
PermaRock K-Finish (1.5mm SiliconeULTRA)	1.5	1.000	0.002	746.67	1.12
PermaRock K and R Primer	0.1	1.000	0.000	750.00	0.15
PermaRock Bedding Mortar and Reinforcement	5.0	1.000	0.005	224.00	1.12
PermaRock Mineral Fibre Insulation (DD)	250.0	0.036	6.944	5.90	1.48
PermaRock Adhesive zone (40%)	5.0	-	0.100	-	0.00
Render, cement-sand	15.0	1.000	0.015	50.00	0.75
No-Fines Concrete (CIBSE Guide A Table 3.38)	300.0	0.960	0.313	20.00	6.00
Gypsum plastering (1000 kg/m ³)	13.0	0.400	0.032	50.00	0.65
Inside surface resistance	-	-	0.130	-	-
Total thickness	589.6mm				

Detailed U-value Calculation Results

Construction includes 1 bridged layer

Non-bridged layers

Outside surface resistance	0.040 m²K/W
PermaRock K-Finish (1.5mm SiliconeULTRA)	0.002 m²K/W
PermaRock K and R Primer	0.000 m²K/W
PermaRock Bedding Mortar and Reinforcement	0.005 m²K/W
PermaRock Mineral Fibre Insulation (DD)	6.944 m²K/W
Render, cement-sand	0.015 m²K/W
No-Fines Concrete (CIBSE Guide A Table 3.38)	0.313 m²K/W
Gypsum plastering (1000 kg/m³)	0.032 m²K/W
Inside surface resistance	0.130 m²K/W
<u>Resistance of non-bridged layers, R_{NB} =</u>	<u>7.482 m²K/W</u>

Bridged layer

PermaRock Adhesive zone (40%) (L1) bridged by Mortar (B1)

Path 1 - PermaRock

Path 2 - Mortar

Resistance and fraction of heat flow paths

$$R_{P1} = R_{NB} + R_{L1} = 7.482 + 0.100 = 7.582 \text{ m}^2\text{K/W} \quad F_{P1} = 59.995\%$$

$$R_{P2} = R_{NB} + R_{L2} = 7.482 + 0.005 = 7.487 \text{ m}^2\text{K/W} \quad F_{P2} = 40.005\%$$

Upper resistance limit

$$R_{upper} = 1 / ((F_{P1}/R_{P1}) + (F_{P2}/R_{P2}))$$

$$R_{upper} = 1 / ((0.600/7.582) + (0.400/7.487)) = 7.543 \text{ m}^2\text{K/W}$$

Lower resistance limit

$$R_{lower} = R_{NB} + 1 / ((F_{L1}/R_{L1}) + (F_{B1}/R_{B1}))$$

$$R_{lower} = 7.482 + 1 / ((0.600/0.100) + (0.400/0.005)) = 7.493 \text{ m}^2\text{K/W}$$

Total resistance of wall

$$R_T = (R_{upper} + R_{lower}) / 2 = (7.543 + 7.493) / 2 = 7.52 \text{ m}^2\text{K/W}$$

Mechanical fasteners :-

Calculations to BS EN ISO 6946:2007

Point thermal transmittance : 0.0020W/K nf : 9.000 per m²

PPxPM/WKT-S - Plastic Screw-in Insulation Anchor - (ABCDE)

Delta Uf for PermaRock Mineral Fibre Insulation (DD) : 0.0180

Correction for air gaps, Delta Ug = 0.0000W/m²K

$$U = (1 / R_T) + (\Delta U_f + \Delta U_g + \Delta U_p + \Delta U_{rc2} + \Delta U_{rc2}) = (1/7.5183) + 0.0180 + 0.0000 + 0.0000 + 0.0000 + 0.0000 = 0.15 \text{ W/m}^2\text{K}$$

Structure element : Wall
 Description : No-fines Concrete + External Wall Insulation
 Condensation calculations performed in accordance with BS5250:2011

Condensation is occurring at the following layers interfaces:-

Interface 1: PermaRock Bedding Mortar and Reinforcement/PermaRock Mineral Fibre Insulation (DD)

Month	Int (C°)	Int (%RH)	Ext (C°)	Ext (%RH)	Interface 1 Gc (Kg/m²)	Ma (Kg/m²)
Jan	20.00	58.20	3.40	86.00	0.04497	0.08755
Feb	20.00	57.20	3.50	83.00	0.00813	0.09568
Mar	20.00	57.30	5.40	80.50	-0.07042	0.02526
Apr	20.00	57.80	7.70	77.50	-0.17621	0.00000
May	20.00	61.00	10.90	77.00	0.00000	0.00000
Jun	20.00	65.70	14.00	76.50	0.00000	0.00000
Jul	20.00	69.80	16.00	76.50	0.00000	0.00000
Aug	20.00	70.70	15.70	78.50	0.00000	0.00000
Sep	20.00	67.80	13.50	81.00	0.00000	0.00000
Oct	20.00	64.20	10.40	84.00	0.00000	0.00000
Nov	20.00	59.80	6.30	85.00	0.00000	0.00000
Dec	20.00	59.20	4.30	87.50	0.04258	0.04258

Gc = Monthly moisture accumulation per area at an interface

Ma = Accumulated moisture content per area at an interface

Peak accumulated moisture content per area at interface (Ma) = 0.09568 Kg/m²

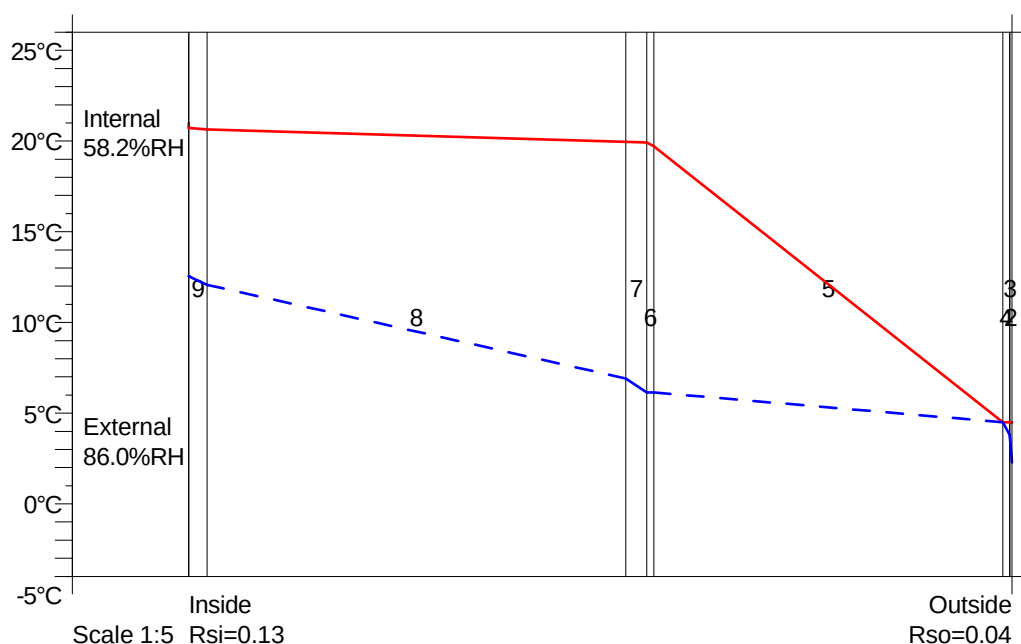
Annual moisture accumulation = 0.00000 Kg/m²

Condensation Risk Analysis (no account taken of thermal bridges)**3 - Dwellings with low occupancy**

Jan (worst)	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.0C 58.2%	20.0C 57.2%	20.0C 57.3%	20.0C 57.8%	20.0C 61.0%	20.0C 65.7%	20.0C 69.8%	20.0C 70.7%	20.0C 67.8%	20.0C 64.2%	20.0C 59.8%	20.0C 59.2%
3.4C 86.0%	3.5C 83.0%	5.4C 80.5%	7.7C 77.5%	10.9C 77.0%	14.0C 76.5%	16.0C 76.5%	15.7C 78.5%	13.5C 81.0%	10.4C 84.0%	6.3C 85.0%	4.3C 87.5%

	Interface Temp. °C	Dewpoint Temp. °C	Vapour Pressure (kPa)	Saturated V.P. (kPa)	Worst Cond. (g/m²)	Peak Buildup (g/m²)	Condensation
1 Outside surface resistance	3.5	1.3	0.67	0.78			No
2 PermaRock K-Finish (1.5mm SiliconeULTRA)	3.5	2.6	0.74	0.78			No
3 PermaRock K and R Primer	3.5	2.8	0.75	0.78			No
4 PermaRock Bedding Mortar and Reinforcement							
5 PermaRock Mineral Fibre Insulation (DD)	3.5	3.5	0.78	0.78	45 in Jan	96 in Feb	Yes
6 PermaRock Adhesive zone (40%)	18.7	5.1	0.88	2.16			No
7 Render, cement-sand	18.9	5.1	0.88	2.19			No
8 No-Fines Concrete (CIBSE Guide A Table 3.38)	19.0	5.9	0.93	2.19			No
9 Gypsum plastering (1000 kg/m³)	19.6	11.1	1.32	2.29			No
10 Inside surface resistance	19.7	11.6	1.36	2.30			No

Worst case internal / external conditions for graph : 20.0°C @ 58.2%RH / 3.4°C @ 86.0%RH

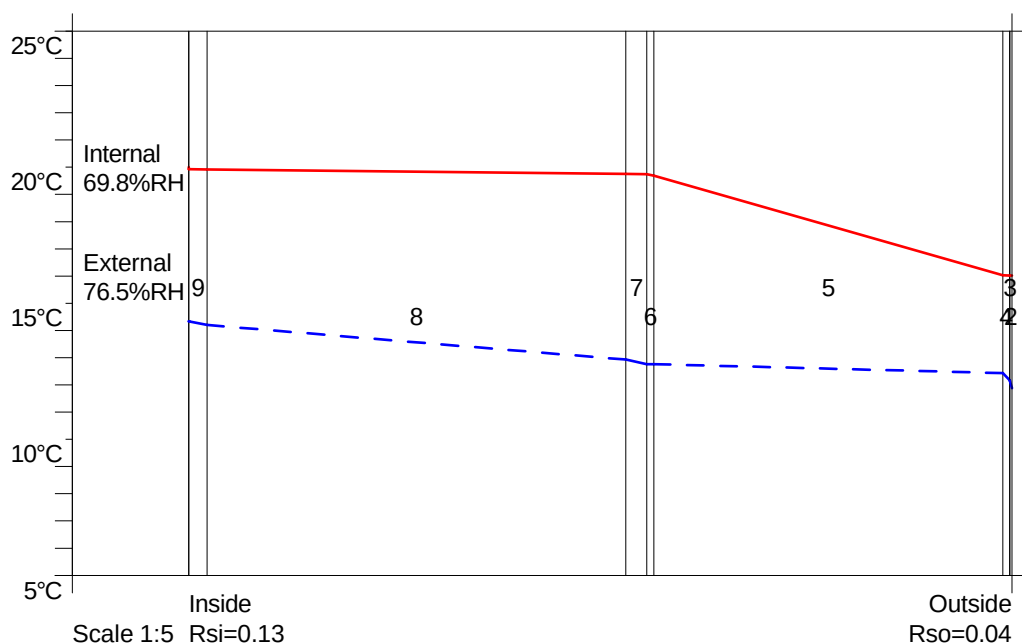


Condensation Risk Analysis (no account taken of thermal bridges)**3 - Dwellings with low occupancy**

Jan (worst)	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.0C 58.2%	20.0C 57.2%	20.0C 57.3%	20.0C 57.8%	20.0C 61.0%	20.0C 65.7%	20.0C 69.8%	20.0C 70.7%	20.0C 67.8%	20.0C 64.2%	20.0C 59.8%	20.0C 59.2%
3.4C 86.0%	3.5C 83.0%	5.4C 80.5%	7.7C 77.5%	10.9C 77.0%	14.0C 76.5%	16.0C 76.5%	15.7C 78.5%	13.5C 81.0%	10.4C 84.0%	6.3C 85.0%	4.3C 87.5%

	Interface Temp. °C	Dewpoint Temp. °C	Vapour Pressure (kPa)	Saturated V.P. (kPa)	Worst Cond. (g/m ²)	Peak Buildup (g/m ²)	Condensation
1 Outside surface resistance	16.0	11.9	1.39	1.82			No
2 PermaRock K-Finish (1.5mm SiliconeULTRA)	16.0	12.1	1.41	1.82			No
3 PermaRock K and R Primer	16.0	12.2	1.42	1.82			No
4 PermaRock Bedding Mortar and Reinforcement	16.0	12.4	1.44	1.82	45 in Jan	96 in Feb	Yes
5 PermaRock Mineral Fibre Insulation (DD)	19.7	12.8	1.47	2.29			No
6 PermaRock Adhesive zone (40%)	19.7	12.8	1.47	2.30			No
7 Render, cement-sand	19.7	12.9	1.49	2.30			No
8 No-Fines Concrete (CIBSE Guide A Table 3.38)	19.9	14.2	1.62	2.32			No
9 Gypsum plastering (1000 kg/m ³)	19.9	14.3	1.63	2.33			No
10 Inside surface resistance							No

Worst case internal / external conditions for graph : 20.0°C @ 69.8%RH / 16.0°C @ 76.5%RH



BuildDesk U 3.4



Documentation of the component

30. November 2020

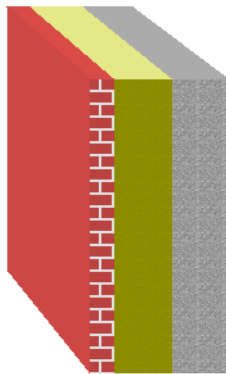
Thermal transmittance (U-value) according to BS EN ISO 6946

Page 1/2

Source: **own catalogue - External walls**Component: **NCDL3665-HTA Architects-External Wall-EWI**

OUTSIDE

INSIDE



Assignment: External wall

	Manufacturer	Name	Thickness [m], number	Lambda [W/(mK)]	Q	R [m²K/W]
☒	Rse	Brick outer leaf & Mortar outer leaf (f = 0.000 / automatic disregarding acc. BRE 4.4.3)	0.1020	0.770	D	0.0400
☒	Generic Building Materials					0.1325
☒	Rockwool Ltd	Cavity -variable thickness	0.0750	0.037	A	2.0270
☒	Fixings	TeploTie Type 1 50-150mm cavity No./m²:	2.5/m²	0.710	C	-
☒	Fixings	equivalent diameter: 6.99959E-03 m / alpha: 0.800				
☒	Air gaps	Level 0: dU" = 0.00 W/(m²K)				
☒	Rockwool Ltd	Cavity -variable thickness	0.1500	0.037	A	4.0541
☒	Fixings	TeploTie Type 1 50-150mm cavity No./m²:	2.5/m²	0.710	C	-
☒	Fixings	equivalent diameter: 6.99959E-03 m / alpha: 0.800				
☒	Air gaps	Level 0: dU" = 0.00 W/(m²K)				
☒	BS EN 12524	Concrete, Reinforced (with 1% of steel)	0.2000	2.300	D	0.0870
☒	BS EN 12524	Gypsum plastering	0.0130	0.570	D	0.0228
	Rsi					0.1300
			0.5400			

$$R_T = R_{si} + \sum R_i + R_{se} = 6.49 \text{ m}^2\text{K/W}$$

Correction to U-value for	according to	delta U [W/(m²K)]
Mechanical fasteners	BS EN ISO 6946 Annex D	~~0.000~~
Air gaps	BS EN ISO 6946 Annex D	~~0.000~~
		0.000

$$U = 1/R_T + \sum \Delta U = 0.15 \text{ W/(m}^2\text{K)}$$

Q .. The physical values of the building materials has been graded by their level of quality. These 5 levels are the following

- A** .. A: Data is entered and validated by the manufacturer or supplier. Data is continuously tested by 3rd party.
- B** .. B: Data is entered and validated by the manufacturer or supplier. Data is certified by 3rd party
- C** .. C: Data is entered and validated by the manufacturer or supplier.
- D** .. D: Information is entered by BuildDesk without special agreement with the manufacturer, supplier or others.
- E** .. E: Information is entered by the user of the BuildDesk software without special agreement with the manufacturer, supplier or others.

$$U_{\max} = \boxed{0.30 \text{ W/(m}^2\text{K)}}$$

$$U = \boxed{0.15 \text{ W/(m}^2\text{K)}} \quad R_T = \boxed{6.49 \text{ m}^2\text{K/W}}$$

Source of U_{max} value: England and Wales Approved Document L1A 2010 Tab 2 Dwellings New

Calculated with BuildDesk 3.4.5

BuildDesk U 3.4



Documentation of the component

30. November 2020

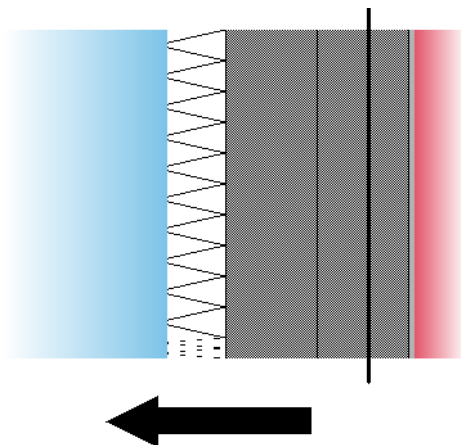
Heat capacity

Page 2/2

Source: **own catalogue - External walls**Component: **NCDL3665-HTA Architects-External Wall-EWI**

OUTSIDE

INSIDE



The list of materials shown below may differ from those in the U-value calculation printout. Only material layers which are used in the heat capacity calculation are listed.

Single material layers shown in the U-value calculation printout may be separated to meet the exclusion criteria:

- A .. The total thickness of the layers exceed 0.1 m.
- B .. The mid point in the construction is reached.

For insulation layers the following criteria applies:

- C .. An insulating layer is reached (defined as $\lambda \leq 0.08 \text{ W/(mK)}$).

Name	Thickness [m]	λ [W/(mK)]	Q	Thermal capacity [kJ/(kgK)]	Q	Density [kg/m³]	Q	Thermal mass kJ/(m²K)	Criteria Exclusion
End of calculation - Cold									
1 Brick outer leaf & Mortar outer leaf (f = 0.000 / automatic disregarding acc. BRE 4.4.3)	0.1020	0.770	D	0.80	D	1700.0	D	~~138.7~~	A, -, C
2 Cavity -variable thickness	0.0750	0.037	A	1.03	C	38.0	C	~~0.0~~	A, -, C
3 Cavity -variable thickness	0.1500	0.037	A	1.03	C	38.0	C	~~0.0~~	A, -, C
4 Concrete, Reinforced (with 1% of steel)	0.1130	2.300	D	1.00	D	2300.0	D	~~259.9~~	A, -, -
4 Concrete, Reinforced (with 1% of steel)	0.0870	2.300	D	1.00	D	2300.0	D	200.1	-, -, -
5 Gypsum plastering	0.0130	0.570	D	1.00	D	1300.0	D	16.9	-, -, -
Start of calculation - Warm									
	0.5400							217.0	

Heat capacity = 217.0 kJ/(m²K)

The following exclusion criteria apply:

- A .. The total thickness of the layers exceed 0.1 m.
- C .. An insulating layer is reached (defined as $\lambda \leq 0.08 \text{ W/(mK)}$).

- Q .. The physical values of the building materials has been graded by their level of quality. These 5 levels are the following
- A .. A: Data is entered and validated by the manufacturer or supplier. Data is continuously tested by 3rd party.
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- C .. C: Data is entered and validated by the manufacturer or supplier.
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- E .. E: Information is entered by the user of the BuildDesk software without special agreement with the manufacturer, supplier or others.

NorDan NTech Passiv Lukkeramme

NTech Passive Sash

Beregning av U-verdier er utført i henhold til NS-EN ISO 10077-1, 10077-2 og programmet "Therm".

Senter U-verdi for glasset er beregnet i henhold til NS-EN 673. Beregningsmetodikken er kvalitetssikret av SINTEF Byggforsk.

Calculation of U-value in accordance to NS-EN ISO 10077-1, 10077-2 and the programme "Therm". Centre U-value of glass is calculated in accordance to NS-EN 673. The calculation methodology is independently quality assured by SINTEF Building and Infrastructure.

Hovedkontor/Head Office: NorDan AS, Stasjonsvei 46, 4460, Moi

Web: www.nordan.no/ www.nordan.co.uk

Report of standard model

Dato/Date: 13.09.2011

Version: S3 10.01

Type: Innadslående lukkeramme/
Inward opening sash

Utførelse/Model: NTech Passive

**Glass oppbygning/
glass configuration:** 4ES+16G+4+16G+ES4
Planitherm one*,
SSP*, Argon 90%

NTech 0,7

Hovedresultater og dimensjoner/ Main results and dimensions

U-verdi / U-value: 0,71 W/m²K

Bredde / Width: 1230 mm

Høyde / Height: 1480 mm

Areal / Area: 1,82 m²

**Glass prosent /
Percent glass:** 72,9 %

U_g 0,53 W/m²K

g-verdi / g-value: 0,37

LT-verdi / LT-value: 0,58



*NorDan reserve the right to change type without notice

 **NorDan**

NorDan NTech Passiv Lukkeramme

NTech Passive Sash

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Hovedkontor/Head Office: NorDan AS, Stasjonsvei 46, 4460, Moi

Web: www.nordan.no/ www.nordan.co.uk

Data for glass



Tegnforklaring for glass / Legend for glass

Farge/ Colour	U _g (W/m ² K)	g-verdi/ g-factor	LT	Navn/ Name
	0,53	0,37	0,58	Planitherm one

Detaljert resultater for glasset / Detailed results for the glass

Farge/ Colour	Vindu areal/ Window area (m ²)	Glass areal/ Glass area (m ²)	*Glass prosent/ Percent glass (%)	UA glass (W/K)	**UA total (%)
	1,820	1,328	72,9	0,704	54,5

*: Tall i forhold til hele vindu / Figure in relation to the whole window

** : Glassets andel av det totale varmetap / The glass's share of the total heat loss



NorDan NTech Passiv Lukkeramme

NTech Passive Sash

Beregning av U-verdier er utført i henhold til NS-EN ISO 10077-1, 10077-2 og programmet "Therm".

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Hovedkontor/Head Office: NorDan AS, Stasjonsvei 46, 4460, Moi

Web: www.nordan.no/ www.nordan.co.uk

Data for ramme og karm elementer/Data for sash and frame elements'



Tegnforklaring for ramme/karm / Legend for sash/frame

Farge/ Colour	Ur/Uf (W/m ² K)	Bredde/Width (m)	Navn/ Name
Yellow	0,90	0,094	Sideprofil/Jamb profile
Green	0,88	0,105	Topprofil/Head profile
Orange	1,12	0,101	Bunnprofil/Sill profile

Detaljert resultater / Detailed results

Farge/ Colour	Ur/Uf (W/m ² K)	Element areal/ Element area (m ²)	*Element prosent/ Percent Element (%)	UrA element/ UfA element (W/K)	**UrA total/ UfA total (%)
Green	0,88	0,119	6,6	0,104	8,1
Yellow	0,90	0,130	7,2	0,116	9,0
Orange	1,12	0,115	6,3	0,129	10,0
Yellow	0,90	0,130	7,2	0,116	9,0
Sum		0,493	27,1	0,466	36,1

*: Tall i forhold til hele vindu / Figure in relation to the whole window

***: Elements andel av det totale varmetap / The elements share of the total heat loss



NorDan NTech Passiv Lukkeramme

NTech Passive Sash

Beregning av U-verdier er utført i henhold til NS-EN ISO 10077-1, 10077-2 og programmet "Therm".

Senter U-verdi for glasset er beregnet i henhold til NS-EN 673. Beregningsmetodikken er kvalitetssikret av SINTEF Byggeforsk.

Calculation of U-value in accordance to NS-EN ISO 10077-1, 10077-2 and the programme "Therm". Centre U-value of glass is calculated in accordance to NS-EN 673. The calculation methodology is independently quality assured by SINTEF Building and Infrastructure.

Hovedkontor/Head Office: NorDan AS, Stasjonsvei 46, 4460, Moi

Web: www.nordan.no/ www.nordan.co.uk

Data for spacer (psi-verdier) / Data for spacer (psi-values)



Tegnforklaring for spacer / Legend for spacer

Farge/ Colour	Psi	Lengde/Length (m)	Navn/ Name
Yellow	0,026	2,548	SSP side
Green	0,026	1,042	SSP top
Orange	0,026	1,042	SSP bottom

Detaljert resultater / Detailed results

Farge/ Colour	Spacer lengde/ Spacer length (m)	L Psi spacer (W/K)	*L Psi spacer (%)	**L Psi total (%)
Green	1,042	0,027	22,5	2,1
Yellow	1,274	0,033	27,5	2,6
Orange	1,042	0,027	22,5	2,1
Yellow	1,274	0,033	27,5	2,6
Sum	4,632	0,121	100,0	9,4

*: Tall i forhold til spacer / Figure in relation to the spacer

** : Elements andel av det totale varmetap / The elements share of the total heat loss

Appendix C - DER worksheet (sample unit)

FULL SAP CALCULATION PRINTOUT

Calculation Type: New Build (As Designed)



REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

DWELLING AS DESIGNED

Mid-floor flat, total floor area 72 m²

This report covers items included within the SAP calculations.
It is not a complete report of regulations compliance.

1a TER and DER

Fuel for main heating:Electricity
Fuel factor:1.55 (electricity)
Target Carbon Dioxide Emission Rate (TER) 25.75 kgCO₂/m²
Dwelling Carbon Dioxide Emission Rate (DER) 49.24 kgCO₂/m²Fail
Excess emissions =23.49 kgCO₂/m² (91.2%)

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)47.5 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)80.5 kWh/m²/yrFail
Excess energy =33.0 kWh/m²/yr (69.5%)

2 Fabric U-values

Element	Average	Highest	
External wall	0.63 (max. 0.30)	1.10 (max. 0.70)	Fail
Party wall	0.00 (max. 0.20)	-	OK
Floor	(no floor)		
Roof	(no roof)		
Openings	0.74 (max. 2.00)	1.00 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

Air permeability at 50 pascals:	3.00 (design value)	
Maximum	10.0	OK

4 Heating efficiency

Main heating system 1: Electric storage heaters - Electric
High heat retention storage heaters

Main heating system 2: Room heaters - Electric
Fan heaters

Secondary heating system: None

5 Cylinder insulation

Hot water storage Nominal cylinder loss: 2.64 kWh/day
Permitted by DBSCG 2.02 Fail
Primary pipework insulated: No primary pipework

6 Controls

Space heating controls 1: Controls for high heat retention storage heaters OK

Space heating controls 2: Appliance thermostats OK

Hot water controls: Cylinderstat OK

7 Low energy lights

Percentage of fixed lights with low-energy fittings:100%
Minimum 75% OK

8 Mechanical ventilation

Continuous supply and extract system
Specific fan power: 0.53
Maximum 1.5 OK
MVHR efficiency: 89%
Minimum: 70% OK

9 Summertime temperature

Overheating risk (Thames Valley): Not significant OK
Based on:
Overshading: Average
Windows facing North: 4.22 m², No overhang
Windows facing East: 8.45 m², No overhang
Air change rate: 4.00 ach
Blinds/curtains: None

10 Key features

Party wall U-value	0.00 W/m ² K
Door U-value	1.00 W/m ² K
Window U-value	0.71 W/m ² K
Air permeability	3.0 m ³ /m ² h

FULL SAP CALCULATION PRINTOUT

Calculation Type: New Build (As Designed)



CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

1. Overall dwelling dimensions

	Area (m ²)	Storey height (m)	Volume (m ³)
Ground floor	72.2700 (1b)	x 2.5000 (2b)	= 180.6750 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	72.2700		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 180.6750 (5)

2. Ventilation rate

					main	secondary	other			total	m3 per hour		
					heating		heating						
Number of chimneys					0	+	0	+	0	=	0 * 40 =	0.0000 (6a)	
Number of open flues					0	+	0	+	0	=	0 * 20 =	0.0000 (6b)	
Number of intermittent fans											0 * 10 =	0.0000 (7a)	
Number of passive vents											0 * 10 =	0.0000 (7b)	
Number of flueless gas fires											0 * 40 =	0.0000 (7c)	
											Air changes per hour		
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =										0.0000 / (5) =		0.0000 (8)	
Pressure test												Yes	
Measured/design AP50												3.0000	
Infiltration rate												0.1500 (18)	
Number of sides sheltered												2 (19)	
Shelter factor										(20) = 1 - [0.075 x (19)] =		0.8500 (20)	
Infiltration rate adjusted to include shelter factor										(21) = (18) x (20) =		0.1275 (21)	
Wind speed	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind factor	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000 (22)	
Adj infilt rate	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)	
	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498 (22b)	
Balanced mechanical ventilation with heat recovery													
If mechanical ventilation:												0.5000 (23a)	
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =												75.6500 (23c)	
Effective ac	0.2843	0.2811	0.2779	0.2620	0.2588	0.2429	0.2429	0.2397	0.2493	0.2588	0.2652	0.2716 (25)	

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K					
Windows (Uw = 0.71)			12.6700	0.6904	8.7473		(27)					
Doors			1.6800	1.0000	1.6800		(26)					
External Wall	53.5800	12.6700	40.9100	0.1500	6.1365		(29a)					
Sheltered Wall	44.1300	1.6800	42.4500	1.1000	46.6950		(29a)					
Total net area of external elements Aum(A, m2)			97.7100				(31)					
Fabric heat loss, W/K = Sum (A x U)			(26) ... (30) + (32) =		63.2588		(33)					
Party Wall			11.7500	0.0000	0.0000		(32)					
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K												
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							250.0000 (35)					
Total fabric heat loss							28.1404 (36)					
							(33) + (36) = 91.3992 (37)					
Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m	Jan 16.9515	Feb 16.7614	Mar 16.5714	Apr 15.6212	May 15.4311	Jun 14.4809	Jul 14.4809	Aug 14.2908	Sep 14.8610	Oct 15.4311	Nov 15.8112	Dec 16.1913 (38)
Heat transfer coeff	108.3507	108.1606	107.9706	107.0203	106.8303	105.8801	105.8801	105.6900	106.2601	106.8303	107.2104	107.5905 (39)
Average = Sum(39)m / 12 =	106.9728 (39)											
HLP	Jan 1.4992	Feb 1.4966	Mar 1.4940	Apr 1.4808	May 1.4782	Jun 1.4651	Jul 1.4651	Aug 1.4624	Sep 1.4703	Oct 1.4782	Nov 1.4835	Dec 1.4887 (40)
HLP (average)	1.4802 (40)											
Days in month	31	28	31	30	31	30	31	31	30	31	30	31 (41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.2999 (42)
Average daily hot water use (litres/day)												88.8238 (43)
Daily hot water use	Jan 97.7062	Feb 94.1532	Mar 90.6003	Apr 87.0473	May 83.4944	Jun 79.9414	Jul 79.9414	Aug 83.4944	Sep 87.0473	Oct 90.6003	Nov 94.1532	Dec 97.7062 (44)
Energy conte	144.8954	126.7265	130.7704	114.0088	109.3941	94.3988	87.4744	100.3781	101.5770	118.3782	129.2190	140.3235 (45)
Energy content (annual)												Total = Sum(45)m = 1397.5443 (45)
Distribution loss (46)m = 0.15 x (45)m												
	21.7343	19.0090	19.6156	17.1013	16.4091	14.1598	13.1212	15.0567	15.2365	17.7567	19.3829	21.0485 (46)
Water storage loss:												

store volume												169.0000	(47)
b) If manufacturer declared loss factor is not known :													
Hot water storage loss factor from Table 2 (kWh/litre/day)												0.0175	(51)
Volume factor from Table 2a												0.8921	(52)
Temperature factor from Table 2b												0.6000	(53)
Enter (49) or (54) in (55)												1.5831	(55)
Total storage loss													
	49.0760	44.3267	49.0760	47.4929	49.0760	47.4929	49.0760	49.0760	47.4929	49.0760	47.4929	49.0760	(56)
If cylinder contains dedicated solar storage													
	49.0760	44.3267	49.0760	47.4929	49.0760	47.4929	49.0760	49.0760	47.4929	49.0760	47.4929	49.0760	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Total heat required for water heating calculated for each month													
	193.9715	171.0532	179.8464	161.5017	158.4701	141.8917	136.5504	149.4541	149.0699	167.4542	176.7119	189.3995	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
								Solar input (sum of months) = Sum(63)m =				0.0000	(63)
Output from w/h													
	193.9715	171.0532	179.8464	161.5017	158.4701	141.8917	136.5504	149.4541	149.0699	167.4542	176.7119	189.3995	(64)
								Total per year (kWh/year) = Sum(64)m =				1975.3747	(64)
Heat gains from water heating, kWh/month													
	87.4385	77.5979	82.7420	75.9022	75.6344	69.3819	68.3460	72.6365	71.7687	78.6215	80.9597	85.9184	(65)

Metabolic gains (Table 5), Watts												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(66)m	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	18.3970	16.3400	13.2886	10.0603	7.5202	6.3489	6.8602	8.9171	11.9685	15.1968	17.7369	18.9083 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	202.5360	204.6377	199.3415	188.0666	173.8340	160.4573	151.5209	149.4192	154.7154	165.9903	180.2230	193.5996 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997 (69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (70)
Losses e.g. evaporation (negative values) (Table 5)	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980 (71)
Water heating gains (Table 5)	117.5249	115.4731	111.2123	105.4198	101.6591	96.3638	91.8630	97.6298	99.6787	105.6741	112.4440	115.4817 (72)
Total internal gains	395.9572	393.9501	381.3417	361.0459	340.5125	320.6692	307.7433	313.4653	323.8619	344.3605	367.9031	385.4888 (73)

[Jan]				Area m ²	Solar flux Table 6a W/m ²	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W			
North				4.2200	10.6334	0.3700	0.7300	0.7700	8.3993			
East				8.4500	19.6403	0.3700	0.7300	0.7700	31.0643 (76)			
Solar gains	39.4636	76.8199	127.3522	189.7674	237.8925	246.2904	233.3151	196.5440	149.1874	91.2140	49.0951	32.5478 (83)
Total gains	435.4208	470.7699	508.6939	550.8133	578.4050	566.9596	541.0584	510.0093	473.0493	435.5745	416.9982	418.0366 (84)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	46.3195	46.4009	46.4826	46.8953	46.9787	47.4003	47.4003	47.4856	47.2308	46.9787	46.8122	46.6468
alpha	4.0880	4.0934	4.0988	4.1264	4.1319	4.1600	4.1600	4.1657	4.1487	4.1319	4.1208	4.1098
util living area												
	0.9978	0.9965	0.9932	0.9829	0.9523	0.8707	0.7417	0.7866	0.9357	0.9872	0.9962	0.9981 (86)
MIT	19.4615	19.5740	19.8066	20.1425	20.4853	20.7705	20.9025	20.8800	20.6528	20.2222	19.7887	19.4421 (87)
Th 2	19.6881	19.6900	19.6920	19.7019	19.7039	19.7138	19.7138	19.7158	19.7098	19.7039	19.6999	19.6960 (88)
util rest of house												
	0.9969	0.9953	0.9905	0.9749	0.9257	0.7872	0.5765	0.6345	0.8863	0.9797	0.9945	0.9975 (89)
MIT 2	17.6631	17.8287	18.1695	18.6633	19.1488	19.5216	19.6469	19.6342	19.3854	18.7832	18.1497	17.6402 (90)
Living area fraction									fLA = Living area / (4) =			0.2254 (91)
MIT	18.0685	18.2221	18.5385	18.9967	19.4501	19.8031	19.9299	19.9150	19.6711	19.1076	18.5191	18.0463 (92)
Temperature adjustment												0.0000
adjusted MIT	18.0685	18.2221	18.5385	18.9967	19.4501	19.8031	19.9299	19.9150	19.6711	19.1076	18.5191	18.0463 (93)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9954	0.9931	0.9869	0.9686	0.9186	0.7944	0.6087	0.6628	0.8843	0.9745	0.9922	0.9961 (94)
Useful gains	433.4090	467.5059	502.0180	533.5222	531.3286	450.4204	329.3437	338.0403	418.3226	424.4602	413.7356	416.4123 (95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000 (96)
Heat loss rate W	1491.8261	1440.9258	1299.8058	1080.5557	827.9422	550.9019	352.5710	371.5039	591.9845	908.8673	1224.2486	1489.7350 (97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000 (97a)
Space heating kWh	787.4623	654.1382	593.5541	393.8642	220.6805	0.0000	0.0000	0.0000	0.0000	360.3989	583.5694	798.5520 (98)
Space heating												4392.2197 (98)
Space heating per m2												60.7751 (99)
										(98) / (4) =		

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CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)													0.0000 (201)
Fraction of space heat from main system(s)													1.0000 (202)
Fraction of main heating from main system 2													0.5000 (203)
Fraction of total heating from main system 1													0.5000 (204)
Fraction of total heating from main system 2													0.5000 (205)
Efficiency of main space heating system 1 (in %)													100.0000 (206)
Efficiency of main space heating system 2 (in %)													100.0000 (207)
Efficiency of secondary/supplementary heating system, %													0.0000 (208)
Space heating requirement													2196.1098 (211)
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Space heating requirement	787.4623	654.1382	593.5541	393.8642	220.6805	0.0000	0.0000	0.0000	0.0000	360.3989	583.5694	798.5520	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	393.7311	327.0691	296.7771	196.9321	110.3403	0.0000	0.0000	0.0000	0.0000	180.1995	291.7847	399.2760	(211)
Space heating efficiency (main heating system 2)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(212)
Space heating fuel (main heating system 2)	393.7311	327.0691	296.7771	196.9321	110.3403	0.0000	0.0000	0.0000	0.0000	180.1995	291.7847	399.2760	(213)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Space heating fuel used, main system 2													2196.1098 (213)
Water heating requirement	193.9715	171.0532	179.8464	161.5017	158.4701	141.8917	136.5504	149.4541	149.0699	167.4542	176.7119	189.3995	(64)
Efficiency of water heater	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month	193.9715	171.0532	179.8464	161.5017	158.4701	141.8917	136.5504	149.4541	149.0699	167.4542	176.7119	189.3995	(219)
Water heating fuel used													1975.3747 (219)
Annual totals kWh/year													
Space heating fuel - main system													2196.1098 (211)
Space heating fuel - secondary													0.0000 (215)
Electricity for pumps and fans:													
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 0.7420)													
mechanical ventilation fans (SFP = 0.7420)													163.5542 (230a)
Total electricity for the above, kWh/year													163.5542 (231)
Electricity for lighting (calculated in Appendix L)													324.8960 (232)
Total delivered energy for all uses													6856.0445 (238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating - main system 1	2196.1098	0.5190	1139.7810 (261)
Space heating - main system 2	2196.1098	0.5190	1139.7810 (262)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating (other fuel)	1975.3747	0.5190	1025.2195 (264)
Space and water heating			3304.7815 (265)
Pumps and fans	163.5542	0.5190	84.8846 (267)
Energy for lighting	324.8960	0.5190	168.6210 (268)
Total CO2, kg/year			3558.2871 (272)
Dwelling Carbon Dioxide Emission Rate (DER)			49.2400 (273)

16 CO2 EMISSIONS ASSOCIATED WITH APPLIANCES AND COOKING AND SITE-WIDE ELECTRICITY GENERATION TECHNOLOGIES

DER		49.2400 ZC1
Total Floor Area	TFA	72.2700
Assumed number of occupants	N	2.2999
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190
CO2 emissions from appliances, equation (L14)		16.6070 ZC2
CO2 emissions from cooking, equation (L16)		2.4104 ZC3
Total CO2 emissions		68.2574 ZC4
Residual CO2 emissions offset from biofuel CHP		0.0000 ZC5
Additional allowable electricity generation, kWh/m²/year		0.0000 ZC6
Resulting CO2 emissions offset from additional allowable electricity generation		0.0000 ZC7
Net CO2 emissions		68.2574 ZC8

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CALCULATION OF TARGET EMISSIONS 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF TARGET EMISSIONS 09 Jan 2014

1. Overall dwelling dimensions

	Area (m ²)	Storey height (m)	Volume (m ³)
Ground floor	72.2700 (1b)	x 2.5000 (2b)	= 180.6750 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	72.2700		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 180.6750 (5)

2. Ventilation rate

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	+	0	=	0 * 40 = 0.0000 (6a)
Number of open flues	0	+	0	=	0 * 20 = 0.0000 (6b)
Number of intermittent fans					3 * 10 = 30.0000 (7a)
Number of passive vents					0 * 10 = 0.0000 (7b)
Number of flueless gas fires					0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =					Air changes per hour
Pressure test					30.0000 / (5) = 0.1660 (8)
Measured/design AP50					Yes
Infiltration rate					5.0000
Number of sides sheltered					0.4160 (18)
					2 (19)
Shelter factor				(20) = 1 - [0.075 x (19)] =	0.8500 (20)
Infiltration rate adjusted to include shelter factor				(21) = (18) x (20) =	0.3536 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000 (22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infilt rate												
Effective ac	0.4509	0.4420	0.4332	0.3890	0.3802	0.3360	0.3360	0.3271	0.3536	0.3802	0.3978	0.4155 (22b)
	0.6016	0.5977	0.5938	0.5757	0.5723	0.5564	0.5564	0.5535	0.5625	0.5723	0.5791	0.5863 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K					
TER Opaque door			1.6800	1.0000	1.6800		(26)					
TER Opening Type (Uw = 1.40)			12.6700	1.3258	16.7973		(27)					
External Wall	53.5800	12.6700	40.9100	0.1800	7.3638		(29a)					
Sheltered Wall	44.1300	1.6800	42.4500	0.1800	7.6410		(29a)					
Total net area of external elements Aum(A, m2)			97.7100				(31)					
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	33.4821		(33)					
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000 (35)					
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							8.2292 (36)					
Total fabric heat loss						(33) + (36) =	41.7113 (37)					
Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m	Jan 35.8720	Feb 35.6367	Mar 35.4060	Apr 34.3225	May 34.1198	Jun 33.1761	Jul 33.1761	Aug 33.0013	Sep 33.5396	Oct 34.1198	Nov 34.5299	Dec 34.9586 (38)
Heat transfer coeff	77.5834	77.3480	77.1173	76.0338	75.8311	74.8874	74.8874	74.7127	75.2509	75.8311	76.2412	76.6700 (39)
Average = Sum(39)m / 12 =												76.0329 (39)
HLP	Jan 1.0735	Feb 1.0703	Mar 1.0671	Apr 1.0521	May 1.0493	Jun 1.0362	Jul 1.0362	Aug 1.0338	Sep 1.0412	Oct 1.0493	Nov 1.0549	Dec 1.0609 (40)
HLP (average)												1.0521 (40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31 (41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy													2.2999 (42)
Average daily hot water use (litres/day)													88.8238 (43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	97.7062	94.1532	90.6003	87.0473	83.4944	79.9414	79.9414	83.4944	87.0473	90.6003	94.1532	97.7062	(44)
Energy content (annual)	144.8954	126.7265	130.7704	114.0088	109.3941	94.3988	87.4744	100.3781	101.5770	118.3782	129.2190	140.3235	(45)
Distribution loss (46)m = 0.15 x (45)m										Total = Sum(45)m =		1397.5443	(45)
	21.7343	19.0090	19.6156	17.1013	16.4091	14.1598	13.1212	15.0567	15.2365	17.7567	19.3829	21.0485	(46)
Water storage loss:													
Store volume													169.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):													1.4951 (48)
Temperature factor from Table 2b													0.5400 (49)
Enter (49) or (54) in (55)													0.8074 (55)
Total storage loss													

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If cylinder contains dedicated solar storage	25.0279	22.6058	25.0279	24.2205	25.0279	24.2205	25.0279	25.0279	24.2205	25.0279	24.2205	25.0279 (56)
Primary loss	25.0279	22.6058	25.0279	24.2205	25.0279	24.2205	25.0279	25.0279	24.2205	25.0279	24.2205	25.0279 (57)
Total heat required for water heating calculated for each month	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624 (59)
Solar input	193.1857	170.3435	179.0607	160.7413	157.6844	141.1314	135.7647	148.6684	148.3095	166.6685	175.9516	188.6138 (62)
Output from w/h	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (63)
Heat gains from water heating, kWh/month	193.1857	170.3435	179.0607	160.7413	157.6844	141.1314	135.7647	148.6684	148.3095	166.6685	175.9516	188.6138 (64)
	86.8100	77.0302	82.1134	75.2939	75.0058	68.7736	67.7175	72.0080	71.1604	77.9930	80.3514	85.2898 (65)

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	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	18.5223	16.4513	13.3791	10.1288	7.5714	6.3921	6.9069	8.9779	12.0501	15.3003	17.8577	19.0370	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	202.5360	204.6377	199.3415	188.0666	173.8340	160.4573	151.5209	149.4192	154.7154	165.9903	180.2230	193.5996	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	(71)
Water heating gains (Table 5)	116.6801	114.6282	110.3674	104.5749	100.8142	95.5189	91.0181	96.7849	98.8338	104.8293	111.5991	114.6368	(72)
Total internal gains	398.2376	396.2165	383.5873	363.2696	342.7188	322.8676	309.9451	315.6812	326.0985	346.6192	370.1790	387.7727	(73)

6. Solar gains

[Jan]				Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c		Access factor Table 6d	Gains W			
North				4.2200	10.6334	0.6300	0.7000		0.7700	13.7137			
East				8.4500	19.6403	0.6300	0.7000		0.7700	50.7196			

Solar gains	64.4333	125.4260	207.9317	309.8386	388.4139	402.1253	380.9403	320.9030	243.5825	148.9277	80.1591	53.1418	(83)
Total gains	462.6709	521.6425	591.5190	673.1082	731.1327	724.9929	690.8854	636.5841	569.6810	495.5468	450.3381	440.9145	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Thl (C)													21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	64.6885	64.8853	65.0794	66.0068	66.1833	67.0173	67.0173	67.1740	66.6935	66.1833	65.8273	65.4591	
alpha	5.3126	5.3257	5.3386	5.4005	5.4122	5.4678	5.4678	5.4783	5.4462	5.4122	5.3885	5.3639	
util living area	0.9973	0.9943	0.9840	0.9426	0.8284	0.6361	0.4725	0.5312	0.8032	0.9683	0.9943	0.9979	(86)
MIT	19.9006	20.0418	20.2926	20.6222	20.8682	20.9759	20.9960	20.9927	20.9182	20.5912	20.1907	19.8797	(87)
Th 2	20.0225	20.0252	20.0278	20.0402	20.0425	20.0533	20.0533	20.0553	20.0491	20.0425	20.0378	20.0329	(88)
util rest of house	0.9964	0.9924	0.9785	0.9230	0.7772	0.5524	0.3732	0.4266	0.7284	0.9536	0.9920	0.9972	(89)
MIT 2	18.5579	18.7655	19.1303	19.6026	19.9176	20.0379	20.0518	20.0523	19.9856	19.5704	18.9925	18.5350	(90)
Living area fraction	18.8605	19.0532	19.3923	19.8324	20.1319	20.2493	20.2646	20.2643	20.1958	19.8005	19.2626	18.8381	(92)
Temperature adjustment	18.8605	19.0532	19.3923	19.8324	20.1319	20.2493	20.2646	20.2643	20.1958	19.8005	19.2626	18.8381	(93)
adjusted MIT	18.8605	19.0532	19.3923	19.8324	20.1319	20.2493	20.2646	20.2643	20.1958	19.8005	19.2626	18.8381	(93)

8. Space heating requirement

Utilisation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Useful gains	0.9948	0.9898	0.9737	0.9178	0.7824	0.5704	0.3957	0.4503	0.7412	0.9488	0.9894	0.9959	(94)
Ext temp.	460.2806	516.3240	575.9591	617.8094	572.0642	413.5022	273.3692	286.6239	422.2276	470.1778	445.5642	439.1267	(95)
Heat loss rate W	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Month fracti	1129.6540	1094.7240	994.2164	831.2350	639.3980	423.0615	274.4340	288.7105	458.7138	697.6843	927.2925	1122.3028	(97)
Space heating kWh	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating	498.0138	388.6848	311.1834	153.6664	50.0964	0.0000	0.0000	0.0000	0.0000	169.2648	346.8444	508.2830	(98)
Space heating per m2												2426.0370	(98)
												33.5691	(99)

8c. Space cooling requirement

Not applicable

FULL SAP CALCULATION PRINTOUT

Calculation Type: New Build (As Designed)



CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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

Fraction of space heat from secondary/supplementary system (Table 11)													0.0000 (201)
Fraction of space heat from main system(s)													1.0000 (202)
Efficiency of main space heating system 1 (in %)													93.5000 (206)
Efficiency of secondary/supplementary heating system, %													0.0000 (208)
Space heating requirement													2594.6920 (211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	498.0138	388.6848	311.1834	153.6664	50.0964	0.0000	0.0000	0.0000	0.0000	169.2648	346.8444	508.2830	(98)
Space heating efficiency (main heating system 1)	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)
Space heating fuel (main heating system)	532.6351	415.7057	332.8165	164.3491	53.5790	0.0000	0.0000	0.0000	0.0000	181.0319	370.9566	543.6182	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating requirement	193.1857	170.3435	179.0607	160.7413	157.6844	141.1314	135.7647	148.6684	148.3095	166.6685	175.9516	188.6138	(64)
Efficiency of water heater (217)m	87.2309	86.9475	86.2747	84.6941	82.1415	79.8000	79.8000	79.8000	79.8000	84.8551	86.5923	87.3308	(217)
Fuel for water heating, kWh/month	221.4647	195.9153	207.5470	189.7904	191.9668	176.8563	170.1312	186.3013	185.8515	196.4155	203.1954	215.9763	(219)
Water heating fuel used												2341.4117	(219)
Annual totals kWh/year													
Space heating fuel - main system												2594.6920	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
central heating pump												30.0000	(230c)
main heating flue fan												45.0000	(230e)
Total electricity for the above, kWh/year												75.0000	(231)
Electricity for lighting (calculated in Appendix L)												327.1087	(232)
Total delivered energy for all uses												5338.2124	(238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating - main system 1	2594.6920	0.2160	560.4535 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating (other fuel)	2341.4117	0.2160	505.7449 (264)
Space and water heating			1066.1984 (265)
Pumps and fans	75.0000	0.5190	38.9250 (267)
Energy for lighting	327.1087	0.5190	169.7694 (268)
Total CO2, kg/m2/year			1274.8928 (272)
Emissions per m2 for space and water heating			14.7530 (272a)
Fuel factor (electricity)			1.5500
Emissions per m2 for lighting			2.3491 (272b)
Emissions per m2 for pumps and fans			0.5386 (272c)
Target Carbon Dioxide Emission Rate (TER) = (14.7530 * 1.55) + 2.3491 + 0.5386, rounded to 2 d.p.			25.7500 (273)

FULL SAP CALCULATION PRINTOUT

Calculation Type: New Build (As Designed)



CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

1. Overall dwelling dimensions

	Area (m ²)	Storey height (m)	Volume (m ³)
Ground floor	72.2700 (1b)	x 2.5000 (2b)	= 180.6750 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	72.2700		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 180.6750 (5)

2. Ventilation rate

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	+	0	=	0 * 40 = 0.0000 (6a)
Number of open flues	0	+	0	=	0 * 20 = 0.0000 (6b)
Number of intermittent fans					3 * 10 = 30.0000 (7a)
Number of passive vents					0 * 10 = 0.0000 (7b)
Number of flueless gas fires					0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =					30.0000 / (5) = 0.1660 (8)
Pressure test					Yes
Measured/design AP50					3.0000
Infiltration rate					0.3160 (18)
Number of sides sheltered					2 (19)
Shelter factor					(20) = 1 - [0.075 x (19)] = 0.8500 (20)
Infiltration rate adjusted to include shelter factor					(21) = (18) x (20) = 0.2686 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000 (22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infilt rate												
	0.3425	0.3358	0.3291	0.2955	0.2888	0.2552	0.2552	0.2485	0.2686	0.2888	0.3022	0.3156 (22b)
Effective ac	0.5587	0.5564	0.5541	0.5437	0.5417	0.5326	0.5326	0.5309	0.5361	0.5417	0.5457	0.5498 (25)

3. Heat losses and heat loss parameter

Element	Gross m ²	Openings m ²	NetArea m ²	U-value W/m ² K	A x U W/K	K-value kJ/m ² K	A x K kJ/K
Windows (Uw = 0.71)			12.6700	0.6904	8.7473		(27)
Doors			1.6800	1.0000	1.6800		(26)
External Wall	53.5800	12.6700	40.9100	0.1500	6.1365		(29a)
Sheltered Wall	44.1300	1.6800	42.4500	1.1000	46.6950		(29a)
Total net area of external elements Aum(A, m ²)			97.7100				(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	63.2588		(33)
Party Wall			11.7500	0.0000	0.0000		(32)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m ² K							250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							28.1404 (36)
Total fabric heat loss							(33) + (36) = 91.3992 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(38)m	33.3087	33.1729	33.0398	32.4145	32.2976	31.7530	31.7530	31.6521	31.9627	32.2976	32.5342	32.7816 (38)
Heat transfer coeff	124.7079	124.5721	124.4390	123.8137	123.6967	123.1522	123.1522	123.0513	123.3619	123.6967	123.9334	124.1808 (39)
Average = Sum(39)m / 12 =												123.8131 (39)
HLP	1.7256	1.7237	1.7219	1.7132	1.7116	1.7041	1.7041	1.7027	1.7070	1.7116	1.7149	1.7183 (40)
HLP (average)												1.7132 (40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31 (41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.2999 (42)
Average daily hot water use (litres/day)												88.8238 (43)
Daily hot water use	97.7062	94.1532	90.6003	87.0473	83.4944	79.9414	79.9414	83.4944	87.0473	90.6003	94.1532	97.7062 (44)
Energy conte	144.8954	126.7265	130.7704	114.0088	109.3941	94.3988	87.4744	100.3781	101.5770	118.3782	129.2190	140.3235 (45)
Energy content (annual)										Total = Sum(45)m =		1397.5443 (45)
Distribution loss (46)m = 0.15 x (45)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (46)
Water storage loss:												
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (57)

Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (59)
Heat gains from water heating, kWh/month	30.7903	26.9294	27.7887	24.2269	23.2463	20.0598	18.5883	21.3304	21.5851	25.1554	27.4590	29.8187 (65)

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
((66)m	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	18.3970	16.3400	13.2886	10.0603	7.5202	6.3489	6.8602	8.9171	11.9685	15.1968	17.7369	18.9083	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	202.5360	204.6377	199.3415	188.0666	173.8340	160.4573	151.5209	149.4192	154.7154	165.9903	180.2230	193.5996	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	(71)
Water heating gains (Table 5)	41.3848	40.0735	37.3504	33.6484	31.2450	27.8608	24.9843	28.6698	29.9793	33.8110	38.1376	40.0790	(72)
Total internal gains	319.8170	318.5505	307.4798	289.2746	270.0984	252.1662	240.8646	244.5054	254.1625	272.4974	293.5967	310.0861	(73)

[Jan]				Area m ²	Solar flux Table 6a W/m ²		g Specific data or Table 6b		FF Specific data or Table 6c		Access factor Table 6d		Gains W
North				4.2200	10.6334		0.3700		0.7300		0.7700		8.3993 (76)
East				8.4500	19.6403		0.3700		0.7300		0.7700		31.0643 (74)
Solar gains	39.4636	76.8199	127.3522	189.7674	237.8925	246.2904	233.3151	196.5440	149.1874	91.2140	49.0951		32.5478 (83)
Total gains	359.2806	395.3703	434.8320	479.0419	507.9909	498.4566	474.1797	441.0493	403.3499	363.7114	342.6918		342.6339 (84)

Temperature during heating periods in the living area from Table 9, Th1 (C)													21.0000 (85)
Utilisation factor for gains for living area, nil/m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	40.2441	40.2879	40.3310	40.5347	40.5730	40.7524	40.7524	40.7858	40.6831	40.5730	40.4955	40.4149	
alpha	3.6829	3.6859	3.6887	3.7023	3.7049	3.7168	3.7168	3.7191	3.7122	3.7049	3.6997	3.6943	
util living area													
	0.9987	0.9980	0.9960	0.9900	0.9724	0.9243	0.8371	0.8738	0.9661	0.9933	0.9980	0.9989	(86)
MIT	18.9725	19.1045	19.3861	19.7932	20.2261	20.6135	20.8289	20.7867	20.4555	19.9093	19.3732	18.9463	(87)
Th 2	19.5226	19.5239	19.5252	19.5314	19.5325	19.5379	19.5379	19.5389	19.5359	19.5325	19.5302	19.5278	(88)
util rest of house													
	0.9982	0.9972	0.9943	0.9848	0.9543	0.8585	0.6712	0.7330	0.9336	0.9890	0.9970	0.9985	(89)
MIT 2	17.7115	17.8444	18.1264	18.5360	18.9618	19.3252	19.4865	19.4646	19.1890	18.6540	18.1176	17.6892	(90)
Living area fraction									fLA = Living area / (4) =			0.2254	(91)
MIT	17.9957	18.1284	18.4104	18.8194	19.2468	19.6156	19.7891	19.7626	19.4744	18.9369	18.4006	17.9725	(92)
Temperature adjustment												0.0000	
adjusted MIT	17.9957	18.1284	18.4104	18.8194	19.2468	19.6156	19.7891	19.7626	19.4744	18.9369	18.4006	17.9725	(93)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9975	0.9961	0.9923	0.9811	0.9493	0.8633	0.7083	0.7622	0.9315	0.9863	0.9959	0.9979 (94)
Useful gains	358.3694	393.8092	431.4869	469.9828	482.2203	430.3235	335.8843	336.1866	375.7283	358.7196	341.2739	341.9121 (95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000 (96)
Heat loss rate W	1707.9666	1647.8907	1482.1137	1228.1536	933.5173	617.6834	392.7477	413.7725	663.0007	1031.2524	1400.5234	1710.2821 (97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000 (97a)
Space heating kWh	1004.1003	842.7428	781.6663	545.8830	335.7649	0.0000	0.0000	0.0000	0.0000	500.3644	762.6596	1018.0673 (98)
Space heating												5791.2487 (98)
Space heating per m2												80.1335 (99)
										(98) / (4) =		

Calculated for June, July and August. see Table 10b												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000
Heat loss rate W												
	0.0000	0.0000	0.0000	0.0000	0.0000	1157.6303	911.3260	935.1900	0.0000	0.0000	0.0000	0.0000 (100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.5430	0.6316	0.5919	0.0000	0.0000	0.0000	0.0000 (101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	628.5887	575.5915	553.5026	0.0000	0.0000	0.0000	0.0000 (102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	668.1920	638.0899	600.8017	0.0000	0.0000	0.0000	0.0000 (103)
Month fracti	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000 (103a)
Space cooling kWh												
	0.0000	0.0000	0.0000	0.0000	0.0000	28.5143	46.4989	35.1906	0.0000	0.0000	0.0000	0.0000 (104)
Space cooling												
Cooled fraction												110.2037 (104)
Intermittency factor (Table 10b)									fc = cooled area / (4) =			1.0000 (105)

FULL SAP CALCULATION PRINTOUT

Calculation Type: New Build (As Designed)



CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.2500	0.2500	0.0000	0.0000	0.0000	0.0000 (106)
Space cooling kWh												
	0.0000	0.0000	0.0000	0.0000	0.0000	7.1286	11.6247	8.7976	0.0000	0.0000	0.0000	0.0000 (107)
Space cooling												27.5509 (107)
Space cooling per m2												0.3812 (108)
Energy for space heating												80.1335 (99)
Energy for space cooling												0.3812 (108)
Total												80.5147 (109)
Dwelling Fabric Energy Efficiency (DFEE)												80.5 (109)

FULL SAP CALCULATION PRINTOUT

Calculation Type: New Build (As Designed)



CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

1. Overall dwelling dimensions

	Area (m ²)	Storey height (m)	Volume (m ³)
Ground floor	72.2700 (1b)	x 2.5000 (2b)	= 180.6750 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	72.2700		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 180.6750 (5)

2. Ventilation rate

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	+	0	=	0 * 40 = 0.0000 (6a)
Number of open flues	0	+	0	=	0 * 20 = 0.0000 (6b)
Number of intermittent fans					3 * 10 = 30.0000 (7a)
Number of passive vents					0 * 10 = 0.0000 (7b)
Number of flueless gas fires					0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =					Air changes per hour 30.0000 / (5) = 0.1660 (8)
Pressure test					Yes
Measured/design AP50					5.0000
Infiltration rate					0.4160 (18)
Number of sides sheltered					2 (19)
Shelter factor			(20) = 1 - [0.075 x (19)] =		0.8500 (20)
Infiltration rate adjusted to include shelter factor			(21) = (18) x (20) =		0.3536 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000 (22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infilt rate												
Effective ac	0.4509	0.4420	0.4332	0.3890	0.3802	0.3360	0.3360	0.3271	0.3536	0.3802	0.3978	0.4155 (22b)
	0.6016	0.5977	0.5938	0.5757	0.5723	0.5564	0.5564	0.5535	0.5625	0.5723	0.5791	0.5863 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K					
TER Opaque door			1.6800	1.0000	1.6800		(26)					
TER Opening Type (Uw = 1.40)			12.6700	1.3258	16.7973		(27)					
External Wall	53.5800	12.6700	40.9100	0.1800	7.3638		(29a)					
Sheltered Wall	44.1300	1.6800	42.4500	0.1800	7.6410		(29a)					
Total net area of external elements Aum(A, m2)			97.7100				(31)					
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	33.4821		(33)					
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000 (35)					
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							8.2292 (36)					
Total fabric heat loss						(33) + (36) =	41.7113 (37)					
Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m	Jan 35.8720	Feb 35.6367	Mar 35.4060	Apr 34.3225	May 34.1198	Jun 33.1761	Jul 33.1761	Aug 33.0013	Sep 33.5396	Oct 34.1198	Nov 34.5299	Dec 34.9586 (38)
Heat transfer coeff	77.5834	77.3480	77.1173	76.0338	75.8311	74.8874	74.8874	74.7127	75.2509	75.8311	76.2412	76.6700 (39)
Average = Sum(39)m / 12 =												76.0329 (39)
HLP	Jan 1.0735	Feb 1.0703	Mar 1.0671	Apr 1.0521	May 1.0493	Jun 1.0362	Jul 1.0362	Aug 1.0338	Sep 1.0412	Oct 1.0493	Nov 1.0549	Dec 1.0609 (40)
HLP (average)												1.0521 (40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31 (41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.2999 (42)
Average daily hot water use (litres/day)												88.8238 (43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily hot water use	97.7062	94.1532	90.6003	87.0473	83.4944	79.9414	79.9414	83.4944	87.0473	90.6003	94.1532	97.7062 (44)
Energy conte	144.8954	126.7265	130.7704	114.0088	109.3941	94.3988	87.4744	100.3781	101.5770	118.3782	129.2190	140.3235 (45)
Energy content (annual)	Total = Sum(45)m =										1397.5443 (45)	
Distribution loss (46)m = 0.15 x (45)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (46)
Water storage loss:												
Total storage loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (56)
If cylinder contains dedicated solar storage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (59)

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Heat gains from water heating, kWh/month
30.7903 26.9294 27.7887 24.2269 23.2463 20.0598 18.5883 21.3304 21.5851 25.1554 27.4590 29.8187 (65)

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	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	114.9975	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	18.5223	16.4513	13.3791	10.1288	7.5714	6.3921	6.9069	8.9779	12.0501	15.3003	17.8577	19.0370	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	202.5360	204.6377	199.3415	188.0666	173.8340	160.4573	151.5209	149.4192	154.7154	165.9903	180.2230	193.5996	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	34.4997	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	-91.9980	(71)
Water heating gains (Table 5)	41.3848	40.0735	37.3504	33.6484	31.2450	27.8608	24.9843	28.6698	29.9793	33.8110	38.1376	40.0790	(72)
Total internal gains	319.9423	318.6617	307.5703	289.3431	270.1496	252.2094	240.9113	244.5661	254.2440	272.6009	293.7175	310.2149	(73)

6. Solar gains

[Jan]					Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d		Gains W	
North					4.2200	10.6334	0.6300	0.7000	0.7700		13.7137 (74)	
East					8.4500	19.6403	0.6300	0.7000	0.7700		50.7196 (76)	

Solar gains	64.4333	125.4260	207.9317	309.8386	388.4139	402.1253	380.9403	320.9030	243.5825	148.9277	80.1591	53.1418 (83)
Total gains	384.3757	444.0877	515.5019	599.1817	658.5635	654.3348	621.8516	565.4691	497.8265	421.5286	373.8765	363.3566 (84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)													21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	64.6885	64.8853	65.0794	66.0068	66.1833	67.0173	67.0173	67.1740	66.6935	66.1833	65.8273	65.4591	
alpha	5.3126	5.3257	5.3386	5.4005	5.4122	5.4678	5.4678	5.4783	5.4462	5.4122	5.3885	5.3639	
util living area	0.9989	0.9973	0.9913	0.9632	0.8714	0.6913	0.5220	0.5916	0.8621	0.9840	0.9976	0.9992	(86)
MIT	19.7985	19.9419	20.1989	20.5464	20.8261	20.9642	20.9935	20.9878	20.8806	20.5051	20.0918	19.7781	(87)
Th 2	20.0225	20.0252	20.0278	20.0402	20.0425	20.0533	20.0533	20.0553	20.0491	20.0425	20.0378	20.0329	(88)
util rest of house	0.9985	0.9964	0.9881	0.9494	0.8266	0.6054	0.4139	0.4783	0.7968	0.9758	0.9967	0.9989	(89)
MIT 2	18.9208	19.0660	19.3234	19.6721	19.9256	20.0370	20.0516	20.0518	19.9814	19.6391	19.2261	18.9088	(90)
Living area fraction										fLA = Living area / (4) =		0.2254	(91)
MIT	19.1186	19.2634	19.5208	19.8691	20.1286	20.2460	20.2639	20.2627	20.1841	19.8343	19.4213	19.1048	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.1186	19.2634	19.5208	19.8691	20.1286	20.2460	20.2639	20.2627	20.1841	19.8343	19.4213	19.1048	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9980	0.9954	0.9859	0.9463	0.8311	0.6239	0.4384	0.5040	0.8074	0.9735	0.9958	0.9985	(94)
Useful gains	383.6160	442.0636	508.2581	567.0249	547.3641	408.2090	272.6236	285.0031	401.9584	410.3380	372.3007	362.8255	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	1149.6783	1110.9825	1004.1260	834.0260	639.1516	422.8153	274.3810	288.5961	457.8355	700.2479	939.3888	1142.7491	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh	569.9503	449.5135	368.9257	192.2408	68.2899	0.0000	0.0000	0.0000	0.0000	215.6930	408.3034	580.2632	(98)
Space heating												2853.1799	(98)
Space heating per m2										(98) / (4) =		39.4795	(99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	703.9417	554.1669	567.8162	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.9132	0.9568	0.9355	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	642.8170	530.2239	531.2055	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	850.4448	810.7556	746.3082	0.0000	0.0000	0.0000	0.0000	(103)
Month fracti	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	(103a)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	149.4920	208.7156	160.0364	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												518.2440	(104)
Cooled fraction												1.0000	(105)
Intermittency factor (Table 10b)	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.2500	0.2500	0.0000	0.0000	0.0000	0.0000	(106)

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Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	37.3730	52.1789	40.0091	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling													129.5610 (107)
Space cooling per m2													1.7927 (108)
Energy for space heating													39.4795 (99)
Energy for space cooling													1.7927 (108)
Total													41.2722 (109)
Target Fabric Energy Efficiency (TFEE)													47.5 (109)

HTA Design LLP
78 Chamber Street
London
E1 8BL

020 7485 8555
info@hta.co.uk
www.hta.co.uk

Chair:
Benjamin Derbyshire
Dip Arch Cantab RIBA

Managing Partner:
Simon Bayliss
MA Dip Arch Dip UD RIBA

Partners:
Mike De'Ath
BA (Hons) Dip Arch RIBA
Colin Ainger
BA (Hons)
Caroline Dove
MA (Hons) Dip Arch RIBA
Sandy Morrison
B Arch RIBA
James Lord
BA (Hons) BLA CMLI
Rory Bergin
B Arch MSc RIBA
Lucy Smith
BA (Hons) MSc
Dr Riëtte Oosthuizen
BA (Hons) MA PhD
Simon Toplis
MA Dip Arch RIBA
Tim Crowther
BA (Hons) B Arch RIBA
John Gray
B Arch (Hons) Dip Arch RIBA

Directors:
Rajiv Ranjan
B Eng MBA
John Nsiah
BSc (Hons) Dip Arch MBA

