



Sustainable Construction Statement Crest Nicholson Midlands

# Oxford Road, Bodicote

Final

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## **Executive Summary**

The purpose of this Sustainable Construction Statement is to demonstrate that the proposed Reserved Matters application for 43 new homes at Oxford Road by Crest Nicholson in Cherwell District Council is considered sustainable, as measured against relevant local and national planning policies and in accordance with the requirements of Condition 20 of the outline consent.

Through the incorporation of sustainable design and construction methods, energy and water saving measures and waste reduction techniques, a good quality and sustainable development is proposed.

The key sustainability features outlined in this Sustainability Statement are listed below:

- > Carbon Dioxide Reduction: The development will target a 19.5% reduction in Regulated CO<sub>2</sub> emissions through energy efficiency measures and PV panels;
- > **Renewable Energy:** PV panels are proposed across the site, providing a total 22 kWp total energy generation;
- > **Water efficiency:** Flow control devices and water efficient fixtures and fittings will be installed in all dwellings to target a maximum internal daily water consumption of 105 litres/person/day;
- > **Waste and recycling:** Adequate facilities will be provided for domestic and construction related waste, including segregated bins for refuse, recycling and food/garden waste collection;
- > **Materials:** Where practical, new building materials will be sourced locally to reduce transportation pollution and support the local economy. New materials will be selected based on their environmental impact and responsible suppliers will be used where possible; and
- > **Sustainable construction:** The site will aim to achieve a 'Beyond Best Practice' score with the Considerate Constructors Scheme and will closely monitor construction site impacts.

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### 1. INTRODUCTION

- 1.1 This Sustainable Construction Statement has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development, appointed by Crest Nicholson Midlands.
- 1.2 This Statement sets out the sustainable design and construction measures included in the Reserved Matters planning application for the proposed development at Bodicote in Cherwell.

### **Planning History**

- 1.3 Outline consent for 95 new homes was awarded on 8<sup>th</sup> January 2015 (14/02156/OUT). A total of 43 dwellings are proposed for this Reserved Matters application.
- **1.4** As part of this consent Condition 20 states the following:
  - "No development shall commence until a Sustainable Construction Statement has been submitted to and approved in writing by the Local Planning Authority. The Statement shall demonstrate which sustainable construction methods shall be used in the development to achieve, as far as practicably possible, zero carbon development including but not limited to:
  - (i) Minimising both energy demands and energy loss;
  - (ii) Maximising passive solar lighting and natural ventilation;
  - (iii) Maximising resource efficiency;
  - (iv) Incorporating the use of recycled and energy efficient materials;
  - (v) Incorporating the use of locally sourced building materials;
  - (vi) Reducing waste and pollution and making adequate provision for the recycling of waste;
  - (vii) Making use of sustainable drainage methods;
  - (viii) Reducing the impact on the external environment and maximising opportunities for cooling and shading; and
  - (ix) Making use of the embodied energy within buildings wherever possible and re-using materials where proposals involve demolition or redevelopment.

The development shall thereafter be carried out in full accordance with the approved Statement.



Reason - In the interests of sustainability and to deliver low carbon development, in accordance with Policy ESD3 of the Cherwell Local Plan 2011-2031: Part 1 and the National Planning Policy Framework."

#### **Sustainable Construction Statement Structure and Methodology**

- **1.5** The formulation of the Sustainable Construction Statement has taken into account several important objectives, including:
  - > To demonstrate conformance with the requirements of Condition 20 of the Outline consent;
  - > To achieve a viable reduction in CO<sub>2</sub> emissions with an affordable, deliverable and technically appropriate strategy;
  - > To minimise the negative impact of the proposed development on both the local and wider climate and environment;
  - > To achieve the highest viable levels of sustainable design and construction; and
  - > To create a pleasant, safe and friendly living environment that will be flexible to its residents' needs.
- 1.6 This Sustainable Construction Statement does not duplicate the work of the technical reports prepared in support of the application, but presents the findings in the overall context of sustainability.
- **1.7 Chapter 2** provides an introduction to the site and the proposed development.
- **1.8 Chapter 3** sets out the relevant national and local policy documents which have been used to guide and inform the sustainability strategy for the proposed development.
- **1.9 Chapters 3 to 9** outline the sustainability strategy of the proposed development in relation to the policy documents listed in Chapter 3.
- **1.10 Chapter 10** provides a summary of the key sustainability features associated with the proposed development.

## 2. DEVELOPMENT OVERVIEW

#### **Site Location**

**2.1** The proposed development site to the south of the village of Bodicote is shown in Figure 1 below.



Figure 1: Site Location - Map data © 2017 Google

## **Proposed Development**

- **2.2** Figure 2 overleaf illustrates the proposed site layout.
- 2.3 The accommodation schedule for the development is presented in Table 1 overleaf. A total of 43 dwellings are proposed for this application, out of the original Outline consent which was granted for 95 new homes.





Figure 2: Proposed Site Layout – (Pegasus Design)

**Table 1: Accommodation Schedule** 

House Type	No. Beds	No. of Units
Open Market		
Hartley	3	4
Walberswick	4	1
Somerton	4	5
Calder	4	4
Radley	4	2
Affordable		
AH2B	2	7
AH2B LTH	2	6
AH2B WC	2	1
AH3B	3	4
AH3B LTH	3	2
Intermediate		
Dovedale Type A	1	2
Dovedale Type B	1	2
AH2B	2	2
AH3B	3	1
TOTAL		43

## 3. RELEVANT PLANNING POLICY

**3.1** The following planning policies and requirements have informed the sustainable design of the proposed development.

## **National Policy: NPPF**

3.2 The National Planning Policy Framework (NPPF) was published in March 2012 and sets out the Government's planning policies for England.

"At the heart of the National Planning Policy Framework is a presumption in favour of sustainable development, which should be seen as a golden thread running through both plan-making and decision-taking."

3.3 The NPPF uses the United Nations General Assembly definition to describe sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". The framework also states that there are three dimensions to sustainable development; economic, social and environmental which give rise to the need for the planning system to perform a number of roles:



- > **An economic role** Contributing to building a strong, responsive and competitive economy, by ensuring that sufficient land of the right type is available in the right places and at the right time to support growth and innovation; and by identifying and coordinating development requirements, including the provision of infrastructure;
- > **A social role** Supporting strong, vibrant and healthy communities, by providing the supply of housing required to meet the needs of present and future generations; and by creating a high quality built environment, with accessible local services that reflect the community's needs and support its health, social and cultural well-being; and
- > **An environmental role** Contributing to protecting and enhancing our natural, built and historic environment; and, as part of this, helping to improve biodiversity, use natural resources prudently, minimise waste and pollution, and mitigate and adapt to climate change including moving to a low carbon economy
- 3.4 The document also makes it clear that the delivery of a wide choice of well-designed high quality homes is central to delivering sustainable development.



#### **Local Policy: Cherwell District Council**

- 3.5 Condition 20 of the Outline consent refers to policy ESD 3 of the Cherwell local plan (2015). The local authority also provides an Energy Statement template to help address this condition. The requirements of this are addressed in Chapter 4 of this report.
- **3.6** Policy ESD 3 states the following:

All new residential development will be expected to incorporate sustainable design and construction technology to achieve zero carbon development through a combination of fabric energy efficiency, carbon compliance and allowable solutions in line with Government policy.

Cherwell District is in an area of water stress and as such the Council will seek a higher level of water efficiency than required in the Building Regulations, with developments achieving a limit of 110 litres/person/day.

The strategic site allocations identified in this Local Plan are expected to provide contributions to carbon emissions reductions and to wider sustainability.

All development proposals will be encouraged to reflect high quality design and high environmental standards, demonstrating sustainable construction methods including but not limited to:

- > Minimising both energy demands and energy loss
- > Maximising passive solar lighting and natural ventilation
- > Maximising resource efficiency
- > Incorporating the use of recycled and energy efficient materials
- > Incorporating the use of locally sourced building materials
- > Reducing waste and pollution and making adequate provision for the recycling of waste
- > Making use of sustainable drainage methods
- > Reducing the impact on the external environment and maximising opportunities for cooling and shading (by the provision of open space and water, planting, and green roofs, for example); and
- > Making use of the embodied energy within buildings wherever possible and re-using materials where proposals involve demolition or redevelopment.

Should the promoters of development consider that individual proposals would be unviable with the above requirements; 'open-book' financial analysis of proposed developments will be expected so that

an independent economic viability assessment can be undertaken. Where it is agreed that an economic viability assessment is required, the cost shall be met by the promoter.

- 3.7 Later information provided by the local authority makes it clear that they would support an Energy Strategy which demonstrated how the requirements of ESD 2 have been addressed, even though this policy is not specifically addressed in Condition 20.
- 3.8 Policy ESD 2 (Energy Hierarchy and Allowance Solutions) sets out the following:
  - > In seeking to achieve carbon emissions reductions, we will promote an 'energy hierarchy' as follows:
  - > Reducing energy use, in particular by the use of sustainable design and construction measures
  - > Supplying energy efficiently and giving priority to decentralised energy supply
  - > Making use of renewable energy
  - > Making use of allowable solutions.

## **Ministerial Statement and Deregulation Act**

- 3.9 Cherwell's Local Plan (2011-2031) policy ESD 3 sets an expectation for new residential development to achieve to achieve a zero carbon development through a combination of fabric energy efficiency, carbon compliance and allowable solutions in line with Government policy.
- 3.10 Whilst the requirement of the policy is acknowledged, the Ministerial Statement to Parliament from the Department for Communities and Local Government and The Rt Hon Eric Pickles issued on 25 March 2015 stipulates that from the date the **Deregulation Bill 2014** is given Royal Assent, local planning authorities should not set any additional local technical standards or requirements relating to the construction, internal layout or performance of new dwellings. This includes any policy requiring any level of the Code for Sustainable Homes to be achieved by new development.
- **3.11** The Deregulation Bill was given Royal Assent on 26 March 2015.
- 3.12 The **Ministerial Statement** details that local planning authorities should review their local information requirements to ensure that technical detail that is no longer necessary is not requested to support planning applications. Planning permissions should not be granted requiring, or subject to conditions requiring, compliance with any technical housing standards other than those areas where authorities have existing policies on access, internal space, or water efficiency.
- **3.13** For the specific issue of energy performance, the **Ministerial Statement** stipulates that local planning authorities will continue to be able to set and apply policies in their Local Plans which require compliance with energy performance standards that exceed the energy requirements of



Building Regulations until commencement of amendments to the Planning and Energy Act 2008 in the **Deregulation Bill 2015**. This is expected to happen alongside the introduction of zero carbon homes policy in late 2016.

- 3.14 The Government has stated that, from then, the energy performance requirements in Building Regulations will be set at a level equivalent to the (outgoing) Code for Sustainable Homes Level 4. Until the amendment is commenced, the Ministerial Statement states that it is expected that local planning authorities will take the statement of the Government's intention into account in applying existing policies and not set conditions with requirements above a Code Level 4 equivalent.
- 3.15 Further to this, it is noted that the published Government White Paper 'Fixing the Foundations' stated that it does not intend to proceed with the zero carbon Allowable Solutions carbon offsetting scheme, or the proposed 2016 increase in on-site energy efficiency standards. These energy efficiency standard have been incorporated in Part L of the Building Regulations though the Target Fabric Energy Efficiency (TFEE) criterion.
- 3.16 The Code Level 4 CO<sub>2</sub> equivalent is a 19% reduction in Regulated CO<sub>2</sub> over Part L (2013) of the Building Regulations, and it is this target that the development at Bodicote is addressing.
- **3.17** The remainder of this report sets out how these policy requirements have been addressed.

## **Energy Targets Summary**

- 3.18 The Energy Strategy will target a 19% reduction in Regulated CO₂ emissions. The zero carbon target requested in Condition 20 is deemed impractical without Allowable Solutions which no longer an option.
- **3.19** A 19% target is in line with the most recent Governmental information provided by the Ministerial Statement and Deregulation Acts. This is a challenging target and is considered a very sustainable.

## 4. ENERGY AND CO<sub>2</sub> CONSERVATION

**4.1** The Cherwell District Council Energy Statement Template which summarises this section can be found in Appendix A.

## **Energy Strategy**

- 4.2 The formulation of the energy strategy for the proposed development to achieve the maximum viable reduction in Regulated CO₂ emissions is in line with the Energy Hierarchy outlined in the Local Plan Policy ESD 2. As set out in Chapter 3, this has been established to be a minimum of 19% reduction over Part L (2013).
- **4.3** This includes:
  - > Reducing energy use, in particular by the use of sustainable design and construction measures;
  - > Supplying energy efficiently, and giving priority to decentralised energy supply;
  - > Making use of renewable energy;
  - > Making use of allowable solutions.
- 4.4 This statement first establishes a baseline assessment of the energy demands and associated CO<sub>2</sub> emissions for the development based on current Building Regulations (2013). It will then outline the energy measures that enable this, as well as local policy targets, to be met.

## **Building Regulations Part L (2013) Baseline**

#### Methodology

- 4.5 This statement first establishes a baseline assessment of the energy demands and associated CO<sub>2</sub> emissions for the development based on Building Regulation (2013). The following hierarchy will then be applied to meet the sustainability objectives for the proposed development:-
  - > Energy efficiency measures;
  - > Low carbon and renewable technologies.
- **4.6** The above hierarchy maximises the benefit to the residents by reducing energy bills.



4.7 The estimated annual energy demand for the proposed development has been calculated using Standard Assessment Procedure (SAP 2012) methodology. SAP calculates the Regulated energy demands associated with hot water, space heating and fixed electrical items.

#### **Baseline**

4.8 The Building Regulations compliant baseline case provides that the homes meet the Target Emission Rate (TER). Table 2 below show the Building Regulations (2013) compliant Regulated emissions for the whole site. This is shown in greater detail in Appendix B.

Table 2: Building Regulations (2013) Baseline

	Regulated CO <sub>2</sub> (Tonnes/year)	
Baseline Emissions	72.76	

## **Energy Efficiency Measures**

- 4.9 The first step of a sustainable energy strategy is to reduce energy demand. It is therefore the Applicant's intention that energy efficiency measures will be prioritised over the generation of renewable energy to meet a demand that need not exist and in accordance with the energy hierarchy.
- **4.10** The energy efficiency measures outlined in this Chapter will be incorporated into the design to enable the proposed development to exceed Building Regulations (2013) through energy efficiency measures alone.

#### **Insulation Standards**

- **4.11** The dwellings elements will incorporate enhanced insulation in the building envelope (walls, roofs, floors and glazing) to achieve average U-values better than those required by Part L (2013) Building Regulations. These are likely to include:
  - > Double glazing with a U-value of 1.30 W/m<sup>2</sup>.K (soft low E-coating, estimated G-value of 0.63);
  - > External walls with a U-value of 0.21 W/m<sup>2</sup>.K;
  - > Party walls will be fully insulated and sealed (achieving an effective U-value of 0.00W/m<sup>2</sup>.K);
  - > Ground Floor U-value will range between 0.15-0.19 W/m<sup>2</sup>.K depending on perimeter to area ratio of the unit;
  - > Roof U-values will be improved to 0.11 W/m<sup>2</sup>.K.

### **Air Tightness and Ventilation**

- **4.12** Air tightness standards will conform to, and exceed, Approved Document Part L requirements. By reducing air leakage loss and convective bypass of insulation, an improvement in the design air permeability rate from 10m3/hr.m² to 5m³/hr.m² or less will further reduce space heating requirements. Apartments will target 4m³/hr.m².
- **4.13** It is proposed to install Parts L & F compliant extract fans to all houses (System 1 natural ventilation) and Mechanical Extraction Ventilation (System 3 MEV) to apartments. These systems will remove stale air and odours from kitchens and bathrooms.
- 4.14 The selected MEV units will have a Specific Fan Power (SFP) lower than 0.25 W/l/s.
- **4.15** Additionally, all homes will have openable windows and therefore the ability to naturally ventilate should the occupant desire. Convective ventilation and night purging of heat will therefore be facilitated.

### **Thermal Bridging**

- 4.16 In well insulated buildings, as much as 30% of heat loss can occur through thermal bridges, which occur when highly conductive elements (e.g. metal studs) in the wall construction enable a low resistance escape route for heat. An improvement over the SAP default y-value may be required for compliance with the required standards.
- **4.17** To ensure the Fabric Energy Efficiency target is achieved a mix of bespoke, Accredited Construction Details (ACDs), and Aircrete Association (APA) details will be used. These have a significantly lower heat loss values for each thermal bridge junction (psi- value) than the SAP default.
- **4.18** Figure 3 illustrates the benefits of reducing thermal bridges.

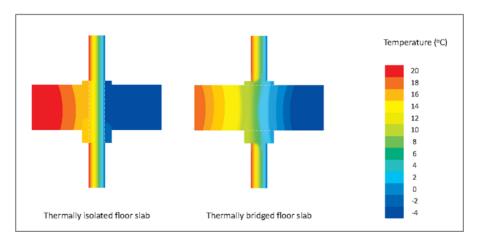


Figure 3: Thermal Bridging



#### **Space Heating & Hot Water**

- **4.19** The space heating requirement of the proposed development will be reduced by the fabric and air tightness measures detailed above.
- **4.20** The combination of the above measures will create highly energy efficient homes.
- **4.21** All dwellings will be installed with a low NO<sub>X</sub> high efficiency SEDBUK 'A' rated boiler. These systems have at least an 89% efficiency rating (SAP 2009) and are Energy Saving Trust recommended.
- **4.22** A compatible weather compensator can be applied to the boiler system to further improve the boiler efficiency. The compensator adjusts the systems emitters (i.e. modulating the circulating radiator temperature) to compensate for changes in outdoor temperature automatically.
- **4.23** The space heating systems will include time and zoning controls. This will allow the occupants to have a flexible and efficient way of controlling heating throughout the dwelling.

#### **Limiting the Risk of Summer Overheating**

- 4.24 Improving passive solar gains has to be balanced with the risk of summer overheating. Minimising the risk of summer overheating is important so as to ensure that homes are adapted to climate change and remain comfortable to occupy in the future. An illustrative strategy is presented here that enables dwellings to pass the overheating test. The sample SAP calculations undertaken do not show a risk of overheating within the SAP criterion with a 0.63 G-factor. Building Regulation Compliance Reports have been included in Appendix C.
- **4.25** Open-able windows will be used across the proposed development and will enable cross-ventilation, convective-ventilation and night purging. These concepts are illustrated in Figure 4 and will reduce the build-up of heat within homes.

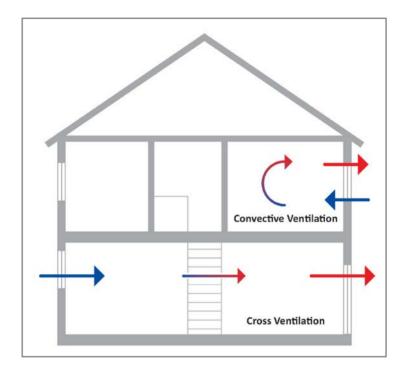


Figure 4: Natural Ventilation

**4.26** If required, security measures can be put in place to enable ground floor dwellings to safely open their windows.

## Lighting

- **4.27** All internal lighting and fittings in the dwellings will be energy efficient lighting (≤40 lumens per Watt)
- **4.28** All external lighting, and any security lighting, will be energy efficient and adequately controlled using PIR sensors, daylight cut-off sensors or time switches where possible. This will ensure the conservation of energy when the lighting is not in use.



## **Appliances (Unregulated Energy Use)**

4.29 It is very difficult to design and construct homes to reduce the unregulated electricity demands, because this is almost entirely dependent on the occupant of a home and can vary substantially. However, the Applicant is committed to ensuring that all efforts are made to enable the residents to minimise their unregulated electricity consumption. Advice will be provided to all occupants in the form of a Home User Guide on how to minimise electricity consumption. This includes advice on purchasing low-energy devices as well as ensuring that they are used efficiently. It has been shown that the provision of such information can significantly reduce energy use.



- 4.30 On average, home appliances can account for around 45% of a household's annual electricity bill. The choice of energy efficient appliances and the effective use of them will not only reduce unregulated CO<sub>2</sub> emissions but will save the occupants money.
- 4.31 Where provided, white goods will aim to be energy efficient in line with the ratings outlined in Table 3 and the resident purchase of them promoted through the provision of information on the EU Labelling Scheme contained within the Home Information Manual.

**Table 3: Energy Efficient White Goods** 

Appliance	Energy Efficiency Rating
Fridges, freezers and fridge-freezers	A+
Dishwashers	А
Washing machines	А
Washer Dryers	В
Tumble dryers	В

**4.32** Energy display devices, which can monitor electricity and primary heating fuel consumption, may also be provided to each of the dwellings. This can empower the occupants to be more aware of their usage and therefore make energy and cost savings, where possible.

## **CO<sub>2</sub> Emissions Following the Application of Energy Efficiency Measures**

**4.33** It can be seen in Table 4, overleaf, that the energy efficiency measures detailed above enable Building Regulations (2013) to be exceeded through these measures alone.

Table 4: Energy Efficiency - Total Regulated CO<sub>2</sub>

	Regulated CO₂ (Tonnes/yr)
Building Regulations (2013) Baseline	72.76
After Energy Efficiency measures	68.63
Reduction Achieved	5.7%

- **4.34** The building meets the Target Emission Rate (TER) and the Target Fabric Energy Efficiency (TFEE) requirements of Building Regulations Part L1A 2013.
- **4.35** Further calculations including Dwelling Emission Rate (DER) worksheets on representative dwelling types can be seen in Appendix C and D.

Sustainable Construction Statement Date: January 2018

## **Decentralised Energy**

- 4.36 In line with Policy ESD 4 of the Local Plan, the feasibility of decentralised heating networks to provide energy in an efficient manner does not need to be evaluated for residential developments of fewer than 50 units. However for completion, reasons against decentralised energy have been provided as this is the next step in the Energy Hierarchy after energy efficiency.
- **4.37** The inclusion of decentralised heating has been investigated in terms of appropriateness to the proposed development, and, to be in line with the priorities for this energy strategy, whether heating decentralised is the best technology to provide the greatest reductions in CO<sub>2</sub> emissions.
- **4.38** There are several disadvantages associated with applying Combine Heat and Power (CHP) to a small development of this nature:
  - > **Diversity of demand**: CHP is best suited to developments where there is a diversity of energy demand. A large mixed-use scheme, or a large residential scheme (>1000 homes) will have extended periods of the day in which there is a continuous demand for heat. In these circumstances, a CHP engine can operate consistently to generate electricity, with heat as a byproduct. On a small residential scheme such as this, there will be long periods of low or very low heat demand with two sharp peaks in demand for hot water in the morning and evening. Sharp peaks in demand must be dealt with either by running CHP engines for shorter hours (resulting in a decreased potential for CO<sub>2</sub> reductions) with storage of heat in large central thermal buffer vessels with substantial space (and height) requirements, OR 'dumping' of heat by connecting CHP engines to heat rejection plant at roof level, or in very well ventilated basements.
  - > **Thermal Storage**: To compensate for fluctuations in the demand for heat, thermal buffers will be required to store CHP thermal output. To store heat without the need for dumping will require a large store that can take >4hrs of charging. On a scheme of this size, such a thermal store could double the size of the plant room.
  - > **Distribution Heat Losses**: Thermal stores are a source of standing heat losses, as are even the best insulated heating distribution networks. When communal systems satisfy a small and intermittent demand, these standing losses will represent a large part (often over 30%) of total demand. CO<sub>2</sub> savings gained within the dwelling through association with CHP may be considerably reduced by the additional losses associated with the network. Furthermore, the build-up of this heat in residential circulation spaces proves hard to dissipate and can increase to an uncomfortable level. Strategies for the rapid ventilation of this heat reduce the efficiency of the system as a whole by throwing heat away.
  - > **CO<sub>2</sub> emissions**: Small Combined Heat and Power (CHP) engines are much less efficient than larger ones, having a worse heat to power ratio (typically >2) than larger ones. This means that they do not enable as large a CO<sub>2</sub> reduction as for a larger development, which would be able to utilise a larger and more efficient CHP engine. This means that more gas must be burnt in



proportion to the electricity generated, meaning they are less effective at reducing CO<sub>2</sub> emissions.

- 4.39 Installed Costs: The installed cost of a heat distribution network benefits from economies of scale when compared with individual heating systems. On a smaller scheme the upfront cost of commercial heating plant and CHP systems must be divided into relatively few numbers of units. In addition, export licenses for grid connection are harder to negotiate on favourable terms for small developments. Grid connection at favourable feed-in-rates is essential to offset the cost of additional gas used by CHP engines (circa twice the gas as gas boilers).
- 4.40 Running Costs: Fixed costs associated with the management and operation of a communal plant room must be shared by occupants as part of an energy standing charge; hence the fewer the number of units, the greater the cost for the individual occupant. CHP engines impose additional running costs because contracts for maintenance and replacement parts are typically handled by specialist companies.
- **4.41** It has therefore been concluded that, due to the size and density of the proposed development, CHP cannot be recommended for the scheme.
- **4.42** With CHP considered as unfeasible due to scale and cost, any decentralised heat network also becomes unfeasible due to the high fixed operation and maintenance costs associated with operating an energy centre for so few final customers.

## **Low Carbon and Renewable Energy**

- **4.43** It can be seen from Table 4 previously that Building Regulations (2013) have been exceeded across the site with energy efficiency measures alone.
- 4.44 Low carbon and renewable energy technologies (LZCT) will be required to assist the development meeting the  $CO_2$  emission reduction target. LZCT are summarised below, for more information see Appendix E.
- **4.45** Due to the prioritisation and optimisation of energy efficiency measures, the requirement for low carbon and renewable energy technologies is reduced.
- **4.46** However, in order to meet a 19% CO<sub>2</sub> reduction over 2013 Building Regulations a further reduction of 9.7 tonnes CO<sub>2</sub>/year is still required.

#### **Biomass Boiler**

- **4.47** Biomass boilers generate heat on a renewable basis as they are run on biomass fuel which is carbon neutral. A biomass boiler would require a central plant room and heat distribution network and would therefore be liable to high capital and running costs.
- **4.48** Whilst technically feasible, a biomass boiler is not appropriate for this development for the same reasons as CHP.

### **Ground and Air Source Heat Pumps (ASHPs and GSHPs)**

- **4.49** Heat Pumps upgrade energy from the ground or air and utilise it for space heating and hot water.
- 4.50 Heat Pumps are able to provide substantial reductions in energy. However, GSHPs require costly ground excavation works to bury the coils boreholes would be required for the proposed development due to the high space requirements of ground coils and this is not possible on this site.
- 4.51 Air Source Heat Pumps are a more economical alternative to GSHPs as they do not require ground works. However, the performance of ASHPs can be lower than for GSHPs are therefore the reductions in CO<sub>2</sub> are correspondingly low.
- **4.52** Whilst reducing energy significantly, heat pumps replace gas as the heating fuel with electricity, which is more carbon intensive. The result of this is that heat pumps do not enable sufficient reductions of CO<sub>2</sub> emissions for policy compliance. Electricity is also a more expensive fuel than gas, so energy bills are not necessarily reduced by heat pumps as much as by other technologies.
- **4.53** It has therefore been concluded that heat pumps are not a viable technology for the proposed development.

#### **Micro Wind Turbines**

- **4.54** Small rooftop wind turbines are designed to generate electricity from the wind for use within each dwelling.
- **4.55** Urban rooftop wind turbines do not generally perform sufficiently to well to warrant their installation, due to the low and turbulent wind conditions present. They are therefore likely to remain technically unfeasible.
- **4.56** It has therefore been concluded that wind turbines are not a suitable technology for the proposed development.



#### Solar Thermal (hot water) Panels

- 4.57 Solar thermal panels use the sun's energy to generate hot water for each dwelling. Due to the seasonality of solar radiation, solar thermal panels can provide up to ~60% of a dwellings hot water demand, with the remainder being provided as top-up by the conventional gas boiler. They are a robust technology that provides substantial benefits to residents in terms of 'free' energy.
- **4.58** Solar thermal panels are generally installed on the roofs of dwellings, with panels facing as close to south as possible to maximise their efficiency. A 100m² dwelling would typically require ~4m² of solar panels.
- **4.59** Solar thermal panels are a technically viable strategy, although it is unlikely that they would enable sufficient CO₂ reductions for policy compliance without additional technologies also being specified.
- **4.60** It has therefore been concluded that PV panels represent a more appropriate solar technology for this development.

### Proposed Technology: Photovoltaic (PV) Panels

- **4.61** Unlike solar thermal panels, PV panels are not constrained by the hot water demand of the dwellings. PV panels are good at enabling substantial reductions in CO₂ emissions as a result.
- 4.62 It has been concluded that PV panels represent the most viable renewable energy technology for the proposed development. They are technically and economically viable for the development and enable the most substantial reductions in CO<sub>2</sub> emissions.
- **4.63** It has been estimated that 22 kWp of PV panels is required and would be able to fit onto the southeast/south-west roofs:
  - > South-east facing; 16kWp, pitch of 30°.
  - > South-west; 6kWp 30°.
- 4.64 The total 22kWp can be distributed over the dwellings roofs and provide onsite electricity for occupants and well as Feed in Tariff income. It has been assumed the PV would be installed on to the Housing Association homes as to benefit from the delivered energy savings.
- 4.65 It has been calculated that this would achieve a 19.5% reduction in Regulated CO<sub>2</sub> emissions over Building Regulations (2013) across the whole development.
- 4.66 The SAP 2012 PV calculation and indicative possible layout is attached as Appendix F.

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## **CO<sub>2</sub> Emissions Following Renewable Energy Measures**

- **4.67** The inclusion of PV panels results in a total 19.5% reduction over the Building Regulations Part L (2013) baseline case (see Table 5).
- **4.68** These calculations can be seen in further detail in Appendix G.

Table 5: Low Carbon & Renewable Energy Measures - Total Regulated CO<sub>2</sub> reduction

	Regulated CO <sub>2</sub> (Tonnes/year)
Building Regulations (2013) Baseline	72.76
After Solar PV	55.16
Reduction Achieved	19.5%



### 5. WATER REDUCTION

### **Internal Water Efficiency**

- 5.1 Water conservation is at the core of sustainable development. Every person in the UK uses approximately 150 litres of water per day which has continued to rise by 1% since 1930. Water is a finite resource and during times of drought supplies can run low. Many natural ecosystems in the United Kingdom can suffer as a result of water abstraction.
- 8.2 Reducing water consumption will not only help to preserve our water sources but will save energy. As much as 25% of a household's energy consumption is used for heating water. As such, internal water consumption will be significantly reduced through the use of practical and hygienic water saving measures.



#### **Residential Water Use**

All new dwellings will target a minimum water efficiency standard of 105 litres/person/day in accordance with the above planning policy and the optional tighter Building Regulations Approved Document G requirement (110 litres/person/day). An evaluation of the proposed fixtures and fittings will be undertaken during the detailed design however an illustrative strategy to achieve this water target is set out in Table 6 below and the Water Efficiency Calculator in Appendix H.

**Table 6: Residential Sanitaryware** 

Installation Type	Water Capacity/Flow Rate	
WC	6/4 litres dual flush	
Bath	160 litres capacity	
Shower	8 litres/ minute flow rate	
Kitchen Tap	5 litres/ minute flow rate	
Basin Tap	4 litres/ minute flow rate	
Washing Machine	8.17 litres/ kg	
Dishwasher	1.25 litres/ place setting	

## **External Water Efficiency**

5.4 All of the houses will be provided with rainwater butts in the private back gardens to reduce the demand on potable water and promote effective use of our water supplies. These will be appropriately sized and capable of harvesting rainwater for external irrigation and car washing.

### 6. WASTE MANAGEMENT

6.1 Waste reduction and recycling is another key challenge of sustainable development. The waste hierarchy, illustrated in Figure 5 below, prioritises those waste management options according to what is best for the environment.



Figure 5: Waste Hierarchy

The waste hierarchy places great importance on the prevention of waste in the first instance through using less material in the designing and manufacturing processes. Once waste is created, the hierarchy then prioritises the re-use of materials through cleaning, repairing and refurbishing whole items. It then gives priority to recycling which is the turning of waste into a new product or substance, including composting. 'Other recovery' including incineration with energy recovery and anaerobic digestion and then final disposal (to landfill or incineration without energy recovery) are seen as the least favourable options.

#### **Household Waste**

- crest Nicholson is committed to following the above waste hierarchy and reducing waste sent to landfill. As such, adequate storage is to be provided to each of the proposed dwellings, where both recyclable and non-recyclable waste can be stored in accordance with Cherwell's waste collection service.
- 6.4 In addition, space will be provided for segregated recycling waste bins within the kitchen areas. This will involve the installation of recycling bins, where waste can be segregated into paper, glass, cans, plastic and cardboard, if necessary.





- **6.5** Brown bins with indoor caddies for garden and food waste are provided by the local authority for composting.
- A Home User Guide will be provided which will explain how the Cherwell waste collection scheme operates to ensure residents are aware.

#### **Construction Waste**

- 6.7 The reduction of construction waste not only minimises environmental impacts through ensuring the responsible use of resources and waste disposal, but can also significantly reduce construction costs for the developer.
- establish ways of minimising waste at source, assess the use, reuse and recycling of materials on and off-site and prevent illegal waste activities. This plan will then be disseminated to all relevant personnel on and off-site.
- **6.9** The following waste minimisation actions will be considered:
  - > Consider opportunities for zero cut and fill to avoid waste from excavation or groundworks;
  - > Design for standardisation of components and the use of fewer materials;
  - > Design for off-site or modular build;
  - > Return packaging for reuse;
  - > Consider community reuse of surplus materials or offcuts; and
  - > Engage with supply chains and include waste minimisation initiatives and targets in tenders and contracts.
- 6.10 As part of their commitment to divert construction waste from landfill, Crest Nicholson will regularly monitor and record the site's waste reduction performance. This will be compared against a target benchmark where at least 85% (by volume) of non-hazardous waste is to be diverted from landfill.

### 7. MATERIALS

### **Environmental Impact**

- **7.1** New building materials will be selected, where possible, to ensure that they minimise environmental impact and have low embodied energy from manufacture, transportation and operational stages, through to eventual demolition and disposal.
- 7.2 All insulation materials will have an Ozone Depleting Potential (ODP) of zero and a Global Warming Potential (GWP) of less than 5. In addition, all decorative paints and varnishes will meet the relevant standards in order to reduce the emission levels of volatile organic compounds (VOCs).

### **Crest Nicholson Sustainable Procurement Policy**

- 7.3 The Crest Nicholson Sustainable Procurement Policy sets out the commitment to specifying sustainable materials and technologies, and to developing long term partnerships with suppliers, contractors and sub-contractors to promote social responsibility and environmental stewardship.
- 7.4 Crest Nicholson will assess the sustainability of their products and services against social, environmental and economic criteria. Suppliers or contractors who do not meet the minimum standards for health and safety, human rights or labour shall not be appointed.
- **7.5** Where economically sustainable and where the agreed social standards are met, Crest Nicholson will give preference to products which:
  - > Have a lower environmental impact, specifically lower levels of embodied energy;
  - > Are locally sourced, contain recycled content, or are reclaimed;
  - > Are responsibly sourced through third party certification schemes including ISO 14001 or EMAS.



- 7.6 Preference will be given to the use of locally sourced materials and local suppliers, where viable. This will benefit the local economy as well as having environmental benefits through reduced transportation.
- 7.7 Major materials will be responsibly and legally sourced from manufacturers with environmental management systems and chain of custody certificates, where appropriate.
- **7.8** Timber used on the site, including timber used in the construction phase, such as hoarding, fencing and scaffolding, will be sourced from sustainable sources (e.g. PEFC and FSC) where possible.

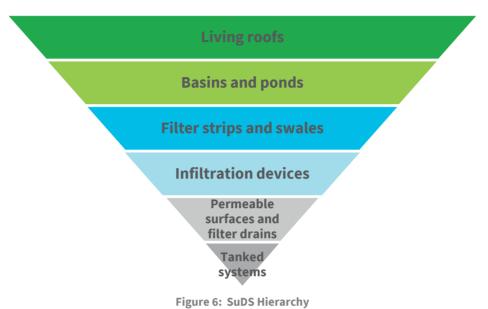


### 8. SURFACE WATER RUN-OFF

#### **Sustainable Drainage Systems**

- **8.1** A Flood Risk Assessment, incorporating a Surface Water Drainage strategy, has been prepared by Banners Gate.
- 8.2 The following listed SuDS are proposed, as set out in the Flood Risk Assessment undertaken by Banners Gate. These will not only help to attenuate surface water but will provide the necessary water treatment.
  - > Infiltration techniques will be used where appropriate in the form of soakaways and pervious paving;
  - > An open attenuation pond will be provided for attenuation purposes.
- 8.3 Sustainable Drainage Systems (SuDS) are designed to maximise opportunities and benefits that can be secured from surface water management. The four pillars of SuDS are:
  - > **Water Quantity** Controls the quantity of runoff to support the management of flood risk and maintain and protect the natural cycle of water.
  - > Water Quality Manages the quality of runoff to prevent pollution.
  - > **Amenity** Creates and sustains better places for people.
  - > **Biodiversity** Creates and sustains better places for nature.
- **8.4** The SuDS Hierarchy, illustrated in Figure 6 overleaf, sets out the preferred method of selecting which system should be used.
- **8.5** Living roofs, basins and ponds, and filter strips and swales are the most sustainable as they contribute to flood reduction, pollution reduction and benefit surrounding landscapes and wildlife.

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### 9. SUSTAINABLE CONSTRUCTION

- **9.1** Sustainable construction is described as involving the prudent use of existing and new resources and the efficient management of the construction process. This includes the following measures:
  - > Reducing waste during construction and demolition and sorting waste on site where practical;
  - > Reducing the risk of statutory nuisance to neighbouring properties as much as possible through effective site management;
  - > Controlling dust and emissions from demolition and construction; and
  - > Complying with protected species legislation.

#### **Considerate Constructors Scheme**

- 9.2 The development site will be registered with the Considerate Constructors Scheme. This is designed to encourage environmentally and socially considerate ways of working, to reduce any adverse impacts arising from the construction process. As commonly known, the Considerate Constructors Scheme aims are as follows:
  - > Enhancing the appearance;
  - > Respecting the community;
  - > Protecting the environment;
  - > Securing everyone's safety;
  - > Caring for the workforce.
- **9.3** The site will target 'Beyond Best Practice' certification, achieving a score of between 35 out of 50, with all of the five sections scoring at least seven points.

### **Monitoring Construction Site Impacts**

9.4 During the construction processes, control procedures will be put in place to minimise noise and dust pollution and roads will be kept clean. The management systems will generally comprise procedures and working methods that are approved by the development team together with commercial arrangements to ensure compliance. 9.5 Further to the above, additional measures will be adopted to minimise the impact on the local area during construction. This will include the limiting of air and water pollution in accordance with best practice principles, as well as the recording, monitoring and displaying of energy and water use from site activities during construction.



9.6 In terms of construction traffic, this will be minimised by restricting deliveries and arrival times

in order to manage potential impacts on existing and future occupants. Work will be limited to appropriate hours to be agreed with the Council, and suppressors will be used to reduce noise from machinery.



### CONCLUSION

- 9.7 The purpose of this Sustainable Construction Statement is to demonstrate that the proposed Reserved Matters application for 43 new homes at Oxford Road by Crest Nicholson in Cherwell District Council is considered sustainable, as measured against relevant local and national planning policies and in accordance with the requirements of Condition 20 of the outline consent.
- **9.8** Through the incorporation of sustainable design and construction methods, energy and water saving measures and waste reduction techniques, a good quality and sustainable development is proposed.
- **9.9** The key sustainability features outlined in this Sustainability Statement are listed below:
  - > **Carbon Dioxide Reduction:** The development will target a 19.5% reduction in Regulated CO<sub>2</sub> emissions through energy efficiency measures and PV panels;
  - > **Renewable Energy:** PV panels are proposed across the site, providing a total 22 kWp total energy generation;
  - > **Water efficiency:** Flow control devices and water efficient fixtures and fittings will be installed in all dwellings to target a maximum internal daily water consumption of 105 litres/person/day;
  - > **Waste and recycling:** Adequate facilities will be provided for domestic and construction related waste, including segregated bins for refuse, recycling and food/garden waste collection;
  - > **Materials:** Where practical, new building materials will be sourced locally to reduce transportation pollution and support the local economy. New materials will be selected based on their environmental impact and responsible suppliers will be used where possible; and
  - > **Sustainable construction:** The site will aim to achieve a 'Beyond Best Practice' score with the Considerate Constructors Scheme and will closely monitor construction site impacts.

### **APPENDICES**

## **Appendix A**

Cherwell District Energy Statement Template

## **Appendix B**

CO<sub>2</sub> Calculations Summary Sheet (Energy Efficiency)

## **Appendix C**

Building Regulations Part L (2013) Compliance Reports

## **Appendix D**

Dwelling Emission Rate (DER) Worksheets

## **Appendix E**

Low and Zero Carbon Technologies Summary

## **Appendix F**

SAP 2012 PV Calculation and indicative layout

## **Appendix G**

CO<sub>2</sub> Calculations Summary Sheet (With PV)



## **Appendix H**

Water Efficiency Calculator

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### **Appendix A**

Cherwell District Energy Statement Template



# Implementation Advice Note: Annex 1 Information Requirements for Policies ESD 2, 3, 4, and 5 of the Cherwell Local Plan: Energy Statement Template

This guidance has been prepared in advance of the Sustainable Buildings in Cherwell Supplementary Planning Document which will provide more detailed guidance on these matters.

#### Introduction

Applicants submitting proposals for major residential development (over 10 dwellings), and all non-residential development are required to submit a statement demonstrating compliance with the energy hierarchy set out in Policy ESD 2. Compliance with Policy ESD 2 will be demonstrated through the application of Policies ESD 3, 4, and 5.

The Council has produced this template which can be used by applicants to demonstrate compliance with ESD 2, 3, 4 and 5.

The majority of the questions in the template require yes/no answers, which will demonstrate to the planning case officer whether the requirements of each of the policies have been addressed.

The statement should be submitted with a planning application whether the application is in outline, reserved matters or is a full planning application.

The processing of an application not submitted with this information is likely to be delayed until the information is provided.

#### **Energy Statement Template**

#### **Section A – Summary of compliance with Policy ESD 2:**

Q1: Please summarise how the principles of the energy hierarchy set out in Policy ESD 2 have been applied (note: it is advisable to complete this summary section last, after the rest of this statement has been completed).

Please refer to Chapter 4: Energy and CO<sub>2</sub> conservation of the Sustainable Construction Statement produced by Hodkinson Consultancy.

It details the fabric first approach to reduce the initial demand of heat within dwellings. This is done through improved insulation, consideration to heat loss though thermal bridges, and efficient heating and ventilation systems. Decentralized energy has been investigated and deems inappropriate for this development.

Renewable energy technologies have been reviewed and Photovoltaic Panels selected as most suitable to provide CO<sub>2</sub> reductions.

# Section B – How does the proposed development promote the reduction of energy use?

The first bullet point of the Energy Hierarchy set out in Policy ESD 2 requires that developments are designed to use less energy, for example through sustainable design and construction measures.

Q2: In what way does the development reflect fabric efficiency in its construction?

Please see Chapter 4: Energy and CO<sub>2</sub> conservation of the Sustainable Construction Statement produced by Hodkinson Consultancy. Part L of the Building Regulations has a fabric energy efficiency target. The dwellings proposed at the development improve on this target (the TFEE) by 13% (see appendix A)

Q3: In what other ways has the building been designed to use less energy?

Consideration into unregulated energy use has been considered. The most effective way of reducing energy use is though occupant education. This is undertaken by the applicant though home user guides.

Q4: For non-residential development, has the development been designed to meet BREEAM 'Very Good'? (as required by Policy ESD 3)

Not applicable (no non-residential units)

NB At outline application stage, a commitment will need to be made to BREEAM 'Very Good' and applicants can expect that the requirement to build to this standard, unless superseded by higher national standards at the time the development is

constructed, will be attached to the outline consent as a condition on the subsequent reserved matters application.

For reserved matters or full applications, the BREEAM Design Stage Assessment will be required to be submitted with the application. If granted, a condition will be applied to the consent requiring the submission of the Post Construction Stage Assessment prior to occupation of the development.

# Section C – How does the proposed development promote supplying energy efficiently and giving priority to decentralised energy supply?

The second bullet point of Policy ESD 2 requires energy to be supplied to a development in an efficient way, with priority given to decentralised energy supply.

Q6: For all residential developments for 100 dwellings or more; all residential developments in off gas areas for 50 dwellings or more; and all applications for non domestic developments above 1000 sqm, has a feasibility assessment for District Heating/Combined Heat and Power been undertaken? (as required by Policy ESD 4)

Yes - Although this scheme is fewer than 50 units, consideration into decentralized heat has been undertaken and deemed inappropriate.

Please submit the feasibility assessment with this statement

Please see chapter 4 of the submitted Sustainable Construction Statement (starting paragraph 4.35)

Q7: Does the feasibility assessment indicate that decentralised energy systems are deliverable as part of the development?

No

Q8: If yes, do decentralised energy systems form part of the proposed development? (as required by Policy ESD 4)

Not Applicable

NB The feasibility assessment is required for all applications whether in outline, reserved matters, or full application form.

If the feasibility assessment indicates that decentralised energy systems are deliverable, conditions will be attached to the consent to secure the provision of such systems.

Please refer to the separate advice note on the kinds of issues to be considered in undertaking the district heating feasibility assessment.

# Section D – How does the proposed development promote the use of renewable energy?

The third bullet point of Policy ESD 2 requires developments to use renewable energy.

Q9: For all residential developments for 100 dwellings or more; all residential developments in off gas areas for 50 dwellings or more; and all applications for non domestic developments above 1000 sqm, has a feasibility assessment for onsite renewable energy provision been undertaken? (as required by Policy ESD 5)

Yes

Please submit the feasibility assessment with this statement

Please see Appendix D and Chapter 4 (paragraph 4.42) of the submitted Sustainable Construction Statement

Q10: Does the feasibility assessment indicate that onsite renewable energy systems are deliverable as part of the development?

Yes

Q11: If yes, does onsite renewable energy form part of the proposed development? (as required by Policy ESD 5)

Yes

NB The feasibility assessment is required for all applications whether in outline, reserved matters, or full application form.

If the feasibility assessment indicates that renewable energy systems are deliverable, conditions will be attached to the consent to secure the provision of such systems.

Please refer to the separate advice note on undertaking the renewable energy feasibility assessment.

#### Allowable Solutions

Please note that the Council does not now intend to require information on the final stage of the energy hierarchy in Policy ESD 2 relating to Allowable Solutions.

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### **Appendix B**

CO<sub>2</sub> Calculations Summary Sheet (Energy Efficiency)



#### Appendix B

#### CO <sub>2</sub> Emissions at Energy Efficiency Stage

		<u>Individual</u>			<u>To</u>	tal		
		Dwelling	Target Emissions			Dwelling	Target Emissions	Emissions Rate
Unit Type Description	Unit Floor Area	Emissions Rate	Rate	Number of Units	Total Floor Area	Emissions Rate	Rate	Improvement
Domestic	m <sup>2</sup>	kg CO <sup>2</sup> /m <sup>2</sup> /year	kg CO <sup>2</sup> /m <sup>2</sup> /year		m <sup>2</sup>	kg CO²/year	kg CO²/year	-
Somerton (semi-detached)	140	17.0	17.9	2	280	4,758	5,018	5.2%
Radley (detached)	152	15.8	16.2	2	304	4,804	4,921	2.4%
Walberswick (detached)	115	16.9	17.0	1	115	1,941	1,947	0.3%
1 bed ground floor appartment	44	20.1	22.3	2	87	1,753	1,944	9.8%
1 bed top floor appartment	55	17.8	20.0	2	110	1,960	2,198	10.8%
HA 2-bed (semi-detached/end-terrace)	78	17.3	18.3	12	938	16,277	17,205	5.4%
HA 3-bed (semi-detached/end-terrace)	93	17.0	17.9	4	370	6,278	6,618	5.1%
Hartly (semi-detached)	93	16.5	17.4	4	372	6,122	6,477	5.5%
Somerton (detached)	140	18.2	19.0	3	420	7,657	7,973	4.0%
HA 2/3-bed (mid-terrace)	78	16.1	17.5	7	547	8,793	9,562	8.0%
Calderwick (detached)	138	15.0	16.2	4	551	8,284	8,894	6.9%
			Total for All Units		4,094	68,629	72,758	5.7%

#### Fabric Energy Efficiency

		<u>Individual</u>			<u>To</u>	<u>tal</u>		Fabric Energy
		Dwelling Fabric	Target Fabric			Dwelling Fabric	Target Fabric	Efficiency
Unit Type Description	Unit Floor Area	Energy Efficiency	Energy Efficiency	Number of Units	Total Floor Area	Energy Efficiency	Energy Efficiency	Improvement
	m <sup>2</sup>	kWh/m²/year	kWh/m²/year		m <sup>2</sup>	kWh/year	kWh/year	-
Somerton (semi-detached)	140	46.6	53.6	2	280	13,055	15,010	13.0%
Radley (detached)	152	50.4	58.9	2	304	15,317	17,884	14.4%
Walberswick (detached)	115	49.7	56.4	1	115	5,705	6,474	11.9%
1 bed ground floor appartment	44	48.1	56.5	2	87	4,198	4,929	14.8%
1 bed top floor appartment	55	40.8	49.1	2	110	4,484	5,397	16.9%
HA 2-bed (semi-detached/end-terrace)	78	45.0	50.4	12	938	42,210	47,326	10.8%
HA 3-bed (semi-detached/end-terrace)	93	46.8	52.7	4	370	17,315	19,498	11.2%
Hartly (semi-detached)	93	44.1	50.6	4	372	16,389	18,820	12.9%
Somerton (detached)	140	52.5	59.1	3	420	22,030	24,843	11.3%
HA 2/3-bed (mid-terrace)	78	38.8	45.5	7	547	21,220	24,903	14.8%
Calderwick (detached)	138	45.6	55.8	4	551	25,113	30,722	18.3%
		Floor	Weighted Average	43	4,094	45.7	52.7	13.3%



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### **Appendix C**

Building Regulations Part L (2013) Compliance Reports



#### L1A 2013 - Regulations Compliance Report As Built - Draft



This as built draft submission provides evidence towards compliance with Part L of the Building Regulations, in accordance with Appendix C of AD L1A. It has been carried out using Approved SAP software. The assessor has confirmed any changes from the design submission with the builder. This report covers only items included within the SAP and is not a complete report of regulations compliance.

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 001 Oxford Road, Bodicaote, OX15		

Check	Evidence	Produced by	OK?
Criterion 1: predicted carbon dioxi	de emission from proposed dwelling does not exceed the target		
TER (kg CO <sub>2</sub> /m <sup>2</sup> .a)	Fuel = N/A Fuel factor = 1.00 TER = 17.92	Authorised SAP Assessor	
DER for dwelling as designed (kg CO <sub>2</sub> /m <sup>2</sup> .a)	DER = 16.99	Authorised SAP Assessor	
Are emissions from dwelling as built less than or equal to the target?	DER 16.99 < TER 17.92	Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as built less than or equal to the target?	DFEE 46.6 < TFEE 53.6	Authorised SAP Assessor	Passed
Criterion 2: the performance of the	building fabric and the heating, hot water and fixed lighting systems should	be no worse than the design	limits
Fabric U-values			
Are all U-values better than the design limits in Table 2?	Element         Weighted average Highest           Wall         0.21 (max 0.30)         0.21 (max 0.70)           Party wall         0.00 (max 0.20)         N/A           Floor         0.15 (max 0.25)         0.15 (max 0.70)           Roof         0.11 (max 0.20)         0.11 (max 0.35)           Openings         1.30 (max 2.00)         1.30 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
How has the loss from thermal bridges been calculated?	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
Does the efficiency of the heating systems meet the minimum value set out in the Domestic Heating Compliance Guide?	Main heating system: Mains gas, Combi boiler from database Potterton Promax Ultra Combi 40 ErP Efficiency = 89.10% - SEDBUK 2009 Minimum = 88.00% Secondary heating system: None	Authorised SAP Assessor	Passed
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder	Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Time and temperature zone control - plumbing circuit Hot water control: No hot water cylinder Boiler interlock (main system 1)	Authorised SAP Assessor	Passed

URN: Plot 001 version 1
NHER Plan Assessor version 6.2.3
SAP version 9.92

Спеск	Evidence	Produced by	OK?
Fixed internal lighting			
with paragraphs 42 to 44?	Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 15 Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passe
Criterion 3: the dwelling has appropriate the company of the compa	priate passive control measures to limit solar gains		
strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (20.09°) Overheating risk (July) = Slight (21.78°) Overheating risk (August) = Slight (21.43°) Region = Thames Thermal mass parameter = 250.00 Ventilation rate in hot weather = 2.50 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of the	dwelling, as built, is consistent with the DER		
(m³/(h.m²) at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00 As built air permeability = 5.00	Authorised SAP Assessor	Passe
Mechanical ventilation system Specific fan power (SFP)	Not applicable	Authorised SAP Assessor	
design been included (or bettered)	The following party walls have a U-value less than 0.2W/m²K: • Party (0.00) The following roofs have a U-value less than 0.13W/m²K: • Insulated at Joists (0.11)	Authorised SAP Assessor	

URN: Plot 001 version 1 NHER Plan Assessor version 6.2.3 SAP version 9.92

#### L1A 2013 - Regulations Compliance Report As Built - Draft



This as built draft submission provides evidence towards compliance with Part L of the Building Regulations, in accordance with Appendix C of AD L1A. It has been carried out using Approved SAP software. The assessor has confirmed any changes from the design submission with the builder. This report covers only items included within the SAP and is not a complete report of regulations compliance.

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 004 Oxford Road, Bodicaote, OX15		

Check	Evidence			Produced by	OK?
Criterion 1: predicted carbon dioxi	de emission fr	om proposed dwelli	ng does not exceed the target		
TER (kg CO <sub>2</sub> /m <sup>2</sup> .a)	Fuel = N/A Fuel factor = 1 TER = 16.20	1.00		Authorised SAP Assessor	
DER for dwelling as designed (kg CO <sub>2</sub> /m <sup>2</sup> .a)	DER = 15.82			Authorised SAP Assessor	
Are emissions from dwelling as built less than or equal to the target?	DER 15.82 < T	ER 16.20	Authorised SAP Assessor	Passed	
Is the fabric energy efficiency of the dwellling as built less than or equal to the target?	DFEE 50.4 < T	FEE 58.9		Authorised SAP Assessor	Passed
Criterion 2: the performance of the	e building fabr	ic and the heating, h	ot water and fixed lighting systems sho	uld be no worse than the design	n limits
Fabric U-values					
Are all U-values better than the design limits in Table 2?	Element Wall Party wall Floor Roof Openings	Weighted average 0.20 (max 0.30) (no party wall) 0.16 (max 0.25) 0.11 (max 0.20) 1.30 (max 2.00)	e Highest 0.20 (max 0.70) 0.16 (max 0.70) 0.19 (max 0.35) 1.30 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging					
How has the loss from thermal bridges been calculated?	Thermal bridg junction	ging calculated from	linear thermal transmittances for each	Authorised SAP Assessor	
Heating and hot water systems					
Does the efficiency of the heating systems meet the minimum value set out in the Domestic Heating Compliance Guide?	Mains gas, Re Potterton Pro Efficiency = 89 Minimum = 8	gular boiler from da max 15 System ErP 9.00% - SEDBUK 200 8.00%		Authorised SAP Assessor	Passed
		ating system: None			
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	Declared cylin Maximum per	me = 170.00 litres ider loss = 1.42kWh, rmitted cylinder loss vater pipes are insula	= 2.03kWh/day	Authorised SAP Assessor	Passed
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Hot water cor	perature zone contr ntrol: ck (main system 1) mostat	rol - plumbing circuit	Authorised SAP Assessor	Passed

URN: Plot 004 version
NHER Plan Accessor version 6.2

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Check	Evidence	Produced by	OK?
Fixed internal lighting			
Does fixed internal lighting comp with paragraphs 42 to 44?	ly Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 15  Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has appr	opriate passive control measures to limit solar gains		
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (19.51°) Overheating risk (July) = Slight (21.27°) Overheating risk (August) = Slight (20.98°) Region = Thames Thermal mass parameter = 176.00 Ventilation rate in hot weather = 4.00 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of the	ne dwelling, as built, is consistent with the DER		
Design air permeability (m³/(h.m²) at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00 As built air permeability = 5.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Not applicable	Authorised SAP Assessor	
Have the key features of the design been included (or bettered in practice?	The following roofs have a U-value less than 0.13W/m²K: d) • Insulated at Joists (0.11)	Authorised SAP Assessor	

URN: Plot 004 version 1 NHER Plan Assessor version 6.2.3 SAP version 9.92

#### Design - Draft



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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 007 Oxford Road, Bodicaote, OX15		

Evidence			Produced by	OK?
de emission fro	m proposed dwellir	ng does not exceed the target		
	.00		Authorised SAP Assessor	
DER = 16.91			Authorised SAP Assessor	
DER 16.91 < TE	ER 16.96		Authorised SAP Assessor	Passed
DFEE 49.7 < TF	EE 56.4		Authorised SAP Assessor	Passed
building fabrio	c and the heating, h	ot water and fixed lighting syste	ems should be no worse than the desig	n limits
Element Wall Party wall Floor Roof Openings	Weighted averag 0.21 (max 0.30) (no party wall) 0.15 (max 0.25) 0.11 (max 0.20) 1.30 (max 2.00)	e Highest 0.21 (max 0.70) 0.15 (max 0.70) 0.21 (max 0.35) 1.30 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridgi junction	ing calculated from	linear thermal transmittances for	or each Authorised SAP Assessor	
Mains gas, Reg Potterton Pror Efficiency = 89 Minimum = 88	gular boiler from dat max 24 System ErP 1.00% - SEDBUK 2009 8.00%		Authorised SAP Assessor	Passed
Declared cyline Maximum peri	der loss = 1.67kWh/ mitted cylinder loss	= 2.56kWh/day	Authorised SAP Assessor	Passed
Time and temp	perature zone contr trol: k (main system 1)	ol - plumbing circuit	Authorised SAP Assessor	Passed
	le emission from Fruel = N/A Fuel = N/A Fuel factor = 1 TER = 16.96 DER = 16.91  DER 16.91 < The state of the	le emission from proposed dwellin  Fuel = N/A  Fuel = N/A  Fuel factor = 1.00  TER = 16.96  DER = 16.91  DER 16.91 < TER 16.96  DFEE 49.7 < TFEE 56.4  building fabric and the heating, h  Element Weighted averag  Wall 0.21 (max 0.30)  Party wall (no party wall)  Floor 0.15 (max 0.25)  Roof 0.11 (max 0.20)  Openings 1.30 (max 2.00)  Thermal bridging calculated from junction  Main heating system:  Mains gas, Regular boiler from da Potterton Promax 24 System Erp  Fficiency = 89.00% - SEDBUK 2009  Minimum = 88.00%  Secondary heating system: None  Cylinder volume = 250.00 litres  Declared cylinder loss = 1.67kWh/  Maximum permitted cylinder loss Primary hot water pipes are insula Space heating control:  Time and temperature zone control:  Hot water control:  Boiler interlock (main system 1)	le emission from proposed dwelling does not exceed the target  Fuel = N/A  Fuel factor = 1.00  TER = 16.96  DER = 16.91  DER 16.91 < TER 16.96  DFEE 49.7 < TFEE 56.4  building fabric and the heating, hot water and fixed lighting system  Weighted average Highest  Wall 0.21 (max 0.30) 0.21 (max 0.70)  Party wall (no party wall)  Floor 0.15 (max 0.25) 0.15 (max 0.70)  Roof 0.11 (max 0.20) 0.21 (max 0.35)  Openings 1.30 (max 2.00) 1.30 (max 3.30)  Thermal bridging calculated from linear thermal transmittances figuration  Main heating system:  Mains gas, Regular boiler from database  Potterton Promax 24 System ErP  Efficiency = 89.00% - SEDBUK 2009  Minimum = 88.00%  Secondary heating system: None  Cylinder volume = 250.00 litres  Declared cylinder loss = 1.67kWh/day  Maximum permitted cylinder loss = 2.56kWh/day  Primary hot water pipes are insulated  Space heating control:  Time and temperature zone control - plumbing circuit  Hot water control:  Boiler interlock (main system 1)	le emission from proposed dwelling does not exceed the target  Fuel = N/A Fuel factor = 1.00 TER = 16.96  DER = 16.91  Authorised SAP Assessor  DER 16.91 < TER 16.96  Authorised SAP Assessor  DER 16.91 < TER 16.96  Authorised SAP Assessor  DER 49.7 < TFEE 56.4  Authorised SAP Assessor  DEE 49.7 < TFEE 56.4  Authorised SAP Assessor  DEI 49.7 < TFEE 56.4  Authorised SAP Assessor  Authorised SAP Assessor  Authorised SAP Assessor  DEI 49.7 < TFEE 56.4  Authorised SAP Assessor  Authorised SAP Assessor  Authorised SAP Assessor  DEI 49.7 < TFEE 56.4  Authorised SAP Assessor  Boiler interlock (main system 1)

URN: Plot 007 version 1	
NHER Plan Assessor version 6.2.3	

Page 1 of 2 SAP version 9.92

Check	Evidence	Produced by	OK?
Fixed internal lighting			
Does fixed internal lighting compl with paragraphs 42 to 44?	ly Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 26	Authorised SAP Assessor	Passed
	Percentage of low energy lights = 100% Minimum = 75 %		
Criterion 3: the dwelling has appr	opriate passive control measures to limit solar gains		
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (20.05°) Overheating risk (July) = Slight (21.79°) Overheating risk (August) = Slight (21.49°) Region = Thames Thermal mass parameter = 191.00 Ventilation rate in hot weather = 4.00 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of th	he dwelling, as designed, is consistent with the DER		
Design air permeability (m³/(h.m²) at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Not applicable	Authorised SAP Assessor	
Have the key features of the design been included (or bettered in practice?	The following roofs have a U-value less than 0.13W/m <sup>2</sup> K: d) • 400mm Mineral wool (0.11) Thermal bridging y value (0.015) is less than 0.04	Authorised SAP Assessor	

URN: Plot 007 version 1 NHER Plan Assessor version 6.2.3 SAP version 9.92

#### Design - Draft



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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 014 Oxford Road, Bodicaote, OX15		

Check	Evidence				Produced by	ок?
Criterion 1: predicted carbon dioxi	Criterion 1: predicted carbon dioxide emission from proposed dwelling does not exceed the target					
TER (kg CO <sub>2</sub> /m <sup>2</sup> .a)	Fuel = N/A Fuel factor = 1 TER = 22.28	1.00			Authorised SAP Assessor	
DER for dwelling as designed (kg CO <sub>2</sub> /m <sup>2</sup> .a)	DER = 20.10				Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 20.10 < T	ER 22.28			Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 48.1 < TI	FEE 56.5			Authorised SAP Assessor	Passed
Criterion 2: the performance of the	e building fabri	ic and the heating, h	ot water and fixed lig	hting systems should	be no worse than the design	limits
Fabric U-values						
Are all U-values better than the design limits in Table 2?	Element Wall Party wall Floor Roof Openings	Weighted averag 0.20 (max 0.30) 0.00 (max 0.20) 0.17 (max 0.25) (no roof) 1.30 (max 2.00)	e Highest 0.20 (max 0.70) N/A 0.17 (max 0.70) 1.30 (max 3.30)		Authorised SAP Assessor	Passed
Thermal bridging						
How has the loss from thermal bridges been calculated?	Thermal bridg junction	ing calculated from	linear thermal transn	nittances for each	Authorised SAP Assessor	
Heating and hot water systems						
Does the efficiency of the heating systems meet the minimum value set out in the Domestic Heating Compliance Guide?	Mains gas, Co Potterton Pro Efficiency = 89 Minimum = 88	mbi boiler from data max Ultra Combi 28 9.10% - SEDBUK 200	ErP		Authorised SAP Assessor	Passed
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water	cylinder			Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Hot water cor No hot water	perature zone contr	ol - plumbing circuit		Authorised SAP Assessor	Passed

URN: Plot 014 version 1
NHER Plan Assessor version 6.2.3
SAP version 9.92

Fixed internal lighting			
with paragraphs 42 to 44?	Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 10 Percentage of low energy lights = 100%	Authorised SAP Assessor	Passe
	Minimum = 75 %		
Criterion 3: the dwelling has appro	priate passive control measures to limit solar gains		
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (20.01°) Overheating risk (July) = Slight (21.75°) Overheating risk (August) = Slight (21.55°) Region = Thames Thermal mass parameter = 194.00 Ventilation rate in hot weather = 3.00 ach Blinds/curtains = Light-coloured curtain or roller blind	Authorised SAP Assessor	Passe
Criterion 4: the performance of the	e dwelling, as designed, is consistent with the DER		
Design air permeability (m³/(h.m²) at 50Pa)	Design air permeability = 4.00 Max air permeability = 10.00	Authorised SAP Assessor	Passe
Mechanical ventilation system Specific fan power (SFP)	Mechanical extract ventilation (decentralised): each SFP must be no greater than 0.7 W/(litre/sec) In room fans (kitchen) SFP = 0.20 In room fans (non-kitchen) SFP = 0.24	Authorised SAP Assessor	Passe
Have the key features of the design been included (or bettered) in practice?	The following party walls have a U-value less than 0.2W/m²K: • Party Wall (0.00)	Authorised SAP Assessor	

Produced by

Evidence

#### Design - Draft



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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 016 Oxford Road, Bodicaote, OX15		

Check	Evidence	Produced by	OK?
Criterion 1: predicted carbon dioxi	de emission from proposed dwelling does not exceed the target		
TER (kg CO <sub>2</sub> /m <sup>2</sup> .a)	Fuel = N/A Fuel factor = 1.00 TER = 19.99	Authorised SAP Assessor	
DER for dwelling as designed (kg CO <sub>2</sub> /m <sup>2</sup> .a)	DER = 17.83	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 17.83 < TER 19.99	Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 40.8 < TFEE 49.1	Authorised SAP Assessor	Passed
Criterion 2: the performance of the	building fabric and the heating, hot water and fixed lighting systems should	be no worse than the design	limits
Fabric U-values			
Are all U-values better than the design limits in Table 2?	Element         Weighted average Highest           Wall         0.20 (max 0.30)         0.20 (max 0.70)           Party wall         0.00 (max 0.20)         N/A           Floor         0.19 (max 0.25)         0.19 (max 0.70)           Roof         0.11 (max 0.20)         0.11 (max 0.35)           Openings         1.30 (max 2.00)         1.30 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
How has the loss from thermal bridges been calculated?	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
Does the efficiency of the heating	Main heating system: Mains gas, Combi boiler from database Potterton Promax Ultra Combi 28 ErP Efficiency = 89.10% - SEDBUK 2009 Minimum = 88.00% Secondary heating system: None	Authorised SAP Assessor	Passed
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder	Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Time and temperature zone control - plumbing circuit Hot water control: No hot water cylinder Boiler interlock (main system 1)	Authorised SAP Assessor	Passed

URN: Plot 016 version 1
NHER Plan Assessor version 6.2.3
SAP version 9.92

Check	Evidence	Produced by	OK?
Fixed internal lighting			
with paragraphs 42 to 44?	Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 10  Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has appro	priate passive control measures to limit solar gains		
strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (18.98°) Overheating risk (July) = Slight (20.78°) Overheating risk (August) = Slight (20.65°) Region = Thames Thermal mass parameter = 185.00 Ventilation rate in hot weather = 4.00 ach Blinds/curtains = Light-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of the	e dwelling, as designed, is consistent with the DER		
Design air permeability (m³/(h.m²) at 50Pa)	Design air permeability = 4.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Mechanical extract ventilation (decentralised): each SFP must be no greater than 0.7 W/(litre/sec) In room fans (kitchen) SFP = 0.20 In room fans (non-kitchen) SFP = 0.24	Authorised SAP Assessor	Passed
Have the key features of the design been included (or bettered) in practice?	The following party walls have a U-value less than 0.2W/m²K: • Party Wall Down (0.00) • Party Wall Up (0.00) The following roofs have a U-value less than 0.13W/m²K: • Cold Roof (pitched) (0.11)	Authorised SAP Assessor	

#### Design - Draft



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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 018 Oxford Road, Bodicaote, OX15		

Check	Evidence	Produced by	OK?
Criterion 1: predicted carbon dioxi	de emission from proposed dwelling does not exceed the target		
TER (kg CO₂/m².a)	Fuel = N/A Fuel factor = 1.00 TER = 18.33	Authorised SAP Assessor	
DER for dwelling as designed (kg CO <sub>2</sub> /m <sup>2</sup> .a)	DER = 17.35	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 17.35 < TER 18.33	Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 45.0 < TFEE 50.4	Authorised SAP Assessor	Passed
Criterion 2: the performance of the	building fabric and the heating, hot water and fixed lighting systems should	be no worse than the design	limits
Fabric U-values			
Are all U-values better than the design limits in Table 2?	Element         Weighted average Highest           Wall         0.21 (max 0.30)         0.21 (max 0.70)           Party wall         0.00 (max 0.20)         N/A           Floor         0.15 (max 0.25)         0.15 (max 0.70)           Roof         0.11 (max 0.20)         0.11 (max 0.35)           Openings         1.30 (max 2.00)         1.30 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
How has the loss from thermal bridges been calculated?	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
Does the efficiency of the heating systems meet the minimum value set out in the Domestic Heating Compliance Guide?	Main heating system: Mains gas, Combi boiler from database Potterton Promax Ultra Combi 33 ErP Efficiency = 89.10% - SEDBUK 2009 Minimum = 88.00% Secondary heating system: None	Authorised SAP Assessor	Passed
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder	Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Time and temperature zone control - plumbing circuit Hot water control: No hot water cylinder Boiler interlock (main system 1)	Authorised SAP Assessor	Passed

Page 1 of 2

URN: Plot 018 version
NHER Plan Assessor version 6.2.

SAP version 9.92

Check	Evidence	Produced by	OK?
Fixed internal lighting			
Does fixed internal lighting compl with paragraphs 42 to 44?	y Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 15  Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has appr	opriate passive control measures to limit solar gains		
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (18.96°) Overheating risk (July) = Slight (20.73°) Overheating risk (August) = Slight (20.53°) Region = Thames Thermal mass parameter = 250.00 Ventilation rate in hot weather = 4.00 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of th	ne dwelling, as designed, is consistent with the DER		
Design air permeability (m³/(h.m²) at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Not applicable	Authorised SAP Assessor	
Have the key features of the design been included (or bettered in practice?	The following party walls have a U-value less than 0.2W/m²K:  1) • Party (0.00)  The following roofs have a U-value less than 0.13W/m²K:  • Insulated at Joists (0.11)	Authorised SAP Assessor	

URN: Plot 018 version 1 NHER Plan Assessor version 6.2.3 SAP version 9.92

#### Design - Draft



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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 021 Oxford Road, Bodicaote, OX15		

Check	Evidence	Produced by	OK?
Criterion 1: predicted carbon dioxi	de emission from proposed dwelling does not exceed the target		
TER (kg CO <sub>2</sub> /m <sup>2</sup> .a)	Fuel = N/A Fuel factor = 1.00 TER = 17.88	Authorised SAP Assessor	
DER for dwelling as designed (kg CO <sub>2</sub> /m <sup>2</sup> .a)	DER = 16.96	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 16.96 < TER 17.88	Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 46.8 < TFEE 52.7	Authorised SAP Assessor	Passed
Criterion 2: the performance of the	building fabric and the heating, hot water and fixed lighting systems should	be no worse than the design	limits
Fabric U-values			
Are all U-values better than the design limits in Table 2?	Element         Weighted average Highest           Wall         0.21 (max 0.30)         0.21 (max 0.70)           Party wall         0.00 (max 0.20)         N/A           Floor         0.16 (max 0.25)         0.16 (max 0.70)           Roof         0.11 (max 0.20)         0.11 (max 0.35)           Openings         1.30 (max 2.00)         1.30 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
How has the loss from thermal bridges been calculated?	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
Does the efficiency of the heating	Main heating system: Mains gas, Combi boiler from database Potterton Promax Ultra Combi 33 ErP Efficiency = 89.10% - SEDBUK 2009 Minimum = 88.00% Secondary heating system: None	Authorised SAP Assessor	Passed
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder	Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Time and temperature zone control - plumbing circuit Hot water control: No hot water cylinder Boiler interlock (main system 1)	Authorised SAP Assessor	Passed

URN: Plot 021 version 1
NHER Plan Assessor version 6.2.3
SAP version 9.92

Check	Evidence	Produced by	OK?
Fixed internal lighting			
Does fixed internal lighting comp with paragraphs 42 to 44?	ply Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 15  Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has app	propriate passive control measures to limit solar gains		
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (18.91°) Overheating risk (July) = Slight (20.68°) Overheating risk (August) = Not significant (20.48°) Region = Thames Thermal mass parameter = 250.00 Ventilation rate in hot weather = 4.00 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of	the dwelling, as designed, is consistent with the DER		
Design air permeability (m³/(h.m²) at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Not applicable	Authorised SAP Assessor	
Have the key features of the design been included (or bettere in practice?	The following party walls have a U-value less than 0.2W/m²K: ed) • Party (0.00) The following roofs have a U-value less than 0.13W/m²K: • Insulated at Joists (0.11)	Authorised SAP Assessor	

URN: Plot 021 version 1 NHER Plan Assessor version 6.2.3 SAP version 9.92

#### Design - Draft



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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 022 Oxford Road, Bodicaote, OX15		

Check	Evidence	Produced by	OK?
Criterion 1: predicted carbon dioxid	de emission from proposed dwelling does not exceed the target		
TER (kg CO <sub>2</sub> /m <sup>2</sup> .a)	Fuel = N/A Fuel factor = 1.00 TER = 17.41	Authorised SAP Assessor	
DER for dwelling as designed (kg CO <sub>2</sub> /m <sup>2</sup> .a)	DER = 16.46	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 16.46 < TER 17.41	Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 44.1 < TFEE 50.6	Authorised SAP Assessor	Passed
Criterion 2: the performance of the	building fabric and the heating, hot water and fixed lighting systems should	d be no worse than the design	limits
Fabric U-values			
Are all U-values better than the design limits in Table 2?	Element         Weighted average Highest           Wall         0.21 (max 0.30)         0.21 (max 0.70)           Party wall         0.00 (max 0.20)         N/A           Floor         0.15 (max 0.25)         0.15 (max 0.70)           Roof         0.11 (max 0.20)         0.11 (max 0.35)           Openings         1.30 (max 2.00)         1.30 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
Does the efficiency of the heating	Main heating system: Mains gas, Combi boiler from database Potterton Promax Ultra Combi 40 ErP Efficiency = 89.10% - SEDBUK 2009 Minimum = 88.00%  Secondary heating system: None	Authorised SAP Assessor	Passed
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder	Authorised SAP Assessor	
	Space heating control: Time and temperature zone control - plumbing circuit Hot water control: No hot water cylinder Boiler interlock (main system 1)	Authorised SAP Assessor	Passed

Page 1 of 2

URN: Plot 022 version 1
NHER Plan Assessor version 6.2.3

NHER Plan Assessor version 6.2.3 SAP version 9.92

Check	Evidence	Produced by	OK?
Fixed internal lighting			
Does fixed internal lighting comp with paragraphs 42 to 44?	oly Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 15  Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has annu	ropriate passive control measures to limit solar gains		
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (19.05°) Overheating risk (July) = Slight (20.81°) Overheating risk (August) = Slight (20.56°) Region = Thames Thermal mass parameter = 250.00 Ventilation rate in hot weather = 4.00 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of t	he dwelling, as designed, is consistent with the DER		
Design air permeability (m³/(h.m²) at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Not applicable	Authorised SAP Assessor	
Have the key features of the design been included (or bettere in practice?	The following party walls have a U-value less than 0.2W/m²K: d) • Party (0.00) The following roofs have a U-value less than 0.13W/m²K: • Insulated at Joists (0.11)	Authorised SAP Assessor	

URN: Plot 022 version 1 NHER Plan Assessor version 6.2.3 SAP version 9.92

#### Design - Draft



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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 024 Oxford Road, Bodicaote, OX15		

Check	Evidence		Produced by	OK?
Criterion 1: predicted carbon dioxi	ide emission from proposed dwel	lling does not exceed the target		
TER (kg CO₂/m².a)	Fuel = N/A Fuel factor = 1.00 TER = 18.98		Authorised SAP Assessor	
DER for dwelling as designed (kg CO <sub>2</sub> /m <sup>2</sup> .a)	DER = 18.23		Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 18.23 < TER 18.98		Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 52.5 < TFEE 59.1		Authorised SAP Assessor	Passed
Criterion 2: the performance of the	e building fabric and the heating,	hot water and fixed lighting systems should	be no worse than the design	limits
Fabric U-values				
Are all U-values better than the design limits in Table 2?	Element         Weighted avera           Wall         0.21 (max 0.30)           Party wall         (no party wall)           Floor         0.16 (max 0.25)           Roof         0.11 (max 0.20)           Openings         1.30 (max 2.00)	0.21 (max 0.70) 0.16 (max 0.70) 0.11 (max 0.35)	Authorised SAP Assessor	Passed
Thermal bridging				
How has the loss from thermal bridges been calculated?	Thermal bridging calculated from junction	n linear thermal transmittances for each	Authorised SAP Assessor	
Heating and hot water systems				
Does the efficiency of the heating systems meet the minimum value set out in the Domestic Heating Compliance Guide?		10 ErP 109	Authorised SAP Assessor	Passed
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder		Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Time and temperature zone con Hot water control: No hot water cylinder Boiler interlock (main system 1)		Authorised SAP Assessor	Passed

URN:	Plot 024	l ver	sion 1
NHER Plan Ass	essor ve	rsior	6.2.3
			0.00

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Check	Evidence	Produced by	OK?
Fixed internal lighting			
Does fixed internal lighting compli with paragraphs 42 to 44?	y Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 15  Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has appro	opriate passive control measures to limit solar gains		
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (18.81°) Overheating risk (July) = Slight (20.57°) Overheating risk (August) = Not significant (20.31°) Region = Thames Thermal mass parameter = 250.00 Ventilation rate in hot weather = 4.00 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of th	e dwelling, as designed, is consistent with the DER		
Design air permeability (m³/(h.m²) at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Not applicable	Authorised SAP Assessor	
Have the key features of the design been included (or bettered in practice?	The following roofs have a U-value less than 0.13W/m²K:  I) Insulated at Joists (0.11)	Authorised SAP Assessor	

URN: Plot 024 version 1 NHER Plan Assessor version 6.2.3 SAP version 9.92

#### Design - Draft



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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 026 Oxford Road, Bodicaote, OX15		

Check	Evidence	Produced by	ок?
Criterion 1: predicted carbon dioxi	de emission from proposed dwelling does not exceed the target		
TER (kg CO <sub>2</sub> /m².a)	Fuel = N/A Fuel factor = 1.00 TER = 17.47	Authorised SAP Assessor	
DER for dwelling as designed (kg CO <sub>2</sub> /m <sup>2</sup> .a)	DER = 16.06	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 16.06 < TER 17.47	Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 38.8 < TFEE 45.5	Authorised SAP Assessor	Passed
Criterion 2: the performance of the	e building fabric and the heating, hot water and fixed lighting systems should	be no worse than the design	limits
Fabric U-values			
Are all U-values better than the design limits in Table 2?	Element         Weighted average Highest           Wall         0.21 (max 0.30)         0.21 (max 0.70)           Party wall         0.00 (max 0.20)         N/A           Floor         0.15 (max 0.25)         0.15 (max 0.70)           Roof         0.11 (max 0.20)         0.11 (max 0.35)           Openings         1.30 (max 2.00)         1.30 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
How has the loss from thermal bridges been calculated?	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
Does the efficiency of the heating	Main heating system: Mains gas, Combi boiler from database Potterton Promax Ultra Combi 33 ErP Efficiency = 89.10% - SEDBUK 2009 Minimum = 88.00% Secondary heating system: None	Authorised SAP Assessor	Passed
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder	Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Time and temperature zone control - plumbing circuit Hot water control: No hot water cylinder Boiler interlock (main system 1)	Authorised SAP Assessor	Passed

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URN: Plot 026 version
NHER Plan Assessor version 6.2

NHER Plan Assessor version 6.2.3 SAP version 9.92

Check	Evidence	Produced by	OK?
Fixed internal lighting			
Does fixed internal lighting comp with paragraphs 42 to 44?	ly Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 15  Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has appr	ropriate passive control measures to limit solar gains		
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (18.86°) Overheating risk (July) = Slight (20.62°) Overheating risk (August) = Not significant (20.39°) Region = Thames Thermal mass parameter = 250.00 Ventilation rate in hot weather = 4.00 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of t	he dwelling, as designed, is consistent with the DER		
Design air permeability (m³/(h.m²) at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Not applicable	Authorised SAP Assessor	
Have the key features of the design been included (or bettere in practice?	The following party walls have a U-value less than 0.2W/m²K: d) • Party (0.00) The following roofs have a U-value less than 0.13W/m²K: • Insulated at Joists (0.11)	Authorised SAP Assessor	

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#### Design - Draft



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Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	45 Meer Stones Road, Balsall Common, Coventry, OX		

Check	Evidence	Produced by	ОК?
Criterion 1: predicted carbon dioxid	de emission from proposed dwelling does not exceed the target		
, ,	Fuel = N/A Fuel factor = 1.00 TER = 16.15	Authorised SAP Assessor	
DER for dwelling as designed (kg CO <sub>2</sub> /m <sup>2</sup> .a)	DER = 15.04	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 15.04 < TER 16.15	Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 45.6 < TFEE 55.8	Authorised SAP Assessor	Passed
Criterion 2: the performance of the	building fabric and the heating, hot water and fixed lighting systems should	be no worse than the design	limits
Fabric U-values			
design limits in Table 2?	Element         Weighted average Highest           Wall         0.20 (max 0.30)         0.20 (max 0.70)           Party wall         (no party wall)         Floor           Floor         0.16 (max 0.25)         0.16 (max 0.70)           Roof         0.11 (max 0.20)         0.11 (max 0.35)           Openings         1.30 (max 2.00)         1.30 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
set out in the Domestic Heating Compliance Guide?	Main heating system: Mains gas, Regular boiler from database Potterton Promax 24 System ErP Efficiency = 89.00% - SEDBUK 2009 Minimum = 88.00% Secondary heating system: None	Authorised SAP Assessor	Passed
water cylinder meet the standards set out in the Domestic Heating	Cylinder volume = 170.00 litres Declared cylinder loss = 1.42kWh/day Maximum permitted cylinder loss = 2.03kWh/day Primary hot water pipes are insulated	Authorised SAP Assessor	Passed
controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Time and temperature zone control - plumbing circuit Hot water control: Boiler interlock (main system 1) Cylinder thermostat Separate water control	Authorised SAP Assessor	Passed

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Check	Evidence	Produced by	OK?
Fixed internal lighting			
Does fixed internal lighting compl with paragraphs 42 to 44?	y Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 16 Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has appro	opriate passive control measures to limit solar gains		
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant (19.76°) Overheating risk (July) = Slight (21.53°) Overheating risk (August) = Slight (21.27°) Region = Thames Thermal mass parameter = 100.00 Ventilation rate in hot weather = 4.00 ach Blinds/curtains = Dark-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of th	ne dwelling, as designed, is consistent with the DER		
Design air permeability (m³/(h.m²) at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Not applicable	Authorised SAP Assessor	
Have the key features of the design been included (or bettered in practice?	The following roofs have a U-value less than 0.13W/m²K:  1) • 400mm mineral wool (0.11)  • over entrance (0.11)  Thermal bridging y value (0.036) is less than 0.04	Authorised SAP Assessor	

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## **Oxford Road, Bodicote**Crest Nicholson Midlands

Sustainable Construction Statement Date: January 2018

### **Appendix D**

Dwelling Emission Rate (DER) Worksheets



#### DER Worksheet As Built - Draft



This as built submission has been carried out using Approved SAP software. The assessor has confirmed any changes from the design submission with the builder.

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 001 Oxford Road, Bodicaote, OX15		

1. Overall dwelling dimensions						
		Area (m²)		Average storey height (m)	Volume (m³)	
Lowest occupied		47.39	(1a) x	2.39 (2a)	= 113.26	(3a)
+1		46.69	(1b) x	2.61 (2b)	= 121.86	(3b)
Total floor area	(1a) + (1b) + (1c) + (1d)(1n) =	94.08	(4)			
Dwelling volume				(3a) + (3b) + (3c) + (3d	d)(3n) = 235.12	(5)

2. Ventilation rate				
			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	4	x 10 =	40	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	

Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 40	÷ (5) =	0.17	(8)
If a pressurisation test has been carried out or is intende	ed, proceed to (17), otherwise continue from (9) to (16)			
Air permeability value, q50, expressed in cubic metres p	per hour per square metre of envelope area		5.00	(17)
If based on air permeability value, then (18) = $[(17) \div 20]$	] + (8), otherwise (18) = (16)		0.42	(18)
Number of sides on which the dwelling is sheltered			1	(19)
Shelter factor		1 - [0.075 x (19)] =	0.93	(20)
Infiltration rate incorporating shelter factor		(18) x (20) =	0.39	(21)

Infiltration rate modified for monthly wind speed:													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2													
	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4													
	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltra	tion rate (a	llowing for	shelter and	wind facto	or) (21) x (2	2a)m							
	0.50	0.49	0.48	0.43	0.42	0.37	0.37	0.36	0.39	0.42	0.44	0.46	(22b)
Calculate effective air change rate for the applicable case:													
If mechanical ventilation: air change rate through system												N/A	(23a)

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d) natural ver	ntilation or	whole hou	se positive	input venti	lation from	loft		
	0.62	0.62	0.61	0.59	0.59	0.57	0.57	0.56

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

ffective air char	nge rate - e	nter (24a) o	or (24b) or (	(24c) or (24	d) in (25)

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0.60

0.58

0.59

N/A

0.60 (24d)

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0.63	0.63	0.61	0.50	0.50	0.57	0.57	0.56	0.50	0.50	0.60	0.60	/25
0.62	0.62	0.61	0.59	0.59	0.57	0.57	0.56	0.58	0.59	0.60	0.60	[(25

3. Heat losses and heat loss para									•	
Element	Gross area, m²	Openings m²		area m²	U-value W/m²K	AxUW		value, I/m².K	Ахк, kJ/K	
Window			15	.76 x	1.24	= 19.48	:			(27)
Door			2.	02 x	1.30	= 2.63				(26)
Ground floor			47	.39 x	0.15	= 7.11				(28a
External wall			79	.78 x	0.21	= 16.75				(29a
Party wall			47	.60 x	0.00	= 0.00				(32)
Roof			46	.69 x	0.11	= 5.14				(30)
Total area of external elements ∑A	, m²		191	1.64						(31)
Fabric heat loss, $W/K = \sum (A \times U)$						(20	5)(30) + (	(32) =	51.10	(33)
Heat capacity Cm = $\sum$ (A x $\kappa$ )					(28)	.(30) + (32)	+ (32a)(3	2e) =	N/A	(34)
Thermal mass parameter (TMP) in	kJ/m²K								250.00	(35)
Thermal bridges: $\Sigma(L \times \Psi)$ calculate	d using Appendix K								9.36	(36)
Total fabric heat loss							(33) + (	(36) =	60.46	(37)
Jan Feb		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated mo	onthly 0.33 x (25)m x (5)	1								_
48.32 47.9		45.57	44.08	44.08	43.81	44.65	45.57	46.21	46.88	(38)
Heat transfer coefficient, W/K (37)									_	_
108.78   108.4	11   108.05   106.34	106.02	104.54	104.54	104.27	105.11	106.02	106.67	107.34	_
	(20) . (4)					Average = 2	(39)112	/12 =	106.34	(39)
Heat loss parameter (HLP), W/m²K		1							1	7
1.16 1.15	5   1.15   1.13	1.13	1.11	1.11	1.11	1.12	1.13	1.13	1.14	_ □ (40)
Number of days in month (Table 1a	a)					Average = 2	(40)112	/12 =	1.13	(40)
31.00 28.0		31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)
32.00   20.0	5   51.00   50.00	32.00	30.00	31.00	32.00	30.00	31.00	30.00	31.00	( /
4. Water heating energy requirer	nent									
Assumed occupancy, N									2.68	(42)
Annual average hot water usage in	litres per day Vd,averag	ge = (25 x N) +	36						97.79	(43)
Jan Feb	Mar Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day fo	r each month Vd,m = fa	ctor from Tab	le 1c x (43	3)						_
107.57 103.6	66 99.75 95.84	91.92	88.01	88.01	91.92	95.84	99.75	103.66	107.57	_
							∑(44)1	12 =	1173.50	(44)
Energy content of hot water used =						_			_	7
159.52 139.5	52   143.97   125.52	120.44	103.93	96.31	110.51	111.83	130.33	142.27	154.49	<u></u>
D: . :							∑(45)1	12 =	1538.65	(45)
Distribution loss 0.15 x (45)m	2 24 50 40 02	10.07	45.50		16.50	46.77	40.55	24.24	22.47	7 (45)
23.93 20.9		18.07	15.59	14.45	16.58	16.77	19.55	21.34	23.17	(46)
Water storage loss calculated for e			0.00	0.00	0.00	0.00	0.00	0.00	0.00	7 (50)
0.00 0.00		0.00 \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	0.00 m x [(47) -	0.00	0.00	0.00	0.00	0.00	0.00	(56)
						0.00	0.00	0.00	0.00	7 (57)
0.00 0.00  Primary circuit loss for each month		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	[57]
0.00 0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for each month from Ta		0.00	0.00	J 0.00	1 0.00	0.00	1 0.00	1 0.00	0.00	T (59)
21.05 18.9		20.84	20.10	20.73	20.80	20.17	20.92	20.32	21.03	(61)
21.03   18.9	20.30   20.22	20.04	20.10	20.73	1 20.00	20.17	20.52	20.32	21.03	_ (01)

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Total heat required for wat	er heating	calculated f	or each m	onth 0.85 x	(45)m + (	46)m + (5	7)m + (59)r	m + (61)m				
180.57	158.51	164.95	145.74	141.28	124.03	117.03	131.3	1 132.00	151.25	162.58	175.52	(6
Solar DHW input calculated	d using App	endix G or A	Appendix H	ł								
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(6
Output from water heater	for each mo	onth (kWh/	month) (6	2)m + (63)n	n							
180.57	158.51	164.95	145.74	141.28	124.03	117.03	131.3	1 132.00	151.25	162.58	175.52	]
									∑(64)1	.12 =	1784.80	(6
Heat gains from water hea	ting (kWh/n	month) 0.2!	5 × [0.85 ×	(45)m + (61	l)m] + 0.8	× [(46)m +	+ (57)m + (5	59)m]				
58.30	51.14	53.12	46.79	45.26	39.58	37.20	41.95	42.23	48.57	52.38	56.63	(6
5. Internal gains												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)												,
133.88	133.88	133.88	133.88	133.88	133.88	133.88	133.8	8 133.88	133.88	133.88	133.88	(6
Lighting gains (calculated in	n Appendix	L, equation	L9 or L9a)	, also see Ta	able 5							
22.72	20.18	16.41	12.42	9.29	7.84	8.47	11.01	14.78	18.76	21.90	23.35	(6
Appliance gains (calculated	in Append	ix L, equatio	on L13 or L	.13a), also s	ee Table 5							
246.39	248.94	242.50	228.78	211.47	195.20	184.33	181.7	7 188.21	201.93	219.24	235.52	(6
Cooking gains (calculated i	n Appendix	L, equation	L15 or L15	5a), also see	Table 5							
36.39	36.39	36.39	36.39	36.39	36.39	36.39	36.39	36.39	36.39	36.39	36.39	(6
Pump and fan gains (Table	5a)											-
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(7
Losses e.g. evaporation (Ta												١.
-107.10	-107.10	-107.10	-107.10	-107.10	-107.10	-107.10	0 -107.1	0 -107.10	-107.10	-107.10	-107.10	(7:
Water heating gains (Table												] (
78.37	76.10	71.39	64.99	60.83	54.97	50.01	56.38	58.65	65.28	72.75	76.11	(7:
Total internal gains (66)m	1					30.01	30.30	30.03	03.20	72.75	70.11	] (
413.63	411.38	396.47	372.36	347.75	324.17	308.97	315.3	2 327.80	352.13	380.06	401.14	(7:
413.03	411.30	350.47	372.30	347.73	324.17	300.57	313.3	2   327.60	332.13	_ 380.00	401.14	] (/:
6. Solar gains												
		Access f	actor	Area	Sc	olar flux		g	FF		Gains	
		Table	6d	m²	,	W/m²		ecific data	specific o		W	
							_	r Table 6b	or Table			,
NorthWest		0.7	7 x	6.68	_ x	11.28	x 0.9 x	0.63	x 0.70	=	23.03	(8:
SouthWest		0.7	7 x	4.04	x	36.79	x 0.9 x	0.63	x 0.70	=	45.43	(79
NorthEast		0.7	7 x	5.04	х	11.28	x 0.9 x	0.63	x 0.70	=	17.38	(7
Solar gains in watts ∑(74)n	n(82)m											
85.84	159.64	254.09	374.59	474.12	494.69	466.95	389.0	2 295.24	186.05	105.26	71.88	(8
Total gains - internal and s	olar (73)m +	- (83)m										
499.47	571.03	650.55	746.95	821.87	818.86	775.91	704.3	4 623.04	538.19	485.32	473.02	(8
7. Mean internal tempera												
Temperature during heatir		the living	area from	Table 9, Th	L(°C)						21.00	(8
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains	for living are	ea n1,m (se	e Table 9a	)								
1.00	1.00	0.99	0.97	0.90	0.74	0.58	0.65	0.89	0.99	1.00	1.00	(8
Mean internal temp of livir	ng area T1 (s	steps 3 to 7	in Table 9	c)								
19.69	19.83	20.08	20.44	20.75	20.94	20.99	20.98	20.83	20.43	20.00	19.67	(8
			_		_				_			

Page 3

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

	19.96	19.96	19.96	19.98	19.98	19.99	19.99	19.99	19.99	19.98	19.97	19.97	(8
Utilisation facto	r for gains f	or rest of d	welling n2,	m									_
	1.00	1.00	0.99	0.96	0.86	0.65	0.45	0.52	0.83	0.98	1.00	1.00	(8
Mean internal t	emperature	in the rest	of dwelling	g T2 (follow	steps 3 to	7 in Table 9	<del>)</del> c)						
	18.20	18.40	18.78	19.30	19.73	19.95	19.99	19.98	19.84	19.29	18.67	18.18	(9
Living area fract	ion								Li	ving area ÷	(4) =	0.21	(9:
Mean internal t	emperature	for the wh	ole dwellin	g fLA x T1 -	(1 - fLA) x	Γ2							
	18.52	18.71	19.06	19.55	19.95	20.16	20.20	20.20	20.05	19.54	18.95	18.50	(9
Apply adjustme	nt to the mo	ean interna	l temperati	ure from Ta	ble 4e whe	re appropr	iate						
	18.37	18.56	18.91	19.40	19.80	20.01	20.05	20.05	19.90	19.39	18.80	18.35	(9:
8. Space heati				_								_	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto													٦
	1.00	0.99	0.99	0.95	0.85	0.66	0.46	0.53	0.83	0.97	0.99	1.00	(9
Useful gains, ηn													,
	498.23	568.07	641.62	712.01	701.95	536.91	357.02	372.85	516.02	523.90	482.88	472.12	(9
Monthly averag													,
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(9)
Heat loss rate fo												1	7
	1529.99			1116.08	858.80	565.74	360.74	380.20	609.97	931.49	1248.44	1518.82	(9
Space heating re													7
	767.63	613.30	519.87	290.94	116.69	0.00	0.00	0.00	0.00	303.25	551.20	778.75	J
									∑(9	8)15, 10		3941.62	] (9i
Space heating re	equirement	. kWh/m²/y	ear							(98)	÷ (4)	41.90	(9
9a. Energy req	uirements -	individual	heating sy	stems inclu	iding micro	-CHP							
Space heating													
Fraction of space	e heat from	ı secondary	/suppleme	ntary syste	m (table 11	L)						0.00	(20
Fraction of space										1 - (2	01) =	1.00	(2
Fraction of space		-								,	<i>'</i> =	0.00	] (21
Fraction of total	I space heat	from main	system 1						(20	02) x [1- (20	3)] =	1.00	(20
Fraction of total										(202) x (2		0.00	] (2)
Efficiency of ma	-										· =	93.00	] (2)
,	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	٠, ٦
Space heating for	uel (main sy	stem 1), kV	Vh/month					-	-				
-	825.41	659.46	559.00	312.83	125.48	0.00	0.00	0.00	0.00	326.07	592.69	837.36	٦
									Σ(21	1)15, 10	.12 = 4	1238.30	] [2:
									۷,	,			_ (-
Water heating	tor hoster												
•													٦ ,,
Water heating Efficiency of wa		89.30	89.18	88.87	88.16	86.70	86.70	86.70	86.70	88.87	89.23	89.37	112
Efficiency of wa	89.35	89.30	89.18	88.87	88.16	86.70	86.70	86.70	86.70	88.87	89.23	89.37	(2
•	89.35		89.18	88.87 163.99	88.16 160.25	86.70	86.70	86.70 151.46	86.70 152.25	170.19	89.23	89.37 196.39	] (2: ]

Annual totals

Space heating fuel - main system 1

Water heating fuel

Electricity for pumps, fans and electric keep-hot (Table 4f)

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4238.30

2019.34

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central heating pump or water pump within warm air heating unit	30.00		(230c)
boiler flue fan	45.00		(230e)
Total electricity for the above, kWh/year		75.00	(231)
Electricity for lighting (Appendix L)		401.17	(232)
Total delivered energy for all uses (211)	(221) + (231) + (232)(237b) =	6733.81	(238)

10a. Fuel costs - individual heating systems including micro-CHP

Energy cost factor (ECF)

SAP rating (section 13)

SAP value

SAP band

· · · · · ·	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4238.30	x	3.48	x 0.01 =	147.49	(240)
Water heating	2019.34	x	3.48	x 0.01 =	70.27	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	401.17	x	13.19	x 0.01 =	52.91	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242) +	(245)(254) =	400.57	(255)
11a. SAP rating - individual heating systems including micro-CF	HP					
Energy cost deflator (Table 12)					0.42	(256)

12a. CO <sub>2</sub> emissions - individual heating systems including micro	o-CHP					
	Energy kWh/year		Emission factor kg CO <sub>2</sub> /kWh		Emissions kg CO <sub>2</sub> /year	
Space heating - main system 1	4238.30	x	0.216	=	915.47	(261)
Water heating	2019.34	x	0.216	=	436.18	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	1351.65	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	401.17	x	0.519	=	208.20	(268)
Total CO <sub>2</sub> , kg/year				(265)(271) =	1598.78	(272)
Dwelling CO₂ emission rate				(272) ÷ (4) =	16.99	(273)
El value					84.60	]
El rating (section 14)					85	(274)
EI band					В	

13a. Primary energy - individual heating systems includ	ing micro-CHP					
	Energy kWh/year		Primary factor		Primary Energy kWh/year	•
Space heating - main system 1	4238.30	x	1.22	=	5170.73	(261)
Water heating	2019.34	x	1.22	=	2463.60	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	7634.32	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	401.17	x	3.07	=	1231.58	(268)
Primary energy kWh/year					9096.15	(272)
Dwelling primary energy rate kWh/m2/year					96.69	(273)

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1.21

83.13

83

В

(258)

DER Worksheet As Built - Draft



This as built submission has been carried out using Approved SAP software. The assessor has confirmed any changes from the design submission with the builder

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 004 Oxford Road, Bodicaote, OX15		

Address	Plot 004 Oxf	ord Road, Bodio	aote, OX15								
1. Overall dwelling dimer	scions										
1. Overall uwening uniter	ISIUIIS		A	area (m²)			age storey ight (m)		Vo	lume (m³)	
Lowest occupied				76.93	(1a) x		2.39	(2a) =		183.86	(3a)
+1				74.93	(1b) x		2.61	(2b) =		195.57	(3b)
Total floor area	(1a) + (1	1b) + (1c) + (1d)	(1n) =	151.86	(4)						
Dwelling volume						(3a)	+ (3b) + (3	c) + (3d)(3	in) =	379.43	(5)
2 Vantilation vata											
2. Ventilation rate										³ per hour	
								1			7 (5.)
Number of chimneys							0	x 40 =		0	(6a)
Number of open flues							0	x 20 =		0	(6b)
Number of intermittent fa	15						0	x 10 = x 10 =		0	] (7a)
Number of passive vents Number of flueless gas fire							0	x 10 = x 40 =		0	] (7b) ] (7c)
Number of flueless gas fire	3						0	J X 40 -		changes pe	_ ` '
									Z.II .	hour	•
Infiltration due to chimney	s, flues, fans, P	SVs	(6a)	+ (6b) + (7	a) + (7b) + (1	7c) =	50	÷ (5) =		0.13	(8)
If a pressurisation test has	been carried ou	it or is intended	, proceed to (	17), otherw	ise continue	from (9) t	o (16)				
Air permeability value, q50	), expressed in o	cubic metres pe	r hour per squ	uare metre	of envelope	area				5.00	(17)
If based on air permeabilit	y value, then (1	8) = [(17) ÷ 20]	+ (8), otherwi	se (18) = (1	6)					0.38	(18)
Number of sides on which	the dwelling is	sheltered								2	(19)
Shelter factor							1 -	[0.075 x (1	9)] = [	0.85	(20)
Infiltration rate incorporat	ing shelter facto	or						(18) x (2	20) =	0.32	(21)
Infiltration rate modified for	or monthly wind	d speed:									
Jan		Mar Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind spe	ed from Table U	J2									_
5.10	5.00	4.90 4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4											7
1.28		1.23 1.10		0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (a											7
0.41		0.40 0.36		0.31	0.31	0.30	0.32	0.35	0.37	0.38	(22b)
Calculate effective air char	-									N1/0	7 (22.)
If mechanical ventilatio	=								H	N/A	(23a)
If balanced with heat re d) natural ventilation of	•	•	_		abie 4h					N/A	(23c)
					0.55	0.55	0.55	0.56	0.57	0.57	(244)
0.59	0.58	0.58 0.56	0.56	0.55	0.55	0.55	0.55	0.56	0.57	0.57	(24d)

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



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Element		ss paramete		Gross	Openings	Net	area	U-value	A x U W/	/K κ-value,	Ахк,	
			а	rea, m²	m²		m²	W/m²K		kJ/m².K	kJ/K	
Window						30	.66 x	1.24	= 37.89			(
Door						2.	02 x	1.30	= 2.63			(
Ground floor						76	.93 x	0.16	= 12.31			(
External wall						169	).11 x	0.20	= 33.82			(
Roof						74	.93 x	0.11	= 8.24			(
Roof						1.	32 x	0.19	= 0.25			(
Total area of ext	ernal elem	ents ∑A, m²				354	1.97					(
Fabric heat loss,	W/K = ∑(A	× U)							(26	)(30) + (32) = [	95.14	(
Heat capacity Cn	n = Σ(A x κ)	,						(28).	(30) + (32) +	(32a)(32e) = [	N/A	(
Thermal mass pa	arameter (1	īMP) in kJ/m	n²K								176.00	(
Thermal bridges:	: <u>Σ</u> (L x Ψ) c	alculated us	ing Appen	dix K							15.60	(
Total fabric heat	loss									(33) + (36) =	110.74	(
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct No	v Dec	
/entilation heat	loss calcula	ated monthl	ly 0.33 x (2	25)m x (5)								
	73.32	72.91	72.50	70.58	70.22	68.56	68.56	68.25	69.20	70.22 70.	95 71.71	(
Heat transfer co	efficient, W	V/K (37)m +	(38)m									
	184.06	183.65	183.24	181.32	180.96	179.29	179.29	178.99	179.94	180.96 181	.69 182.45	
									Average = ∑	(39)112/12 = [	181.32	(
Heat loss parame	eter (HLP),	W/m²K (39	)m ÷ (4)									
	1.21	1.21	1.21	1.19	1.19	1.18	1.18	1.18	1.18	1.19 1.2	1.20	
									Average = ∑	(40)112/12 = [	1.19	(
Number of days	in month (	Table 1a)										
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00 30.0	00 31.00	(
4 Mateu beetin		o viji o vo ov										
4. Water heatir		equirement								Γ	2.94	٦,
Assumed occupa	-	: !: !:		\/-l	(25 N)	26				L		( (
Annual average I	not water t Jan	usage in litre <b>Feb</b>	es per day Mar	_		Jun	Jul	Δυσ	Sep	Oct No	103.96 v Dec	(
Hot water usage				Apr	May			Aug	Sep	OCI NO	ov Dec	
iot water usage							-	07.72	104.00	100.03 110	40 44435	_
	114.35	110.19	106.03	101.88	97.72	93.56	93.56	97.72	101.88	106.03   110		=
	- <b>6</b>		014		2000 LAMb (		T-61 46	4 - 4 - 1		∑(44)112 = [	1247.46	(
nergy content o				_					1			_
	169.58	148.31	153.05	133.43	128.03	110.48	102.38	117.48	118.88	138.54   151		=
	0.45 /:-	,								∑(45)112 = [	1635.62	(
Distribution loss									1			_
	25.44	22.25	22.96	20.01	19.20	16.57	15.36	17.62	17.83	20.78 22.		(
storage volume		uding any so	olar or WW	/HRS storag	ge within san	ne vessel					170.00	(
Mator ctorace la										г		_
-			r is known	(kWh/day	)					ٳ	1.42	(
a) If manufacture		n Table 2b									0.54	(
a) If manufacture Temperature											0.77	(
Water storage lo  a) If manufacture  Temperature  Energy lost fr		storage (kW	'h/day) (48	8) x (49)						_	****	_
a) If manufacture Temperature	om water	storage (kW	'h/day) (48	8) x (49)							0.77	(
Temperature Energy lost fr	om water s											] (

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NHER Plan Assessor version 6.2.3 SAP version 9.92 he vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

If the vessel cont	ains dedica	ated solar s	torage or d	edicated W	/WHRS (56)	m x [(47) -	Vs] ÷ (47),	else (56)					
	23.77	21.47	23.77	23.00	23.77	23.00	23.77	23.77	23.00	23.77	23.00	23.77	(57)
Primary circuit lo	ss for each	month fro	m Table 3										
	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
Combi loss for ea	ch month	from Table	3a, 3b or 3	С									
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total heat requir	ed for wate	er heating o	alculated f	or each mo	onth 0.85 x	(45)m + (4	6)m + (57)r	n + (59)m +	(61)m				_
	216.61	190.80	200.08	178.95	175.06	156.00	149.41	164.51	164.40	185.58	196.75	211.26	(62)
Solar DHW input	calculated	using Appe	endix G or A	Appendix H									_
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
Output from wat	er heater f	or each mo	nth (kWh/i	month) (62	2)m + (63)m	1							_
	216.61	190.80	200.08	178.95	175.06	156.00	149.41	164.51	164.40	185.58	196.75	211.26	
										∑(64)1	.12 = 2	189.40	(64)
Heat gains from	water heat	ing (kWh/n	nonth) 0.25	5 × [0.85 ×	(45)m + (61	)m] + 0.8 ×	[(46)m + (5	57)m + (59)	m]				
	94.01	83.30	88.51	80.78	80.20	73.15	71.67	76.69	75.94	83.69	86.70	92.23	(65)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains	s (Table 5)												
	146.85	146.85	146.85	146.85	146.85	146.85	146.85	146.85	146.85	146.85	146.85	146.85	(66
Lighting gains (d	calculated in	Appendix	L, equation	L9 or L9a),	also see Ta	ble 5							
	28.93	25.69	20.90	15.82	11.83	9.98	10.79	14.02	18.82	23.90	27.89	29.73	(67
Appliance gains	(calculated	in Appendi	x L, equatio	on L13 or L1	13a), also se	ee Table 5							
	322.54	325.89	317.45	299.50	276.83	255.53	241.30	237.95	246.38	264.34	287.00	308.31	(68
												•	_
Cooking gains (	calculated in	Appendix	L, equation	L15 or L15	a), also see	Table 5							
Cooking gains (	calculated in 37.69	Appendix 37.69	L, equation 37.69	115 or L15 37.69	a), also see 37.69	Table 5 37.69	37.69	37.69	37.69	37.69	37.69	37.69	(69
'	37.69	37.69					37.69	37.69	37.69	37.69	37.69	37.69	(69
'	37.69	37.69					37.69	37.69	37.69	37.69	37.69	37.69	] (69) ] (70)
Pump and fan g	37.69 gains (Table !	37.69 5a) 3.00	37.69	37.69	37.69	37.69							,
Pump and fan g	37.69 gains (Table !	37.69 5a) 3.00	37.69	37.69	37.69	37.69							70
Pump and fan g Losses e.g. evap	37.69 gains (Table 9 3.00 poration (Tal -117.48	37.69 5a) 3.00 ble 5) -117.48	37.69	37.69	37.69	37.69	3.00	3.00	3.00	3.00	3.00	3.00	70
Cooking gains ( Pump and fan g Losses e.g. evap Water heating g	37.69 gains (Table 9 3.00 poration (Tal -117.48	37.69 5a) 3.00 ble 5) -117.48	37.69	37.69	37.69	37.69	3.00	3.00	3.00	3.00	3.00	3.00	,
Pump and fan g Losses e.g. evap	37.69 gains (Table 9 3.00 poration (Tal -117.48 gains (Table 126.36	37.69 5a) 3.00 ble 5) -117.48 5) 123.96	37.69 3.00 -117.48 118.97	37.69 3.00 -117.48	37.69 3.00 -117.48	37.69 3.00 -117.48	3.00	3.00	3.00	3.00	3.00	3.00	] (70 ] (71

6. Solar gains															
			Access f Table		Area m²		Solar flux W/m²		g specific or Tab		specif	F ic data ble 6c		Gains W	
NorthEast			0.7	7 x	12.24	_ x [	11.28	x 0.9 x	0.6	3	¢ 0.	70	= [	42.21	(75)
SouthWest			0.7	7 x	9.76	_ x [	36.79	x 0.9 x	0.6	3	¢ 0.	70	= [	109.75	(79)
SouthEast			0.7	7 x	1.50	_ x [	36.79	x 0.9 x	0.6	3	¢ 0.	70	= [	16.87	(77)
NorthWest			0.7	7 x	4.84	_ x [	11.28	x 0.9 x	0.6	3	¢ 0.	70	=	16.69	(81)
North			0.7	7 x	1.16	x	10.63	x 0.9 x	0.6	3	¢ 0.	70	=	3.77	(74)
South			0.7	7 x	1.16	_ x [	46.75	x 0.9 x	0.6	3	¢ 0.	70	= [	16.57	(78)
Solar gains in wa	tts ∑(74)m	(82)m													
	205.85	369.90	557.90	779.10	953.56	982.4	16 932.2	9 79	6.52	633.55	422.7	2 250	0.06	173.92	(83)
Total gains - inte	rnal and so	lar (73)m +	(83)m												
	753.74	915.50	1085.28	1276.66	1420.07	1419.	62 1350.7	75 122	21.62 1	1074.28	893.5	1 755	5.42	705.98	(84)

This part   This	emperature dur	_		_									21.00	(8
Rean internal temp of living area TI (steps 3 to 7 in Table 9c)  19.15 19.37 19.73 20.21 20.62 20.88 20.96 20.94 20.73 20.19 19.58 19.12 emperature during heating periods in the rest of dwelling from Table 9, Th2("C).  19.91 19.91 19.91 19.91 19.92 19.93 19.94 19.94 19.94 19.93 19.93 19.92 19.92 19.92 Publisation factor for gains for rest of dwelling n2, m  20.99 0.99 0.97 0.92 0.81 0.62 0.83 0.50 0.78 0.95 0.99 1.00 Atean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)  Atean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)  Atean internal temperature for the whole dwelling fLA x T1 + (1 - fLA) x T2  17.44 17.75 18.28 18.96 19.53 19.84 19.92 19.91 19.68 18.95 18.07 17.39 19.09 and internal temperature for the whole dwelling fLA x T1 + (1 - fLA) x T2  17.85 18.15 18.63 19.27 19.79 20.09 20.09 20.17 20.16 19.94 19.25 18.44 17.81 47.81		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tean internal temp of living area T1 (steps 3 to 7 in Table 9c)  19.15 19.37 19.37 20.21 20.62 20.88 20.96 20.94 20.73 20.19 19.58 19.12 emperature during heating periods in the rest of dwelling from Table 9, Th2("C):  19.91 19.91 19.91 19.91 19.92 19.93 19.94 19.94 19.94 19.93 19.93 19.93 19.92 19.92 19.92 tilisation factor for gains for rest of dwelling n2, m  20.99 0.99 0.97 0.92 0.81 0.62 0.43 0.50 0.78 0.95 0.99 10.00 dean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)  40.91 17.44 17.75 18.28 18.96 19.53 19.84 19.92 19.91 19.68 18.95 18.07 17.39 wing area fraction of gains for rest of twelling fLA x T1 +(1 + fLA) x T2  17.85 18.15 18.63 19.27 19.79 20.09 20.17 20.16 19.94 19.25 18.44 17.81 pply adjustment to the mean internal temperature from Table 4 where appropriate 17.70 18.00 18.48 19.12 19.64 19.94 20.02 20.01 19.79 19.10 18.29 17.66 18.95 18.40 17.81 pply adjustment to the mean internal temperature from Table 4 where appropriate 18.77 18.09 18.09 18.48 19.12 19.64 19.94 20.02 20.01 19.79 19.10 18.29 17.66 18.09 19.94 19.25 18.44 17.81 pply adjustment to the mean internal temperature from Table 4 where appropriate 18.77 18.09 18.00 18.48 19.12 19.64 19.94 20.02 20.01 19.79 19.10 18.29 17.66 18.99 19.90 19.9	tilisation factor	for gains f	or living are	a n1,m (se	e Table 9a)	<u> </u>								_
19.15   19.37   19.73   20.21   20.62   20.88   20.96   20.94   20.73   20.19   19.58   19.12   emperature during heating periods in the rest of dwelling from Table 9, Th2/CV   19.91   19.92   19.93   19.94   19.94   19.94   19.93   19.93   19.92   19.92   19.92   19.93   19.94   19.94   19.94   19.93   19.93   19.92   19.92   19.92   19.93   19.94   19.94   19.95   19.95   19.95   19.92   19.92   19.93   19.94   19.94   19.95   19.95   19.95   19.95   19.95   19.95   10.95   10.99   10.95   10.99   10.		1.00	0.99	0.98	0.94	0.85	0.70	0.55	0.62	0.84	0.97	0.99	1.00	(8
emperature during heating periods in the rest of dwelling from Table 9, Th2("C)"  1991 1991 1991 1992 1993 1994 1994 1994 1994 1993 1993 1999 1992 1999 1999 1999 1999	/lean internal te	mp of livin	g area T1 (s	teps 3 to 7	in Table 90	:)								_
Attilisation factor for gains for rest of dwelling n2    0.99		19.15	19.37	19.73	20.21	20.62	20.88	20.96	20.94	20.73	20.19	19.58	19.12	(8
Attilisation factor for gains for rest of dwelling n2    0.99	emperature dur	ing heatin	g periods in	the rest of	dwelling fi	rom Table 9	9, Th2(°C)							_
Near internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)   17.44   17.75   18.28   18.96   19.53   19.84   19.92   19.91   19.68   18.95   18.07   17.39     Near internal temperature for the whole dwelling ft.A x T1 + (1 - ft.A) x T2   17.85   18.15   18.63   19.27   19.79   20.09   20.17   20.16   19.94   19.25   18.44   17.81     Apply adjustment to the mean internal temperature from Table 4e where appropriate   17.70   18.00   18.48   19.12   19.64   19.94   20.02   20.01   19.79   19.10   18.29   17.66     S. Space heating requirement   Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct   Nov   Dec     Apply adjustment temperature from Table 4e where appropriate   17.70   18.00   18.48   19.12   19.64   19.94   20.02   20.01   19.79   19.10   18.29   17.66     S. Space heating requirement   Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct   Nov   Dec     Apply adjustment temperature from Table 4th   19.94   19.94   19.94   19.94   19.94   19.95   19.10   18.29   17.66     S. Space heating requirement   T.	[	19.91	19.91	19.91	19.92	19.93	19.94	19.94	19.94	19.93	19.93	19.92	19.92	(8
Are an intermal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)    17.44   17.75   18.28   18.96   19.53   19.84   19.92   19.91   19.68   18.95   18.07   17.39	Jtilisation factor	for gains f	or rest of d	welling n2,	m									
Living area $\div$ (4) = 0.24  Mean internal temperature for the whole dwelling fLA x T1 + (1 - fLA) x T2  17.85   18.15   18.63   19.27   19.79   20.09   20.17   20.16   19.94   19.25   18.44   17.81  Apply adjustment to the mean internal temperature from Table 4e where appropriate  17.70   18.00   18.48   19.12   19.64   19.94   20.02   20.01   19.79   19.10   18.29   17.66  8. Space heating requirement  Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct   Nov   Dec  2. Still gains, nym (3) = 0.99   0.98   0.96   0.91   0.79   0.62   0.44   0.50   0.77   0.94   0.98   0.99    3. Seful gains, nym (4) = 0.99   0.98   0.96   0.91   0.79   0.62   0.44   0.50   0.77   0.94   0.98   0.99    3. Seful gains, nym (74.712   899.35   1043.30   1157.14   1126.88   873.84   595.92   616.89   827.30   840.21   743.42   701.06    4. 30   4.90   6.50   8.90   11.70   14.60   16.60   16.40   14.10   10.60   7.10   4.20    4. 43   4.90   4.90   6.50   8.90   11.70   14.60   16.60   16.40   14.10   10.60   7.10   4.20    4. 43   4.90   4.90   6.50   8.90   11.70   14.60   16.50   16.40   14.10   10.60   7.10   4.20    4. 4267.28   2405.27   2195.58   1852.62   1437.30   957.60   613.55   645.91   1023.79   1538.29   2033.26   2455.98    4. 49   4.90   4.90   4.90   4.90   4.90   4.90   4.90   4.90   4.90    4. 40   4.90   4.90   4.90   4.90   4.90   4.90   4.90    4. 40   4.90   4.90   4.90   4.90   4.90   4.90   4.90    4. 40   4.90   4.90   4.90   4.90   4.90   4.90    4. 40   4.90   4.90   4.90   4.90   4.90    4. 40   4.90   4.90   4.90   4.90    4. 40   4.90   4.90   4.90   4.90    4. 40   4.90   4.90   4.90   4.90    4. 40   4.90   4.90   4.90   4.90    4. 40   4.90   4.90   4.90    4. 40   4.90   4.90   4.90    4. 40   4.90   4.90   4.90    4. 40   4.90   4.90   4.90    4. 40   4.90   4.90   4.90    4. 40   4.90   4.90   4.90    4. 40   4.90   4.90   4.90    4. 40   4.90   4.90   4.90    4. 40   4.90   4.90   4.90    4. 40   4.90   4.90   4.90    4. 40   4.90   4.90   4.90    4. 40   4.90   4.90   4.90    4. 40   4.9		0.99	0.99	0.97	0.92	0.81	0.62	0.43	0.50	0.78	0.95	0.99	1.00	(8
Living area ÷ (4) =   0.24       0.24	∕lean internal te	mperature	in the rest	of dwelling	T2 (follow	steps 3 to	7 in Table 9	ec)						
Mean internal temperature for the whole dwelling fLA x T1 +{1 - fLA} x T2    17.85	[	17.44	17.75	18.28	18.96	19.53	19.84	19.92	19.91	19.68	18.95	18.07	17.39	(9
17.85 18.15 18.63 19.27 19.79 20.09 20.17 20.16 19.94 19.25 18.44 17.81 apply adjustment to the mean internal temperature from Table 4e where appropriate    17.70 18.00 18.48 19.12 19.64 19.94 20.02 20.01 19.79 19.10 18.29 17.66    8. Space heating requirements    Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec    Utilisation factor for gains, nm    0.99 0.98 0.96 0.91 0.79 0.62 0.44 0.50 0.77 0.94 0.98 0.99    0.99 0.98 10.43.00 1157.14 1126.88 873.84 595.92 616.89 827.30 840.21 743.42 701.06    Anothly average external temperature from Table U1    4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20    teat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (95)m]    2467.28 2405.27 2195.58 1852.62 1437.30 957.60 613.55 645.91 1023.79 1538.29 2033.26 2455.98    pace heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m    1279.80 1011.98 857.29 500.74 230.95 0.00 0.00 0.00 0.00 519.37 928.68 1305.67    29a. Energy requirements + individual heating systems including micro-CHP    pace heating requirement kWh/m³/year    (98) ± (1) 1.00    raction of space heat from main system 2    raction of space heat from main system 2    raction of total space heat from main system 2    raction of total space heat from main system 2    raction of total space heat from main system 2    raction of total space heat from main system 2    raction of total space heat from main system 2    raction of total space heat from main system 2    raction of total space heat from main system 1    (202) x [1-(203)] =    0.00    93.00    10.00    1	iving area fraction	on								Liv	ving area ÷	(4) =	0.24	(9
spiply adjustment to the mean internal temperature from Table 4e where appropriate  17.70   18.00   18.48   19.12   19.64   19.94   20.02   20.01   19.79   19.10   18.29   17.66  8. Space heating requirement  Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct   Nov   Dec Italisation factor for gains, nm  0.99   0.98   0.96   0.91   0.79   0.62   0.44   0.50   0.77   0.94   0.98   0.99   0.98   0.99   0.98   0.99   0.98   0.99   0.98   0.91   0.79   0.62   0.44   0.50   0.77   0.94   0.98   0.99	∕lean internal te	mperature	for the wh	ole dwellin	g fLA x T1 +	+(1 - fLA) x ¹	T2							
8. Space heating requirement    17.70		17.85	18.15	18.63	19.27	19.79	20.09	20.17	20.16	19.94	19.25	18.44	17.81	(9
Second   S	Apply adjustmen	t to the me	ean internal	l temperati	ıre from Ta	ble 4e whe	ere appropr	iate						
Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct   Nov   December		17.70	18.00	18.48	19.12	19.64	19.94	20.02	20.01	19.79	19.10	18.29	17.66	(9
State   Stat														_
Utilisation factor for gains, nm    0.99   0.98   0.96   0.91   0.79   0.62   0.44   0.50   0.77   0.94   0.98   0.99	8. Space heating	g requiren	ent											
0.99 0.98 0.96 0.91 0.79 0.62 0.44 0.50 0.77 0.94 0.98 0.99  Useful gains, nmGm, W (94)m x (84)m  747.12 899.35 1043.30 1157.14 1126.88 873.84 595.92 616.89 827.30 840.21 743.42 701.06  Monthly average external temperature from Table U1  4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20  deat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m])  2467.28 2405.27 2195.58 1852.62 1437.30 957.60 613.55 645.91 1023.79 1538.29 2033.26 2455.98  Upace heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m  1279.80 1011.98 857.29 500.74 230.95 0.00 0.00 0.00 0.00 519.37 928.68 1305.67  Space heating requirement kWh/m²/year  (98) ÷ (4) 43.69  93. Energy requirements - individual heating systems including micro-CHP  Upace heating requirements - individual heating systems including micro-CHP  Upace heating requirements - individual heating systems including micro-CHP  Upace heating requirements - individual heating systems including micro-CHP  Upace heating requirements - individual heating systems including micro-CHP  Upace heating requirements - individual heating systems including micro-CHP  Upace heat from main system 1  (202) x [1- (203)] = 1.00  Upace heating requirements - individual heating systems 1  (202) x [1- (203)] = 1.00  Upace heating requirements - individual heating systems 1  (202) x [1- (203)] = 0.00  Upace heating requirements - individual heating systems 1  (202) x [1- (203)] = 0.00  Upace heating requirements - individual heating systems 1  (202) x [1- (203)] = 0.00  Upace heating requirements - individual heating systems 1  (202) x [1- (203)] = 0.00  Upace heating requirements - individual heating systems 1  (202) x [1- (203)] = 0.00  Upace heating requirements - individual heating systems 1  (202) x [1- (203)] = 0.00  Upace heating requirements - individual heating systems 1  (202) x [1- (203)] = 0.00  Upace heating requirements - individual heating systems 1  (202) x [1- (203)] = 0.00  Upace heating requirements - individual heating systems 1  (202) x [1-		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Seeful gains, nmGm, W (94)m x (84)m   T47.12   899.35   1043.30   1157.14   1126.88   873.84   595.92   616.89   827.30   840.21   743.42   701.06	Itilisation factor	for gains,	ηm											
747.12   899.35   1043.30   1157.14   1126.88   873.84   595.92   616.89   827.30   840.21   743.42   701.06     Monthly average external temperature from Table U1   4.30		0.99	0.98	0.96	0.91	0.79	0.62	0.44	0.50	0.77	0.94	0.98	0.99	(9
Anothly average external temperature from Table U1  4.30	Jseful gains, ηm	Gm, W (94	l)m x (84)m	ı										
4.30		747.12	899.35	1043.30	1157.14	1126.88	873.84	595.92	616.89	827.30	840.21	743.42	701.06	(9
leat loss rate for mean internal temperature, Lm, W [(93)m x [(93)m x [(93)m - (96)m]]  2467.28	Monthly average	external t	emperature	from Table	e U1									
2467.28 2405.27 2195.58 1852.62 1437.30 957.60 613.55 645.91 1023.79 1538.29 2033.26 2455.98 pace heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m  1279.80 1011.98 857.29 500.74 230.95 0.00 0.00 0.00 519.37 928.68 1305.67    26634.49 pace heating requirement kWh/m²/year (98) ÷ (4) 43.69    92. Energy requirements - individual heating systems including micro-CHP    1279.80 1011.98 857.29 500.74 230.95 0.00 0.00 0.00 0.00 519.37 928.68 1305.67    269815, 1012 = 6634.49    43.69    92. Energy requirements - individual heating systems including micro-CHP    1279.80 1011.98 857.29 500.74 230.95 0.00 0.00 0.00 0.00 0.00 519.37 928.68 1305.67    269815, 1012 = 6634.49    43.69    93.00    1 - (201) = 1.00    1 - (201	[	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(9
pace heating requirement, kWh/month	leat loss rate for	mean inte	ernal tempe	erature, Lm	, W [(39)m	ı x [(93)m -	(96)m]							
1279.80 1011.98 857.29 500.74 230.95 0.00 0.00 0.00 519.37 928.68 1305.67  Σ(98)15, 1012 = 6634.49  space heating requirement kWh/m²/year  9a. Energy requirements - individual heating systems including micro-CHP  space heating  reaction of space heat from secondary/supplementary system (table 11)  reaction of space heat from main system(s)  reaction of space heat from main system 2  reaction of total space heat from main system 1  (202) x [1-(203)] = 1.00  reaction of total space heat from main system 2  reaction of total space heat from main system 2  (202) x (203) = 0.00  1 - (201) = 1.00		2467.28	2405.27	2195.58	1852.62	1437.30	957.60	613.55	645.91	1023.79	1538.29	2033.26	2455.98	(9
	pace heating re	quirement	, kWh/mon	th 0.024 x	[(97)m - (9	5)m] x (41)	m							_
Space heating requirement kWh/m²/year (98) $\div$ (4) $43.69$ 9a. Energy requirements - individual heating systems including micro-CHP  Space heating  Fraction of space heat from secondary/supplementary system (table 11) $0.00$ Fraction of space heat from main system(s) $1 - (201) = 1.00$ Fraction of space heat from main system 2 $0.00$ Fraction of total space heat from main system 1 $0.00$ Fraction of total space heat from main system 2 $0.00$ Fraction of total space h		1279.80	1011.98	857.29	500.74	230.95	0.00	0.00	0.00	0.00	519.37	928.68	1305.67	7
Space heating requirement kWh/m²/year (98) $\div$ (4) $43.69$ 9a. Energy requirements - individual heating systems including micro-CHP  Space heating  Fraction of space heat from secondary/supplementary system (table 11) $0.00$ Fraction of space heat from main system(s) $1 - (201) = 1.00$ Fraction of space heat from main system 2 $0.00$ Fraction of total space heat from main system 1 $0.00$ Fraction of total space heat from main system 2 $0.00$ Fraction of total space h	ı							7		Σ(98	3)15. 10	.12 = (	6634.49	_     
9a. Energy requirements - individual heating systems including micro-CHP  ipace heating  fraction of space heat from secondary/supplementary system (table 11)  fraction of space heat from main system(s)  fraction of space heat from main system 2  fraction of total space heat from main system 1  fraction of total space heat from main system 1  fraction of total space heat from main system 2  fraction of total space heat from m	Space heating re	auirement	kWh/m²/ve	ear						_,				(9
pace heating  Fraction of space heat from secondary/supplementary system (table 11)  Fraction of space heat from main system(s)  Fraction of space heat from main system(s)  Fraction of space heat from main system 2  Fraction of total space heat from main system 1  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 1  Fraction of total space heat from main system 1  Fraction of total space heat from main system 2  Fraction of tota	,	,	,,,,								(00)	. ( . )		_ (-
Fraction of space heat from secondary/supplementary system (table 11)	9a. Energy requ	irements -	individual	heating sys	tems inclu	iding micro	-CHP							
Fraction of space heat from main system(s) $1 - \{201\} = \boxed{1.00}$ Fraction of space heat from main system 2 $\{202\} \times [1 - \{203\}] = \boxed{1.00}$ Fraction of total space heat from main system 1 $\{202\} \times [203] \times [203] = \boxed{0.00}$ Fifticiency of main system 1 (%) $\boxed{93.00}$ If the probability of main system 1 (%) $\boxed{93.00}$ For the probability of main system 2 (%) $\boxed{93.00}$ The probability of main system 1 (%) $\boxed{93.00}$ The probability of main system 2 (%) $\boxed{93.00}$ The probability of main system 3 (%) $93.00$	pace heating													
Fraction of space heat from main system 2 $ (202) \times [1 - (203)] = 1.00 $ Fraction of total space heat from main system 1 $ (202) \times (203) \times (203) = 0.00 $ Fraction of total space heat from main system 2 $ (202) \times (203) \times (203) = 0.00 $ Fifticiency of main system 1 (%) $ 93.00 $ Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	raction of space	heat from	secondary	/supplemer	ntary syste	m (table 11	1)						0.00	(2
Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00  Fraction of total space heat from main system 2 (202) x (203) = 0.00  Fifticiency of main system 1 (%) 93.00  Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	raction of space	heat from	main syste	m(s)							1 - (20	01) =	1.00	(2
Fraction of total space heat from main system 2 (202) x (203) = 0.00  Efficiency of main system 1 (%) 93.00	raction of space	heat from	main syste	m 2									0.00	(2
raction of total space heat from main system 2 (202) x (203) = 0.00    Gradient   Gradie	raction of total s	space heat	from main	system 1						(20	)2) x [1- (20	3)] =	1.00	(2
fficiency of main system 1 (%)  Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec												=		] (2
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec		-										·		] (2
				Mar	Apr	Mav	Jun	Jul	Aug	Sen	Oct	Nov		J (~
pace nearing root (main system ±), kwin/month	nace heating fu					,								
1376.13 1088.15 921.82 538.43 248.34 0.00 0.00 0.00 0.00 558.46 998.58 1403.94	pace nearing lui				539 43	248 24	0.00	0.00	0.00	0.00	559 46	000 50	1403.94	٦
		13/0.13	1088.15	921.82	336.43	246.34	0.00	0.00	0.00					=
Σ(211)15, 1012 = 7133.86  Vater heating	l													(2

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	88.28	88.11	87.76	86.91	85.05	79.30	79.30	79.30	79.30	86.91	87.93	88.34	(217)
Water heating fu	uel, kWh/m	onth											
	245.38	216.53	227.99	205.89	205.83	196.72	188.41	207.45	207.31	213.52	223.77	239.15	
										∑(219a)1	.12 = 2	577.95	(219)
Annual totals													
Space heating fu	el - main sy	stem 1									7	133.86	]
Water heating fu	ıel										2	577.95	]
Electricity for pu	mps, fans a	ind electric	keep-hot (	Table 4f)									
central heatir	ng pump or	water pun	np within w	arm air hea	ating unit				30.00	]			(230c)
boiler flue far	n								45.00	]			(230e
Total electricity f	for the abov	ve, kWh/ye	ar									75.00	(231)
Electricity for ligi	hting (Appe	endix L)										510.90	(232)

10a. Fuel costs - individual heating systems including micro-C	HP					
	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	7133.86	x	3.48	x 0.01 =	248.26	(240)
Water heating	2577.95	x	3.48	x 0.01 =	89.71	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	510.90	x	13.19	x 0.01 =	67.39	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242)	+ (245)(254) =	535.25	(255)

Total delivered energy for all uses

Energy cost deflator (Table 12)       0.42 (256)         Energy cost factor (ECF)       1.14 (257)         SAP value       84.07         SAP rating (section 13)       84 (258)	11a. SAP rating - individual heating systems including micro-CHP		
SAP value         84.07           SAP rating (section 13)         84         (258)	Energy cost deflator (Table 12)	0.42 (256)	
SAP rating (section 13) 84 (258)	Energy cost factor (ECF)	1.14 (257)	
	SAP value	84.07	
	SAP rating (section 13)	84 (258)	
SAP band	SAP band	В	

12a. CO <sub>2</sub> emissions - individual heating systems including micro-CHP								
	Energy kWh/year		Emission factor kg CO <sub>2</sub> /kWh		Emissions kg CO <sub>2</sub> /year			
Space heating - main system 1	7133.86	x	0.216	= [	1540.91	(261)		
Water heating	2577.95	x	0.216	= [	556.84	(264)		
Space and water heating			(261) + (262) +	(263) + (264) =	2097.75	(265)		
Pumps and fans	75.00	x	0.519	= [	38.93	(267)		
Electricity for lighting	510.90	x	0.519	= [	265.16	(268)		
Total CO <sub>2</sub> , kg/year				(265)(271) =	2401.83	(272)		
Dwelling CO₂ emission rate				(272) ÷ (4) =	15.82	(273)		
El value				[	83.65	]		
El rating (section 14)				[	84	(274)		
El band					В	]		

13a. Primary energy - individual heating systems including micro-CHP									
	Energy kWh/year		Primary factor		Primary Energy kWh/year				
Space heating - main system 1	7133.86	x	1.22	=	8703.30 (261)				
Water heating	2577.95	x	1.22	=	3145.09 (264)				

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(211)...(221) + (231) + (232)...(237b) = 10297.70 (238)

11848.40 (265) (261) + (262) + (263) + (264) = Space and water heating 75.00 3.07 230.25 Pumps and fans 510.90 Electricity for lighting 3.07 1568.47 Primary energy kWh/year 13647.12 (272) Dwelling primary energy rate kWh/m2/year 89.87

**DER Worksheet** Design - Draft

(267)

(268)



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 007 Oxford Road, Bodicaote, OX15		

1. Overall dwelling o	dimen	sions											
					А	rea (m²)			Average storey height (m)		Vo	olume (m³)	
Lowest occupied						57.64	(1a)	x	2.38	(2a) =		137.18	(3a)
+1						57.16	(1b)	x	2.61	(2b) =		149.19	(3b)
Total floor area		(1a)	+ (1b) + (1	c) + (1d)(	1n) =	114.80	(4)						
Dwelling volume									(3a) + (3b) + (3	c) + (3d)(3	3n) =	286.37	(5)
2. Ventilation rate													
										,		<sup>3</sup> per hour	_
Number of chimneys									0	x 40 =	:	0	(6a)
Number of open flues	5								0	x 20 =	· <u>L</u>	0	(6b)
Number of intermitte	nt fan	S							5	x 10 =	· <u>L</u>	50	(7a)
Number of passive ve	ents								0	x 10 =	· <u>L</u>	0	(7b)
Number of flueless ga	as fires	5							0	x 40 =		0	(7c)
											Air	changes pe	er
Infiltration due to chi	mnevs	s. flues. fans	. PSVs		(6a)	+ (6b) + (7	a) + (7b)	+ (7c) =	50	÷ (5) =		0.17	(8)
If a pressurisation tes				ntended, pi									
Air permeability value	e, q50,	expressed	in cubic m	etres per h	our per squ	are metre	of envelo	ope are	a			5.00	(17)
If based on air perme												0.42	(18)
Number of sides on w						. , .						1	(19)
Shelter factor									1 -	[0.075 x (1	9)1 =	0.93	(20)
Infiltration rate incorp	ooratii	ng shelter fa	actor							(18) x (2		0.39	(21)
Infiltration rate modif		ŭ		:						(==) (=	-, <u></u>		
	an	Feb	Mar	Apr	May	Jun	Jul		Aug Sep	Oct	Nov	Dec	
Monthly average win	d spee	ed from Tab	le U2										
5	.10	5.00	4.90	4.40	4.30	3.80	3.80	3	3.70 4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1												
1	.28	1.25	1.23	1.10	1.08	0.95	0.95		0.93 1.00	1.08	1.13	1.18	(22a
Adjusted infiltration r	ate (a	llowing for:	shelter and	d wind facto	or) (21) x (2	2a)m							
_	.50	0.49	0.48	0.43	0.42	0.37	0.37		0.36 0.39	0.42	0.44	0.46	(22b
ت Calculate effective air							1 2.37					1 20	
If mechanical vent		=										N/A	(23a
If balanced with h		_				ctor from T	able 4h					N/A	(230
d) natural ventilat		•	-	_								,	,
	.63	0.62	0.62	0.59	0.59	0.57	0.57		0.57 0.58	0.59	0.60	0.61	(240
	.05	0.02	0.02	0.55	0.55	0.57	1 0.37		, 0.36	0.55	0.00	0.01	(240

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



3. Heat losses a	and heat lo	ss paramet	ter										
Element			а	Gross irea, m²	Opening: m²	s Net		U-value W/m²K	AxUW		/alue, /m².K	Ахк, kJ/K	
Window						28	.59 x [	1.24	= 35.33				(2
Door						2.0	03 x [	1.30	= 2.64				(2
Ground floor						57.	.64 x [	0.15	= 8.65				(2
External wall						124	.15 x [	0.21	= 26.07				(2
Roof						57.	.16 x [	0.11	= 6.29				(3
Roof						0.4	47 x [	0.21	= 0.10				(3
Total area of ext	ternal elem	ents ∑A, m²	2			270	0.04						(3
Fabric heat loss,	W/K = ∑(A	× U)							(26	5)(30) + (	32) =	79.07	(3
Heat capacity Cn	m = ∑(A x κ)	)						(28)	.(30) + (32) +	(32a)(3	2e) =	N/A	(3
Thermal mass pa	arameter (1	TMP) in kJ/n	m²K									191.00	(3
Thermal bridges	:: Σ(L x Ψ) c	alculated us	sing Appen	dix K								13.80	(3
Total fabric heat	t loss									(33) + (	36) =	92.87	(3
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat	loss calcula	ated month	nly 0.33 x (	25)m x (5)									
	59.10	58.64	58.19	56.07	55.67	53.83	53.83	53.49	54.54	55.67	56.48	57.31	(3
Heat transfer co	efficient, W	V/K (37)m +	+ (38)m										
	151.97	151.51	151.06	148.94	148.54	146.70	146.70	146.36	147.41	148.54	149.35	150.18	]
									Average = ∑	(39)112,	/12 =	148.94	(3
Heat loss parame	eter (HLP),	W/m <sup>2</sup> K (39	9)m ÷ (4)										
	1.32	1.32	1.32	1.30	1.29	1.28	1.28	1.27	1.28	1.29	1.30	1.31	
									Average = ∑	(40)112	/12 =	1.30	(4
Number of days	in month (	Table 1a)											
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(4
4. Water heatir		requiremen	it										
Assumed occupa												2.84	(4
Annual average I	hot water i												٦.
		-		_				_	_			101.67	(4
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	101.67 Dec	(4
Hot water usage	in litres pe	Feb er day for ea	Mar ach month	Apr Vd,m = fact	May tor from Tal	Jun ble 1c x (43	)					Dec	] (4
Hot water usage		Feb	Mar	Apr	May	Jun		<b>Aug</b> 95.57	<b>Sep</b> 99.63	103.70	107.77	Dec 111.84	]
	in litres pe	Feb er day for ea	Mar ach month	<b>Apr</b> Vd,m = fact 99.63	May for from Tal 95.57	Jun ble 1c x (43 91.50	91.50	95.57			107.77	Dec	(4
Hot water usage	in litres pe	Feb er day for ea 107.77 er used = 4.1	Mar ach month 103.70	Apr Vd,m = fact 99.63	May for from Tal 95.57 8600 kWh/r	Jun ble 1c x (43 91.50 month (see	91.50 Tables 1b,	95.57 1c 1d)	99.63	103.70 Σ(44)1	107.77	Dec 111.84 1220.02	]
	in litres pe	Feb er day for ea	Mar ach month	<b>Apr</b> Vd,m = fact 99.63	May for from Tal 95.57	Jun ble 1c x (43 91.50	91.50	95.57		103.70 Σ(44)1 135.50	107.77	Dec 111.84 1220.02 160.62	] ] [ ]
Energy content o	111.84 of hot wate	Feb er day for ea 107.77 er used = 4.1 145.05	Mar ach month 103.70	Apr Vd,m = fact 99.63	May for from Tal 95.57 8600 kWh/r	Jun ble 1c x (43 91.50 month (see	91.50 Tables 1b,	95.57 1c 1d)	99.63	103.70 Σ(44)1	107.77	Dec 111.84 1220.02	]
	in litres per 111.84 of hot water 165.85	Feb er day for ea 107.77 er used = 4.1 145.05	Mar ach month 103.70 18 x Vd,m x 149.68	Apr Vd,m = fact 99.63  c nm x Tm/3 130.50	May for from Tal 95.57 8600 kWh/r 125.21	Jun ble 1c x (43 91.50  month (see 108.05	91.50 Tables 1b,	95.57 1c 1d) 114.89	99.63	103.70 Σ(44)1 135.50 Σ(45)1	107.77 .12 =	Dec 1111.84 1220.02 1599.64	(4
Energy content of Distribution loss	e in litres pe 111.84 of hot wate 165.85 6 0.15 x (45 24.88	Feb er day for ea 107.77 er used = 4.1 145.05  5)m 21.76	Mar ach month 103.70 18 x Vd,m > 149.68	Apr Vd,m = fact 99.63  c nm x Tm/3 130.50	May for from Tal 95.57 8600 kWh/r 125.21	Jun ble 1c x (43 91.50 month (see 108.05	91.50 Tables 1b,	95.57 1c 1d)	99.63	103.70 Σ(44)1 135.50	107.77	Dec 1111.84 1220.02 160.62 1599.64 24.09	(4
Energy content of Distribution loss	e in litres per 111.84	Feb er day for ea 107.77 er used = 4.1 145.05  5)m 21.76	Mar ach month 103.70 18 x Vd,m > 149.68	Apr Vd,m = fact 99.63  c nm x Tm/3 130.50	May for from Tal 95.57 8600 kWh/r 125.21	Jun ble 1c x (43 91.50 month (see 108.05	91.50 Tables 1b,	95.57 1c 1d) 114.89	99.63	103.70 Σ(44)1 135.50 Σ(45)1	107.77 .12 =	Dec 1111.84 1220.02 1599.64	(4
Energy content of Distribution loss Storage volume (	111.84  of hot water  165.85  0.15 x (45)  24.88  (litres) includes:	Feb er day for ea 107.77 107.77 145.05 145.05 176 176 176 176 176 176 176 176 176 176	Mar ach month 103.70 18 x Vd,m x 149.68	Apr Vd,m = fact 99.63  x nm x Tm/3 130.50  19.57  /HRS storage	May tor from Tal 95.57 95.57 125.21 18.78 te within said	Jun ble 1c x (43 91.50 month (see 108.05	91.50 Tables 1b,	95.57 1c 1d) 114.89	99.63	103.70 Σ(44)1 135.50 Σ(45)1	107.77 .12 =	Dec 1111.84 1220.02 160.62 1599.64 24.09 250.00	(4
Energy content of Distribution loss Storage volume ( Water storage lo	e in litres per 111.84 of hot water 165.85 of 0.15 x (45 24.88 (litres) includes:	Feb ar day for each 107.77 107	Mar ach month 103.70 18 x Vd,m x 149.68	Apr Vd,m = fact 99.63  x nm x Tm/3 130.50  19.57  /HRS storage	May tor from Tal 95.57 95.57 125.21 18.78 te within said	Jun ble 1c x (43 91.50 month (see 108.05	91.50 Tables 1b,	95.57 1c 1d) 114.89	99.63	103.70 Σ(44)1 135.50 Σ(45)1	107.77 .12 =	111.84   1220.02   160.62   1599.64   24.09   250.00	(4
Energy content of Distribution loss Storage volume   Water storage lo a) If manufactur Temperature	e in litres per 111.84  of hot water 165.85  of 0.15 x (45) 24.88 ((litres) includes: er's declare er actor from the control of the control o	Feb rday for each 107.77 107.7	Mar ach month 103.70  18 x Vd,m x 149.68  22.45 olar or WW	Apr Vd,m = fact 99.63  nm x Tm/3 130.50  19.57  VHRS storage i (kWh/day)	May tor from Tal 95.57 95.57 125.21 18.78 te within said	Jun ble 1c x (43 91.50 month (see 108.05	91.50 Tables 1b,	95.57 1c 1d) 114.89	99.63	103.70 Σ(44)1 135.50 Σ(45)1	107.77 .12 =	Dec  111.84  1220.02  160.62  1599.64  24.09  250.00  1.67  0.54	(4)
Energy content of Distribution loss Storage volume I Water storage loa) If manufactur Temperature Energy lost fr	e in litres per 111.84  of hot wate 165.85  of 0.15 x (45) 24.88 (litres) inclusives: er's declare e factor from water se	Feb rday for each 107.77 107.7	Mar ach month 103.70  18 x Vd,m x 149.68  22.45 olar or WW	Apr Vd,m = fact 99.63  nm x Tm/3 130.50  19.57  VHRS storage i (kWh/day)	May tor from Tal 95.57 95.57 125.21 18.78 te within said	Jun ble 1c x (43 91.50 month (see 108.05	91.50 Tables 1b,	95.57 1c 1d) 114.89	99.63	103.70 Σ(44)1 135.50 Σ(45)1	107.77 .12 =	111.84   1220.02   160.62   1599.64   24.09   250.00   1.67   0.54   0.90	(4
Energy content of Distribution loss Storage volume I Water storage loa) If manufactur. Temperature Energy lost fr Enter (50) or (54	e in litres per 111.84  of hot water 165.85  of 0.15 x (45)  24.88 (litres) incluses: er's declare e factor from water self.) in (55)	Feb er day for ea 107.77 107.7	Mar ach month 103.70  18 x Vd,m x 149.68  22.45  olar or WW  or is known	Apr Vd,m = fact 99.63  x nm x Tm/3 130.50  19.57  /HRS storag i (kWh/day) 8) x (49)	May tor from Tal 95.57 95.57 125.21 18.78 te within said	Jun ble 1c x (43 91.50 month (see 108.05	91.50 Tables 1b,	95.57 1c 1d) 114.89	99.63	103.70 Σ(44)1 135.50 Σ(45)1	107.77 .12 =	Dec  111.84  1220.02  160.62  1599.64  24.09  250.00  1.67  0.54	(4)
Energy content of Distribution loss Storage volume I Water storage loa) If manufacture Temperature Energy lost fr	e in litres per 111.84  of hot water 165.85  of 0.15 x (45)  24.88 (litres) incluses: er's declare e factor from water self.) in (55)	Feb er day for ea 107.77 107.7	Mar ach month 103.70  18 x Vd,m x 149.68  22.45  olar or WW  or is known	Apr Vd,m = fact 99.63  x nm x Tm/3 130.50  19.57  /HRS storag i (kWh/day) 8) x (49)	May tor from Tal 95.57 95.57 125.21 18.78 te within said	Jun ble 1c x (43 91.50 month (see 108.05	91.50 Tables 1b,	95.57 1c 1d) 114.89	99.63	103.70 Σ(44)1 135.50 Σ(45)1	107.77 .12 =	111.84   1220.02   160.62   1599.64   24.09   250.00   1.67   0.54   0.90	

0.62 0.59 0.59 0.57 0.57 0.57 0.58 0.59 0.60 0.61 (25)

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NHER Plan Assessor version 6.2.3 SAP version 9.92 If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) 27.96 | 25.25 | 27.96 | 27.05 | 27.96 | 27.05 | 27.96 | 27.05 | 27.96 | 27.05 | 27.96 | 27.05 | 27.96 | (57) Primary circuit loss for each month from Table 3 23.26 21.01 23.26 22.51 23.26 22.51 23.26 23.26 22.51 23.26 22.51 23.26 (59) Combi loss for each month from Table 3a, 3b or 3c 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 (61) Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m 217.07 | 191.31 | 200.90 | 180.06 | 176.43 | 157.62 | 151.34 | 166.11 | 165.83 | 186.71 | 197.47 | 211.83 | (62) Solar DHW input calculated using Appendix G or Appendix H 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 (63) Output from water heater for each month (kWh/month) (62)m + (63)m 217.07 | 191.31 | 200.90 | 180.06 | 176.43 | 157.62 | 151.34 | 166.11 | 165.83 | 186.71 | 197.47 | 211.83  $\Sigma(64)1...12 = 2202.69$  (64) Heat gains from water heating (kWh/month)  $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$ 

96.12 85.24 90.74 83.04 82.61 75.58 74.27 79.18 78.31 86.03 88.83 94.38 (65)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Metabolic gains (	Table 5)											
[	142.04	142.04	142.04	142.04	142.04	142.04	142.04	142.04	142.04	142.04	142.04	142.04
Lighting gains (ca	lculated in	Appendix	L, equation	L9 or L9a),	also see Ta	ble 5						
	24.81	22.04	17.92	13.57	10.14	8.56	9.25	12.03	16.14	20.49	23.92	25.50
Appliance gains (d	calculated	in Appendi	x L, equation	on L13 or L1	13a), also se	ee Table 5						
[	278.28	281.17	273.89	258.40	238.84	220.46	208.19	205.30	212.58	228.07	247.62	266.00
Cooking gains (ca	lculated in	Appendix	L, equation	L15 or L15	a), also see	Table 5						
[	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20	37.20
Pump and fan gai	ns (Table 5	Sa)										
[	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
	ration (Tab	ole 5)										
Losses e.g. evapo								440.00	112.62	-113.63	-113.63	-113.63
Losses e.g. evapo	-113.63	-113.63	-113.63	-113.63	-113.63	-113.63	-113.63	-113.63	-113.63	-113.03	-115.05	-113.63
Losses e.g. evapo [ Water heating ga			-113.63	-113.63	-113.63	-113.63	-113.63	-113.63	-113.63	-115.05	-113.03	-113.63

6. Solar gains									
	Access factor Table 6d	Area m²	Solar flux W/m²	•	g ific data able 6b	FF specific da or Table 6		Gains W	
NorthWest	0.77 x	7.15	x 11.28	x 0.9 x	0.63 x	0.70	=	24.65	(81)
SouthWest	0.77 x	3.21	x 36.79	x 0.9 x	0.63 x	0.70	=	36.10	(79)
SouthEast	0.77 x	14.51	x 36.79	x 0.9 x	0.63 x	0.70	=	163.16	(77)
North	0.77 x	0.52	x 10.63	x 0.9 x	0.63 x	0.70	=	1.69	(74)
NorthEast	0.77 x	2.67	x 11.28	x 0.9 x	0.63 x	0.70	=	9.21	(75)
East	0.77 x	0.53	x 19.64	x 0.9 x	0.63 x	0.70	=	3.18	(76)
Solar gains in watts ∑(74)m(82)m									
237.99 417.78	604.31 803.11	948.83	963.56 920.	00 808.04	672.67	470.58	287.32	202.20	(83)
Total gains - internal and solar (73)m +	(83)m								
738.88 916.44	1086.70 1259.02	1377.46	1366.17 1305	87 1200.39	1078.76	903.38	750.85	689.16	(84)

emperature duri	ng heatin	g periods in	the living	area from T	able 9, Th	1(°C)						21.00	(85
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tilisation factor f	for gains f	or living are	a n1,m (se	e Table 9a)									
	0.99	0.98	0.96	0.90	0.79	0.62	0.48	0.53	0.77	0.94	0.99	0.99	(86
Aean internal ten	np of livin	g area T1 (st	eps 3 to 7	in Table 90	:)								
	19.25	19.51	19.89	20.35	20.71	20.92	20.98	20.97	20.81	20.32	19.70	19.21	(8
emperature duri	ng heatin	g periods in	the rest of	dwelling f	rom Table	9, Th2(°C)							
	19.82	19.83	19.83	19.84	19.85	19.86	19.86	19.86	19.85	19.85	19.84	19.83	(8
Jtilisation factor f	or gains f	or rest of dv	velling n2,	m									
	0.99	0.98	0.95	0.88	0.73	0.53	0.36	0.41	0.69	0.92	0.98	0.99	(89
Mean internal ten	nperature	in the rest	of dwelling	T2 (follow	steps 3 to	7 in Table 9	9c)						
	17.52	17.89	18.43	19.09	19.56	19.80	19.85	19.84	19.70	19.07	18.18	17.47	(90
iving area fractio	n								Li	ving area ÷	(4) =	0.18	(9:
Mean internal ten	nperature	for the who	ole dwellin	g fLA x T1 +	(1 - fLA) x	T2							
	17.83	18.18	18.69	19.32	19.77	20.00	20.05	20.04	19.90	19.29	18.45	17.78	(92
Apply adjustment	to the me	ean internal	temperati	ire from Ta	ble 4e whe	ere appropr	riate						
	17.68	18.03	18.54	19.17	19.62	19.85	19.90	19.89	19.75	19.14	18.30	17.63	(93
8. Space heating	roquirom	ont											
o. Space neating			Man	A	May	lum	nut.	A.1.0	Com.	0-4	Neu	Das	
Itilication factor f	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Itilisation factor f			0.03	0.00	0.72	0.52	0.27	0.42	0.60	0.00	0.07	1 0.00	7 /0
	0.98	0.97	0.93	0.86	0.72	0.53	0.37	0.42	0.68	0.90	0.97	0.99	(9
Jseful gains, ηmG											T		٦
	727.33	887.12	1014.88	1079.68	995.29	728.50	476.79	499.51	731.15	811.85	729.31	680.61	(9
Monthly average					44.70	14.50	15.50	1 45 40	1440	10.50	T 740	1	٦,,
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(9)
Heat loss rate for						_	404.00	F44.44	022.60	1200.02	14672.70	2016 07	7 (0:
	2032.69	1989.05	1819.44	1529.28	1176.33	769.90	484.09	511.44	832.60	1268.83	1672.70	2016.87	(97
Space heating req							0.00	0.00	0.00	220.00	T 670.24	004.40	7
L	971.19	740.49	598.59	323.71	134.69	0.00	0.00	0.00	0.00	339.99	679.24	994.18	] ] (0)
		1341 / 2/							∑(9	8)15, 10		4782.08	] (98
Space heating req	uirement	kwn/m²/ye	ar							(98)	÷ (4)	41.66	(99
9a. Energy requi	rements -	individual l	neating sy	stems inclu	iding micro	o-CHP							
Space heating													
Fraction of space	heat from	secondary/	suppleme	ntary system	m (table 11	1)						0.00	(20
Fraction of space	heat from	main syster	m(s)							1 - (2	01) =	1.00	(20
Fraction of space	heat from	main syster	m 2									0.00	(2
raction of total s	pace heat	from main :	system 1						(20	02) x [1- (20	03)] =	1.00	(2
raction of total s	pace heat	from main :	system 2							(202) x (2	03) =	0.00	(2
fficiency of main	system 1	(%)										93.00	(2
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	_ `
space heating fue				•	•			-	•				
_	1044.28	796.23	643.65	348.07	144.83	0.00	0.00	0.00	0.00	365.58	730.36	1069.01	7
L				-						1)15, 10		5142.02	(2
*/-* b*!									21-1	, -, -3			_ ,_
Vater heating													

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	87.83	87.57	87.05	85.86	83.60	79.30	79.30	79.30	79.30	85.89	87.35	87.92	(217)
Water heating for	uel, kWh/m	onth											
	247.13	218.46	230.79	209.72	211.03	198.76	190.85	209.47	209.12	217.38	226.08	240.95	]
										∑(219a)1	.12 = 2	2609.74	(219)
Annual totals													
Space heating fu	el - main sy	stem 1										5142.02	]
Water heating fu	ıel											2609.74	]
Electricity for pu	mps, fans a	ind electric	keep-hot (	Table 4f)									
central heati	ng pump or	water pum	p within w	arm air hea	iting unit				30.00	]			(230c)
boiler flue fa	n								45.00	]			(230e)
Total electricity	for the abo	ve, kWh/ye	ar									75.00	(231)
Electricity for lig	hting (Appe	endix L)										438.13	(232)

(211)...(221) + (231) + (232)...(237b) =

8264.89 (238)

10a. Fuel costs - individual heating systems including micro	o-CHP					
	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	5142.02	x	3.48	x 0.01 =	178.94	(240)
Water heating	2609.74	x	3.48	x 0.01 =	90.82	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	438.13	x	13.19	x 0.01 =	57.79	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242) +	(245)(254) =	457.44	(255)

Total delivered energy for all uses

11a. SAP rating - individual heating systems including micro-CHP		
Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.20	(257)
SAP value	83.23	
SAP rating (section 13)	83	(258)
SAP band	В	

12a. CO <sub>2</sub> emissions - individual heating systems including mic	ro-CHP					
	Energy kWh/year		Emission factor kg CO₂/kWh		Emissions kg CO <sub>2</sub> /year	
Space heating - main system 1	5142.02	x	0.216	=	1110.68	(261)
Water heating	2609.74	x	0.216	=	563.70	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	1674.38	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	438.13	x	0.519	=	227.39	(268)
Total CO <sub>2</sub> , kg/year				(265)(271) =	1940.70	(272)
Dwelling CO₂ emission rate				(272) ÷ (4) =	16.91	(273)
El value					83.73	]
El rating (section 14)					84	(274)
El band					В	]

13a. Primary energy - individual heating systems inc	luding micro-CHP				
	Energy kWh/year		Primary factor		Primary Energy kWh/year
Space heating - main system 1	5142.02	x	1.22	=	6273.26 (261)
Water heating	2609.74	x	1.22	=	3183.88 (264)

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(261) + (262) + (263) + (264) = 9457.15 Space and water heating 75.00 3.07 230.25 Pumps and fans 438.13 1345.07 Electricity for lighting 3.07 Primary energy kWh/year 11032.46 (272) Dwelling primary energy rate kWh/m2/year 96.10

**DER Worksheet** Design - Draft

(265)

(267)

(268)



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 014 Oxford Road, Bodicaote, OX15		

	ling dimens	ions											
					A	rea (m²)			rage storey eight (m)		Vo	lume (m³)	
Lowest occupied						43.62	(1a) x		2.39	(2a) =		104.25	(3a
Total floor area		(1a)	+ (1b) + (1	c) + (1d)(	1n) =	43.62	(4)						
Dwelling volume								(3a)	+ (3b) + (3d	c) + (3d)(	3n) =	104.25	(5)
2. Ventilation ra	ate												
											m	per hour	
Number of chimi	neys								0	x 40 =	=	0	(6a
Number of open	flues								0	x 20 =	=	0	(6t
Number of interr	mittent fans	5							0	x 10 =	-	0	(7a
Number of passiv	ve vents								0	x 10 =	-	0	(7t
Number of fluele	ss gas fires								0	x 40 =	-	0	(70
											Air	hanges pe	er
Infiltration due to	chimneys,	, flues, fan	s, PSVs		(6a)	+ (6b) + (7a	a) + (7b) +	(7c) =	0	÷ (5) :	-	0.00	(8)
If a pressurisation	n test has b	een carrie	d out or is i	ntended, pi	roceed to (1	7), otherw	ise continu	ie from (9) t	o (16)				
Air permeability	value, q50,	expressed	in cubic m	etres per h	our per squ	are metre	of envelop	e area				4.00	(1
If based on air pe	ermeability	value, the	n (18) = [(1	7) ÷ 20] + (8	3), otherwis	se (18) = (16	5)					0.20	(18
Number of sides	on which th	ne dwelling	g is shelter	ed								1	(1
Shelter factor									1 -	[0.075 x (1	9)] =	0.93	(2)
Infiltration rate in	ncorporatin	g shelter f	actor							(18) x (	20) =	0.19	(2:
Infiltration rate n	nodified for	monthly	wind speed	:									
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average	wind spee	d from Tab	ole U2										
	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22
Wind factor (22)	m ÷ 4												
	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22
Adjusted infiltrat	ion rate (al	lowing for	shelter and	d wind facto	or) (21) x (2	2a)m							
ļ	0.24	0.23	0.23	0.20	0.20	0.18	0.18	0.17	0.19	0.20	0.21	0.22	(2:
Calculate effective	e air chang	e rate for	the applica	ble case:									
If mechanical	ventilation	: air chang	e rate thro	ugh system								0.50	(23
	ith heat rec	overy: effi	ciency in %	allowing fo	or in-use fac	ctor from T	able 4h					N/A	(23
If balanced w													
If balanced w	se extract v	entilation	or positive	input venti	lation from	outside							
	e extract v	entilation of	or positive 0.50	input venti 0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(2
	0.50	0.50	0.50	0.50	0.50		0.50	0.50	0.50	0.50	0.50	0.50	(2



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Element				Gross area, m²	Openings m <sup>2</sup>		area m²	U-value W/m²K	AxUW		/alue, /m².K	Αxκ, kJ/K	
Window				area, m	m-	_		1.24	= 8.84		/mĸ	KJ/K	(27)
Door							15 x	1.30	= 2.89	=			(26)
Ground floor							.62 x	0.17	= 7.42	=			(28a
External wall							.43 x	0.20	= 8.69	=			(29a
Party wall							.40 x	0.00	= 0.00	=			(32)
Total area of ex	ternal elem	ents ΣA. m²	2				.42	0.00	0.00				(31)
Fabric heat loss									(2	6)(30) + (	32) =	27.82	(33)
Heat capacity C								(28).	(30) + (32)		=	N/A	(34)
Thermal mass p			n²K									194.00	(35)
Thermal bridges	s: Σ(L x Ψ) c	alculated u	sing Appe	ndix K								5.81	(36)
Total fabric hea	t loss									(33) + (	36) =	33.64	(37)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation hea	t loss calcula	ated month	ly 0.33 x	(25)m x (5)									
	17.20	17.20	17.20	17.20	17.20	17.20	17.20	17.20	17.20	17.20	17.20	17.20	(38)
Heat transfer co	efficient, W	//K (37)m +	+ (38)m										
	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	50.84	
									Average =	∑(39)112,	/12 =	50.84	(39)
Heat loss param	neter (HLP),	W/m²K (39	9)m ÷ (4)										
	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	
									Average =	∑(40)112,	/12 =	1.17	(40)
Number of days	in month (	Table 1a)											
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)
4. Water heati	ing energy i	eguiremen	t										
Assumed occup												1.51	(42)
Annual average		usage in litr	es per dav	Vd.average	e = (25 x N) +	36						69.96	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage	e in litres pe	er day for ea	ach month	vd,m = fac	tor from Tab	le 1c x (43	3)	_	-				
	76.95	74.15	71.36	68.56	65.76	62.96	62.96	65.76	68.56	71.36	74.15	76.95	
			•							Σ(44)1	.12 =	839.48	(44)
Energy content	of hot wate	r used = 4.1	18 x Vd,m	x nm x Tm/	3600 kWh/m	onth (see	Tables 1b	, 1c 1d)					_
	114.12	99.81	102.99	89.79	86.16	74.35	68.89	79.06	80.00	93.23	101.77	110.52	
										∑(45)1	.12 =	1100.68	(45)
Distribution loss	0.15 x (45	)m											
	17.12	14.97	15.45	13.47	12.92	11.15	10.33	11.86	12.00	13.98	15.27	16.58	(46)
Water storage I	oss calculat	ed for each	month (5	55) x (41)m									
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
		ated solar s	torago or	dedicated V	WHRS (56)	n x [(47) -	Vs] ÷ (47)	, else (56)					
If the vessel cor	ntains dedic		torage or	dedicated .					0.00		1		T
If the vessel cor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
If the vessel cor Primary circuit I	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	<u> </u> (57)
	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
	0.00 loss for each	0.00 month fro 0.00 from Table	0.00 m Table 3 0.00 3a, 3b or	0.00 0.00	0.00	0.00							
Primary circuit l Combi loss for ε	0.00 loss for each 0.00 each month 21.54	0.00 n month fro 0.00 from Table 19.43	0.00 m Table 3 0.00 3a, 3b or 21.47	0.00 0.00 3c 20.74	0.00	0.00	0.00	0.00	0.00				
Primary circuit l	0.00 loss for each 0.00 each month 21.54	0.00 n month fro 0.00 from Table 19.43	0.00 m Table 3 0.00 3a, 3b or 21.47	0.00 0.00 3c 20.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)

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NHER Plan Assessor version 6.2.3 SAP version 9.92 Solar DHW input calculated using Appendix G or Appendix H

0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 (63) Output from water heater for each month (kWh/month) (62)m + (63)m

135.65 119.24 124.47 110.53 107.56 95.02 90.23 100.43 100.71 114.68 122.57 132.04

 $\Sigma(64)1...12 = 1353.13$  (64)

Heat gains from water heating (kWh/month)  $0.25 \times [0.85 \times (45) \text{m} + (61) \text{m}] + 0.8 \times [(46) \text{m} + (57) \text{m} + (59) \text{m}]$ 

43.33 38.04 39.61 35.04 34.00 29.89 28.24 31.63 31.78 36.36 39.04 42.13 (65)

5. Internal gains

Jan Feh Mar Oct Anr Mav Sep Nov Dec Metabolic gains (Table 5) 75.28 75.28 75.28 75.28 75.28 75.28 75.28 75.28 75.28 75.28 75.28 75.28 (66)

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

12.44 (67) 12.10 10.75 8.74 6.62 4.95 4.18 4.51 5.87 7.87 10.00 11.67

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

130.73 132.09 128.67 121.39 112.21 103.57 97.80 96.45 99.87 107.14 116.33 124.96 (68) Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

30.53 30.53 30.53 30.53 30.53 30.53

30.53 30.53 30.53 30.53 30.53 30.53 (69) Pump and fan gains (Table 5a) 3.00

Losses e.g. evaporation (Table 5)

3.00 3.00

-60.22 -60.22 -60.22 -60.22 -60.22 -60.22 -60.22 -60.22 -60.22 -60.22 -60.22 -60.22 (71)

3.00

Water heating gains (Table 5)

58.24 56.61 53.24 48.67 45.69 41.51 37.96 42.51 44.14 48.87 56.62 (72)

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

3.00

3.00

249.66 248.03 239.24 225.26 211.43 197.84 188.86 193.41 200.46 214.60 230.80 242.61 (73)

3.00

3.00

3.00

3.00

3.00

3.00 (70)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
NorthWest	0.77	x [	1.70	x	11.28	x 0.9 x	0.63	x	0.70	=	5.86	(81)
NorthEast	0.77	х [	1.66	х	11.28	x 0.9 x	0.63	x	0.70	=	5.72	(75)
SouthEast	0.77	х [	3.79	x	36.79	x 0.9 x	0.63	x	0.70	=	42.62	(77)
Solar gains in watts ∑(74)m(82)m											_	_

54.20 96.18 141.82 192.85 231.65 236.85 225.49 195.49 159.32 109.05 65.62 45.93 (83)

Total gains - internal and solar (73)m + (83)m

303.86 344.21 381.05 418.11 443.08 434.69 414.35 388.90 359.78 323.65 296.43 288.54 (84)

7. Mean internal temperature (heating season)

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

Dec Oct Nov Utilisation factor for gains for living area n1,m (see Table 9a) 0.99 0.98 0.97 0.92 0.83 0.67 0.52 0.57 0.79 0.94 0.98 0.99 (86)

Page 3

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.57 19.75 20.04 20.40 20.72 20.92 20.98 20.97 20.83 20.42 19.92 19.52 (87) Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

19.95 | 19.95 | 19.95 | 19.95 | 19.95 | 19.95 | 19.95 | 19.95 | 19.95 | 19.95 | 19.95 | 19.95 | 19.95 |

Utilisation factor for gains for rest of dwelling n2,m

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21.00

(85)

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[													
L L	0.99	0.98	0.96	0.90	0.78	0.59	0.40	0.45	0.72	0.92	0.98	0.99	(89)
Aean internal te	mperature	in the rest	of dwelling	g T2 (follow	steps 3 to	7 in Table 9	9c)						
	18.06	18.31	18.73	19.24	19.67	19.88	19.94	19.93	19.80	19.27	18.56	17.98	(90)
iving area fractio	on								Li	ving area ÷	(4) =	0.43	(91)
Mean internal te	mperature	for the wh	ole dwellin	g fLA x T1	+(1 - fLA) x	T2							
	18.71	18.93	19.29	19.74	20.12	20.33	20.38	20.38	20.24	19.77	19.14	18.64	(92)
Apply adjustment	it to the me	ean internal	temperati	ure from Ta	able 4e wh	ere appropi	iate						
	18.56	18.78	19.14	19.59	19.97	20.18	20.23	20.23	20.09	19.62	18.99	18.49	(93)
8. Space heating	g requirem	ent											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor	for gains, i	ηm											
[	0.98	0.97	0.95	0.89	0.78	0.61	0.44	0.49	0.73	0.91	0.97	0.99	(94)
Jseful gains, ηm(	Gm, W (94	l)m x (84)m											
	298.72	334.55	361.31	373.21	346.36	264.12	180.93	188.62	263.20	295.94	287.97	284.50	(95)
Monthly average	e external to	emperature	from Tabl	le U1									
[	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for	r mean inte	ernal tempe	rature, Lm	, W [(39)m	n x [(93)m -	(96)m]							
	724.83	705.63	642.72	543.52	420.52	283.57	184.78	194.55	304.71	458.32	604.67	726.62	(97)
space heating red	quirement,	, kWh/mon	th 0.024 x	[(97)m - (9	5)m] x (41)	m							
	317.02	249.37	209.37	122.62	55.18	0.00	0.00	0.00	0.00	120.81	228.02	328.94	
									∑(9	8)15, 10	.12 =	1631.33	(98)
pace heating red	quirement	kWh/m²/ye	ear							(98)	÷ (4)	37.40	(99)
naco hoatina					uding micro	J-CHP							
-	heat from	secondary										0.00	(201)
Fraction of space			/suppleme							1 - (2	01) =	0.00	_՝ ՝
Fraction of space	heat from	main syste	/suppleme m(s)							1 - (2	01) =		(202
Fraction of space Fraction of space Fraction of space	heat from heat from	main syste	/suppleme m(s) m 2						(20	1 - (20 02) x [1- (20		1.00	(202)
Fraction of space Fraction of space Fraction of space Fraction of total s	heat from heat from space heat	main syste main syste from main	/suppleme m(s) m 2 system 1						(20		03)] =	1.00	(202)
Fraction of space Fraction of space Fraction of space Fraction of total s Fraction of total s	e heat from heat from space heat space heat	main syste main syste from main from main	/suppleme m(s) m 2 system 1						(20	02) x [1- (20	03)] =	1.00 0.00 1.00	(201) (202) (202) (204) (205) (206)
Fraction of space Fraction of space Fraction of space Fraction of total s	e heat from heat from space heat space heat	main syste main syste from main from main	/suppleme m(s) m 2 system 1				Jul	Aug	(20 Sep	02) x [1- (20	03)] =	1.00 0.00 1.00 0.00	(202) (202) (204) (205)
Fraction of space Fraction of space Fraction of space Fraction of total s Fraction of total s	e heat from e heat from space heat space heat n system 1 Jan	main syste main syste from main from main (%) Feb	/suppleme m(s) m 2 system 1 system 2 Mar	ntary syste	m (table 1	1)	Jul	Aug		02) x [1- (20 (202) x (20	03)] =	1.00 0.00 1.00 0.00 93.00	(202) (202) (204) (205)
Fraction of space Fraction of space Fraction of space Fraction of total s Fraction of total s	e heat from e heat from space heat space heat n system 1 Jan	main syste main syste from main from main (%) Feb	/suppleme m(s) m 2 system 1 system 2 Mar	ntary syste	m (table 1	1)	Jul 0.00	Aug		02) x [1- (20 (202) x (20	03)] =	1.00 0.00 1.00 0.00 93.00	(202) (202) (204) (205)
Fraction of space Fraction of space Fraction of space Fraction of total s Fraction of total s	e heat from e heat from space heat space heat n system 1 Jan el (main sys	main syste main syste from main from main (%) Feb stem 1), kW	/suppleme m(s) m 2 system 1 system 2 Mar /h/month	ntary syste	m (table 1:	Jun			<b>Sep</b>	02) x [1- (20 (202) x (20 Oct	(Nov 245.19	1.00 0.00 1.00 0.00 93.00 Dec	(202) (202) (204) (204) (205) (206)
rraction of space Fraction of space Fraction of space Fraction of total s Fraction of total s Efficiency of main	e heat from e heat from space heat space heat n system 1 Jan el (main sys	main syste main syste from main from main (%) Feb stem 1), kW	/suppleme m(s) m 2 system 1 system 2 Mar /h/month	ntary syste	m (table 1:	Jun			<b>Sep</b>	02) x [1- (20 (202) x (20 Oct	(Nov 245.19	1.00 0.00 1.00 0.00 93.00 Dec	(202 (202 (204 (205 (206
rraction of space rraction of space rraction of space rraction of total s rraction of total s rraction of total s efficiency of main	e heat from e heat from space heat space heat n system 1 Jan el (main sy:	main syste main syste from main from main (%) Feb stem 1), kW	/suppleme m(s) m 2 system 1 system 2 Mar /h/month	ntary syste	m (table 1:	Jun			<b>Sep</b>	02) x [1- (20 (202) x (20 Oct	(Nov 245.19	1.00 0.00 1.00 0.00 93.00 Dec	(202 (202 (204 (205 (206
rraction of space rraction of space rraction of space rraction of total s rraction of total s rraction of total s efficiency of main	e heat from e heat from space heat space heat n system 1 Jan el (main sy:	main syste main syste from main from main (%) Feb stem 1), kW	/suppleme m(s) m 2 system 1 system 2 Mar /h/month	ntary syste	m (table 1:	Jun			<b>Sep</b>	02) x [1- (20 (202) x (20 Oct	(Nov 245.19	1.00 0.00 1.00 0.00 93.00 Dec	(202) (202) (204) (205) (206)
rraction of space Fraction of space Fraction of space Fraction of total s	e heat from heat from space heat space heat n system 1 Jan el (main sy: 340.89 er heater 88.99	main syste main syste from main from main (%) Feb stem 1), kW 268.14	/suppleme m(s) m 2 system 1 system 2 Mar /h/month	Apr	May 59.33	Jun 0.00	0.00	0.00	Sep 0.00 ∑(21	O2) x [1- (20 (202) x (2d) Oct 129.90 1)15, 10	Nov 245.19	1.00 0.00 1.00 0.00 93.00 Dec 353.70	(202) (202) (204) (205) (206)
rraction of space Fraction of space Fraction of space Fraction of total s	e heat from heat from space heat space heat n system 1 Jan el (main sy: 340.89 er heater 88.99	main syste main syste from main from main (%) Feb stem 1), kW 268.14	/suppleme m(s) m 2 system 1 system 2 Mar /h/month	Apr	May 59.33	Jun 0.00	0.00	0.00	Sep 0.00 ∑(21	O2) x [1- (20 (202) x (2d) Oct 129.90 1)15, 10	Nov 245.19	1.00 0.00 1.00 93.00 Dec 353.70 1754.11	(202) (202) (204) (205)
Space heating Fraction of space Fraction of space Fraction of space Fraction of space Fraction of total s Fraction of total s Efficiency of main Space heating fue  Water heating  Water heating  Water heating fue	e heat from the heat from space heat space heat n system 1 Jan el (main sy: 340.89 er heater 88.99	main syste main syste from main from main (%) Feb stem 1), kW 268.14	/suppleme m(s) m 2 system 1 system 2 Mar /h/month 225.12	Apr 131.85	May 59.33	Jun 0.00	0.00	86.70	Sep  0.00  ∑(21  86.70	O2) × [1- (20 (202) × (2) Oct 129.90 1)15, 10	Nov  245.19 .12 =  88.82	1.00 0.00 1.00 93.00 Dec 353.70 1754.11	(202 (202 (202 (204 (205 ) (206 ) (211
Fraction of space Fraction of space Fraction of space Fraction of total s Fraction of total s Efficiency of main  Water heating  Water heating	e heat from the heat from space heat space heat n system 1 Jan el (main sy: 340.89 er heater 88.99	main syste main syste from main from main (%) Feb stem 1), kW 268.14	/suppleme m(s) m 2 system 1 system 2 Mar /h/month 225.12	Apr 131.85	May 59.33	Jun 0.00	0.00	86.70	Sep  0.00  ∑(21  86.70	O2) x [1- (20 (202) x (2) Oct 129.90 1)15, 10	Nov  245.19 .12 =  88.82	1.00 0.00 1.00 0.00 93.00 Dec 353.70 1754.11 89.03	(202 (202 (202 (204 (205 ) (206 ) (211
rraction of space Fraction of space Fraction of space Fraction of space Fraction of total s Fraction of space Fraction of total s Fraction of tota	e heat from e heat from space heat space heat n system 1 Jan el (main sy: 340.89 er heater 88.99 iel, kWh/m	main syste main syste main syste from main from main from main (%)  Feb stem 1), kW  268.14  88.91 onth	/suppleme m(s) m 2 system 1 system 2 Mar /h/month 225.12	Apr 131.85	May 59.33	Jun 0.00	0.00	86.70	Sep  0.00  ∑(21  86.70	O2) x [1- (20 (202) x (2) Oct 129.90 1)15, 10	Nov 245.19  138.00  12 = 138.00	1.00 0.00 1.00 0.00 93.00 Dec 353.70 1754.11 89.03	(202 (202 (202 (204 (205 ) (206 ) (211
Fraction of space Fraction of space Fraction of space Fraction of space Fraction of total s Fraction of total s Efficiency of main  Space heating fue  Water heating  Water heating fue  Water heating fue	e heat from e heat from space heat space heat n system 1 Jan el (main sy: 340.89 er heater 88.99 iel, kWh/m 152.45	main syste main syste main syste from main from main from main (%)  Feb stem 1), kW  268.14  88.91 onth	/suppleme m(s) m 2 system 1 system 2 Mar /h/month 225.12	Apr 131.85	May 59.33	Jun 0.00	0.00	86.70	Sep  0.00  ∑(21  86.70	O2) x [1- (20 (202) x (2) Oct 129.90 1)15, 10	Nov 245.19 .12 = 888.82	1.00 0.00 1.00 93.00 Dec 353.70 1754.11 89.03 148.31	(202 (202 (202 (204 (205 ) (206 ) (211
Fraction of space Fraction of space Fraction of space Fraction of space Fraction of total s Fraction of space heating function of total s Fraction of total s Fraction of space heating function of total s Fraction of	e heat from e heat from space heat space heat n system 1 Jan el (main sy: 340.89 er heater 88.99 iel, kWh/m 152.45	main syste main syste main syste from main from main (%) Feb stem 1), kW 268.14  88.91 onth 134.12	/suppleme m(s) m 2 system 1 system 2 Mar /h/month 225.12 88.74	Apr 131.85	May 59.33	Jun 0.00	0.00	86.70	Sep  0.00  ∑(21  86.70	O2) x [1- (20 (202) x (2) Oct 129.90 1)15, 10	Nov 245.19 .12 = 888.82	1.00 0.00 1.00 93.00 Dec 353.70 1754.11 1536.12	(202) (202) (204) (205) (206)

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central heating pump or water pump within warm air heating unit

 boiler flue fan
 45.00
 (230e)

 Total electricity for the above, kWh/year
 106.14
 (231)

 Electricity for lighting (Appendix L)
 213.73
 (232)

 Total delivered energy for all uses
 (211)...(221) + (231) + (232)...(237b) = 3610.10
 (238)

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1754.11	x	3.48	x 0.01 =	61.04	(240)
Water heating	1536.12	x	3.48	x 0.01 =	53.46	(247)
Pumps and fans	106.14	x	13.19	x 0.01 =	14.00	(249)
Electricity for lighting	213.73	x	13.19	x 0.01 =	28.19	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242) +	(245)(254) =	276.69	(255)
11a. SAP rating - individual heating systems inc	cluding micro-CHP					
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					1.31	(257)
SAP value					81.71	]
SAP rating (section 13)					82	(258)

12a. CO <sub>2</sub> emissions - individual heating systems including micr	o-CHP					
	Energy kWh/year		Emission factor kg CO₂/kWh		Emissions kg CO <sub>2</sub> /year	
Space heating - main system 1	1754.11	x	0.216	=	378.89	(261)
Water heating	1536.12	x	0.216	=	331.80	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	710.69	(265)
Pumps and fans	106.14	x	0.519	=	55.08	(267)
Electricity for lighting	213.73	x	0.519	=	110.93	(268)
Total CO <sub>2</sub> , kg/year				(265)(271) =	876.70	(272)
Dwelling CO₂ emission rate				(272) ÷ (4) =	20.10	(273)
El value					86.74	]
El rating (section 14)					87	(274)
El band					В	]

13a. Primary energy - individual heating systems includin	g micro-CHP			
	Energy kWh/year		Primary factor	Primary Energy kWh/year
Space heating - main system 1	1754.11	x	1.22 =	2140.02 (261)
Water heating	1536.12	x	1.22 =	1874.07 (264)
Space and water heating			(261) + (262) + (263) + (264) =	4014.09 (265)
Pumps and fans	106.14	x	3.07 =	325.84 (267)
Electricity for lighting	213.73	x	3.07 =	656.16 (268)
Primary energy kWh/year				4996.08 (272)
Dwelling primary energy rate kWh/m2/year				114.54 (273)

URN: Plot 014 version 1

NHER Plan Assessor version 6.2.3

30.00

SAP version 9.92

(230c)

SAP band

URN: Plot 014 version 1 NHER Plan Assessor version 6.2.3

#### DER Worksheet Design - Draft



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 016 Oxford Road, Bodicaote, OX15		

1. Overall dwelling dimensions					
		Area (m²)		Average storey height (m)	Volume (m³)
Lowest occupied		4.51 (1a)	x	2.83 (2a) =	12.76 (3a)
+1		50.48 (1b)	x	2.39 (2b) =	120.65 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d)(1n) =	54.99 (4)			
Dwelling volume				(3a) + (3b) + (3c) + (3d)(3n)	= 133.41 (5)

2. Ventilation rate				
			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 0	÷ (5) =	0.00	(8)
If a pressurisation test has been carried out or is intended	d, proceed to (17), otherwise continue from (9) to (16)			

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4.00	(17)
If based on air permeability value, then (18) = $[(17) \div 20] + (8)$ , otherwise (18) = (16)		0.20	(18)
Number of sides on which the dwelling is sheltered		1	(19)
Shelter factor	1 - [0.075 x (19)] =	0.93	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.19	(21)

Infiltration rate i	ncorporati	ng shelter f	actor							(18) x (	20) =	0.19	(21)
Infiltration rate r	modified fo	or monthly v	wind speed:	:									
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average	e wind spee	ed from Tab	le U2										
	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)	m ÷ 4												
	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltrat	tion rate (a	llowing for	shelter and	wind facto	or) (21) x (2	2a)m							
	0.24	0.23	0.23	0.20	0.20	0.18	0.18	0.17	0.19	0.20	0.21	0.22	(22b)
Calculate effective	ve air chan	ge rate for	the applical	ble case:									

Calculate effective air change rate for the applicable case:		
If mechanical ventilation: air change rate through system	0.50	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

c) whole hous	c) whole house extract ventilation or positive input ventilation from outside													
	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)	

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



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SAP version 9.92

0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	125
0.50	0.30	0.30	0.30	0.50	0.30	0.50	0.50	0.30	0.50	0.50	0.50	(23)

				Gross area, m <sup>2</sup>	Openings m <sup>2</sup>	Net a		U-value W/m²K	AxUW		value, /m².K	Ахк, kJ/K	
Window				a. ca,		5.4		1.24	= 6.78		,	10711	(:
Door						2.:		1.30	= 2.89	=			(:
Ground floor						4.		0.19	= 0.86	=			(:
external wall						53.		0.20	= 10.68	=			(
Party wall						41.	_ ;	0.00	= 0.00	Ħ			(
Roof						50.		0.11	= 5.55	=			(
гоtal area of ex	ternal elem	ents ΣA. m²	2			116	<b>=</b> '		0.00				(
Fabric heat loss									(2	5)(30) + (	32) =	26.76	٦,
Heat capacity C								(28)	.(30) + (32)			N/A	ī
Thermal mass p			m²K					(==,	(00) (0-)	(0-10)(0	,	185.00	Ĭ
Thermal bridges				ndix K								5.94	Ĭ
Total fabric hea			8							(33) + (	36) =	32.69	ī'
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
/entilation heat	t loss calcula	ated month	nly 0.33 x	-	•			, i					
	22.01	22.01	22.01	22.01	22.01	22.01	22.01	22.01	22.01	22.01	22.01	22.01	٦
Heat transfer co	pefficient, W		-	•					1				_
	54.70	54.70	54.70	54.70	54.70	54.70	54.70	54.70	54.70	54.70	54.70	54.70	٦
								•	Average = 1	(39)112		54.70	Ť.
Heat loss param	neter (HLP),	W/m²K (39	9)m ÷ (4)										_
	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	٦
		•	•	•					Average = 1	(40)112	/12 =	0.99	Ī
Number of days	in month (	Table 1a)											_
		,											
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	] (
	31.00	28.00		30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	
4. Water heati	31.00	28.00		30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00		
Assumed occup	31.00 ing energy r	28.00	nt				31.00	31.00	30.00	31.00	30.00	1.84	] (
Assumed occup	31.00 ing energy reancy, N hot water t	28.00 requirement	es per day	v Vd,average	= (25 x N) +	36						1.84 77.83	
Assumed occup Annual average	31.00  ing energy reancy, N hot water to	28.00 requirementusage in litr	es per day Mar	Vd,average	= (25 x N) + <b>May</b>	36 Jun	Jul	31.00	30.00 Sep	31.00 Oct	30.00	1.84	] (
Assumed occup Annual average	31.00  ing energy r ancy, N hot water t Jan e in litres pe	28.00 requirementusage in litr Feb	es per day  Mar  ach month	v Vd,average Apr n Vd,m = fac	= (25 x N) + <b>May</b> tor from Tab	36 Jun le 1c x (43	Jul	Aug	Sep	Oct	Nov	1.84 77.83 Dec	] (
Assumed occup Annual average	31.00  ing energy reancy, N hot water to	28.00 requirementusage in litr	es per day Mar	Vd,average	= (25 x N) + <b>May</b>	36 Jun	Jul			Oct 79.39	Nov 82.50	1.84 77.83 <b>Dec</b>	
Assumed occup Annual average Hot water usage	31.00  ing energy reancy, N hot water to Jan e in litres pe	28.00 requirementusage in litr Feb er day for ea	es per day Mar ach month	v Vd,average	= (25 x N) + <b>May</b> tor from Tab	36 <b>Jun</b> le 1c x (43 70.05	<b>Jul</b> ) 70.05	Aug 73.16	Sep	Oct	Nov 82.50	1.84 77.83 Dec	
Assumed occup Annual average Hot water usage	31.00  ing energy r ancy, N hot water t Jan e in litres pe  85.61	28.00  equirement usage in litr Feb er day for ea 82.50  r used = 4	es per day Mar ach month 79.39	v Vd,average Apr n Vd,m = fact 76.27 x nm x Tm/	= (25 x N) +  May tor from Tab  73.16	36 Jun le 1c x (43 70.05 onth (see	<b>Jul</b> ) 70.05  Tables 1b	Aug 73.16	Sep 76.27	Oct 79.39 Σ(44)1	Nov 82.50	1.84 77.83 Dec 85.61 933.96	
4. Water heati Assumed occup Annual average Hot water usage Energy content	31.00  ing energy reancy, N hot water to Jan e in litres pe	28.00 requirementusage in litr Feb er day for ea	es per day Mar ach month	v Vd,average	= (25 x N) + <b>May</b> tor from Tab	36 <b>Jun</b> le 1c x (43 70.05	<b>Jul</b> ) 70.05	Aug 73.16	Sep	Oct 79.39 Σ(44)1	Nov 82.50 .12 =	1.84 77.83 Dec 85.61 933.96	
Assumed occup Annual average Hot water usage	31.00 ing energy rancy, N hot water to Jan e in litres pe 85.61 of hot wate 126.96	28.00  equirement  usage in litr  Feb  er day for ea  82.50  er used = 4  111.04	es per day Mar ach month 79.39	v Vd,average Apr n Vd,m = fact 76.27 x nm x Tm/	= (25 x N) +  May tor from Tab  73.16	36 Jun le 1c x (43 70.05 onth (see	<b>Jul</b> ) 70.05  Tables 1b	Aug 73.16	Sep 76.27	Oct 79.39 Σ(44)1	Nov 82.50 .12 =	1.84 77.83 Dec 85.61 933.96	
Assumed occup Annual average Hot water usage	31.00 ing energy rancy, N hot water t Jan e in litres pe 85.61 of hot wate 126.96	28.00  equirement  usage in litr  Feb  er day for exit	es per day Mar ach month 79.39 18 x Vd,m 114.59	v Vd,average Apr n Vd,m = fact 76.27 x nm x Tm/3	= (25 x N) + May tor from Tab 73.16 3600 kWh/m 95.85	36 Jun le 1c x (43 70.05 onth (see	Jul 70.05 Tables 1b,	Aug 73.16 1c 1d) 87.95	Sep 76.27 89.01	Oct 79.39 Σ(44)1 103.73 Σ(45)1	Nov 82.50 .12 = 113.23 .12 = 1	1.84 77.83 Dec 85.61 933.96	
Assumed occup Annual average Hot water usage Energy content Distribution loss	31.00  ing energy rancy, N  hot water to  Jan  e in litres pe  85.61  of hot wate  126.96  s 0.15 x (45)	28.00  equirement usage in litr Feb er day for ex 82.50  used = 4 111.04	es per day Mar ach month 79.39 18 x Vd,m 114.59	VVd,average Apr 1 Vd,m = fact 76.27  x nm x Tm/3 99.90	= (25 x N) +  May tor from Tab  73.16	36 Jun le 1c x (43 70.05 onth (see	<b>Jul</b> ) 70.05  Tables 1b	Aug 73.16	Sep 76.27	Oct 79.39 Σ(44)1	Nov 82.50 .12 =	1.84 77.83 Dec 85.61 933.96	
Assumed occup Annual average Hot water usage Energy content Distribution loss	31.00  ing energy rancy, N  hot water to Jan  e in litres pee  85.61  of hot wate  126.96  s 0.15 x (45)  19.04  oss calculation	28.00  equirement usage in litr Feb er day for ea 82.50  ur used = 4 111.04  )m 16.66 ed for each	es per day  Mar  ach month  79.39  18 x Vd,m  114.59  17.19  month (5	v Vd,average Apr n Vd,m = fact 76.27 x nm x Tm/3 99.90 14.98 55) x (41)m	= (25 x N) + May tor from Tab 73.16  3600 kWh/m 95.85	36 Jun le 1c x (43 70.05 onth (see 82.72	Jul 70.05 Tables 1b, 76.65	Aug 73.16 1c 1d) 87.95	Sep 76.27 89.01	Oct 79.39 Σ(44)1 103.73 Σ(45)1 15.56	Nov 82.50 .12 =	1.84 77.83 Dec 85.61 933.96 122.96 1224.57	
Assumed occup Annual average Hot water usage Energy content Distribution loss Water storage le	31.00  ing energy rancy, N  hot water to Jan  e in litres per  85.61  of hot water  126.96  s 0.15 x (45)  19.04  oss calculate  0.00	28.00  equirement usage in litr Feb er day for er 82.50  ur used = 4 111.04  )m 16.66 ed for each 0.00	ses per day  Mar  ach month  79.39  18 x Vd,m  114.59  17.19  month (5	VVd,average Apr 1 Vd,m = fact 76.27  x nm x Tm/5 99.90  14.98 55) x (41)m 0.00	= (25 x N) + May tor from Tab 73.16  3600 kWh/m 95.85	36 Jun le 1c x (43 70.05 onth (see 82.72	Jul ) 70.05 Tables 1b, 76.65	Aug 73.16 1c 1d) 87.95 13.19	Sep 76.27 89.01	Oct 79.39 Σ(44)1 103.73 Σ(45)1	Nov 82.50 .12 = 113.23 .12 = 1	1.84 77.83 Dec 85.61 933.96	
Assumed occup Annual average Hot water usage	31.00  ing energy rancy, N  hot water to Jan  e in litres pe  85.61  of hot wate  126.96  s 0.15 x (45)  19.04  oss calculations dedictions dedictions dedictions designed and dedictions designed and dedictions designed and dedictions dedictions dedictions designed and dedictions dedictins dedictions dedictions dedictions dedictions dedictions dedicti	28.00	wes per day  Mar  ach month  79.39  18 x Vd,m  114.59  17.19  month (5  0.00  storage or	v Vd,average Apr n Vd,m = fac 76.27 x nm x Tm/3 99.90 14.98 55) x (41)m 0.00 dedicated V	= (25 x N) + May tor from Tab 73.16  3600 kWh/m 95.85  14.38	36 Jun le 1c x (43 70.05 onth (see 82.72 12.41 0.00 n x [(47) -	Jul ) 70.05 Tables 1b, 76.65  11.50  0.00 Vs] ÷ (47),	Aug 73.16 1c 1d) 87.95 13.19 0.00 else (56)	Sep 76.27 89.01 13.35	Oct 79.39 Σ(44)1 103.73 Σ(45)1 15.56	Nov  82.50 .12 =   113.23 .12 =   16.98	1.84 77.83 Dec 85.61 933.96 122.96 1224.57 18.44	
Assumed occup Annual average Hot water usage Energy content Distribution loss Water storage left the vessel con	31.00  ing energy rancy, N  hot water to Jan  e in litres pe  85.61  of hot wate  126.96  s 0.15 x (45)  19.04  oss calculations dedictions dedictions dedictions dedictions desired and dedictions desired and dedictions d	28.00     28.00	wes per day  Mar  ach month  79.39  18 x Vd,m  114.59  17.19  month (5  0.00  storage or  0.00	Vd,average   Apr   Vd,m = fact   76.27   x nm x Tm/3   99.90   14.98   55) x (41)m   0.00   dedicated V	= (25 x N) + May tor from Tab 73.16  3600 kWh/m 95.85	36 Jun le 1c x (43 70.05 onth (see 82.72	Jul ) 70.05 Tables 1b, 76.65	Aug 73.16 1c 1d) 87.95 13.19	Sep 76.27 89.01	Oct 79.39 Σ(44)1 103.73 Σ(45)1 15.56	Nov 82.50 .12 =	1.84 77.83 Dec 85.61 933.96 122.96 1224.57	
Assumed occup Annual average Hot water usage Energy content Distribution loss Water storage le	31.00  ing energy rancy, N hot water to Jan e in litres pe 85.61  of hot wate 126.96  s 0.15 x (45) 19.04 oss calculate 0.00 ntains dedict 0.00 loss for each	28.00     28.00	Mar   Mar	Vd,average	= (25 x N) + May tor from Tab 73.16  3600 kWh/m 95.85  14.38  0.00  VWHRS (56)r	36 Jun le 1c x (43 70.05 onth (see 82.72 12.41 0.00 n x [(47) -	Jul ) 70.05 Tables 1b, 76.65  11.50  0.00 Vs] ÷ (47), 0.00	Aug 73.16 10 10) 87.95 13.19 0.00 else (56) 0.00	Sep 76.27 89.01 13.35 0.00	Oct 79.39 Σ(44)1 103.73 Σ(45)1 15.56 0.00	Nov  82.50 .12 =   113.23 .12 =   16.98	1.84 77.83 Dec 85.61 933.96 122.96 1224.57 18.44	
Assumed occup Annual average Hot water usage Energy content Distribution loss Water storage I If the vessel cor	31.00  ing energy rancy, N  hot water to Jan  e in litres per  85.61  of hot wate  126.96  s 0.15 x (45)  19.04  oss calculate  0.00  ntains dedict  0.00  loss for each	28.00     28.00	wes per day Mar ach month 79.39 18 x Vd,m 114.59 17.19 10.00 torage or 0.00 m Table 3 0.00	Vd,average	= (25 x N) + May tor from Tab 73.16  3600 kWh/m 95.85  14.38	36 Jun le 1c x (43 70.05 onth (see 82.72 12.41 0.00 n x [(47) -	Jul ) 70.05 Tables 1b, 76.65  11.50  0.00 Vs] ÷ (47),	Aug 73.16 1c 1d) 87.95 13.19 0.00 else (56)	Sep 76.27 89.01 13.35	Oct 79.39 Σ(44)1 103.73 Σ(45)1 15.56	Nov  82.50 .12 =   113.23 .12 =   16.98	1.84 77.83 Dec 85.61 933.96 122.96 1224.57 18.44	
Assumed occup Annual average Hot water usage Energy content Distribution loss Water storage left the vessel con	31.00  ing energy rancy, N  hot water to Jan  e in litres per  85.61  of hot wate  126.96  s 0.15 x (45)  19.04  oss calculate  0.00  ntains dedict  0.00  loss for each	28.00     28.00	wes per day Mar ach month 79.39 18 x Vd,m 114.59 17.19 10.00 torage or 0.00 m Table 3 0.00	Vd,average	= (25 x N) + May tor from Tab 73.16  3600 kWh/m 95.85  14.38  0.00  VWHRS (56)r	36 Jun le 1c x (43 70.05 onth (see 82.72 12.41 0.00 n x [(47) -	Jul ) 70.05 Tables 1b, 76.65  11.50  0.00 Vs] ÷ (47), 0.00	Aug 73.16 10 10) 87.95 13.19 0.00 else (56) 0.00	Sep 76.27 89.01 13.35 0.00	Oct 79.39 Σ(44)1 103.73 Σ(45)1 15.56 0.00	Nov  82.50 .12 =   113.23 .12 =   16.98	1.84 77.83 Dec 85.61 933.96 122.96 1224.57 18.44	

Contingenies   Cont		
*** The contribute of the cont	Total heat required for water heating calculated for each month $0.85 \times (45) \text{m} + (46) \text{m} + (57) \text{m} + (59) \text{m} + (61) \text{m}$	Utilisation factor for gains for rest of dwelling n2,m
March   Marc	148.59         130.55         136.14         120.70         117.31         103.44         98.03         109.39         109.77         125.24         134.10         144.57         (62)	0.99 0.98 0.97 0.93 0.84 0.66 0.47 0.51 0.77 0.94 0.98 0.99 (89)
Continue was not become with the property of	Solar DHW input calculated using Appendix G or Appendix H	Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)
Mary	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 (63)	18.38         18.58         18.93         19.38         19.78         20.01         20.08         20.07         19.94         19.46         18.83         18.31         (90)
Part	Output from water heater for each month (kWh/month) (62)m + (63)m	Living area fraction Living area $\div$ (4) = 0.34 (91)
Part	148.59   130.55   136.14   120.70   117.31   103.44   98.03   109.39   109.77   125.24   134.10   144.57	Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2
This content is not content is proportion of the Series	$\Sigma(64)112 = 1477.83$ (64)	18.84 19.02 19.33 19.73 20.10 20.32 20.38 20.38 20.25 19.80 19.24 18.78 (92)
Substitution   Subs	Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]	Apply adjustment to the mean internal temperature from Table 4e where appropriate
Mary	47.62 41.80 43.49 38.42 37.24 32.68 30.83 34.60 34.79 39.87 42.87 46.29 (65)	18.69     18.87     19.18     19.58     19.95     20.17     20.23     20.23     20.10     19.65     19.09     18.63     (93)
Mary	5 Internal gains	& Snace heating requirement
Uniform property   Section   Part Property		
The content of the		. ,
Contact   Cont		
Mathematical Part		
More lighted part collinger in collinger i		
Cooling gains;   Cacillated in Aggrenation   September   Septemb		
Metal Local California plane (California plane		
Residence   Pump and fine planes   Pump and		
Space heating requirement. With/invoid to 10 Life Space   1 Life S		
Second   S		
Space   Part		
Space   Part		
Mater heating gains (Table   S   S   S   S   S   S   S   S   S		
Second   S	-73.48   -73.	Space heating requirement kWh/m²/year (98) $\div$ (4)   31.87   (99)
Space heating   Space heating		
Fraction of space heat from supstremely su		9a. Energy requirements - individual heating systems including micro-CHP
Fraction of space heat from main system !	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)	
Fraction of space heat from main system 1. Table 9. The production of pages (pages) with responsible production	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	Space heating
Fraction of total space heat from #illow 1 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine of total space heat from #illow 2 years with the fine with the fine of total space heat from #illow 2 years with the fine with the fine of total space heat from #illow 2 years with the fine with th	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	Space heating Fraction of space heat from secondary/supplementary system (table 11)  0.00 (201)
Procing   Proc	64.01     62.20     58.45     53.36     50.05     45.39     41.44     46.51     48.31     53.58     59.54     62.21     (72)       Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m       294.22     292.23     281.55     264.65     247.81     231.53     220.97     226.22     234.94     252.03     271.51     285.81     (73)	Space heating  Fraction of space heat from secondary/supplementary system (table 11)  Fraction of space heat from main system(s)  1 - (201) = 1.00 (202)
Solition	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains	Space heating  Fraction of space heat from secondary/supplementary system (table 11)  Fraction of space heat from main system(s)  Fraction of space heat from main system 2  0.00 (201)  1 - (201) = 1.00 (202)
North-West   1.70   x   1.70	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains  Access factor Area My/m² Specific data Specific data W	Space heating         Fraction of space heat from secondary/supplementary system (table 11)       0.00 (201)         Fraction of space heat from main system(s) $1 - (201) = 1.00$ (202)         Fraction of space heat from main system 2       0.00 (202)         Fraction of total space heat from main system 1 $(202) \times [1 - (203)] = 1.00$ (204)
Solar gains in watts \$\(\frac{1}{3}\) \ \ \ \ \ \ \ \	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains  Access factor Area My/m² Specific data Specific data W	Space heating         Fraction of space heat from secondary/supplementary system (table 11)       0.00 (201)         Fraction of space heat from main system(s) $1 - (201) = 1.00$ (202)         Fraction of space heat from main system 2       0.00 (202)         Fraction of total space heat from main system 1 $(202) \times [1 - (203)] = 1.00$ (204)         Fraction of total space heat from main system 2 $(202) \times (203) = 0.00$ (205)
Solar gains in watts \$\(\frac{1}{3}\)1\(\cong{2}\)1\(\co	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains  Access factor Table 6d M² Solar flux W/m² specific data or Table 6b or Table 6c  NorthWest 0.77 x 1.70 x 11.28 x 0.9 x 0.63 x 0.70 = 5.86 (81)	Space heating         Fraction of space heat from secondary/supplementary system (table 11)       0.00       (201)         Fraction of space heat from main system(s) $1 - (201) = 1.00$ (202)         Fraction of space heat from main system 2       0.00       (202)         Fraction of total space heat from main system 1 $(202) \times [1 - (203)] = 1.00$ (204)         Fraction of total space heat from main system 2 $(202) \times (203) = 0.00$ (205)         Efficiency of main system 1 (%) $93.00$ (206)
48.48 84.53 120.82 158.37 187.45 179.27 158.65 133.74 94.81 58.42 41.26 (83)  Total gains - internal and solar (73)m + (83)m  342.70 376.75 402.38 423.02 433.11 418.97 400.23 384.86 368.69 346.84 329.93 327.07 (84)  Temperature during heating periods in the living area from 1 living area T1 (steps 3 to 7 in Table 9 living area T1 (steps 3 to 7 in Table 9 to 1 in 19.72 19.87 20.11 20.42 20.71 20.91 20.98 20.97 20.84 20.47 20.03 19.68 (87)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating field  Temperature during heating periods in the rest of dwelling from Table 9, Th2('C)  Temperature during heating heating field  Temperature during heating field  Temperature durin	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains  Access factor Table 6d m² Solar flux w/m² specific data or Table 6b or Table 6c  NorthWest 0.77 x 1.70 x 11.28 x 0.9 x 0.63 x 0.70 = 5.86 (81)  SouthEast 0.77 x 3.79 x 36.79 x 0.9 x 0.63 x 0.70 = 42.62 (77)	Space heating  Fraction of space heat from secondary/supplementary system (table 11)  Fraction of space heat from main system(s)  Fraction of space heat from main system 2  Fraction of total space heat from main system 1  Fraction of total space heat from main system 1  Fraction of total space heat from main system 2  Fraction o
Total gains - internal and solar (73)m + (83)m  342.70 376.75 402.38 423.02 433.11 418.97 400.23 384.86 368.69 346.84 329.93 327.07 (84)  7. Mean internal temperature (heating season	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains  Access factor Table 6d m² Solar flux w/m² specific data or Table 6b or Table 6c  NorthWest 0.77 x 1.70 x 11.28 x 0.9 x 0.63 x 0.70 = 5.86 (81)  SouthEast 0.77 x 3.79 x 36.79 x 0.9 x 0.63 x 0.70 = 42.62 (77)	Space heating  Fraction of space heat from secondary/supplementary system (table 11)  Fraction of space heat from main system(s)  Fraction of space heat from main system 2  Fraction of total space heat from main system 1  Fraction of total space heat from main system 1  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of total space heat from main system 2  Fraction of space heat from main system 1  Fraction of space heat fr
342.70 376.75 402.38 423.02 433.11 418.97 400.23 384.86 386.99 346.84 32.99 327.07 [84]  The presenture during heating periods in the living area from Table 9, Th1(°C)  Jan Feb May Apr May Jun Jul Aug Sep Oct Nov Dec  Utilisation factor for gains for living area n1,m (see Table 9a)  Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)  19.72 19.87 20.11 20.42 20.71 20.91 20.98 20.97 20.84 20.47 20.03 19.68 [87]  Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)  Efficiency of water heater  Efficiency of water heater  88.96 88.89 88.74 88.44 87.88 86.70 86.70 86.70 86.70 86.70 86.70 88.34 88.79 89.00 [217]  Water heating fuel, kWh/month  167.03 146.87 153.41 136.47 133.50 119.31 113.07 126.17 126.61 141.76 151.04 162.43 (219)  Annual totals  Space heating fuel - main system 1  Water heating fuel - main system 1  Water heating fuel - main system 1  Electricity for pumps, fans and electric keep-hot (Table 4f)	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains  Access factor Table 6d M² Solar flux W/m² specific data or Table 6b or Table 6c  NorthWest 0.77 x 1.70 x 11.28 x 0.9 x 0.63 x 0.70 = 5.86 (81)  SouthEast 0.77 x 3.79 x 36.79 x 0.9 x 0.9 x 0.63 x 0.70 = 42.62 (77)  Solar gains in watts Σ(74)m(82)m	Space heating         Fraction of space heat from secondary/supplementary system (table 11)       \$\$\$ \$\$ 0.00\$ (201)         Fraction of space heat from main system(s)       \$\$\$\$ \$\$\$ 1 - (201) = \$\$\$ 0.00\$ (202)         Fraction of space heat from main system 2       \$\$\$\$\$ (202) x [1- (203)] = \$\$\$\$\$ 0.00\$ (202)         Fraction of total space heat from main system 1       \$\$\$\$\$\$\$\$ (202) x [203] = \$\$\$\$\$\$\$\$\$\$\$\$ 0.00\$ (205)         Efficiency of main system 1 (%)       \$
Respectative during heating periods in the living area from Table 9, Th1(°C)   Sandard Heading fundation factor for gains for living area T1 (steps 3 to 7 in Table 9.    Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating fine the periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating fine the periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)   Temperature during heating per	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains  Access factor Table 6d m² Solar flux W/m² specific data or Table 6b or Table 6c  NorthWest 0.77 x 1.70 x 11.28 x 0.9 x 0.63 x 0.70 = 5.86 (81)  SouthEast 0.77 x 3.79 x 36.79 x 0.9 x 0.63 x 0.70 = 42.62 (77)  Solar gains in watts Σ(74)m(82)m  48.48 84.53 120.82 158.37 185.31 187.45 179.27 158.65 133.74 94.81 58.42 41.26 (83)  Total gains - internal and solar (73)m + (83)m	Space heating         Fraction of space heat from secondary/supplementary system (table 11)       0.00 (201)         Fraction of space heat from main system(s)       1 - (201) = 1.00 (202)         Fraction of space heat from main system 2       (202) × [1- (203)] = 1.00 (204)         Fraction of total space heat from main system 1       (202) × [1- (203)] = 0.00 (205)         Efficiency of main system 1 (%)         Jan       Feb       Mar       Apr       May       Jul       Aug       Sep       Oct       No       Dec         Space heating fuel (main system 1), kWh/month         359.31 286.17 245.89 150.87 72.41 0.00 0.00 0.00 0.00 138.62 258.41 372.78         ∑(211)15, 1012 = 1884.46 (211)
Space   Feb   Mar   Apr   Space   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct   Nov   Dec   167.03   146.87   153.41   136.47   133.50   119.31   113.07   126.17   126.61   141.76   151.04   162.43   129   1677.68   129   1677.68   129   1677.68   167.03   146.87   153.41   136.47   133.50   146.87   153.41   136.47   133.50   146.87   153.41   136.47   133.50   146.87   153.41   136.47   133.50   146.87   153.41   136.47   133.50   146.87   153.41   136.47   133.50   146.87   154.76   154.7	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains  Access factor Table 6d m² Solar flux W/m² specific data or Table 6b or Table 6c  NorthWest 0.77 x 1.70 x 11.28 x 0.9 x 0.63 x 0.70 = 5.86 (81)  SouthEast 0.77 x 3.79 x 36.79 x 0.9 x 0.63 x 0.70 = 42.62 (77)  Solar gains in watts Σ(74)m(82)m  48.48 84.53 120.82 158.37 185.31 187.45 179.27 158.65 133.74 94.81 58.42 41.26 (83)  Total gains - internal and solar (73)m + (83)m	Space heating         Fraction of space heat from secondary/supplementary system (table 11)       \$\$ \$\$ \$\$ \$\$ \$\$ \$\$ \$\$ \$\$ \$\$ \$\$ \$\$ \$\$ \$\$
Utilisation factor for gains for living area n1,m (see Table 9a)    0.99	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains  Access factor Table 6d m² Solar flux W/m² specific data or Table 6b or Table 6c	Space heating         Fraction of space heat from secondary/supplementary system (table 11)       0.00 (201)         Fraction of space heat from main system (s)       1 - (201) = 1.00 (202)         Fraction of space heat from main system 2       0.00 (202)         Fraction of total space heat from main system 1       (202) × [1- (203)] = 1.00 (204)         Fraction of total space heat from main system 1       (202) × [1- (203)] = 0.00 (205)         Efficiency of main system 1 (%)         Space heating fuel (main system 1), kWh/month         359.31 286.17 245.89 150.87 72.41 0.00 0.00 0.00 0.00 138.62 258.41 372.78         ∑(211)15, 1012 = 1884.46 (211)         Water heating         Efficiency of water heater
0.99   0.98   0.95   0.88   0.74   0.57   0.62   0.83   0.95   0.99   0.99   0.99   0.99   0.86	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains  Access factor Table 6d m² Solar flux w/m² specific data or Table 6b or Table 6c  NorthWest 0.77 x 1.70 x 11.28 x 0.9 x 0.63 x 0.70 = 5.86 (81)  SouthEast 0.77 x 3.79 x 36.79 x 0.9 x 0.63 x 0.70 = 42.62 (77)  Solar gains in watts Σ(74)m(82)m  48.48 84.53 120.82 158.37 185.31 187.45 179.27 158.65 133.74 94.81 58.42 41.26 (83)  Total gains - internal and solar (73)m + (83)m  342.70 376.75 402.38 423.02 433.11 418.97 400.23 384.86 368.69 346.84 329.93 327.07 (84)	Space heating         Fraction of space heat from secondary/supplementary system (table 11)       1 - (201) = 1.00 (202)       (201)         Fraction of space heat from main system (s)       1 - (201) = 1.00 (202)       (202)         Fraction of space heat from main system 2       (202) × [1- (203)] = 1.00 (204)         Fraction of total space heat from main system 1       (202) × [1- (203)] = 0.00 (205)         Efficiency of main system 1 (%)       33.00 (206)         Space heating fuel (main system 1), kWh/month       Mar       Apr       May       Jul       Aug       Sep       Oct       Nov       Dec         Space heating fuel (main system 1), kWh/month         359.31       286.17       245.89       150.87       72.41       0.00       0.00       0.00       138.62       258.41       372.78         Water heating         Efficiency of water heater
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)  19.72 19.87 20.11 20.42 20.71 20.91 20.98 20.97 20.84 20.47 20.03 19.68 (87)  Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)  Electricity for pumps, fans and electric keep-hot (Table 4f)	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains  Access factor Table 6d m² Solar flux w/m² specific data or Table 6b or Table 6c  NorthWest 0.77 x 1.70 x 11.28 x 0.9 x 0.63 x 0.70 = 5.86 (81)  SouthEast 0.77 x 3.79 x 36.79 x 0.9 x 0.63 x 0.70 = 42.62 (77)  Solar gains in watts Σ(74)m(82)m  48.48 84.53 120.82 158.37 185.31 187.45 179.27 158.65 133.74 94.81 58.42 41.26 (83)  Total gains - internal and solar (73)m + (83)m  342.70 376.75 402.38 423.02 433.11 418.97 400.23 384.86 368.69 346.84 329.93 327.07 (84)  7. Mean internal temperature (heating season)  Temperature during heating periods in the living area from Table 9, Th1(*C) 21.00 (85)	Space heating         Fraction of space heat from secondary/supplementary system (table 11)
19.72 19.87 20.11 20.42 20.71 20.98 20.97 20.84 20.47 20.03 19.68 (87)  Temperature during heating periods in the rest of dwelling from Table 9, Th2(*C)  Electricity for pumps, fans and electric keep-hot (Table 4f)	G4.01   G2.20   58.45   53.36   50.05   45.39   41.44   46.51   48.31   53.58   59.54   G2.21   (72)	Space heating         Fraction of space heat from secondary/supplementary system (table 11)       0.00 (201)         Fraction of space heat from main system(s)       1 - (201) = 1.00 (202)         Fraction of space heat from main system 2       0.00 (202)         Fraction of total space heat from main system 1       (202) x [1- (203)] = 1.00 (204)         Fraction of total space heat from main system 1 (%)       (202) x [20] x [20] x [20] = 0.00 (205)         Efficiency of main system 1 (%)       93.00 (206)         Space heating fuel (main system 1), kWh/month       Nov       Dec         Space heating fuel (main system 1), kWh/month       15.84 (211)       0.00 (202)       0.00 (202)         Water heating       88.96 (88.89) (88.74) (88.44) (87.88) (86.70) (86.70) (86.70) (86.70) (86.70) (88.34) (88.79) (89.00) (217)         Water heating fuel, kWh/month       167.03 (146.87) (153.41) (136.47) (133.50) (119.31) (113.07) (126.17) (126.61) (141.76) (151.04) (162.43)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)  Electricity for pumps, fans and electric keep-hot (Table 4f)	64.01 62.20 58.45 53.36 50.05 45.39 41.44 46.51 48.31 53.58 59.54 62.21 (72)  Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m  294.22 292.23 281.55 264.65 247.81 231.53 220.97 226.22 234.94 252.03 271.51 285.81 (73)  6. Solar gains  Access factor Table 6d m² W/m² specific data or Table 6b specific data or Table 6c V  NorthWest	Space heating         Fraction of space heat from secondary/supplementary system (table 11)       0.00 (201)         Fraction of space heat from main system(s)       1 - (201) = 1.00 (202)         Fraction of space heat from main system 2       0.00 (202)         Fraction of total space heat from main system 1       (202) x [1-(203)] = 1.00 (202)         Fraction of total space heat from main system 2       (202) x [2-(203)] = 0.00 (205)         Efficiency of main system 1 (%)       0.00 (205)         Space heating fuel (main system 1), kWh/month       Nov       Nov       Dec         Space heating fuel (main system 1), kWh/month       150.87 (72.41 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0
	G4.01   G2.20   S8.45   S3.36   S0.05   45.39   41.44   46.51   48.31   S3.58   S9.54   G2.21   (72)	Space heating         Fraction of space heat from secondary/supplementary system (table 11)       1 - (201) = 1.00 (202)         Fraction of space heat from main system 2       0.00 (202)         Fraction of total space heat from main system 1       (202) x [1 - (203]] = 1.00 (204)         Fraction of total space heat from main system 2       (202) x [1 - (203]] = 1.00 (204)         Efficiency of main system 1 (%)       (202) x (203) = 93.00 (205)         Space heating fuel (main system 1), kWh/month       359.31 (286.17) (245.89) (150.87) (72.41) (0.00) (0.00) (0.00) (0.00) (0.00) (138.62) (258.41) (372.78)         Space heating fuel (main system 1), kWh/month       (211)         Water heating         Efficiency of water heater         88.96 (88.89) (88.74) (88.74) (88.74) (87.88) (86.70) (86.70) (86.70) (86.70) (88.34) (88.79) (89.00) (217)         Water heating fuel, kWh/month         [167.03] (146.87) (153.41) (136.47) (133.50) (119.31) (113.07) (126.17) (126.61) (141.76) (151.04) (162.43)         Σ(219a)112 (1677.68) (219)         Annual totals
20.09 20.09	G4.01   G2.20   S8.45   S3.36   S0.05   45.39   41.44   46.51   48.31   S3.58   S9.54   G2.21   (72)	Space heating         Fraction of space heat from secondary/supplementary system (table 11)
	Section   Sec	Space heating         Fraction of space heat from secondary/supplementary system (table 11)       1 - (201) = 1 - (201)

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central heating pump or water pump within warm air heating unit	30.00		(230c)
boiler flue fan	45.00		(230e)
Total electricity for the above, kWh/year		114.84	(231)
Electricity for lighting (Appendix L)		291.28	(232)
Total delivered energy for all uses (211)	(221) + (231) + (232)(237b) =	3968.26	(238)

Fuel

kWh/year

1884.46

Fuel price

3.48

x 0.01 =

Fuel

cost £/year

65.58

10a. Fuel costs - individual heating systems including micro-CHP

Space heating - main system 1

SAP band

Water heating	1677.68	x	3.48	x 0.01 =	58.38	(247)
Pumps and fans	114.84	x	13.19	x 0.01 =	15.15	(249)
Electricity for lighting	291.28	x	13.19	x 0.01 =	38.42	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242)	+ (245)(254) =	297.53	(255)
11a. SAP rating - individual heating systems including micro-CH	IP					
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					1.25	(257)
SAP value					82.57	
SAP rating (section 13)					83	(258)

12a. CO <sub>2</sub> emissions - individual heating systems	s including micro-CHP				
	Energy kWh/year	Emission factor kg CO <sub>2</sub> /kWh		Emissions kg CO <sub>2</sub> /year	
Space heating - main system 1	1884.46	x 0.216	=	407.04	(261)
Water heating	1677.68	x 0.216	=	362.38	(264)
Space and water heating		(261) + (262) + (26	3) + (264) =	769.42	(265)
Pumps and fans	114.84	x 0.519	=	59.60	(267)
Electricity for lighting	291.28	x 0.519	=	151.17	(268)
Total CO <sub>2</sub> , kg/year		(26	55)(271) =	980.20	(272)
Dwelling CO₂ emission rate		(	272) ÷ (4) =	17.83	(273)
El value				86.86	]
El rating (section 14)				87	(274)
EI band				В	]

13a. Primary energy - individual heating systems inclu	uding micro-CHP					
	Energy kWh/year		Primary factor		Primary Energy kWh/year	′
Space heating - main system 1	1884.46	x	1.22	=	2299.04	(261)
Water heating	1677.68	x	1.22	=	2046.76	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	4345.81	(265)
Pumps and fans	114.84	x	3.07	=	352.57	(267)
Electricity for lighting	291.28	x	3.07	=	894.22	(268)
Primary energy kWh/year					5592.59	(272)
Dwelling primary energy rate kWh/m2/year					101.70	(273)

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SAP version 9.92

DER Worksheet Design - Draft



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 018 Oxford Road, Bodicaote, OX15		

Address	Plot 018	Oxford Roa	ıd, Bodicao	te, OX15								
1. Overall dwelling dime	nsions											
2. O Colon Cheming Chine				A	rea (m²)			rage storey eight (m)		Vo	olume (m³)	
Lowest occupied +1 Total floor area	(12)	+ (1b) + (1c	c) . (1d) _ (1		39.10 39.10 78.20	] (1a) x ] (1b) x		2.39	(2a) = (2b) =		93.45	(3a) (3b)
Dwelling volume	(10)	, (10), (1	c) · (1u)(	111) -	76.20	] (4)	(3a	) + (3b) + (3c	c) + (3d)(	3n) =	195.50	(5)
							(4.	, (==,	., (, (			
2. Ventilation rate											_	
Number of chimneys							F	0	x 40 =		o 0	(6a)
Number of open flues  Number of intermittent fa	ne							3	x 20 = x 10 =		30	(6b) (7a)
Number of passive vents	113							0	x 10 =		0	] (7b)
Number of flueless gas fire	es							0	x 40 =		0	(7c)
									,	Air	changes pe hour	r
Infiltration due to chimne	ys, flues, fans	s, PSVs		(6a)	+ (6b) + (7a	a) + (7b) + (	(7c) =	30	÷ (5) :		0.15	(8)
If a pressurisation test has	been carried	d out or is i	ntended, pi	roceed to (1	17), otherw	ise continu	e from (9)	to (16)				
Air permeability value, q5	0, expressed	in cubic me	etres per h	our per squ	are metre	of envelop	e area				5.00	(17)
If based on air permeabilit	y value, ther	n (18) = [(17	7) ÷ 20] + (8	3), otherwis	se (18) = (16	5)					0.40	(18)
Number of sides on which	the dwelling	s is sheltere	ed								2	(19)
Shelter factor								1 -	[0.075 x (1		0.85	(20)
Infiltration rate incorporat	_								(18) x (	20) =	0.34	(21)
Infiltration rate modified f							_				_	
Jan  Monthly average wind spe	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	3.00	4.50	4.40	4.30	3.60	3.80	3.70	4.00	4.30	4.30	4.70	(22)
1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (							1 0.00					()
0.44	0.43	0.42	0.38	0.37	0.33	0.33	0.32	0.34	0.37	0.39	0.40	(22b)
Calculate effective air cha	nge rate for t	the applica	ble case:			•	•	-			'	
If mechanical ventilation	n: air change	e rate thro	ugh system								N/A	(23a)
If balanced with heat r	ecovery: effic	ciency in %	allowing fo	or in-use fac	ctor from T	able 4h					N/A	(23c)
d) natural ventilation of	r whole hou	se positive	input venti	ilation from	loft							
0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(24d)

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



	0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(25)
3. Heat losses a	and heat lo	ss paramet	er										
Element		·		Gross rea, m²	Openings m <sup>2</sup>		area m²	U-value W/m²K	AxUW		alue, 'm².K	Ахк, kJ/K	
Window			_			_	1.89 x	1.24	= 13.46	_		,	(27)
Door							.12 x	1.30	= 2.76				(26)
Ground floor							3.91 x	0.15	= 5.84	=			(28a)
External wall							5.02 x	0.21	= 15.96	=			(29a)
Party wall							1.76 x	0.00	= 0.00	=			(32)
Roof							3.90 x	0.11	= 4.28				(30)
Total area of ext	ernal elem	ents 5A m²					6.84			_			(31)
Fabric heat loss,									(26	5)(30) + (3	(2) =	42.29	(33)
Heat capacity Cr		-,						(28)	.(30) + (32) +			N/A	(34)
Thermal mass pa		MP) in kJ/n	n²K					(==)	.(00)	(0_0,(0_	·	250.00	(35)
Thermal bridges				dix K								8.76	(36)
Total fabric heat			0 111-							(33) + (3	(6) =	51.06	(37)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	. ,
Ventilation heat	loss calcula	ited month	ly 0.33 x (2	-	•			J					
	38.42	38.19	37.95	36.85	36.64	35.68	35.68	35.50	36.05	36.64	37.06	37.50	(38)
Heat transfer co	efficient, W	//K (37)m +	(38)m									'	
	89.48	89.24	89.01	87.90	87.70	86.74	86.74	86.56	87.11	87.70	88.12	88.55	1
									Average = ∑	(39)112/	12 =	87.90	(39)
Heat loss param	eter (HLP),	W/m²K (39	9)m ÷ (4)										_
	1.14	1.14	1.14	1.12	1.12	1.11	1.11	1.11	1.11	1.12	1.13	1.13	1
									Average = ∑	(40)112/	12 =	1.12	(40)
Number of days	in month (1	Table 1a)											
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)
4. Water heati		equiremen	t										1
Assumed occupa											<u> </u>	2.43	(42)
Annual average								_				91.86	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage								06.25	00.02	02.70	07.27	101.05	1
	101.05	97.37	93.70	90.02	86.35	82.67	82.67	86.35	90.02	93.70	97.37	101.05	]
Engravagntont	of bototo	r used = 4.1	10 v 1/d m v	nm v Tm/	acoo lawb/w	onth (con	Tables 1b	1014)		∑(44)1:	12 =	1102.33	(44)
Energy content									105.05	122.42	122.64	145 13	1
	149.85	131.06	135.24	117.91	113.13	97.63	90.47	103.81	105.05	122.43 Σ(45)1:	133.64	145.12	(45)
Distribution loss	0.1E v /4E	lm								2(45)1	12 =	1445.55	(45)
Distribution loss	22.48	19.66	20.29	17.69	16.97	14.64	13.57	15.57	15.76	18.36	20.05	21.77	(46)
Water storage lo					10.57	14.04	13.37	13.37	13.70	16.50	20.03	21.//	(40)
water storage it	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel con									0.00	0.00	0.00	0.00	[30]
ii tiic vessereon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit lo				0.00	0.00	0.00	0.00	1 0.00	0.00	0.00	0.00	1 0.00	] (37)
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for e					0.00	0.00	0.00	1 0.00	0.00	0.00	0.00	1 0.00	] (33)
22.1101.1030.101.0	21.91	19.75	21.81	21.03	21.68	20.92	21.58	21.64	20.98	21.75	21.14	21.89	(61)
	21.71	15.75	21.01	21.03	21.00	20.32	21.30	1 21.04	20.30	21./3	21.14	21.03	7 (01)

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0.60 0.59 0.59 0.57 0.57 0.55 0.55 0.55 0.56 0.57 0.57 0.58 (25)

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NHER Plan Assessor version 6.2.3 SAP version 9.92 Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m 171.76 | 150.81 | 157.05 | 138.94 | 134.81 | 118.55 | 112.04 | 125.45 | 126.03 | 144.18 | 154.77 | 167.01 | (62) Solar DHW input calculated using Appendix G or Appendix H 0.00 (63) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 Output from water heater for each month (kWh/month) (62)m + (63)m 171.76 | 150.81 | 157.05 | 138.94 | 134.81 | 118.55 | 112.04 | 125.45 | 126.03 | 144.18 | 154.77 | 167.01  $\Sigma(64)1...12 = 1701.41$  (64)

55.30 48.52 50.42 44.46 43.04 37.69 35.47 39.93 40.17 46.15 49.72 53.72 (65)

Heat gains from water heating (kWh/month)  $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$ 

5. Internal gains Jan Feb Mar Mav Oct Nov Dec Metabolic gains (Table 5) Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 20.65 18.34 14.91 11.29 8.44 7.13 7.70 10.01 13.43 17.06 21.22 (67) Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 215.64 217.88 212.24 200.23 185.08 170.84 161.32 159.08 164.72 176.73 191.88 206.12 (68) Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 35.14 35.14 35.14 35.14 35.14 35.14 35.14 35.14 35.14 35.14 35.14 35.14 35.14 (69) Pump and fan gains (Table 5a) 3.00 3.00 3.00 3.00 3.00 3.00 3.00 3.00 3.00 3.00 3.00 3.00 (70) Losses e.g. evaporation (Table 5) -97.11 -97.11 -97.11 -97.11 -97.11 -97.11 -97.11 -97.11 -97.11 -97.11 -97.11 (71) Water heating gains (Table 5) 74.33 72.20 67.77 61.75 57.85 52.35 47.68 53.67 55.80 62.02 69.05 72.21 (72) Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m 373.03 370.83 357.34 335.69 313.78 292.73 279.12 285.18 296.37 318.22 343.26 361.97 (73)

6. Solar gains														
			Access f Table		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific da or Table		Gains W	
East			0.7	7 x	2.77	x [	19.64	x 0.9 x	0.63	] x	0.70	=	16.63	(76)
West			0.7	7 x	4.89	_ x [	19.64	x 0.9 x	0.63	] x	0.70	=	29.35	(80)
SouthEast			0.7	7 x	2.63	_ x [	36.79	x 0.9 x	0.63	] x	0.70	=	29.57	(77)
South			0.7	7 x	0.60	_ x [	46.75	x 0.9 x	0.63	] x	0.70	=	8.57	(78)
Solar gains in wat	tts ∑(74)m	(82)m												
[	84.12	154.36	234.93	321.64	381.47	386	.25 369.3	8 324	1.78 265.5	9	177.54	102.9	1 70.53	(83)
Total gains - inter	rnal and so	lar (73)m +	(83)m											
[	457.16	525.19	592.27	657.33	695.25	678	.98 648.5	0 609	9.95 561.9	6	495.77	446.1	7 432.50	(84)

7. Mean internal tem	perati	ure (heati	ng season)										
Temperature during he	ating	periods in	the living a	area from T	able 9, Th1	.(°C)						21.00	(85)
Ja	n	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for ga	ins fo	r living are	a n1,m (se	e Table 9a)									
1.0	0	1.00	0.99	0.97	0.90	0.74	0.57	0.63	0.86	0.98	1.00	1.00	(86)
Mean internal temp of	living	area T1 (s	teps 3 to 7	in Table 9d	)								
19.	75	19.90	20.15	20.48	20.77	20.94	20.99	20.98	20.86	20.49	20.06	19.73	(87)

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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	Electricity for pumps, fans and electric keep-hot (Table 4f)
19.96         19.97         19.98         19.98         19.99         19.99         20.00         19.99         19.98         19.99 <td< td=""><td>central heating pump or water pump within warm air heating unit 30.00 (230c)</td></td<>	central heating pump or water pump within warm air heating unit 30.00 (230c)
Utilisation factor for gains for rest of dwelling n2,m	boiler flue fan (230e)
1.00 0.99 0.99 0.95 0.85 0.65 0.45 0.50 0.80 0.97 0.99 1.00 (89)	Total electricity for the above, kWh/year 75.00 (231)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	Electricity for lighting (Appendix L) 364.65 (232)
18.30         18.52         18.89         19.37         19.75         19.95         19.99         19.99         19.87         19.38         18.76         18.27         (90)	Total delivered energy for all uses (211)(221) + (231) + (232)(237b) = 5663.12 (238)
Living area fraction Living area $\div$ (4) = 0.23 (91)	
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	10a. Fuel costs - individual heating systems including micro-CHP
18.63         18.83         19.17         19.62         19.98         20.17         20.21         20.21         20.10         19.63         19.05         18.60         (92)	Fuel Fuel price Fuel kWh/year cost £/year
Apply adjustment to the mean internal temperature from Table 4e where appropriate	Space heating - main system 1 3296.34 x 3.48 x 0.01 = 114.71 (240)
18.48         18.68         19.02         19.47         19.83         20.02         20.06         20.06         19.95         19.48         18.90         18.45         (93)	Water heating 1927.13 x 3.48 x 0.01 = 67.06 (247)
8. Space heating requirement	Pumps and fans 75.00 x 13.19 x 0.01 = 9.89 (249)
	Electricity for lighting 364.65 x 13.19 x 0.01 = 48.10 (250)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	Additional standing charges 120.00 (251)
Utilisation factor for gains, ηm  1.00 0.99 0.98 0.94 0.85 0.66 0.46 0.51 0.79 0.96 0.99 1.00 (94)	Total energy cost (240)(242) + (245)(254) = 359.77 (255)
Useful gains, ηmGm, W (94)m x (84)m	
455.46 521.09 580.75 620.13 588.98 446.37 297.45 311.72 446.07 476.78 442.78 431.27 (95)	11a. SAP rating - individual heating systems including micro-CHP
433.40 321.09 380.73 820.13 388.98 448.37 297.43 311.72 448.07 478.78 442.78 431.27 (93)  Monthly average external temperature from Table U1	Energy cost deflator (Table 12) 0.42 (256)
4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20 (96)	Energy cost factor (ECF) 1.23 (257)
4.30 4.30 6.30 6.30 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20 (96)  Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	SAP value 82.89
1268.67 1229.86 1114.52 929.00 712.95 470.55 300.49 316.93 509.34 778.59 1039.98 1261.92 (97)	SAP rating (section 13) 83 (258)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	SAP band
605.03 476.29 397.12 222.39 92.23 0.00 0.00 0.00 224.55 429.98 618.00	12a. CO <sub>2</sub> emissions - individual heating systems including micro-CHP
$\Sigma(98)15, 1012 = 3065.59$ (98)	Energy Emission factor Emissions kWh/year kg CO <sub>2</sub> /kWh kg CO <sub>2</sub> /year
	Energy Emission factor Emissions
$\Sigma(98)15, 1012 = 3065.59$ (98)	Energy Emission factor Emissions kWh/year kg CO <sub>2</sub> /kWh kg CO <sub>2</sub> /year
$\Sigma(98)15, 1012 = 3065.59 $ (98) Space heating requirement kWh/m²/year (98) ÷ (4) 39.20 (99)	Energy kWh/year kg CO <sub>2</sub> /kWh Emissions kg CO <sub>2</sub> /year  Space heating - main system 1 3296.34 x 0.216 = 712.01 (261)
$\Sigma(98)15, 1012 = 3065.59  (98)$ Space heating requirement kWh/m²/year $(98) \div (4)  39.20  (99)$ 9a. Energy requirements - individual heating systems including micro-CHP	Energy kWh/year kg CO <sub>2</sub> /kWh kg CO <sub>2</sub> /year  Space heating - main system 1 3296.34 x 0.216 = 712.01 (261)  Water heating 1927.13 x 0.216 = 416.26 (264)
Space heating requirement kWh/m²/year  (98) ± (4) 39.20 (99)  9a. Energy requirements - individual heating systems including micro-CHP  Space heating	
Space heating requirement kWh/m²/year  (98) ÷ (4) 39.20 (99)  9a. Energy requirements - individual heating systems including micro-CHP  Space heating  Fraction of space heat from secondary/supplementary system (table 11)	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$
Space heating requirement kWh/m²/year	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$
Space heating requirement kWh/m²/year	Energy kWh/year         Emission factor kg CO₂/kWh         Emissions kg CO₂/ker           Space heating - main system 1         3296.34         x         0.216         =         712.01         (261)           Water heating         1927.13         x         0.216         =         416.26         (264)           Space and water heating         (261) + (262) + (263) + (264) =         1128.27         (265)           Pumps and fans         75.00         x         0.519         =         38.93         (267)           Electricity for lighting         364.65         x         0.519         =         189.25         (268)           Total CO₂, kg/year         (265)(271) =         1356.45         (272)
Space heating requirement kWh/m²/year	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
Space heating requirement kWh/m²/year	Energy kWh/year         Emission factor kg CO₂/kWh         Emissions kg CO₂/year           Space heating - main system 1         3296.34         x         0.216         =         712.01         (261)           Water heating         1927.13         x         0.216         =         416.26         (264)           Space and water heating         (261) + (262) + (263) + (264) =         1128.27         (265)           Pumps and fans         75.00         x         0.519         =         38.93         (267)           Electricity for lighting         364.65         x         0.519         =         189.25         (268)           Total CO₂, kg/year         (265)(271) =         1356.45         (272)         (272)         (272) ÷ (4) =         17.35         (273)           El value         85.25
Space heating requirement kWh/m²/year	Energy kWh/year         Emission factor kg CO₂/kWh         Emissions kg CO₂/ker           Space heating - main system 1         3296.34         x         0.216         =         712.01         (261)           Water heating         1927.13         x         0.216         =         416.26         (264)           Space and water heating         (261) + (262) + (263) + (264) =         1128.27         (265)           Pumps and fans         75.00         x         0.519         =         38.93         (267)           Electricity for lighting         364.65         x         0.519         =         189.25         (268)           Total CO₂, kg/year         (265)(271) =         1356.45         (272)           Dwelling CO₂ emission rate         (272) ÷ (4) =         17.35         (273)           El value         85.25         85         (274)           El band         B         B
Space heating requirement kWh/m²/year	Energy kWh/year kg CO₂/kWh kg CO₂/kwh kg CO₂/kwh kg CO₂/year
Space heating requirement kWh/m²/year   Space heating requirement kWh/m²/year   Space heating requirements - individual heating systems including micro-CHP	Energy kWh/year         Emission factor kg CO₂/kWh         Emissions kg CO₂/ker           Space heating - main system 1         3296.34         x         0.216         =         712.01         (261)           Water heating         1927.13         x         0.216         =         416.26         (264)           Space and water heating         (261) + (262) + (263) + (264) =         1128.27         (265)           Pumps and fans         75.00         x         0.519         =         38.93         (267)           Electricity for lighting         364.65         x         0.519         =         189.25         (268)           Total CO₂, kg/year         (265)(271) =         1356.45         (272)           Dwelling CO₂ emission rate         (272) ÷ (4) =         17.35         (273)           El value         85.25         85         (274)           El band         B         B
Space heating requirement kWh/m²/year   \$\sqrt{98}\) 15, 1012 = \$\sqrt{3065.59}\$ (98)	Energy kWh/year kg CO <sub>2</sub> /kWh kg CO <sub>2</sub> /kWh kg CO <sub>2</sub> /kWh kg CO <sub>2</sub> /year  Space heating - main system 1 3296.34 x 0.216 = 712.01 (261)  Water heating 1927.13 x 0.216 = 416.26 (264)  Space and water heating (261) + (262) + (263) + (264) = 1128.27 (265)  Pumps and fans 75.00 x 0.519 = 38.93 (267)  Electricity for lighting 364.65 x 0.519 = 189.25 (268)  Total CO <sub>2</sub> , kg/year (265)(271) = 1356.45 (272)  Dwelling CO <sub>2</sub> emission rate (272) ÷ (4) = 17.35 (273)  El value 85.25 El rating (section 14)  El band 85 (274)  El band 85 (274)  Energy kWh/year Primary factor Primary Energy kWh/year
Space heating requirement kWh/m²/year   (98) ± (4)   39.20   (99)	Energy kWh/year   Emission factor kg CO <sub>2</sub> /kWh   kg CO <sub>2</sub> /kWh   kg CO <sub>2</sub> /year
Space heating requirement kWh/m²/year   Space heating requirement kWh/m²/year   Space heating requirements - individual heating systems including micro-CHP    Space heating   Space heat from secondary/supplementary system (table 11)   Space heating   Space heat from main system(s)   Space hea	Energy kWh/year   Emission factor kg CO <sub>2</sub> /kWh   kg CO <sub>2</sub> /year
Space heating requirement kWh/m²/year   Space heating requirements - individual heating systems including micro-CHP	Energy kWh/year   Emission factor kg CO <sub>2</sub> /kWh   kg CO <sub>2</sub> /year
Space heating requirement kWh/m²/year   Space heating requirements - individual heating systems including micro-CHP	Energy kWh/year   Emission factor kg CO <sub>2</sub> /kWh   kg CO <sub>2</sub> /year
Space heating requirement kWh/m²/year   Space heating requirement kWh/m²/year   Space heating requirements - individual heating systems including micro-CHP	Energy kWh/year   Emission factor kg CO <sub>2</sub> /kWh   kg CO <sub>3</sub> /year
Space heating requirement kWh/m²/year   S[98]15, 1012 = 3065.59   98	Energy kWh/year   Emission factor kg CO <sub>2</sub> /kWh   kg CO <sub>3</sub> /year
Space heating requirement kWh/m²/year   Space heating requirements - individual heating systems including micro-CHP	Energy kWh/year   Emission factor kg CO <sub>2</sub> /kWh   Emissions kg CO <sub>2</sub> /year   Space heating - main system 1   3296.34   x   0.216   =   712.01   (261)

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#### DER Worksheet Design - Draft



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 021 Oxford Road, Bodicaote, OX15		

1. Overall dwelling dimensions									
		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		46.26	(1a)	x	2.39	(2a) =		110.56	(3a)
+1		46.26	(1b)	x	2.61	(2b) =		120.74	(3b)
Total floor area	(1a) + (1b) + (1c) + (1d)(1n) =	92.52	(4)						
Dwelling volume					(3a) + (3b) + (3c	c) + (3d)	(3n) =	231.30	(5)

Dwelling volume		(3a) + (3b) + (3c)	+ (3d)(3n) =	231.30	(5)
2. Ventilation rate					
				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		3	x 10 =	30	(7a)
Number of passive vents		0	x 10 =	0	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes pe hour	r
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	= 30	÷ (5) =	0.13	(8)
If a pressurisation test has been carried out or is intended, p	roceed to (17), otherwise continue fro	om (9) to (16)			
Air permeability value, q50, expressed in cubic metres per h	our per square metre of envelope are	ea		5.00	(17)
If based on air permeability value, then (18) = $[(17) \div 20] + (3)$	8), otherwise (18) = (16)			0.38	(18)

Shelter factor									1 -	[0.075 x (1	9)] =	0.93	(20)
Infiltration rate i	ncorporatir	ng shelter fa	actor							(18) x (2	20) =	0.35	(21)
Infiltration rate r	nodified for	r monthly v	vind speed	:									
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average	wind spee	d from Tab	le U2										
	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)

Wind factor (22)	m ÷ 4												
	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltrat	ion rate (a	llowing for	shelter and	wind facto	or) (21) x (2	2a)m							
	0.45	0.44	0.43	0.39	0.38	0.33	0.33	0.32	0.35	0.38	0.40	0.41	(22b)

Calculate effective air change rate for the applicable case:
--

Number of sides on which the dwelling is sheltered

If mechanical ventilation: air change rate through system	N/A (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A (23c)
d) natural ventilation or whole house positive input ventilation from loft	

0.56

0.55

0.56

0.57

	0.60	0.60	0.59	0.57	0.57	0.56
Effective air char	nge rate - e	nter (24a) o	or (24b) or (	(24c) or (24	d) in (25)	

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0.58

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0.59 (24d)

(19)

0.60	0.60	0.50	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.50	0.59	/25
0.60	0.60	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59	(23

			á	Gross area, m²	Openings m <sup>2</sup>	Net		U-value W/m²K	AxUW		value, I/m².K	Αxκ, kJ/K	
Window						14.	29 x	1.24	= 17.66				(27
Door						2.:	12 x	1.30	= 2.76				(26
Ground floor						46.	29 x	0.16	= 7.41	ī			(28
External wall						96.	.27 x	0.21	= 20.22				(29
Party wall						30.	.63 x	0.00	= 0.00	=			(32
Roof						46.	.37 x	0.11	= 5.10				(30
Total area of ex	ternal elem	ents ∑A, m²				205	.34						(3:
Fabric heat loss,	, W/K = ∑(A	× U)							(26	)(30) +	(32) =	53.14	(33
Heat capacity C	m = ∑(A x κ)	ł						(28)	(30) + (32) +	(32a)(3	32e) =	N/A	(34
Thermal mass p	arameter (1	TMP) in kJ/r	n²K									250.00	(35
Thermal bridges	s: ∑(L x Ψ) c	alculated us	sing Apper	ndix K								10.20	(36
Total fabric hear	t loss									(33) +	(36) =	63.34	(3:
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	_
Ventilation heat	t loss calcul:	ated month	ly 0.33 x (	25)m x (5)									
	45.82	45.52	45.23	43.86	43.61	42.41	42.41	42.19	42.87	43.61	44.12	44.66	(38
Heat transfer co	efficient, W	J/K (37)m +	- (38)m										
	109.16	108.86	108.57	107.20	106.94	105.75	105.75	105.53	106.21	106.94	107.46	108.00	1
									Average = ∑	(39)112	/12 =	107.20	(3
Heat loss param	neter (HLP),	W/m²K (39	9)m ÷ (4)										_
	1.18	1.18	1.17	1.16	1.16	1.14	1.14	1.14	1.15	1.16	1.16	1.17	7
	,	-							Average = ∑	(40)112	/12 =	1.16	(40
Number of days	in month (	Table 1a)											_
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(4
4. Water heati		equiremen	t										
Assumed occup	•											2.66	(4:
Annual average												97.34	(4:
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage		er day for ea	ach month	Vd.m = fact		le 1c v (43						_	
asagi													_
at mater dough	107.08	103.18	99.29	95.40	91.50	87.61	87.61	91.50	95.40	99.29	103.18	107.08	
				95.40	91.50	87.61	87.61		95.40	99.29 Σ(44)1.		107.08 1168.12	(4
Energy content	of hot wate	er used = 4.1	18 x Vd,m :	95.40 x nm x Tm/3	91.50 8600 kWh/m	87.61	87.61 Tables 1b	, 1c 1d)		∑(44)1.	12 =	1168.12	] (4
				95.40	91.50	87.61	87.61		95.40	Σ(44)1. 129.73	12 =	1168.12	]
Energy content	of hot wate	er used = 4.1 138.88	18 x Vd,m :	95.40 x nm x Tm/3	91.50 8600 kWh/m	87.61	87.61 Tables 1b	, 1c 1d)		∑(44)1.	12 =	1168.12	]
Energy content	of hot wate 158.79 s 0.15 x (45	er used = 4.1 138.88	18 x Vd,m :	95.40 x nm x Tm/3 124.94	91.50 8600 kWh/m	87.61 nonth (see 103.45	87.61 Tables 1b 95.86	, 1c 1d)	111.32	Σ(44)1. 129.73 Σ(45)1.	12 =	1168.12 153.78 1531.59	] (4
Energy content	of hot wate	er used = 4.1 138.88	18 x Vd,m :	95.40 x nm x Tm/3	91.50 8600 kWh/m	87.61	87.61 Tables 1b	, 1c 1d)		Σ(44)1. 129.73	12 =	1168.12	] (4
Energy content  Distribution loss	of hot wate 158.79 s 0.15 x (45 23.82	er used = 4.1 138.88 )m 20.83	18 x Vd,m : 143.31 21.50	95.40 x nm x Tm/3 124.94	91.50 8600 kWh/m	87.61 nonth (see 103.45	87.61 Tables 1b 95.86	, 1c 1d)	111.32	Σ(44)1. 129.73 Σ(45)1.	12 =	1168.12 153.78 1531.59	] (4
Energy content  Distribution loss  Water storage le	of hot wate  158.79  s 0.15 x (45  23.82  oss calculate  0.00	r used = 4.1 138.88 )m 20.83 ed for each	18 x Vd,m: 143.31 21.50 month (5	95.40 x nm x Tm/3 124.94 18.74 5) x (41)m 0.00	91.50 8600 kWh/m 119.89 17.98	87.61 nonth (see 103.45 15.52 0.00	87.61  Tables 1b, 95.86  14.38	, 1c 1d)	111.32	Σ(44)1. 129.73 Σ(45)1.	12 =	1168.12 153.78 1531.59	] ] (4 ] (4
	of hot wate  158.79  s 0.15 x (45  23.82  oss calculate  0.00	r used = 4.1 138.88 )m 20.83 ed for each	18 x Vd,m: 143.31 21.50 month (5	95.40 x nm x Tm/3 124.94 18.74 5) x (41)m 0.00	91.50 8600 kWh/m 119.89 17.98	87.61 nonth (see 103.45 15.52 0.00	87.61  Tables 1b, 95.86  14.38	, 1c 1d)	111.32	Σ(44)1. 129.73 Σ(45)1. 19.46	12 =	1168.12 153.78 1531.59 23.07	] ] (4 ] (4
Energy content  Distribution loss  Water storage le	of hot wate  158.79  s 0.15 x (45  23.82  oss calculate  0.00	r used = 4.1 138.88 )m 20.83 ed for each	18 x Vd,m: 143.31 21.50 month (5	95.40 x nm x Tm/3 124.94 18.74 5) x (41)m 0.00	91.50 8600 kWh/m 119.89 17.98	87.61 nonth (see 103.45 15.52 0.00	87.61  Tables 1b, 95.86  14.38	, 1c 1d)	111.32	Σ(44)1. 129.73 Σ(45)1. 19.46	12 =	1168.12 153.78 1531.59 23.07	] (4! ] (4! ] (5!
Energy content  Distribution loss  Water storage le	of hot wate  158.79  s 0.15 x (45)  23.82  oss calculate  0.00  ntains dedicate	er used = 4.1  138.88  )m  20.83 ed for each  0.00 ated solar s	21.50 month (5 0.00 torage or 0	95.40 x nm x Tm/3 124.94 18.74 5) x (41)m 0.00 dedicated W	91.50 6600 kWh/m 119.89 17.98 0.00 /WHRS (56)	87.61 wonth (see 103.45 15.52 0.00 m x [(47) -	87.61  Tables 1b, 95.86  14.38  0.00  Vs] ÷ (47),	16.50  16.50  0.00 else (56)	111.32 16.70	Σ(44)1.  129.73 Σ(45)1.  19.46	12 =   141.61  12 =   21.24	1168.12 153.78 1531.59 23.07	] (4! ] (4! ] (5!
Energy content  Distribution loss  Water storage le  If the vessel con	of hot wate  158.79  s 0.15 x (45)  23.82  oss calculate  0.00  ntains dedicate	er used = 4.1  138.88  )m  20.83 ed for each  0.00 ated solar s	21.50 month (5 0.00 torage or 0	95.40 x nm x Tm/3 124.94 18.74 5) x (41)m 0.00 dedicated W	91.50 6600 kWh/m 119.89 17.98 0.00 /WHRS (56)	87.61 wonth (see 103.45 15.52 0.00 m x [(47) -	87.61  Tables 1b, 95.86  14.38  0.00  Vs] ÷ (47),	16.50  16.50  0.00 else (56)	111.32 16.70	Σ(44)1.  129.73 Σ(45)1.  19.46	12 =   141.61  12 =   21.24	1168.12 153.78 1531.59 23.07	(44)
Energy content  Distribution loss  Water storage le  If the vessel con	of hot wate  158.79  s 0.15 x (45  23.82  oss calculati  0.00  ntains dedici  0.00  loss for each	er used = 4.1  138.88  )m  20.83  ed for each  0.00  ated solar s  0.00  n month fro	21.50 month (5 0.00 torage or 0 0.00 m Table 3 0.00	95.40 x nm x Tm/3 124.94  18.74 5) x (41)m 0.00 dedicated W 0.00  0.00	91.50   91.50   191.5	87.61 nonth (see 103.45 15.52 0.00 n x [(47) - 0.00	87.61  Tables 1b, 95.86  14.38  0.00  Vs] ÷ (47), 0.00	1c 1d) 110.01 16.50 0.00 else (56) 0.00	111.32 16.70 0.00	Σ(44)1.  129.73 Σ(45)1.  19.46  0.00	12 =	1168.12 153.78 1531.59 23.07 0.00	(4)

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Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m Temperature during heating periods in the rest of the contract of	dwelling from Table 9, Th2(°C)	
180.74     158.69     165.19     146.03     141.62     124.42     117.48     131.70     132.35     151.55     162.80     175.71     (62)	19.95 19.96 19.97 19.93	97         19.97         19.96         19.96         19.95         19.95         (88)
Solar DHW input calculated using Appendix G or Appendix H  Utilisation factor for gains for rest of dwelling n2, m	ı	
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0.96 0.86 0.67 0.46	6 0.51 0.80 0.97 0.99 1.00 (89)
Output from water heater for each month (kWh/month) (62)m + (63)m  Mean internal temperature in the rest of dwelling	T2 (follow steps 3 to 7 in Table 9c)	
180.74         158.69         165.19         146.03         141.62         124.42         117.48         131.70         132.35         151.55         162.80         175.71         18.20         18.44         18.81	19.29 19.69 19.92 19.90	06 19.96 19.83 19.32 18.68 18.17 (90)
$\Sigma$ (64)112 = 1788.28 (64) Living area fraction		Living area $\div$ (4) = 0.23 (91)
Heat gains from water heating (kWh/month) $0.25 \times [0.85 \times (45)\text{m} + (61)\text{m}] + 0.8 \times [(46)\text{m} + (57)\text{m} + (59)\text{m}]$ Mean internal temperature for the whole dwelling	fLA x T1 +(1 - fLA) x T2	
58.29     51.13     53.12     46.82     45.30     39.64     37.28     42.00     42.27     48.59     52.38     56.61     (65)	19.55 19.93 20.15 20.19	.9 20.19 20.06 19.58 18.98 18.51 (92)
5. Internal gains  Apply adjustment to the mean internal temperature	e from Table 4e where appropriate	
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	19.40 19.78 20.00 20.04	04 20.04 19.91 19.43 18.83 18.36 (93)
Metabolic gains (Table 5)  8. Space heating requirement		
132.93   132	Apr May Jun Jul	Aug Sep Oct Nov Dec
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5  Utilisation factor for gains, nm	Api May Juli Jul	Aug Sep Oct Nov Dec
22.82 20.27 16.48 12.48 9.33 7.88 8.51 11.06 14.85 18.85 22.00 23.46 (67) 1.00 0.99 0.98	0.95 0.86 0.67 0.47	7 0.52 0.80 0.96 0.99 1.00 (94)
Appliance gains (calculated in Appendix L, equation L13a), also see Table 5  Useful gains, ηmGm, W (94)m x (84)m	0.93 0.80 0.07 0.47	0.32 0.00 0.90 0.99 1.00 (94)
243.64 246.17 239.80 226.23 209.11 193.02 182.27 179.74 186.11 199.68 216.80 232.89 (68) 533.07 619.80 688.76	732.43 700.16 536.73 359.5	55 376.34 533.98 569.48 523.18 502.81 (95)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5  Monthly average external temperature from Table		75 370.34 333.50 303.40 323.10 302.01 (55)
36.29 36.29	8.90 11.70 14.60 16.60	50 16.40 14.10 10.60 7.10 4.20 (96)
Pump and fan gains (Table 5a)  Heat loss rate for mean internal temperature, Lm,		0 10.40 14.10 10.00 7.10 4.20 (50)
3.00 3.00 3.00 3.00 3.00 3.00 3.00 3.00		09 384.04 617.51 944.41 1261.03 1529.68 (97)
Losses e.g. evaporation (Table 5)  Space heating requirement, kWh/month 0.024 x [		3 30 101 01/131 31 1111 120103 1323100 (57)
	283.39 122.14 0.00 0.00	0 0.00 0.00 278.94 531.25 763.99
Water heating gains (Table 5)		Σ(98)15, 1012 = 3807.38 (98)
78.34 76.09 71.40 65.02 60.88 55.05 50.11 56.45 58.71 65.31 72.75 76.09 (72) Space heating requirement kWh/m²/year		(98) ÷ (4) 41.15 (99)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m		(, (-)
410.68 408.40 393.56 369.61 345.20 321.83 306.77 313.14 325.55 349.72 377.43 398.32 (73)	ems including micro-CHP	
Space heating		
6. Solar gains Fraction of space heat from secondary/supplement	tary system (table 11)	0.00 (201)
Access factor Area Solar flux g FF Gains Fraction of space heat from main system(s)  Table 6d m² W/m² specific data specific data W		1 - (201) = 1.00 (202)
or Table 6b or Table 6c Fraction of space heat from main system 2		0.00 (202)
NorthEast 0.77 x 3.15 x 11.28 x 0.9 x 0.63 x 0.70 = 10.86 (75)		(202) x [1- (203)] = 1.00 (204)
SouthWest 0.77 x 7.54 x 36.79 x 0.9 x 0.63 x 0.70 = 84.78 (79) Fraction of total space heat from main system 2		(202) x (203) = 0.00 (205)
South 0.77 x 1.50 x 46.75 x 0.9 x 0.63 x 0.70 = 21.43 (78)		93.00 (206)
NorthWest 0.77 x 2.10 x 11.28 x 0.9 x 0.63 x 0.70 = 7.24 (81)	Apr May Jun Jul	Aug Sep Oct Nov Dec
Solar gains in watts 5(74)m(82)m		
124.32 216.37 308.70 404.40 473.46 479.18 458.17 405.16 341.57 242.51 149.74 105.86 (83)	304.72   131.33   0.00   0.00	
Total gains - internal and solar (73)m + (83)m		$\Sigma$ (211)15, 1012 = 4093.96 (211)
535.00 624.77 702.26 774.02 818.66 801.01 764.94 718.30 667.12 592.22 527.17 504.18 (84) Water heating		
Efficiency of water heater		
7. Mean internal temperature (heating season) 89.34 89.28 89.15	88.85 88.20 86.70 86.70	70 86.70 86.70 88.81 89.20 89.36 (217)
Temperature during heating periods in the living area from Table 9, Th1(°C)  21.00 (85)  Water heating fuel, kWh/month		
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec <u>202.31   177.75   185.30  </u>	164.36   160.57   143.50   135.5	
Utilisation factor for gains for living area n1,m (see Table 9a)		$\Sigma$ (219a)112 = 2023.62 (219)
1.00 1.00 0.99 0.97 0.90 0.76 0.59 0.64 0.87 0.98 1.00 1.00 (86) Annual totals		1000
1.00     1.00     0.99     0.97     0.90     0.76     0.59     0.64     0.87     0.98     1.00     1.00     (86)     Annual totals       Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)     Space heating fuel - main system 1       19.70     19.86     20.11     20.44     20.74     20.93     20.98     20.98     20.85     20.46     20.02     19.67     (87)     Water heating fuel		4093.96 2023.62

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Electricity for pumps, fans and electric keep-hot (Table 4f)			
central heating pump or water pump within warm air heating unit	30.00		(230c)
boiler flue fan	45.00		(230e)
Total electricity for the above, kWh/year		75.00	(231)
Electricity for lighting (Appendix L)		403.04	(232)
Total delivered energy for all uses	(211)(221) + (231) + (232)(237b) =	6595.62	(238)

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4093.96	x	3.48	x 0.01 =	142.47	(240)
Water heating	2023.62	x	3.48	x 0.01 =	70.42	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	403.04	x	13.19	x 0.01 =	53.16	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242) +	(245)(254) =	395.95	(255)
11a. SAP rating - individual heating systems ind	cluding micro-CHP					
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					1.21	(257)

SAP value SAP rating (section 13)

SAP band

12a. CO₂ emissions - individual heating systems	s including micro-CHP				
	Energy kWh/year		Emission factor kg CO <sub>2</sub> /kWh	Emissions kg CO₂/year	
Space heating - main system 1	4093.96	x	0.216 =	884.29	(261)
Water heating	2023.62	x	0.216 =	437.10	(264)
Space and water heating			(261) + (262) + (263) + (2	64) = 1321.40	(265)
Pumps and fans	75.00	x	0.519 =	38.93	(267)
Electricity for lighting	403.04	x	0.519 =	209.18	(268)
Total CO <sub>2</sub> , kg/year			(265)(2	71) = 1569.50	(272)
Dwelling CO₂ emission rate			(272) ÷	(4) = 16.96	(273)
El value				84.71	
El rating (section 14)				85	(274)
FI hand				B	1

13a. Primary energy - individual heating systems including	micro-CHP					
	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	4093.96	x	1.22	=	4994.63	(261)
Water heating	2023.62	x	1.22	=	2468.81	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	7463.44	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	403.04	x	3.07	=	1237.34	(268)
Primary energy kWh/year					8931.03	(272)
Dwelling primary energy rate kWh/m2/year					96.53	(273)

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83.13

83

В

(258)

**DER Worksheet Design - Draft** 



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 022 Oxford Road, Bodicaote, OX15		

Client								Ld	st mounieu		10/01	1/2018	
Address		Plot 022 (	Oxford Ro	ad, Bodicao	te, OX15								
1. Overall dwe	lling dimen	sions											
					А	rea (m²)			age storey eight (m)		Vo	olume (m³)	
Lowest occupied	t					46.49	(1a) x		2.39	(2a) =		111.11	(3a)
+1						46.50	(1b) x		2.61	(2b) =		121.37	(3b)
Total floor area		(1a)	+ (1b) + (1	c) + (1d)(	1n) =	92.99	(4)						
Dwelling volume	9							(3a)	+ (3b) + (3	c) + (3d)(	3n) =	232.48	(5)
2. Ventilation	rate												
											m	³ per hour	
Number of chim	ineys								0	x 40 =	. [	0	(6a)
Number of oper	n flues								0	x 20 =	. [	0	(6b)
Number of inter	mittent fan	S							4	x 10 =	- [	40	(7a)
Number of pass	ive vents								0	x 10 =	- [	0	(7b)
Number of fluel	ess gas fires	;							0	x 40 =	· [	0	(7c)
											Air	changes pe hour	r
Infiltration due t	to chimneys	, flues, fans	, PSVs		(6a)	+ (6b) + (7a	a) + (7b) + (	7c) =	40	÷ (5) :	- [	0.17	(8)
If a pressurisation	on test has l	oeen carried	out or is	ntended, pi	oceed to (2	17), otherw	ise continue	e from (9) t	o (16)				
Air permeability	value, q50,	expressed	in cubic m	etres per h	our per squ	are metre	of envelope	e area				5.00	(17)
If based on air p	ermeability	value, then	(18) = [(1	7) ÷ 20] + (8	3), otherwis	se (18) = (16	5)					0.42	(18)
Number of sides	on which t	he dwelling	is shelter	ed								2	(19)
Shelter factor									1 -	[0.075 x (1	.9)] =	0.85	(20)
Infiltration rate	incorporatii	ng shelter fa	ctor							(18) x (	20) =	0.36	(21)
Infiltration rate	modified fo	r monthly w	ind speed	l:									
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average	e wind spee	d from Tab	le U2										_
	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)

	00	0.00				0.00	0.00						
Wind factor (22)	m ÷ 4												-
	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltrat	ion rate (al	llowing for	shelter and	wind facto	or) (21) x (2	2a)m							
	0.46	0.45	0.44	0.39	0.39	0.34	0.34	0.33	0.36	0.39	0.40	0.42	(22b)
Calculate effective	ve air chang	ge rate for t	the applicat	ole case:									
If mechanical	ventilation	: air chang	e rate throu	ıgh system								N/A	(23a)

If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h N/A d) natural ventilation or whole house positive input ventilation from loft 0.60 0.60 0.60 0.58 0.57 0.56 0.56 0.56 0.57 0.58 0.59 (24d)

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



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	•	0.57	0.56 0.56	0.56	0.56	0.57	0.58	0.59	(25)
3. Heat losses and heat loss parameter									
Element	Gross	Openings	Net area	U-value	A x U W	/К к-va	alue,	Ахк,	
	area, m²	m²	A, m²	W/m²K		kJ/	m².K	kJ/K	
Window			14.52 x	1.24	= 17.94				(27)
Door			2.02 x	1.30	= 2.63				(26)
Ground floor			46.49 x	0.15	= 6.97				(28a
External wall			80.65 x	0.21	= 16.94				(29a
Party wall			42.49 x	0.00	= 0.00				(32)
Roof			46.50 x	0.11	= 5.12				(30)
Total area of external elements ∑A, m²			190.18						(31)
Fabric heat loss, W/K = $\sum$ (A × U)					(26	)(30) + (3	2) =	49.59	(33)
Heat capacity $Cm = \sum (A \times \kappa)$				(28)	.(30) + (32) +	(32a)(32	e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²k	(							250.00	(35)
Thermal bridges: Σ(L x Ψ) calculated using	g Appendix K							8.07	(36)
Total fabric heat loss						(33) + (3	6) =	57.67	(37)
Jan Feb	Mar Apr	May	Jun Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly									7
	45.77 44.33	44.06	42.81 42.81	42.58	43.30	44.06	44.61	45.17	(38)
Heat transfer coefficient, W/K (37)m + (3	·								7
104.05   103.74   1	103.44   102.00	101.73	100.48 100.48	100.25	100.96	101.73	102.28	102.84	
					Average = ∑	(39)112/	12 =	102.00	(39)
Heat loss parameter (HLP), W/m²K (39)m									7
1.12   1.12	1.11 1.10	1.09	1.08 1.08	1.08	1.09	1.09	1.10	1.11	
								4 40	7 ( )
Number of days in month (Table 1a)					Average = ∑	(40)112/	12 =	1.10	(40)
Number of days in month (Table 1a)	31.00 30.00	31.00	20.00 21.00	21.00					
	31.00 30.00	31.00	30.00 31.00	31.00	Average = ∑	31.00	30.00	31.00	(40)
	31.00 30.00	31.00	30.00 31.00	31.00					_
31.00 28.00	31.00   30.00	31.00	30.00 31.00	31.00					_
31.00 28.00 4. Water heating energy requirement				31.00				31.00	(40)
4. Water heating energy requirement Assumed occupancy, N				31.00				31.00 2.66	(40)
4. Water heating energy requirement Assumed occupancy, N Annual average hot water usage in litres	per day Vd,average <b>Mar Apr</b>	= (25 x N) + 3 <b>May</b>	36 Jun Jul		30.00	31.00	30.00	31.00 2.66 97.48	(40)
4. Water heating energy requirement Assumed occupancy, N Annual average hot water usage in litres   Jan Feb Hot water usage in litres per day for each	per day Vd,average <b>Mar Apr</b>	= (25 x N) + 3 <b>May</b>	36 Jun Jul		30.00	31.00	30.00	31.00 2.66 97.48	(40)
4. Water heating energy requirement Assumed occupancy, N Annual average hot water usage in litres   Jan Feb Hot water usage in litres per day for each	per day Vd,average <b>Mar Apr</b> ı month Vd,m = fact	= (25 x N) + 3 <b>May</b> or from Table	36 Jun Jul e 1c x (43)	Aug	30.00 Sep	31.00 Oct	30.00 Nov	2.66 97.48 Dec	(40) (42) (43)
4. Water heating energy requirement Assumed occupancy, N Annual average hot water usage in litres   Jan Feb Hot water usage in litres per day for each	per day Vd,average  Mar Apr  month Vd,m = fact  99.43 95.53	= (25 x N) + 3 <b>May</b> or from Table 91.63	36 Jun Jul e 1c x (43) 87.73 87.73	Aug 91.63	30.00 Sep	31.00 Oct	30.00 Nov	2.66 97.48 Dec	(40) (42) (43)
4. Water heating energy requirement Assumed occupancy, N Annual average hot water usage in litres  Jan Feb  Hot water usage in litres per day for each  107.23 103.33  Energy content of hot water used = 4.18 and the second seco	per day Vd,average  Mar Apr  month Vd,m = fact  99.43 95.53	= (25 x N) + 3 <b>May</b> or from Table 91.63	36 Jun Jul e 1c x (43) 87.73 87.73	Aug 91.63	30.00 Sep	31.00 Oct	30.00 Nov	2.66 97.48 Dec	(40) (42) (43)
4. Water heating energy requirement Assumed occupancy, N Annual average hot water usage in litres  Jan Feb  Hot water usage in litres per day for each  107.23 103.33  Energy content of hot water used = 4.18 and the second seco	per day Vd,average  Mar Apr  month Vd,m = fact 99.43 95.53  x Vd,m x nm x Tm/3	= (25 x N) + 3  May or from Table 91.63	36 Jun Jul e 1c x (43) 87.73 87.73	Aug 91.63	\$ep 95.53	31.00 Oct 99.43 Σ(44)1:	30.00 Nov 103.33 12 =	2.66 97.48 Dec	] (40) ] (42) ] (43)
4. Water heating energy requirement Assumed occupancy, N Annual average hot water usage in litres  Jan Feb  Hot water usage in litres per day for each  107.23 103.33  Energy content of hot water used = 4.18 and the second seco	per day Vd,average  Mar Apr  month Vd,m = fact 99.43 95.53  x Vd,m x nm x Tm/3	= (25 x N) + 3  May or from Table 91.63	36 Jun Jul e 1c x (43) 87.73 87.73	Aug 91.63	\$ep 95.53	31.00 Oct 99.43 Σ(44)1:	30.00 Nov 103.33 12 =	2.66 97.48 Dec 107.23 1169.78	] (40) ] (42) ] (43)
4. Water heating energy requirement Assumed occupancy, N Annual average hot water usage in litres   Jan Feb Hot water usage in litres per day for each 107.23 103.33  Energy content of hot water used = 4.18 or 159.02 139.08 :	per day Vd,average  Mar Apr  month Vd,m = fact 99.43 95.53  x Vd,m x nm x Tm/3	= (25 x N) + 3  May or from Table 91.63	36 Jun Jul e 1c x (43) 87.73 87.73	Aug 91.63	\$ep 95.53	31.00 Oct 99.43 Σ(44)1:	30.00 Nov 103.33 12 =	2.66 97.48 Dec 107.23 1169.78	] (40) ] (42) ] (43)
4. Water heating energy requirement Assumed occupancy, N Annual average hot water usage in litres   Jan Feb Hot water usage in litres per day for each 107.23 103.33  Energy content of hot water used = 4.18 or 159.02 139.08 :	per day Vd,average  Mar Apr  month Vd,m = fact  99.43 95.53  x Vd,m x nm x Tm/3  143.52 125.12	= (25 x N) + 3  May  or from Table  91.63  600 kWh/mo  120.06	36 Jun Jul e 1c x (43) 87.73 87.73 onth (see Tables 1 103.60 96.00	Aug 91.63 b, 1c 1d) 110.16	30.00	31.00 Oct 99.43 Σ(44)1 129.92 Σ(45)1	30.00  Nov  103.33 12 =   141.81 12 =	2.66 97.48 Dec 107.23 1169.78 154.00	(40) (42) (43) (43)
4. Water heating energy requirement  Assumed occupancy, N  Annual average hot water usage in litres    Jan Feb  Hot water usage in litres per day for each  107.23 103.33    Energy content of hot water used = 4.18 or  159.02 139.08    Distribution loss 0.15 x (45)m	per day Vd,average  Mar Apr  month Vd,m = fact  99.43 95.53  x Vd,m x nm x Tm/3  143.52 125.12	= (25 x N) + 3  May  or from Table  91.63  600 kWh/mo  120.06	36 Jun Jul e 1c x (43) 87.73 87.73 onth (see Tables 1 103.60 96.00	Aug 91.63 b, 1c 1d) 110.16	30.00	31.00 Oct 99.43 Σ(44)1 129.92 Σ(45)1	30.00  Nov  103.33 12 =   141.81 12 =	2.66 97.48 Dec 107.23 1169.78 154.00	(40) (42) (43) (43)
4. Water heating energy requirement Assumed occupancy, N Annual average hot water usage in litres  Jan Feb  Hot water usage in litres per day for each  107.23 103.33  Energy content of hot water used = 4.18 or 159.02 139.08 or 159.02	per day Vd,average Mar Apr month Vd,m = fact 99.43 95.53  x Vd,m x nm x Tm/3 143.52 125.12  21.53 18.77 onth (55) x (41)m 0.00 0.00	= (25 x N) + 3  May  or from Table  91.63  600 kWh/mo  120.06  18.01	36 Jun Jul e 1c x (43) 87.73 87.73 onth (see Tables 1 103.60 96.00 15.54 14.40 0.00 0.00	Aug 91.63 b, 1c 1d) 110.16	30.00	31.00 Oct  99.43 Σ(44)1  129.92 Σ(45)1  19.49	30.00  Nov  103.33  12 =   141.81  12 =   21.27	2.66 97.48 Dec 107.23 1169.78 154.00 1533.76	] (40] ] (42] ] (43] ] (44] ] (45]
4. Water heating energy requirement Assumed occupancy, N Annual average hot water usage in litres  Jan Feb  Hot water usage in litres per day for each  107.23 103.33  Energy content of hot water used = 4.18 or 159.02 139.08 120.20  Distribution loss 0.15 x (45)m  23.85 20.86  Water storage loss calculated for each model of the content	per day Vd,average Mar Apr month Vd,m = fact 99.43 95.53  x Vd,m x nm x Tm/3 143.52 125.12  21.53 18.77 onth (55) x (41)m 0.00 0.00	= (25 x N) + 3  May  or from Table  91.63  600 kWh/mo  120.06  18.01	36 Jun Jul e 1c x (43) 87.73 87.73 onth (see Tables 1 103.60 96.00 15.54 14.40 0.00 0.00	Aug 91.63 b, 1c 1d) 110.16	30.00	31.00 Oct  99.43 Σ(44)1  129.92 Σ(45)1  19.49	30.00  Nov  103.33  12 =   141.81  12 =   21.27	2.66 97.48 Dec 107.23 1169.78 154.00 1533.76	(40) (42) (43) (44) (44) (45) (46)
31.00   28.00	per day Vd,average Mar Apr a month Vd,m = fact 99.43 95.53  x Vd,m x nm x Tm/3 143.52 125.12  21.53 18.77 onth (55) x (41)m 0.00 0.00 rage or dedicated W 0.00 0.00	= (25 x N) + 3  May  or from Table  91.63  600 kWh/mo  120.06  18.01  0.00  WHRS (56)m	36 Jun Jul e 1c x (43) 87.73 87.73 onth (see Tables 1 103.60 96.00 15.54 14.40 0.00 0.00 a x [(47) - Vs] ÷ (47	Aug 91.63 b, 1c 1d) 110.16 16.52 0.00 0, else (56)	30.00	31.00 Oct 99.43 Σ(44)1 129.92 Σ(45)1 19.49 0.00	30.00  Nov  103.33 12 =   141.81 12 =   21.27  0.00	2.66 97.48 Dec 107.23 1169.78 154.00 1533.76 23.10	] (40) ] (42) ] (43) ] (44) ] (45)
31.00   28.00	per day Vd,average Mar Apr a month Vd,m = fact 99.43 95.53  x Vd,m x nm x Tm/3 143.52 125.12  21.53 18.77 onth (55) x (41)m 0.00 0.00 rage or dedicated W 0.00 0.00	= (25 x N) + 3  May  or from Table  91.63  600 kWh/mo  120.06  18.01  0.00  WHRS (56)m	36 Jun Jul e 1c x (43) 87.73 87.73 onth (see Tables 1 103.60 96.00 15.54 14.40 0.00 0.00 a x [(47) - Vs] ÷ (47	Aug 91.63 b, 1c 1d) 110.16 16.52 0.00 0, else (56)	30.00	31.00 Oct 99.43 Σ(44)1 129.92 Σ(45)1 19.49 0.00	30.00  Nov  103.33 12 =   141.81 12 =   21.27  0.00	2.66 97.48 Dec 107.23 1169.78 154.00 1533.76 23.10	] (40) ] (42) ] (43) ] (44) ] (45) ] (46)
31.00   28.00	per day Vd,average Mar Apr a month Vd,m = facte 99.43 95.53  x Vd,m x nm x Tm/3 143.52 125.12  21.53 18.77 onth (55) x (41)m 0.00 0.00 rage or dedicated W 0.00 0.00 Table 3 0.00 0.00	= (25 x N) + 3  May  or from Table  91.63  600 kWh/mo  120.06  18.01  0.00  WHRS (56)m  0.00	36  Jun Jul e 1c x (43)  87.73 87.73  onth (see Tables 1  103.60 96.00  15.54 14.40  0.00 0.00  0 x [(47) - Vs] ÷ (47  0.00 0.00	Aug 91.63 b, 1c 1d) 110.16 16.52 0.00 0, else (56) 0.00	30.00	31.00   Oct   99.43   Σ(44)1:   129.92   Σ(45)1:   19.49   0.00	30.00  Nov  103.33 12 =   141.81 12 =   21.27  0.00  0.00	2.66 97.48 Dec 107.23 1169.78 154.00 1533.76 23.10 0.00	(40) (42) (43) (44) (44) (45) (46)

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NHER Plan Assessor version 6.2.3 SAP version 9.92 Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m 180.07 | 158.07 | 164.49 | 145.34 | 140.89 | 123.70 | 116.73 | 130.96 | 131.64 | 150.84 | 162.13 | 175.03 | (62) Solar DHW input calculated using Appendix G or Appendix H 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 (63) Output from water heater for each month (kWh/month) (62)m + (63)m 180.07 | 158.07 | 164.49 | 145.34 | 140.89 | 123.70 | 116.73 | 130.96 | 131.64 | 150.84 | 162.13 | 175.03 Σ(64)1...12 = 1779.88 (64) Heat gains from water heating (kWh/month)  $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$ 

58.14 50.99 52.96 46.66 45.13 39.47 37.10 41.83 42.11 48.43 52.23 56.46 (65)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
∕letabolic gains	(Table 5)												
	133.22	133.22	133.22	133.22	133.22	133.22	133.22	133.22	133.22	133.22	133.22	133.22	(66
ghting gains (ca	alculated in	Appendix I	., equation	L9 or L9a),	also see Ta	able 5							
	22.85	20.29	16.50	12.50	9.34	7.89	8.52	11.08	14.87	18.87	22.03	23.48	(67
ppliance gains	(calculated	in Appendi	x L, equatio	on L13 or L1	13a), also se	ee Table 5							
	244.47	247.01	240.62	227.01	209.83	193.68	182.89	180.36	186.75	200.36	217.54	233.69	(68
ooking gains (ca	alculated in	Appendix	L, equation	L15 or L15	a), also see	Table 5							
	36.32	36.32	36.32	36.32	36.32	36.32	36.32	36.32	36.32	36.32	36.32	36.32	(69
ump and fan ga	ins (Table 5	5a)											
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70
osses e.g. evapo	oration (Tal	ble 5)											
	-106.58	-106.58	-106.58	-106.58	-106.58	-106.58	-106.58	-106.58	-106.58	-106.58	-106.58	-106.58	(71
Vater heating g	ains (Table	5)											
	78.14	75.88	71.19	64.80	60.66	54.82	49.87	56.22	58.48	65.09	72.54	75.89	(72
Total internal ga	ins (66)m +	+ (67)m + (6	8)m + (69)ı	m + (70)m -	+ (71)m + (	72)m							
	411.43	409.15	394.28	370.27	345.79	322.35	307.25	313.62	326.06	350.29	378.08	399.03	7 (73

6. Solar gains															
		Access f Table		Area m²		olar flux W/m²		•	g fic data able 6b		FF specific d or Table			Gains W	
West		0.77	7 x	5.81	х 🗌	19.64	x 0.9 x	0	.63	х	0.70	=		34.87	(80
East		0.7	7 x	8.71	х 🗌	19.64	x 0.9 x	0	.63	х	0.70	=		52.28	(76
Solar gains in watts ∑(74)m.	(82)m														
87.15	170.49	280.77	409.49	501.85	513.73	489.09	420	).12	326.55		202.30	108.6	57	71.67	(83
Total gains - internal and sol	ar (73)m +	(83)m													
498.58	579.64	675.05	779.76	847.64	836.09	796.34	733	3.74	652.62	: [	552.59	486.7	75	470.70	(84

7. Mean intern	al tempera	ture (heati	ng season)										
Temperature du	ring heatin	g periods in	the living a	area from T	able 9, Th1	(°C)						21.00	(85)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	r for gains f	or living are	ea n1,m (se	e Table 9a)									
	1.00	1.00	0.99	0.96	0.88	0.71	0.54	0.61	0.87	0.98	1.00	1.00	(86)
Mean internal to	emp of livin	g area T1 (s	steps 3 to 7	in Table 90	:)								
	19.74	19.89	20.16	20.51	20.80	20.95	20.99	20.98	20.87	20.48	20.05	19.72	(87)
Temperature du	ring heatin	g periods in	the rest of	dwelling f	rom Table 9	9, Th2(°C)							
	19.99	19.99	19.99	20.00	20.01	20.02	20.02	20.02	20.01	20.01	20.00	20.00	(88)

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Utilisation facto	or for gains f	or rest of d	welling n2,	m									
	1.00	1.00	0.99	0.95	0.84	0.63	0.43	0.49	0.80	0.98	1.00	1.00	(89)
Mean internal t	temperature	in the rest	of dwelling	T2 (follow	steps 3 to	7 in Table 9	e)						
	18.30	18.52	18.91	19.42	19.80	19.99	20.01	20.01	19.90	19.38	18.76	18.27	(90)
Living area fract	tion								Li	ving area ÷	(4) =	0.22	(91)
Mean internal t	temperature	for the wh	ole dwellin	g fLA x T1 +	(1 - fLA) x	Г2							
	18.61	18.82	19.18	19.66	20.02	20.20	20.23	20.23	20.11	19.62	19.04	18.59	(92)
Apply adjustme	ent to the me	ean internal	l temperatu	ire from Ta	ble 4e whe	re appropr	iate						
	18.46	18.67	19.03	19.51	19.87	20.05	20.08	20.08	19.96	19.47	18.89	18.44	(93)
8. Space heati	ng requirem	ent											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	or for gains,	ηm		•	•								
	1.00	0.99	0.98	0.94	0.83	0.63	0.44	0.50	0.80	0.97	0.99	1.00	(94)
Useful gains, ηn													
	497.32	576.32	663.69	734.47	704.63	525.69	346.88	363.58	519.92	535.32	484.17	469.81	(95)
Monthly averag		emperature	e from Table	e U1									
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate fo													, ()
			1295.96		831.37	547.34	349.42	368.42	591.90	902.44	1205.62	1464.60	(97)
Space heating r							0.0						_ (=-,
-,	726.50	572.55	470.41	250.21	94.29	0.00	0.00	0.00	0.00	273.14	519.45	740.13	1
	720.50	372.33		250.21	31.23	0.00	0.00	0.00		8)15, 10		3646.68	(98)
Conso booting s									2(3,	0,10, 10		,0.00	(30)
Space nearing n	equirement	kWh/m²/ye	ear							(98)	÷ (4)	39.22	(99)
_	•									(98)	÷ (4)	39.22	(99)
9a. Energy req	•			stems inclu	iding micro	-СНР				(98)	÷ (4)	39.22	(99)
_	•			stems inclu	iding micro	-СНР				(98)	÷ (4)	39.22	(99)
9a. Energy req	quirements -	individual	heating sys									0.00	(99)
9a. Energy req	quirements -	individual secondary	heating sys							1 - (20			
9a. Energy req Space heating Fraction of space	quirements - ce heat from ce heat from	individual secondary, main syste	heating sys /supplementer em(s)									0.00	(201)
9a. Energy req Space heating Fraction of space Fraction of space	ce heat from the heat from the heat from	individual secondary, main syste main syste	heating sys /supplement em(s) em 2						(20		01) =	0.00	(201) (202)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of space	ce heat from the heat from the heat from the heat from	secondary, main syste main syste from main	/supplements: /sm(s) em 2 system 1						(20	1 - (20	01) =	0.00 1.00 0.00	] (201) ] (202) ] (202)
9a. Energy req Space heating Fraction of space Fraction of space Fraction of total	te heat from the heat from the heat from the heat from the space heat the space heat	secondary, main syste main syste from main from main	/supplements: /sm(s) em 2 system 1						(20	1 - (20 02) x [1- (20	01) =	0.00 1.00 0.00 1.00	[ (201) [ (202) ] (202) ] (204)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of tota	te heat from the heat from the heat from the heat from the space heat the space heat	secondary, main syste main syste from main from main	/supplements: /sm(s) em 2 system 1				Jul	Aug	(20 Sep	1 - (20 02) x [1- (20	01) =	0.00 1.00 0.00 1.00	] (201) ] (202) ] (202) ] (204) ] (205)
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of spac Fraction of tota	te heat from the heat from the heat from the heat from all space heat all space heat ain system 1 Jan	secondary, main syste main syste from main from main (%)	/supplemenem(s) em 2 system 1 system 2	ntary syste	m (table 11	)	Jul	Aug		1 - (20 02) x [1- (20 (202) x (20	(2) (2) (3) (3) (3) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4	0.00 1.00 0.00 1.00 0.00 93.00	] (201) ] (202) ] (202) ] (204) ] (205)
9a. Energy red Space heating Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma	te heat from the heat from the heat from the heat from all space heat all space heat ain system 1 Jan	secondary, main syste main syste from main from main (%)	/supplemenem(s) em 2 system 1 system 2	ntary syste	m (table 11	)	Jul 0.00	Aug		1 - (20 02) x [1- (20 (202) x (20	(2) (2) (3) (3) (3) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4	0.00 1.00 0.00 1.00 0.00 93.00	] (201) ] (202) ] (202) ] (204) ] (205)
9a. Energy red Space heating Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma	ce heat from ce heat from ce heat from al space heat al system 1 Jan uel (main sy	secondary, main syste main syste from main from main (%) Feb stem 1), kW	/supplemenem(s) em(s) system 2 system 2 Mar	Apr	m (table 11	Jun		_	<b>Sep</b>	1 - (20 )2) x [1- (20 (202) x (20 Oct	01) =	0.00 1.00 0.00 1.00 0.00 93.00 Dec	] (201) ] (202) ] (202) ] (204) ] (205)
9a. Energy red Space heating Fraction of space Fraction of space Fraction of tota Fraction of tota Efficiency of ma	ce heat from ce heat from ce heat from al space heat al system 1 Jan uel (main sy	secondary, main syste main syste from main from main (%) Feb stem 1), kW	/supplemenem(s) em(s) system 2 system 2 Mar	Apr	m (table 11	Jun		_	<b>Sep</b>	1 - (2( )2) x [1- (20 (202) x (2( Oct	01) =	0.00 1.00 0.00 1.00 0.00 93.00 Dec	[ (201) [ (202) [ (202) ] (204) [ (205) [ (206) ]
9a. Energy red Space heating Fraction of spac Fraction of spac Fraction of tota Fraction of tota Efficiency of ma	the heat from the heat of the heat from the heat of the heat of the heat from the heat of the heat from the heat of the	secondary, main syste main syste from main from main (%) Feb stem 1), kW	/supplemenem(s) em(s) system 2 system 2 Mar	Apr	m (table 11	Jun		_	<b>Sep</b>	1 - (2( )2) x [1- (20 (202) x (2( Oct	01) =	0.00 1.00 0.00 1.00 0.00 93.00 Dec	[ (201) [ (202) [ (202) ] (204) [ (205) [ (206) ]
9a. Energy red Space heating Fraction of spac Fraction of spac Fraction of tota Fraction of tota Efficiency of ma Space heating for	the heat from the heat of the heat from the heat of the heat of the heat from the heat of the heat from the heat of the	secondary, main syste main syste from main from main (%) Feb stem 1), kW	/supplemenem(s) em(s) system 2 system 2 Mar	Apr	m (table 11	Jun		_	<b>Sep</b>	1 - (2( )2) x [1- (20 (202) x (2( Oct	01) =	0.00 1.00 0.00 1.00 0.00 93.00 Dec	[ (201) [ (202) [ (202) ] (204) [ (205) [ (206) ]
9a. Energy red Space heating Fraction of spac Fraction of spac Fraction of tota Fraction of tota Efficiency of ma Space heating for	the heat from the heat had space heat also system 1 Jan under (main sy 781.18	secondary, main syste main syste from main from main (%) Feb stem 1), kW 615.65	/supplemenem(s) em 2 system 1 system 2  Mar Vh/month 505.82	Apr 269.05	May 101.39	Jun 0.00	0.00	0.00	Sep 0.00 Σ(21:	1 - (20) 2) x [1- (20) (202) x (20) Oct 293.70 1)15, 10	01) =	0.00 1.00 0.00 1.00 0.00 93.00 Dec 795.83	[ (201) [ (202) [ (202) ] (204) [ (205) [ (206) ] (201) [ (211) ]
9a. Energy red Space heating Fraction of spac Fraction of spac Fraction of tota Fraction of tota Fraction of tota Space heating for Water heating Efficiency of wa	the heat from the heat had space heat also system 1 Jan under (main sy 781.18	secondary, main syste main syste from main from main (%) Feb stem 1), kW 615.65	/supplemenem(s) em 2 system 1 system 2  Mar Vh/month 505.82	Apr 269.05	May 101.39	Jun 0.00	0.00	0.00	Sep 0.00 Σ(21:	1 - (20) 2) x [1- (20) (202) x (20) Oct 293.70 1)15, 10	01) =	0.00 1.00 0.00 1.00 0.00 93.00 Dec 795.83	[ (201) [ (202) [ (202) ] (204) [ (205) [ (206) ] (201) [ (211) ]
9a. Energy red Space heating Fraction of spac Fraction of spac Fraction of tota Fraction of tota Fraction of tota Space heating for Water heating Efficiency of wa	te heat from the heat had space heat all s	secondary, main syste main syste from main from main (%)  Feb stem 1), kW  615.65	/supplemenem(s) em 2 system 1 system 2  Mar Vh/month 505.82	Apr 269.05	May 101.39 87.99	Jun 0.00	0.00 86.70	0.00	Sep  0.00  ∑(21:	1 - (20) 2) x [1- (20) (202) x (20) Oct 293.70 1)15, 10	01) =	0.00 1.00 0.00 1.00 0.00 93.00 Dec 795.83 8921.16	[ (201) [ (202) [ (202) ] (204) [ (205) [ (206) ] (201) [ (211) ]
9a. Energy red Space heating Fraction of spac Fraction of spac Fraction of tota Fraction of tota Fraction of tota Space heating for Water heating Efficiency of wa	te heat from the heat had space heat all s	secondary, main syste main syste from main from main (%)  Feb stem 1), kW  615.65	/supplemenem(s) em 2 system 1 system 2  Mar Vh/month 505.82	Apr 269.05	May 101.39 87.99	Jun 0.00	0.00 86.70	0.00	Sep  0.00  ∑(21:	1 - (20 )2) x [1- (20 (202) x (20  Oct  293.70  1)15, 10	01) =	0.00 1.00 0.00 1.00 0.00 93.00 Dec 795.83 8921.16	[ (201) [ (202) [ (202) ] (204) [ (205) [ (206) ] (211) [ (217) ]
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of tota Fraction of tota Fraction of tota Efficiency of ma Space heating for Water heating Efficiency of wa	the heat from th	secondary, main syste main syste from main from main (%)  Feb stem 1), kW 615.65	/supplemenem(s) em 2 system 1 system 2  Mar Vh/month 505.82	Apr 269.05	May 101.39 87.99	Jun 0.00	0.00 86.70	0.00	Sep  0.00  ∑(21:	1 - (20 )2) x [1- (20 (202) x (20  Oct  293.70  1)15, 10	01) =	0.00 1.00 0.00 1.00 0.00 93.00 Dec 795.83 8921.16	[ (201) [ (202) [ (202) ] (204) [ (205) [ (206) ] (211) [ (217) ]
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of tota Fraction of tota Efficiency of ma Space heating for Water heating Efficiency of wa Water heating for	the heat from th	secondary, main syste main syste from main from main (%)  Feb stem 1), kW 615.65	/supplemenem(s) em 2 system 1 system 2  Mar Vh/month 505.82	Apr 269.05	May 101.39 87.99	Jun 0.00	0.00 86.70	0.00	Sep  0.00  ∑(21:	1 - (20 )2) x [1- (20 (202) x (20  Oct  293.70  1)15, 10	01) =	0.00 1.00 0.00 1.00 0.00 93.00 Dec 795.83 3921.16 89.35	[ (201) [ (202) [ (202) ] (204) [ (205) [ (206) ] (211) [ (217) ]
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of tota Fraction of tota Efficiency of ma Space heating for Water heating Efficiency of wa Water heating for Annual totals Space heating for	the heat from th	secondary, main syste main syste from main from main (%)  Feb stem 1), kW 615.65  89.26 onth	/supplemenem(s) em 2 system 1 system 2  Mar Vh/month 505.82	Apr 269.05 88.76	May 101.39 87.99	Jun 0.00	0.00 86.70	0.00	Sep  0.00  ∑(21:	1 - (20 )2) x [1- (20 (202) x (20  Oct  293.70  1)15, 10	01) =	0.00 1.00 0.00 1.00 0.00 93.00 Dec 795.83 3921.16 89.35	[ (201) [ (202) [ (202) ] (204) [ (205) [ (206) ] (211) [ (217) ]
9a. Energy req Space heating Fraction of spac Fraction of spac Fraction of tota Fraction of tota Efficiency of ma Space heating for Water heating Efficiency of wa Water heating for Annual totals Space heating for	the heat from th	secondary, main syste main syste from main from main (%)  Feb stem 1), kW 615.65  89.26 onth 177.08	/supplemenem(s) em 2 system 1 system 2  Mar Vh/month 505.82  89.12	Apr 269.05 88.76 163.75	May 101.39 87.99	Jun 0.00	0.00 86.70	0.00 86.70 151.05	Sep  0.00  ∑(21:	1 - (20 )2) x [1- (20 (202) x (20  Oct  293.70  1)15, 10	01) =	0.00 1.00 0.00 1.00 0.00 93.00 Dec 795.83 3921.16 89.35	[ (201) [ (202) [ (202) ] (204) [ (205) [ (206) ] (211) [ (217) ]

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boiler flue fan			45.00		
Total electricity for the above, kWh/year				75.00	
Electricity for lighting (Appendix L)				403.53	
Total delivered energy for all uses		(21	11)(221) + (231) + (232)	(237b) = 6414.51	
10a. Fuel costs - individual heating systems includin	g micro-CHP				
	Fuel kWh/year		Fuel price	Fuel cost £/yea	r
Space heating - main system 1	3921.16	x	3.48 x 0	.01 = 136.46	
Water heating	2014.82	х	3.48 x 0	.01 = 70.12	
Pumps and fans	75.00	х	13.19 x 0	.01 = 9.89	
Electricity for lighting	403.53	х	13.19 x 0	.01 = 53.23	
Additional standing charges				120.00	
Total energy cost			(240)(242) + (245).	(254) = 389.69	
11a. SAP rating - individual heating systems including	ng micro-CHP				
Energy cost deflator (Table 12)				0.42	
Energy cost factor (ECF)				1.19	
SAP value				83.45	
SAP rating (section 13)				83	
SAP band				В	
12a. CO <sub>2</sub> emissions - individual heating systems incl	uding micro-CHP				
	Energy kWh/year		Emission factor kg CO <sub>2</sub> /kWh	Emissions kg CO <sub>2</sub> /yea	
Space heating - main system 1	3921.16	x	0.216	= 846.97	
Water heating	2014.82	x	0.216	= 435.20	
Space and water heating			(261) + (262) + (263) +	- (264) = 1282.17	
Pumps and fans	75.00	x	0.519	= 38.93	
Electricity for lighting	403.53	x	0.519	= 209.43	
Total CO <sub>2</sub> , kg/year			(265).	(271) = 1530.53	
Dwelling CO₂ emission rate			(272	!) ÷ (4) = 16.46	
El value				85.14	
El rating (section 14)				85	
EI band				В	

	Energy kWh/year		Primary factor	Primary Energy kWh/year	,	
Space heating - main system 1	3921.16	x	1.22	=	4783.82	(261)
Water heating	2014.82	x	1.22	=	2458.08	(264)
Space and water heating			(261) + (262) + (	263) + (264) =	7241.91	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	403.53	x	3.07	=	1238.82	(268)
Primary energy kWh/year					8710.98	(272)
Dwelling primary energy rate kWh/m2/year					93.68	(273)

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#### **DER Worksheet Design - Draft**



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 024 Oxford Road, Bodicaote, OX15		

1. Overall dwelling dimensions					
		Area (m²)		Average storey height (m)	Volume (m³)
Lowest occupied		47.39 (1a)	x	2.39 (2a) =	113.26 (3a)
+1		46.69 (1b)	x	2.61 (2b) =	121.86 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d)(1n) =	94.08 (4)			
Dwelling volume				(3a) + (3b) + (3c) + (3d)(3n)	= 235.12 (5)

2. Ventilation rate					
				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		4	x 10 =	40	(7a)
Number of passive vents		0	x 10 =	0	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes pe hour	r
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	40	÷ (5) =	0.17	(8)

Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	40	÷ (5) =	0.17	
If a pressurisation test has been carried out or is intend	ed, proceed to (17), otherwise continue from	n (9) to (16)			

ij a pressansation test has been carned out or is in	terraca, proceed to (1)	), otherwise continue from (5) to (10)
Air permeability value, q50, expressed in cubic me	tres per hour per squa	are metre of envelope area

hased on air nermeability value	then (18) - [(17) ± 20	01 ± (8) otherwise (1	18) - (16)

Number of sides on which the dwelling is sheltered 1 - [0.075 x (19)] = Shelter factor

Infiltration rate incorporating shelter factor

(18) x (20) =

Infiltration rate	nodified fo	r monthly v	wind speed											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Monthly average wind speed from Table U2														
	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)	
Wind factor (22)m ÷ 4														
	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)	
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m														
	0.46	0.45	0.44	0.39	0.38	0.34	0.34	0.33	0.36	0.38	0.40	0.42	(22b)	
0 1 1 1 11 11 11													•	

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

d) natural ver	d) natural ventilation or whole house positive input ventilation from loft												
	0.60	0.60	0.60	0.58	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59	(24d)

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



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5.00

0.42

0.36

0.60	0.60	0.60	0.58	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59	7 (25
	0.00		0.00		0.00	0.00		0.00			0.00	_

				Gross	Openings		area	U-value	AxUW	•	alue,	Ахк,
			а	rea, m²	m²	_	m²	W/m²K		_	/m².K	kJ/K
Vindow							.76 x		= 19.48	=		
Door							02 x		= 2.63	_		
Ground floor							.39 x		= 7.58	_		
external wall							7.43 x		= 26.76	_		
Roof							.69 x	0.11	= 5.14			
otal area of exter						239	9.29					
abric heat loss, W		× U)								5)(30) + (	. =	61.58
leat capacity Cm			_					(28)	(30) + (32) +	- (32a)(3	2e) = [	N/A
hermal mass para												250.00
Thermal bridges: ∑		Iculated us	ing Appen	dix K								9.67
Total fabric heat lo										(33) + (		71.25
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
entilation heat lo												
L	46.84	46.53	46.22	44.78	44.51	43.26	43.26	43.03	43.74	44.51	45.06	45.63
leat transfer coef												
L	118.08	117.77	117.47	116.03	115.76	114.51	114.51	114.27	114.99	115.76	116.30	116.87
									Average = ∑	(39)112,	/12 =	116.03
Heat loss paramet			))m ÷ (4)									
L	1.26	1.25	1.25	1.23	1.23	1.22	1.22	1.21	1.22	1.23	1.24	1.24
									Average = ∑	(40)112,	/12 =	1.23
Number of days in												
				30.00	31.00		31.00	31.00				
L	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00
4. Water heating				30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00
4. Water heating	energy re			30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	2.68
Assumed occupan	energy re	equiremen	t				31.00	31.00	30.00	31.00	30.00	
Assumed occupan	energy re	equiremen	t				Jul	Aug	30.00 Sep	31.00 Oct	30.00 Nov	2.68
Assumed occupan Annual average ho	energy re cy, N ot water us Jan	equirement sage in litre Feb	es per day '	√d,average <b>Apr</b>	= (25 x N) + May	36 Jun	Jul					2.68 97.79
Assumed occupan Annual average ho	energy re cy, N ot water us Jan	equirement sage in litre Feb	es per day '	√d,average <b>Apr</b>	= (25 x N) + May	36 Jun	Jul					2.68 97.79
Assumed occupan Annual average ho	energy re cy, N ot water us Jan n litres per	equirement sage in litre Feb r day for ea	es per day ' Mar ich month	/d,average Apr Vd,m = fact	= (25 x N) + <b>May</b> or from Tab	36 <b>Jun</b> le 1c x (43	Jul )	Aug	Sep	Oct	Nov 103.66	2.68 97.79 Dec
Assumed occupan Annual average ho Hot water usage ir	energy recy, N of water us Jan n litres per	sage in litre Feb r day for ea	es per day Mar ich month	Vd,average Apr Vd,m = fact 95.84	= (25 x N) + May cor from Tab	36 Jun le 1c x (43 88.01	Jul ) 88.01	Aug 91.92	Sep	Oct 99.75	Nov 103.66	2.68 97.79 <b>Dec</b>
Assumed occupan Annual average ho Hot water usage ir	energy recy, N of water us Jan n litres per	sage in litre Feb r day for ea	es per day Mar ich month	Vd,average Apr Vd,m = fact 95.84	= (25 x N) + May cor from Tab	36 Jun le 1c x (43 88.01	Jul ) 88.01	Aug 91.92	Sep	Oct 99.75	Nov 103.66	2.68 97.79 <b>Dec</b>
Assumed occupan Annual average ho Hot water usage ir	energy recy, N ot water us Jan n litres per 107.57	sage in litre Feb r day for ea 103.66	es per day ' Mar ch month 99.75	Vd,average Apr Vd,m = fact 95.84 nm x Tm/3	= (25 x N) +	36 Jun le 1c x (43 88.01	Jul ) 88.01 Tables 1b	Aug 91.92	<b>Sep</b> 95.84	Oct 99.75 Σ(44)1	Nov 103.66 .12 = 142.27	2.68 97.79 <b>Dec</b> 107.57
	energy recy, N ot water us Jan h litres per 107.57 hot water	sage in litre Feb r day for ea 103.66	es per day ' Mar ch month 99.75	Vd,average Apr Vd,m = fact 95.84 nm x Tm/3	= (25 x N) +	36 Jun le 1c x (43 88.01	Jul ) 88.01 Tables 1b	Aug 91.92	<b>Sep</b> 95.84	Oct 99.75 Σ(44)1	Nov 103.66 .12 = 142.27	2.68 97.79 <b>Dec</b> 107.57 1173.50
Assumed occupant Annual average ho Hot water usage ir	energy recy, N by water us Jan hitres per 107.57 hot water 159.52	sage in litre Feb r day for ea 103.66 r used = 4.1 139.52	Mar such month 99.75	/d,average	= (25 x N) + May or from Tab 91.92  0600 kWh/m 120.44	36 Jun le 1c x (43 88.01 onth (see	Jul ) 88.01 Tables 1b, 96.31	Aug 91.92 1c 1d) 110.51	Sep 95.84 111.83	Oct 99.75 Σ(44)1 130.33 Σ(45)1	Nov 103.66 .12 = 142.27	2.68 97.79 Dec 107.57 1173.50 154.49
Assumed occupant Annual average ho Hot water usage ir Energy content of Distribution loss 0	energy recy, N bit water us Jan litres per 107.57 hot water 159.52  0.15 x (45) 23.93	r used = 4.1 139.52	es per day ' Mar ich month 99.75 8 x Vd,m x 143.97	/d,average Apr Vd,m = fact 95.84  nm x Tm/3 125.52	= (25 x N) +	36 Jun le 1c x (43 88.01	Jul ) 88.01 Tables 1b	Aug 91.92	<b>Sep</b> 95.84	Oct 99.75 Σ(44)1	Nov 103.66 .12 = 142.27	2.68 97.79 <b>Dec</b> 107.57 1173.50
Assumed occupant Annual average ho Hot water usage ir Energy content of Distribution loss 0	energy recy, N bit water us Jan litres per 107.57 hot water 159.52 0.15 x (45) 23.93 s calculate	r used = 4.1 139.52  m 20.93 dd for each	es per day ' Mar ich month 99.75 8 x Vd,m x 143.97 21.60 month (55	/d,average Apr Vd,m = fact 95.84  nm x Tm/3 125.52  18.83 6) x (41)m	= (25 x N) + May or from Tab 91.92  8600 kWh/m 120.44	36 Jun le 1c x (43 88.01 onth (see 103.93	Jul ) 88.01 Tables 1b, 96.31	Aug 91.92 1c 1d) 110.51	Sep 95.84 111.83 16.77	Oct 99.75 Σ(44)1 130.33 Σ(45)1 19.55	Nov  103.66 .12 =   142.27 .12 =   21.34	2.68 97.79 Dec 107.57 1173.50 154.49 1538.65
Assumed occupant Annual average ho Hot water usage in Energy content of Distribution loss 0 Water storage loss	energy recy, N of water us Jan hitres per 107.57 hot water 159.52  0.15 x (45) 23.93 s calculate 0.00	r used = 4.1 139.52  m 20.93 d for each	es per day Mar ich month 99.75 8 x Vd,m x 143.97 21.60 month (55	/d,average Apr Vd,m = fact 95.84  nm x Tm/3 125.52  18.83 6) x (41)m 0.00	= (25 x N) + May or from Tab 91.92  3600 kWh/m 120.44	36 Jun le 1c x (43 88.01 onth (see 103.93 15.59	Jul ) 88.01 Tables 1b, 96.31	Aug 91.92 1c 1d) 110.51 16.58	Sep 95.84 111.83	Oct 99.75 Σ(44)1 130.33 Σ(45)1	Nov 103.66 .12 = 142.27	2.68 97.79 Dec 107.57 1173.50 154.49
Assumed occupant Annual average ho Hot water usage ir Energy content of Distribution loss 0 Water storage loss	energy recy, N of water us Jan n litres per 107.57 hot water 159.52 0.15 x (45) 23.93 s calculate 0.00 ins dedica	requirements sage in litre Feb r day for ea 103.66 r used = 4.1 139.52 m 20.93 rd for each 0.00 red solar st	es per day Mar  the month 99.75  8 x Vd,m x  143.97  21.60  month (58  0.00  torage or day	/d,average Apr Vd,m = fact 95.84  nm x Tm/3  125.52  18.83 6) x (41)m  0.00 edicated W	= (25 x N) + May  or from Tab  91.92  6600 kWh/m  120.44  18.07	36 Jun le 1c x (43 88.01 onth (see 103.93 15.59 0.00 n x [(47) -	Jul ) 88.01 Tables 1b, 96.31  14.45  0.00 Vs] ÷ (47),	Aug 91.92 , 1c 1d) 110.51  16.58  0.00 else (56)	Sep 95.84 111.83 16.77 0.00	Oct 99.75 Σ(44)1 130.33 Σ(45)1 19.55	Nov  103.66 .12 =   142.27 .12 =   21.34	2.68 97.79 Dec 107.57 1173.50 154.49 1538.65 23.17 0.00
Assumed occupant Annual average ho Hot water usage in Energy content of Distribution loss 0 Water storage loss	energy recy, N of water us Jan n litres per 107.57 hot water 159.52 0.15 x (45) 23.93 s calculate 0.00 ins dedica 0.00	requirements sage in litre Feb r day for ea 103.66 r used = 4.1 139.52 m 20.93 rd for each 0.00 rted solar st 0.00	es per day Mar  the month 99.75  8 x Vd,m x  143.97  21.60  month (58  0.00  torage or day 1	/d,average Apr Vd,m = fact 95.84  nm x Tm/3 125.52  18.83 6) x (41)m 0.00	= (25 x N) + May or from Tab 91.92  3600 kWh/m 120.44	36 Jun le 1c x (43 88.01 onth (see 103.93 15.59	Jul ) 88.01 Tables 1b, 96.31	Aug 91.92 1c 1d) 110.51 16.58	Sep 95.84 111.83 16.77	Oct 99.75 Σ(44)1 130.33 Σ(45)1 19.55	Nov  103.66 .12 =   142.27 .12 =   21.34	2.68 97.79 Dec 107.57 1173.50 154.49 1538.65
Assumed occupant Annual average ho Hot water usage in Energy content of Distribution loss 0 Water storage loss	energy recy, N of water us Jan n litres per 107.57 hot water 159.52 0.15 x (45) 23.93 s calculate 0.00 ins dedica 0.00 s for each	requirements sage in litre Feb r day for ea 103.66 r used = 4.1 139.52 m 20.93 rd for each 0.00 tted solar st 0.00 month from	es per day Mar  ch month 99.75  8 x Vd,m x  143.97  21.60  month (55  0.00  torage or d  0.00  m Table 3	/d,average Apr Vd,m = fact 95.84  nm x Tm/3  125.52  18.83 6) x (41)m  0.00 edicated W	= (25 x N) + May  or from Tab  91.92  3600 kWh/m  120.44  18.07  0.00  //WHRS (56)r	36 Jun le 1c x (43 88.01 onth (see 103.93 15.59 0.00 n x [(47) -	Jul ) 88.01 Tables 1b, 96.31  14.45  0.00 Vs] ÷ (47), 0.00	Aug 91.92 .1c 1d) 110.51 .16.58	Sep 95.84 111.83 16.77 0.00 0.00	Oct 99.75 Σ(44)1 130.33 Σ(45)1 19.55 0.00	Nov  103.66 .12 =  142.27 .12 =  21.34  0.00	2.68 97.79 Dec 107.57 1173.50 154.49 1538.65 23.17 0.00
Assumed occupant Annual average ho Hot water usage in Energy content of Distribution loss 0 Water storage loss If the vessel conta	cenergy received by the state of the state o	rused = 4.1 139.52  m 20.93 d for each 0.00 month froi	es per day Mar  sch month 99.75  8 x Vd,m x  143.97  21.60  month (55  0.00  torage or d  0.00  m Table 3  0.00	/d,average Apr Vd,m = fact 95.84  nm x Tm/3  125.52  18.83  i) x (41)m  0.00  edicated W  0.00	= (25 x N) + May  or from Tab  91.92  6600 kWh/m  120.44  18.07	36 Jun le 1c x (43 88.01 onth (see 103.93 15.59 0.00 n x [(47) -	Jul ) 88.01 Tables 1b, 96.31  14.45  0.00 Vs] ÷ (47),	Aug 91.92 , 1c 1d) 110.51  16.58  0.00 else (56)	Sep 95.84 111.83 16.77 0.00	Oct 99.75 Σ(44)1 130.33 Σ(45)1 19.55	Nov  103.66 .12 =   142.27 .12 =   21.34	2.68 97.79 Dec 107.57 1173.50 154.49 1538.65 23.17 0.00
Assumed occupant Annual average ho Hot water usage in Energy content of Distribution loss 0 Water storage loss	cenergy received by the state of the state o	rused = 4.1 139.52  m 20.93 d for each 0.00 month froi	es per day Mar  sch month 99.75  8 x Vd,m x  143.97  21.60  month (55  0.00  torage or d  0.00  m Table 3  0.00	/d,average Apr Vd,m = fact 95.84  nm x Tm/3  125.52  18.83  i) x (41)m  0.00  edicated W  0.00	= (25 x N) + May  or from Tab  91.92  3600 kWh/m  120.44  18.07  0.00  //WHRS (56)r	36 Jun le 1c x (43 88.01 onth (see 103.93 15.59 0.00 n x [(47) -	Jul ) 88.01 Tables 1b, 96.31  14.45  0.00 Vs] ÷ (47), 0.00	Aug 91.92 .1c 1d) 110.51 .16.58	Sep 95.84 111.83 16.77 0.00 0.00	Oct 99.75 Σ(44)1 130.33 Σ(45)1 19.55 0.00	Nov  103.66 .12 =  142.27 .12 =  21.34  0.00	2.68 97.79 Dec 107.57 1173.50 154.49 1538.65 23.17 0.00

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Metabolic gains (	(Table 5)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
5. Internal gains	s												
		•											_
	58.30	51.14	53.12	46.79	45.26	39.58	37.20	41.95	42.23	48.57	52.38	56.63	(65)
Heat gains from	water heati	ng (kWh/m	onth) 0.25	5 × [0.85 × (	(45)m + (61	)m] + 0.8 ×	[(46)m + (5	57)m + (59)	m]				
										∑(64)1	12 = 1	784.80	(64)
	180.57	158.51	164.95	145.74	141.28	124.03	117.03	131.31	132.00	151.25	162.58	175.52	
Output from wat	er heater f	or each mo	nth (kWh/ı	month) (62	!)m + (63)m	1							
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
Solar DHW input	calculated	using Appe	ndix G or A	Appendix H									_
	180.57	158.51	164.95	145.74	141.28	124.03	117.03	131.31	132.00	151.25	162.58	175.52	(62)
													_

5. Internal gain	S												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains	(Table 5)												
	133.88	133.88	133.88	133.88	133.88	133.88	133.88	133.88	133.88	133.88	133.88	133.88	(66)
Lighting gains (ca	alculated in	Appendix I	L, equation	L9 or L9a),	also see Ta	ıble 5							
	22.72	20.18	16.41	12.42	9.29	7.84	8.47	11.01	14.78	18.76	21.90	23.35	(67)
Appliance gains (	calculated	in Appendi	x L, equatio	on L13 or L1	L3a), also s	ee Table 5							
	246.39	248.94	242.50	228.78	211.47	195.20	184.33	181.77	188.21	201.93	219.24	235.52	(68)
Cooking gains (ca	alculated in	Appendix	L, equation	L15 or L15	a), also see	Table 5							
	36.39	36.39	36.39	36.39	36.39	36.39	36.39	36.39	36.39	36.39	36.39	36.39	(69)
Pump and fan ga	ins (Table !	5a)											
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evapo	oration (Tal	ble 5)											
	-107.10	-107.10	-107.10	-107.10	-107.10	-107.10	-107.10	-107.10	-107.10	-107.10	-107.10	-107.10	(71)
Water heating ga	ains (Table	5)											
	78.37	76.10	71.39	64.99	60.83	54.97	50.01	56.38	58.65	65.28	72.75	76.11	(72)
Total internal gai	Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m +												
	413.63	411.38	396.47	372.36	347.75	324.17	308.97	315.32	327.80	352.13	380.06	401.14	(73)

o. Solar gains																
			Access f Table		Area m²		Solar flux W/m²			g ific data able 6b		FF specific d or Table			Gains W	
NorthWest			0.7	7 x	6.68	_ x [	11.28	x 0.9 x		0.63	х	0.70		= [	23.03	(81)
SouthWest			0.7	7 x	4.04	_ x [	36.79	x 0.9 x		0.63	х	0.70		= [	45.43	(79)
NorthEast			0.7	7 x	5.04	x [	11.28	x 0.9 x	(	0.63	х	0.70		= [	17.38	(75)
Solar gains in wa	tts ∑(74)m	n(82)m														
	85.84	159.64	254.09	374.59	474.12	494.	69 466.9	5 38	9.02	295.24	ı	186.05	105	.26	71.88	(83)
Total gains - inte	otal gains - internal and solar (73)m + (83)m															
	499.47	571.03	650.55	746.95	821.87	818.	86 775.9	1 70	4.34	623.04	Į.	538.19	485	.32	473.02	(84)

					-								1
7. Mean interna	al tempera	ture (heati	ng season)										
Temperature during heating periods in the living area from Table 9, Th1(*C)										(85)			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	1.00	1.00	0.99	0.98	0.92	0.78	0.62	0.69	0.91	0.99	1.00	1.00	(86)
Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct   Nov   Dec													
	19.56	19.70	19.96	20.34	20.68	20.91	20.98	20.96	20.78	20.34	19.89	19.54	(87)
Temperature du	ring heating	g periods in	the rest of	f dwelling f	rom Table 9	9, Th2(°C)							
	19.88	19.88	19.88	19.89	19.90	19.91	19.91	19.91	19.90	19.90	19.89	19.89	(88)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 18.30 18.49 18.85 19.36 19.81 20.07 20.13 20.12 19.94 19.37 18.75 18.27 (92) Apply adjustment to the mean internal temperature from Table 4e where appropriate 18.15 18.34 18.70 19.21 19.66 19.92 19.98 19.97 19.79 19.22 18.60 18.12 (93) 8. Space heating requirement lan Feb Mar Anr Mav lun Iul Aug Sep Oct Nov Dec Utilisation factor for gains, ηm 1.00 0.99 0.99 0.96 0.87 0.69 0.49 0.56 0.85 0.97 0.99 1.00 (94) Useful gains, ηmGm, W (94)m x (84)m 498.14 567.99 641.84 714.92 715.08 563.15 379.85 395.00 527.45 524.70 482.80 472.04 (95) Monthly average external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 7.10 4.20 (96) Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] 1635.00 1583.10 1433.31 1196.35 921.29 609.02 386.82 407.95 653.87 997.82 1337.98 1627.24 (97) Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m 845.82 682.16 588.85 346.63 153.42 0.00 0.00 0.00 0.00 352.00 615.73 859.47 Σ(98)1...5, 10...12 = 4444.08 (98) Space heating requirement kWh/m²/year (98) ÷ (4) 47.24 9a. Energy requirements - individual heating systems including micro-CHP Space heating Fraction of space heat from secondary/supplementary system (table 11) 0.00 (201) Fraction of space heat from main system(s) 1 - (201) = 1.00 (202)Fraction of space heat from main system 2 0.00 (202) Fraction of total space heat from main system 1 (202) x [1-(203)] = 1.00 (204) Fraction of total space heat from main system 2 (202) x (203) = 0.00 (205) Efficiency of main system 1 (%) (206) 93.00 Feb Oct Nov Dec Space heating fuel (main system 1), kWh/month 909.49 733.50 633.18 372.72 164.96 0.00 0.00 0.00 0.00 378.49 662.08 924.16  $\Sigma(211)1...5$ , 10...12 = 4778.58 (211) Water heating Efficiency of water heater 89.40 89.36 89.26 89.00 88.39 86.70 86.70 86.70 86.70 88.98 89.29 89.42 (217) Water heating fuel, kWh/month 201.98 | 177.39 | 184.81 | 163.76 | 159.84 | 143.06 | 134.99 | 151.46 | 152.25 | 169.98 | 182.09 | 196.28  $\Sigma(219a)1...12 = 2017.88$  (219) **Annual totals** Space heating fuel - main system 1 4778.58 Water heating fuel 2017.88 Electricity for pumps, fans and electric keep-hot (Table 4f) central heating pump or water pump within warm air heating unit 30.00 (230c)

0.55

0.85

0.98

Living area ÷ (4) =

1.00

19.71 19.11 18.45 17.93 (90)

1.00 (89)

0.21

0.48

Utilisation factor for gains for rest of dwelling n2,m

Living area fraction

1.00 1.00 0.99 0.97 0.88 0.69

17.95 18.16 18.55 19.10 19.57 19.84 19.90 19.89

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

boiler flue fan 45.00
tal electricity for the above, kWh/year 75.00

Total electricity for the above, kWh/year Electricity for lighting (Appendix L)

401.17

Total delivered energy for all uses

SAP band

(211)...(221) + (231) + (232)...(237b) = 7272.63 (238)

10a. Fuel costs - individual heating systems including micro-CHP	

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4778.58	x	3.48	x 0.01 =	166.29	(240)
Water heating	2017.88	x	3.48	x 0.01 =	70.22	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	401.17	x	13.19	x 0.01 =	52.91	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242)	+ (245)(254) =	419.32	(255)

#### 11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12) 0.42 (256)
Energy cost factor (ECF) 1.27 (257)
SAP value 82.34
SAP rating (section 13) 82 (258)

#### 12a. CO₂ emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO₂/kWh		Emissions kg CO <sub>2</sub> /year	
Space heating - main system 1	4778.58	x	0.216	=	1032.17	(261)
Water heating	2017.88	x	0.216	=	435.86	(264)
Space and water heating			(261) + (262) + (263) +	(264) =	1468.04	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	401.17	x	0.519	=	208.20	(268)
Total CO <sub>2</sub> , kg/year			(265)	(271) =	1715.17	(272)
Dwelling CO₂ emission rate			(272	2) ÷ (4) =	18.23	(273)
El value					83.47	
El rating (section 14)					83	(274)
El band				Г	В	

#### 13a. Primary energy - individual heating systems including micro-CHI

13a. Filmary energy - murvidual nearing systems micro-err									
	Energy kWh/year		Primary factor		Primary Energy kWh/year				
Space heating - main system 1	4778.58	x	1.22	=	5829.87	(261)			
Water heating	2017.88	x	1.22	=	2461.82	(264)			
Space and water heating			(261) + (262) +	(263) + (264) =	8291.68	(265)			
Pumps and fans	75.00	x	3.07	=	230.25	(267)			
Electricity for lighting	401.17	x	3.07	=	1231.58	(268)			
Primary energy kWh/year					9753.51	(272)			
Dwelling primary energy rate kWh/m2/year					103.67	(273)			

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#### DER Worksheet Design - Draft

(230e)

(231)

(232)

В



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	Plot 026 Oxford Road, Bodicaote, OX15		

1. Overall dwelling dimensions	;				
		Area (m²)		Average storey height (m)	Volume (m³)
Lowest occupied		39.10 (1a)	x	2.39 (2a) =	93.45 (3a)
+1		39.10 (1b)	x	2.61 (2b) =	102.05 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d)(1n) =	78.20 (4)			
Dwelling volume				(3a) + (3b) + (3c) + (3d)(3n	) = 195.50 (5)

2. Ventilation rate					
				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		3	x 10 =	30	(7a)
Number of passive vents		0	x 10 =	0	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes pe hour	er
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	30	÷ (5) =	0.15	(8)
If a pressurisation test has been carried out or is intended	d, proceed to (17), otherwise continue from (	(9) to (16)			
Air permeability value, q50, expressed in cubic metres pe	er hour per square metre of envelope area			5.00	(17)
If based on air permeability value, then (18) = [(17) $\div$ 20]	+ (8), otherwise (18) = (16)			0.40	(18)
Number of sides on which the dwelling is sheltered				2	(19)

Infiltration rate i	filtration rate incorporating shelter factor (18) $\times$ (20) =										20) =	0.34	(21)
Infiltration rate	modified fo	r monthly v	wind speed	:									
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average	e wind spee	d from Tab	le U2										
	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)	m ÷ 4												
	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltra	tion rate (a	llowing for	shelter and	wind facto	or) (21) x (2	2a)m							
	0.44	0.43	0.42	0.38	0.37	0.33	0.33	0.32	0.34	0.37	0.39	0.40	(22b)
Calculate effective air change rate for the applicable case:													
If mechanica	If mechanical ventilation: air change rate through system											N/A	(23a)

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

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

 0.60
 0.59
 0.59
 0.57
 0.57
 0

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



Shelter factor

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0.58 (24d)

N/A

0.57

0.85

1 - [0.075 x (19)] =

0.55

0.55

0.56

0.57

	0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(25)
3. Heat losses a	and heat lo	ss paramet	er										
Element				Gross rea, m²	Opening m <sup>2</sup>		area m²	U-value W/m²K	AxUW		alue, 'm².K	Ахк, kJ/K	
Window						10	).29 x	1.24	= 12.72	_ `			(27)
Door							.12 x	1.30	= 2.76	=			(26)
Ground floor							3.91 x	0.15	= 5.84	=			(28a)
External wall							3.29 x	0.21	= 6.99				(29a)
Party wall							5.59 x	0.00	= 0.00	=			(32)
Roof							3.90 x	0.11	= 4.28				(30)
Total area of ext	ternal elem	ents ΣA. m²					3.51						(31)
Fabric heat loss,									(26	5)(30) + (3	32) =	32.58	(33)
Heat capacity Cr								(28)	.(30) + (32) +			N/A	(34)
Thermal mass pa			n²K									250.00	(35)
Thermal bridges	::Σ(L x Ψ) c	alculated us	sing Appen	dix K								6.69	(36)
Total fabric heat			0							(33) + (3	36) =	39.27	(37)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat	loss calcul	ated month	ly 0.33 x (	25)m x (5)									
	38.42	38.19	37.95	36.85	36.64	35.68	35.68	35.50	36.05	36.64	37.06	37.50	(38)
Heat transfer co	efficient, V	V/K (37)m +	· (38)m									•	_
	77.69	77.45	77.22	76.12	75.91	74.95	74.95	74.77	75.32	75.91	76.33	76.76	1
									Average = ∑	(39)112/	12 =	76.12	(39)
Heat loss param	eter (HLP),	W/m²K (39	9)m ÷ (4)										_
	0.99	0.99	0.99	0.97	0.97	0.96	0.96	0.96	0.96	0.97	0.98	0.98	
									Average = ∑	(40)112/	12 =	0.97	(40)
Number of days	in month (	Table 1a)											
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)
4. Water heati		equiremen	τ									2.42	7 (40)
Assumed occupa					(25 11)	25						2.43	(42)
Annual average								A	Com.	0.4	Nov	91.86	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage	101.05	97.37	93.70	90.02	86.35	82.67	82.67	86.35	90.02	93.70	97.37	101.05	7
	101.05	97.37	93.70	90.02	80.33	82.07	82.07	00.33	90.02	5(44)1		1102.33	(44)
Energy content	of hot wate	or used = 4.1	I 8 v Vd m v	nm v Tm/	3600 kWh/r	nonth (see	Tables 1h	1c 1d)		2(44)1	12	1102.33	(44)
Lifergy content	149.85	131.06	135.24	117.91	113.13	97.63	90.47	103.81	105.05	122.43	133.64	145.12	7
	145.65	131.00	155.24	117.51	113.13	37.03	30.47	103.61	103.03	Σ(45)1		1445.33	(45)
Distribution loss	0 15 x (45	)m								2(43)1		1445.55	_ (45)
Distribution loss	22.48	19.66	20.29	17.69	16.97	14.64	13.57	15.57	15.76	18.36	20.05	21.77	(46)
Water storage lo		1			10.57	14.04	15.57	15.57	15.70	10.50	20.03	21.77	(40)
water storage is	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel con									1 0.00	0.00	0.00	1 0.00	(30)
ii tiic vessei eeii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit le				0.00	1 0.00	0.00	0.00	1 0.00	0.00	0.00	0.00	0.00	] (31)
,	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for e					, 0.00	0.00	0.00	1 0.00	0.00	5.50	- 0.00	1 0.00	_ (55)
	21.91	19.75	21.81	21.03	21.68	20.92	21.58	21.64	20.98	21.75	21.14	21.89	(61)
		1 23.73											_ (01)

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0.60 0.59 0.59 0.57 0.57 0.55 0.55 0.55 0.56 0.57 0.57 0.58 (25)

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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains	(Table 5)												
	121.39	121.39	121.39	121.39	121.39	121.39	121.39	121.39	121.39	121.39	121.39	121.39	(66)
Lighting gains (c	alculated in	Appendix	L, equation	L9 or L9a),	also see Ta	ble 5							
	20.91	18.57	15.10	11.43	8.55	7.21	7.80	10.13	13.60	17.27	20.16	21.49	(67)
Appliance gains	(calculated	in Appendi	x L, equation	on L13 or L1	13a), also se	ee Table 5							
	215.64	217.88	212.24	200.23	185.08	170.84	161.32	159.08	164.72	176.73	191.88	206.12	(68)
Cooking gains (c	alculated in	Appendix	L, equation	L15 or L15	a), also see	Table 5							
	35.14	35.14	35.14	35.14	35.14	35.14	35.14	35.14	35.14	35.14	35.14	35.14	(69)
Pump and fan g	ains (Table !	5a)											
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evap	oration (Tal	ble 5)											
	-97.11	-97.11	-97.11	-97.11	-97.11	-97.11	-97.11	-97.11	-97.11	-97.11	-97.11	-97.11	(71)
Water heating g	ains (Table	5)											
	74.33	72.20	67.77	61.75	57.85	52.35	47.68	53.67	55.80	62.02	69.05	72.21	(72)
	. (66)	167\m + 16	281m ± (60)	m + (70)m -	+ (71)m + (	72)m							
Total internal ga	iins (66)m -	r (07)111 + (C	00)111 1 (00)	. (70)	(, 1)	-,							

6. Solar gains															
		Access f Table		Area m²		lar flux W/m²			g fic data able 6b		FF specific d or Table			Gains W	
SouthWest		0.77	7 x	2.77	х 🗀	36.79	x 0.9 x	С	0.63	х	0.70	=		31.15	(79
NorthEast		0.7	7 x	7.52	х 🔃	11.28	x 0.9 x	0	0.63	х	0.70	=		25.93	(75
Solar gains in watts ∑(74)m	(82)m														
57.08	105.84	167.69	246.12	310.68	323.83	305.80	255	5.28	194.48		123.14	69.9	94	47.83	(83
Total gains - internal and so	lar (73)m +	(83)m													
430.37	476.90	525.21	581.96	624.57	616.65	585.02	540	).59	491.02	П	441.58	413.	44	410.07	(84

7. Mean intern	al tempera	ture (heati	ng season)										
Temperature du	emperature during heating periods in the living area from Table 9, Th1(°C)											21.00	(85)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	r for gains f	or living are	ea n1,m (se	e Table 9a)									
	1.00	1.00	0.99	0.97	0.90	0.73	0.55	0.62	0.88	0.98	1.00	1.00	(86)
Mean internal to	emp of livin	g area T1 (s	teps 3 to 7	in Table 90	:)								
	19.93	20.05	20.26	20.56	20.82	20.96	20.99	20.99	20.89	20.56	20.20	19.91	(87)
Temperature du	ring heating	g periods in	the rest of	dwelling f	rom Table 9	9, Th2(°C)							
	20.09	20.09	20.09	20.11	20.11	20.12	20.12	20.12	20.11	20.11	20.10	20.10	(88)

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Othisation factor for gain	s for rest of c	lwelling n2,	m									
1.00	1.00	0.99	0.96	0.86	0.65	0.45	0.51	0.82	0.98	1.00	1.00	(89)
Mean internal temperat	re in the rest	of dwelling	T2 (follow	steps 3 to	7 in Table 9	)c)						
18.6	18.82	19.13	19.57	19.93	20.09	20.12	20.11	20.02	19.58	19.05	18.63	(90)
Living area fraction								Li	ving area ÷	(4) =	0.23	(91)
Mean internal temperat	re for the wh	nole dwellin	g fLA x T1 +	(1 - fLA) x	T2							_
18.9	19.10	19.39	19.80	20.13	20.29	20.31	20.31	20.22	19.80	19.31	18.92	(92)
Apply adjustment to the	mean interna	l temperati	ure from Ta	ble 4e whe	re appropr	iate		,		•	•	_
18.79	18.95	19.24	19.65	19.98	20.14	20.16	20.16	20.07	19.65	19.16	18.77	(93)
	•	•		•					•	•	•	
8. Space heating requi	ement											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gain	s, ηm											-
1.00	0.99	0.99	0.95	0.85	0.65	0.45	0.51	0.81	0.97	0.99	1.00	(94)
Useful gains, ηmGm, W	(94)m x (84)n	1										_
429.2	2 474.40	518.21	555.66	533.91	400.67	265.62	278.31	399.07	428.62	411.13	409.23	(95)
Monthly average extern	l temperatur	e from Tabl	e U1									_
4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean	nternal temp	erature, Lm	, W [(39)m	x [(93)m -	(96)m]							
1125.4	1 1088.04	983.63	817.94	628.37	415.15	267.13	281.32	449.35	687.06	920.34	1118.22	(97)
Space heating requirem	nt, kWh/mor	nth 0.024 x	[(97)m - (9	5)m] x (41)	m							
517.9	7 412.36	346.27	188.84	70.28	0.00	0.00	0.00	0.00	192.28	366.63	527.49	
								Σ(9	8)15, 10	.12 =	2622.13	(98)
Space heating requirem	nt kWh/m²/y	ear							(98)	÷ (4)	33.53	(99)
9a. Energy requiremen	e - individual	heating sy	stoms inclu	iding micro	-CHD							
Space heating	.s marviada	neuting sy.	sterns mera	iding inicio	CIII							
	om cocondari	/cupplomo	ntany systa	m (table 11							0.00	(201)
	om secondary		ntary syste	m (table 11	1)				1 (2)	01) =	0.00	(201)
Fraction of space heat fr	om main syste	em(s)	ntary syste	m (table 11	1)				1 - (20	01) =	1.00	(202)
Fraction of space heat fr Fraction of space heat fr	om main systo om main systo	em(s) em 2	ntary syste	m (table 11	L)			(2)			1.00 0.00	(202)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h	om main systo om main systo eat from mair	em(s) em 2 n system 1	ntary system	m (table 11	L)			(20	02) x [1- (20	03)] =	1.00 0.00 1.00	(202) (202) (204)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h	om main systo om main systo eat from mair eat from mair	em(s) em 2 n system 1	ntary syste	m (table 11	.)			(20		03)] =	1.00 0.00 1.00 0.00	(202) (202) (204) (205)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main system	om main systo om main systo eat from mair eat from mair n 1 (%)	em(s) em 2 n system 1 n system 2					A		02) x [1- (20 (202) x (20	03)] =	1.00 0.00 1.00 0.00 93.00	(202) (202) (204)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster Jan	om main systo om main systo eat from mair eat from mair n 1 (%) Feb	em(s) em 2 a system 1 a system 2 Mar	Apr	m (table 11	Jun	Jul	Aug	(20 Sep	02) x [1- (20	03)] =	1.00 0.00 1.00 0.00	(202) (202) (204) (205)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster Jan Space heating fuel (mair	om main syste om main syste eat from mair eat from mair 1 1 (%) Feb system 1), k	em(s) em 2 n system 1 n system 2 Mar Wh/month	Apr	May	Jun			Sep	02) x [1- (20 (202) x (20 Oct	03)] = 03) = Nov	1.00 0.00 1.00 0.00 93.00 Dec	(202) (202) (204) (205)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster Jan	om main syste om main syste eat from mair eat from mair 1 1 (%) Feb system 1), k	em(s) em 2 a system 1 a system 2 Mar				Jul 0.00	<b>Aug</b>	<b>Sep</b>	02) x [1- (20 (202) x (20 Oct	(Nov 394.23	1.00 0.00 1.00 0.00 93.00 Dec	(202) (202) (204) (205) (206)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster Jan Space heating fuel (mair	om main syste om main syste eat from mair eat from mair 1 1 (%) Feb system 1), k	em(s) em 2 n system 1 n system 2 Mar Wh/month	Apr	May	Jun			<b>Sep</b>	02) x [1- (20 (202) x (20 Oct	(Nov 394.23	1.00 0.00 1.00 0.00 93.00 Dec	(202) (202) (204) (205)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster Jan Space heating fuel (main 556.9	om main system main system main system trom main at from main at 1 (%)  Feb  system 1), kt	em(s) em 2 n system 1 n system 2 Mar Wh/month	Apr	May	Jun			<b>Sep</b>	02) x [1- (20 (202) x (20 Oct	(Nov 394.23	1.00 0.00 1.00 0.00 93.00 Dec	(202) (202) (204) (205) (206)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster  Jan Space heating fuel (main  556.9  Water heating Efficiency of water heat	om main system main system main system main system main system main at 1 (%)  Feb  System 1), kv  443.40	em(s) em 2 a system 1 a system 2  Mar  Wh/month  372.34	Apr 203.06	<b>May</b> 75.57	Jun 0.00	0.00	0.00	Sep 0.00 <u>Σ</u> (21	02) x [1- (20 (202) x (20 Oct 206.75 1)15, 10	Nov 394.23	1.00 0.00 1.00 0.00 93.00 Dec 567.20 2819.50	(202) (202) (202) (204) (205) (206)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster  Jan Space heating fuel (main  556.9  Water heating Efficiency of water heate  89.1	om main system main system main system main system main system at from main at 1 (%)  Feb  System 1), kv  443.40  r  89.09	em(s) em 2 n system 1 n system 2 Mar Wh/month	Apr	May	Jun			<b>Sep</b>	02) x [1- (20 (202) x (20 Oct	(Nov 394.23	1.00 0.00 1.00 0.00 93.00 Dec	(202) (202) (204) (205) (206)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster  Jan Space heating fuel (main  556.9  Water heating  Efficiency of water heate  89.1: Water heating fuel, kWH	om main system main system main system main system main system main at from main at 1 (%)  Feb  System 1), kv  6 443.40  r  89.09	em(s) em 2 system 1 system 2  Mar Wh/month 372.34	Apr 203.06	May 75.57 87.80	Jun 0.00	0.00 86.70	0.00 86.70	Sep  0.00  ∑(21  86.70	02) × [1- (20 (202) × (20 Oct 206.75 1)15, 10	(3)] = (1) (3) = (1) (Nov (3) 394.23 (12 = (1) (88.99)	1.00 0.00 1.00 0.00 93.00 Dec  567.20 2819.50	(202) (202) (202) (204) (205) (206)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster  Jan Space heating fuel (main  556.9  Water heating Efficiency of water heate  89.1	om main system main system main system main system main system main at from main at 1 (%)  Feb  System 1), kv  6 443.40  r  89.09	em(s) em 2 a system 1 a system 2  Mar  Wh/month  372.34	Apr 203.06	<b>May</b> 75.57	Jun 0.00	0.00	0.00	Sep 0.00 <u>Σ</u> (21	02) x [1- (20 (202) x (20 Oct 206.75 1)15, 10	Nov  394.23 .12 =	1.00 0.00 1.00 0.00 93.00 Dec  \$567.20 2819.50  \$89.18	(202) (202) (202) (204) (205) (206)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster  Jan Space heating fuel (main  556.9  Water heating Efficiency of water heat  89.1  Water heating fuel, kWh  192.6	om main system main system main system main system main system main at from main at 1 (%)  Feb  System 1), kv  6 443.40  r  89.09	em(s) em 2 system 1 system 2  Mar Wh/month 372.34	Apr 203.06	May 75.57 87.80	Jun 0.00	0.00 86.70	0.00 86.70	Sep  0.00  ∑(21  86.70	02) × [1- (20 (202) × (20 Oct 206.75 1)15, 10	Nov  394.23 .12 =	1.00 0.00 1.00 0.00 93.00 Dec  567.20 2819.50	(202) (202) (202) (204) (205) (206)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster  Jan Space heating fuel (mair  556.9  Water heating Efficiency of water heat  89.1  Water heating fuel, kWh  192.6	om main system main system main system main system that from main at f	em(s) em 2 system 1 system 2  Mar Wh/month 372.34	Apr 203.06	May 75.57 87.80	Jun 0.00	0.00 86.70	0.00 86.70	Sep  0.00  ∑(21  86.70	02) x [1- (20 (202) x (20 Oct 206.75 1)15, 10	Nov  394.23 .12 =  888.99	1.00 0.00 1.00 0.00 93.00 Dec  \$567.20 2819.50  \$89.18  \$187.26	(202) (202) (202) (204) (205) (206)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster  Jan Space heating fuel (mair  556.9  Water heating Efficiency of water heat  89.1  Water heating fuel, kWh  192.6  Annual totals Space heating fuel - mai	om main system main system main system main system that from main at f	em(s) em 2 system 1 system 2  Mar Wh/month 372.34	Apr 203.06	May 75.57 87.80	Jun 0.00	0.00 86.70	0.00 86.70	Sep  0.00  ∑(21  86.70	02) x [1- (20 (202) x (20 Oct 206.75 1)15, 10	Nov  394.23 .12 =  888.99	1.00 0.00 1.00 0.00 93.00 Dec  \$567.20 2819.50  \$89.18	(202) (202) (202) (204) (205) (206)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster  Jan Space heating fuel (mair  556.9  Water heating Efficiency of water heat  89.1  Water heating fuel, kWh  192.6  Annual totals  Space heating fuel - mai Water heating fuel	om main system main system main system main system that from main at f	em(s) em 2 system 1 system 2  Mar Wh/month 372.34  888.94	Apr 203.06 88.57	May 75.57 87.80	Jun 0.00	0.00 86.70	0.00 86.70	Sep  0.00  ∑(21  86.70	02) x [1- (20 (202) x (20 Oct 206.75 1)15, 10	Nov  394.23 .12 =  888.99	1.00 0.00 1.00 0.00 93.00 Dec  \$567.20 2819.50  \$89.18  \$187.26	(202) (202) (202) (204) (205) (206)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster  Jan Space heating fuel (mair  556.9  Water heating Efficiency of water heat  89.1  Water heating fuel, kWh  192.6  Annual totals  Space heating fuel - mai Water heating fuel Electricity for pumps, fa	om main system main system main system main system that from main at f	em(s) em 2 system 1 system 2  Mar Wh/month 372.34  176.57	Apr 203.06 88.57 156.87	May 75.57 87.80 153.54	Jun 0.00	0.00 86.70	86.70 144.70	Sep  0.00	02) x [1- (20 (202) x (20 Oct 206.75 1)15, 10	Nov  394.23 .12 =  888.99	1.00 0.00 1.00 0.00 93.00 Dec  \$567.20 2819.50  \$89.18	[ (202)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster  Jan Space heating fuel (mair  556.9  Water heating Efficiency of water heat  89.1  Water heating fuel, kWh  192.6  Annual totals  Space heating fuel - mai Water heating fuel	om main system main system main system main system that from main at f	em(s) em 2 system 1 system 2  Mar Wh/month 372.34  176.57	Apr 203.06 88.57 156.87	May 75.57 87.80 153.54	Jun 0.00	0.00 86.70	86.70 144.70	Sep  0.00  ∑(21  86.70	02) x [1- (20 (202) x (20 Oct 206.75 1)15, 10	Nov  394.23 .12 =  888.99	1.00 0.00 1.00 0.00 93.00 Dec  \$567.20 2819.50  \$89.18	(202) (202) (202) (204) (205) (206)
Fraction of space heat fr Fraction of space heat fr Fraction of total space h Fraction of total space h Efficiency of main syster  Jan Space heating fuel (mair  556.9  Water heating Efficiency of water heat  89.1  Water heating fuel, kWh  192.6  Annual totals  Space heating fuel - mai Water heating fuel Electricity for pumps, fa	om main system main system main system main system that from main at f	em(s) em 2 system 1 system 2  Mar Wh/month 372.34  176.57	Apr 203.06 88.57 156.87	May 75.57 87.80 153.54	Jun 0.00	0.00 86.70	86.70 144.70	Sep  0.00	02) x [1- (20 (202) x (20 Oct 206.75 1)15, 10	Nov  394.23 .12 =  888.99	1.00 0.00 1.00 0.00 93.00 Dec  \$567.20 2819.50  \$89.18	[ (202)

boiler flue fan			45.00	
Total electricity for the above, kWh/year				75.00
Electricity for lighting (Appendix L)				369.22
Total delivered energy for all uses		(21	1)(221) + (231) + (232)(237b)	= 5192.64
10a. Fuel costs - individual heating systems including	g micro-CHP			
	Fuel kWh/year		Fuel price	Fuel cost £/year
Space heating - main system 1	2819.50	x	3.48 x 0.01 =	98.12
Water heating	1928.93	x	3.48 x 0.01 =	67.13
Pumps and fans	75.00	x	13.19 x 0.01 =	9.89
Electricity for lighting	369.22	x	13.19 x 0.01 =	48.70
Additional standing charges				120.00
Total energy cost			(240)(242) + (245)(254)	= 343.84
11a. SAP rating - individual heating systems including	g micro-CHP			
Energy cost deflator (Table 12)				0.42
Energy cost factor (ECF)				1.17
SAP value				83.65
SAP rating (section 13)				84
SAP band				В
12a. CO <sub>2</sub> emissions - individual heating systems inclu	uding micro-CHP			
	Energy kWh/year		Emission factor kg CO₂/kWh	Emissions kg CO <sub>2</sub> /year
Space heating - main system 1	2819.50	х	0.216 =	609.01
Water heating	1928.93	x	0.216 =	416.65

12a. CO <sub>2</sub> emissions - individual heating systems	including micro-CHP				
	Energy kWh/year		Emission factor kg CO <sub>2</sub> /kWh	Emissions kg CO₂/year	
Space heating - main system 1	2819.50	x	0.216 =	609.01	(261)
Water heating	1928.93	x	0.216 =	416.65	(264)
Space and water heating			(261) + (262) + (263) + (264	1) = 1025.66	(265)
Pumps and fans	75.00	x	0.519 =	38.93	(267)
Electricity for lighting	369.22	x	0.519 =	191.62	(268)
Total CO₂, kg/year			(265)(27	.) = 1256.21	(272)
Dwelling CO₂ emission rate			(272) ÷ (	1) = 16.06	(273)
El value				86.34	
El rating (section 14)				86	(274)
El band				В	

13a. Primary energy - individual heating systems including	micro-CHP					
	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	2819.50	x	1.22	=	3439.78	(261)
Water heating	1928.93	x	1.22	=	2353.29	(264)
Space and water heating			(261) + (262) + (263)	) + (264) =	5793.08	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	369.22	x	3.07	=	1133.50	(268)
Primary energy kWh/year					7156.83	(272)
Dwelling primary energy rate kWh/m2/year					91.52	(273)

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URN: Plot 026 version 1

NHER Plan Assessor version 6.2.3

URN: Plot 026 version 1

#### **DER Worksheet** Design - Draft



This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Simon Gowing	Assessor number	9641
Client		Last modified	16/01/2018
Address	45 Meer Stones Road, Balsall Common, Coventry, OX		

1. Overall dwelling dimensions					
		Area (m²)		Average storey height (m)	Volume (m³)
Lowest occupied		70.13 (1a	) x	2.39 (2a) =	167.61 (3a)
+1		67.55 (1b	) x	2.61 (2b) =	176.31 (3b)
Total floor area	(1a) + (1b) + (1c) + (1d)(1n) =	137.68 (4)			
Dwelling volume				(3a) + (3b) + (3c) + (3d)(	(3n) = 343.92 (5)

2. Ventilation rate					
				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		5	x 10 =	50	(7a)
Number of passive vents		0	x 10 =	0	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes per hour	r
Infiltration due to chimneys flues fans PSVs	(6a) + (6b) + (7a) + (7b) + (7b)	7c) = 50	÷ (5) =	0.15	(8)

Number of flueless gas fires	0	x 40 =	0
			Air changes phour
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 50	÷ (5) =	0.15
If a pressurisation test has been carried out or is intended, p	proceed to (17), otherwise continue from (9) to (16)	)	
Air permeability value, q50, expressed in cubic metres per h	nour per square metre of envelope area		5.00
If based on air permeability value, then (18) = $[(17) \div 20] + ($	(8), otherwise (18) = (16)		0.40
Number of sides on which the dwelling is sheltered			2
Shelter factor		1 - [0.075 x (19)] =	0.85
Infiltration rate incorporating shelter factor		(18) x (20) =	0.34

Infiltration rate in	ncorporati	ng shelter f	actor							(18) x (2	20) =	0.34	(21)
Infiltration rate r	nodified fo	r monthly v	vind speed	:									
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average	wind spee	ed from Tab	le U2										
	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)	m ÷ 4												
	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltrat	ion rate (a	llowing for	shelter and	wind facto	or) (21) x (2	2a)m							
	0.43	0.42	0.41	0.37	0.36	0.32	0.32	0.31	0.34	0.36	0.38	0.39	(22b)
Calculate effective	ve air chan	ge rate for t	the applica	ble case:									

Calculate effective all Change rate for the applicable case.	
If mechanical ventilation: air change rate through system	N/A

If mechanical	ff mechanical ventilation: air change rate through system												(23a)
If balanced w	If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h												(23c)
d) natural ver	ntilation or	whole hous	se positive	input ventil	lation from	loft							
	0.59	0.59	0.58	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(24d)

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



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												٦
0.59	0.59	0.58	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58	(25

			a	Gross area, m²	Openings m <sup>2</sup>	Net A,		U-value W/m²K	AxUW		/alue, /m².K	Ахк, kJ/K	
Window						21	15 x	1.24	= 26.14	1			(2
Door						2.	03 x	1.30	= 2.64				(2
Ground floor						70	.13 x	0.16	= 11.22	2			(2
External wall						147	.96 x	0.20	= 29.59	•			(2
Roof						70	.12 x	0.11	= 7.71	=			(3
Total area of exte	ernal eleme	ents ∑A, m²				311	39			<del></del>			(3
Fabric heat loss,	W/K = ∑(A	× U)							(2	6)(30) + (	32) =	77.30	) (E
Heat capacity Cm	n = ∑(A x κ)							(28)	(30) + (32)	+ (32a)(3	2e) =	N/A	=     
Thermal mass pa	arameter (T	MP) in kJ/m	n²K									100.00	_ ] (3
Thermal bridges:	: Σ(L x Ψ) ca	alculated us	ing Appen	ıdix K								11.16	<u> </u>
Total fabric heat	loss									(33) + (	36) =	88.46	_ ] (3
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat	loss calcula	ited monthl	y 0.33 x (	25)m x (5)									
I	67.17	66.76	66.36	64.50	64.15	62.53	62.53	62.23	63.16	64.15	64.86	65.60	٦ (٤
Heat transfer coe	efficient, W	/K (37)m+	(38)m										
I	155.63	155.23	154.83	152.97	152.62	151.00	151.00	150.69	151.62	152.62	153.32	154.06	٦
,									Average = 1	Σ(39)112,	/12 =	152.96	J (3
Heat loss parame	eter (HLP),	W/m²K (39	)m ÷ (4)							_, , ,			
	1.13	1.13	1.12	1.11	1.11	1.10	1.10	1.09	1.10	1.11	1.11	1.12	٦
'								•		Σ(40)112,		1.11	۱ (۷
Number of days	in month (1	Table 1a)							)	_ , ,			`
	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	7 (4
		'								'	'	'	
4. Water heatin	ng energy r	equirement											_
	ancy N											2.91	(4
•												103.37	
•	hot water u	-		_									(4
Annual average h	hot water u	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	(4
Annual average h	hot water u  Jan  in litres pe	<b>Feb</b> r day for ea	Mar ch month	Apr Vd,m = fact	May tor from Tab	<b>Jun</b> le 1c x (43	)					Dec	(4
Annual average h	hot water u	Feb	Mar	Apr	May	Jun		<b>Aug</b> 97.17	Sep 101.31	105.44	109.58	Dec 113.71	] ( <sup>4</sup>
Annual average h	hot water u  Jan  in litres pe	<b>Feb</b> r day for ea	Mar ch month	Apr Vd,m = fact	May tor from Tab	<b>Jun</b> le 1c x (43	)				109.58	Dec	]
Annual average h	Jan in litres pe	Feb r day for ea 109.58	Mar ch month 105.44	Apr Vd,m = fact 101.31	May for from Tab	<b>Jun</b> le 1c x (43 93.04	93.04	97.17		105.44	109.58	Dec 113.71	] (4 ] (4
Assumed occupa Annual average h Hot water usage	Jan in litres pe	Feb r day for ea 109.58	Mar ch month 105.44	Apr Vd,m = fact 101.31	May for from Tab	<b>Jun</b> le 1c x (43 93.04	93.04	97.17		105.44	109.58	Dec 113.71 1240.47	]
Annual average h	Jan in litres pe 113.71 of hot wate	Feb r day for ea 109.58 r used = 4.1	Mar ch month 105.44 8 x Vd,m x	Apr Vd,m = fact 101.31 x nm x Tm/3	May for from Tab 97.17	Jun le 1c x (43 93.04 onth (see	93.04 Tables 1b,	97.17 1c 1d)	101.31	105.44 Σ(44)1	109.58 .12 =	Dec 113.71 1240.47	] ] [
Annual average h	Jan in litres pe 113.71 of hot wate 168.63	Feb r day for ea 109.58 r used = 4.1 147.48	Mar ch month 105.44 8 x Vd,m x	Apr Vd,m = fact 101.31 x nm x Tm/3	May for from Tab 97.17	Jun le 1c x (43 93.04 onth (see	93.04 Tables 1b,	97.17 1c 1d)	101.31	105.44 Σ(44)1	109.58 .12 =	Dec 113.71 1240.47 163.31	]
Annual average h  Hot water usage  Energy content o	Jan in litres pe 113.71 of hot wate 168.63	Feb r day for ea 109.58 r used = 4.1 147.48	Mar ch month 105.44 8 x Vd,m x	Apr Vd,m = fact 101.31 x nm x Tm/3	May for from Tab 97.17	Jun le 1c x (43 93.04 onth (see	93.04 Tables 1b,	97.17 1c 1d)	101.31	105.44 Σ(44)1	109.58 .12 =	Dec 113.71 1240.47 163.31	] ] [
Annual average I  Hot water usage  Energy content of	hot water u Jan in litres pe 113.71 of hot wate 168.63 0.15 x (45) 25.29	Feb r day for ea 109.58 r used = 4.1 147.48	Mar ch month 105.44 8 x Vd,m x 152.19	Apr Vd,m = fact 101.31 x nm x Tm/3 132.68	May sor from Tab 97.17 8600 kWh/m 127.31	Jun le 1c x (43 93.04  onth (see 109.86	93.04 Tables 1b,	97.17 1c 1d) 116.82	101.31	105.44 Σ(44)1 137.77 Σ(45)1	109.58 .12 = 150.38 .12 =	113.71 1240.47 163.31 1626.45	] (4 ] (4
Annual average h  Hot water usage  Energy content o	Jan in litres pe 113.71 of hot wate 168.63 0.15 x (45) 25.29 (litres) includes	Feb r day for ea 109.58 r used = 4.1 147.48	Mar ch month 105.44 8 x Vd,m x 152.19	Apr Vd,m = fact 101.31 x nm x Tm/3 132.68	May sor from Tab 97.17 8600 kWh/m 127.31	Jun le 1c x (43 93.04  onth (see 109.86	93.04 Tables 1b,	97.17 1c 1d) 116.82	101.31	105.44 Σ(44)1 137.77 Σ(45)1	109.58 .12 = 150.38 .12 =	Dec         113.71         1240.47         163.31         1626.45         24.50	] (4
Annual average I  Hot water usage  Energy content c  Distribution loss  Storage volume (  Water storage lo	hot water u Jan in litres pe 113.71 of hot wate 168.63 0.15 x (45) 25.29 (litres) incluses:	Feb r day for ea 109.58 1 r used = 4.1 147.48 1 m 22.12 1 ding any so	Mar ch month 105.44 8 x Vd,m x 152.19 22.83	Apr Vd,m = fact 101.31 x nm x Tm/3 132.68 19.90 VHRS storage	May 97.17  8600 kWh/m 127.31  19.10  e within san	Jun le 1c x (43 93.04  onth (see 109.86	93.04 Tables 1b,	97.17 1c 1d) 116.82	101.31	105.44 Σ(44)1 137.77 Σ(45)1	109.58 .12 = 150.38 .12 =	Dec         113.71         1240.47         163.31         1626.45         24.50	] (4 ] (4
Annual average I  Hot water usage  Energy content c  Distribution loss	hot water u Jan in litres pe 113.71 of hot wate 168.63 0.15 x (45) 25.29 (litres) incluses: er's declaree	Feb r day for ea 109.58 1 109.58 1 147.48 1 147.48 1 1 147.48 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Mar ch month 105.44 8 x Vd,m x 152.19 22.83	Apr Vd,m = fact 101.31 x nm x Tm/3 132.68 19.90 VHRS storage	May 97.17  8600 kWh/m 127.31  19.10  e within san	Jun le 1c x (43 93.04  onth (see 109.86	93.04 Tables 1b,	97.17 1c 1d) 116.82	101.31	105.44 Σ(44)1 137.77 Σ(45)1	109.58 .12 =	Dec 113.71 1240.47 163.31 1626.45 24.50 170.00	(4)
Annual average I  Hot water usage  Energy content of  Distribution loss  Storage volume (  Water storage lo  a) If manufacture	in litres pe  113.71  of hot wate  168.63  0.15 x (45)  25.29  (litres) incluses: er's declaree factor from	r tused = 4.1 147.48  The state of the state	Mar ch month 105.44 8 x Vd,m x 152.19 22.83 olar or WW	Apr Vd,m = fact 101.31 x nm x Tm/3 132.68 19.90 VHRS storag	May 97.17  8600 kWh/m 127.31  19.10  e within san	Jun le 1c x (43 93.04  onth (see 109.86	93.04 Tables 1b,	97.17 1c 1d) 116.82	101.31	105.44 Σ(44)1 137.77 Σ(45)1	109.58 .12 =	Dec 113.71 1240.47 163.31 1626.45 24.50 170.00 1.42	
Annual average I  Hot water usage  Energy content of  Distribution loss  Storage volume (  Water storage lo  a) If manufacture  Temperature	in litres pe  113.71  of hot wate  168.63  0.15 x (45)  25.29  (litres) incluses: er's declare factor from om water s	r tused = 4.1 147.48  The state of the state	Mar ch month 105.44 8 x Vd,m x 152.19 22.83 olar or WW	Apr Vd,m = fact 101.31 x nm x Tm/3 132.68 19.90 VHRS storag	May 97.17  8600 kWh/m 127.31  19.10  e within san	Jun le 1c x (43 93.04  onth (see 109.86	93.04 Tables 1b,	97.17 1c 1d) 116.82	101.31	105.44 Σ(44)1 137.77 Σ(45)1	109.58 .12 =	113.71   1240.47   163.31   1626.45   24.50   170.00   1.42   0.54	
Annual average I  Hot water usage  Energy content of  Distribution loss  Storage volume (  Water storage lo  a) If manufacture  Temperature  Energy lost fri	in litres pe  113.71  of hot wate  168.63  0.15 x (45)  25.29  (litres) incluses: er's declare factor fron om water s ) in (55)	r tused = 4.1 147.48  Imm 22.12 Iding any so I loss facto In Table 2b torage (kW	Mar ch month 105.44 8 x Vd,m x 152.19 22.83 olar or WW r is known	Apr Vd,m = fact 101.31 x nm x Tm/3 132.68 19.90 VHRS storage n (kWh/day) 8) x (49)	May 97.17  8600 kWh/m 127.31  19.10  e within san	Jun le 1c x (43 93.04  onth (see 109.86	93.04 Tables 1b,	97.17 1c 1d) 116.82	101.31	105.44 Σ(44)1 137.77 Σ(45)1	109.58 .12 =	113.71 1240.47 163.31 1626.45 24.50 170.00 1.42 0.54 0.77	

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	23.77	21.47	23.77	23.00	23.77	23.00	23.77	23.77	23.00	23.77	23.00	23.77	(57)
Primary circuit	loss for each	month fro	m Table 3										_
	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
Combi loss for e	each month	from Table	3a, 3b or 3	c								•	_
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total heat requ	ired for wat	er heating o	alculated f	or each mo	onth 0.85 x	(45)m + (4	6)m + (57)r	n + (59)m +	· (61)m				_
	215.66	189.97	199.22	178.20	174.35	155.38	148.84	163.85	163.73	184.80	195.90	210.34	(62)
Solar DHW inpu	ıt calculated	using Appe	endix G or A	Appendix H		•			•				_
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
Output from wa	ater heater i	for each mo	nth (kWh/	month) (62	2)m + (63)m	1							
	215.66	189.97	199.22	178.20	174.35	155.38	148.84	163.85	163.73	184.80	195.90	210.34	7
							•			∑(64)1	.12 = 2	180.23	(64)
Heat gains from	n water heat	ing (kWh/n	nonth) 0.2!	5 × [0.85 ×	(45)m + (61	.)m] + 0.8 ×	[(46)m + (	57)m + (59)	m]	∑(64)1	.12 = 2	180.23	(64)
Heat gains from	water heat	ing (kWh/n 83.02	nonth) 0.2!	5 × [0.85 × 80.53	(45)m + (61 79.96	.)m] + 0.8 ×	[(46)m + (5	57)m + (59) 76.47	m] 75.72	Σ(64)1 83.43	.12 = 2	91.93	(64)
	93.70				. , .								
Heat gains from  5. Internal gai	93.70	83.02	88.23	80.53	79.96	72.94	71.48	76.47	75.72	83.43	86.42	91.93	
5. Internal gai	93.70 ns Jan				. , .								
	93.70 ns Jan s (Table 5)	83.02 Feb	88.23 Mar	80.53 Apr	79.96 May	72.94 Jun	71.48	76.47	75.72 Sep	83.43 Oct	86.42 Nov	91.93 Dec	
5. Internal gains	93.70 ns Jan s (Table 5) 145.63	83.02 Feb	88.23 Mar	80.53 Apr	79.96 <b>May</b>	72.94 Jun 145.63	71.48	76.47	75.72	83.43	86.42	91.93	
5. Internal gai	93.70 ns Jan s (Table 5) 145.63	83.02 Feb	88.23 Mar	80.53 Apr	79.96 <b>May</b>	72.94 Jun 145.63	71.48	76.47	75.72 Sep	83.43 Oct	86.42 Nov	91.93 Dec	(65)
5. Internal gains	93.70 ns Jan s (Table 5) 145.63	83.02 Feb	88.23 Mar	80.53 Apr	79.96 <b>May</b>	72.94 Jun 145.63	71.48	76.47	75.72 Sep	83.43 Oct	86.42 Nov	91.93 Dec	(65)
5. Internal gains	93.70  ns  Jan s (Table 5)  145.63 calculated in  28.77	Feb 145.63 Appendix 25.55	Mar  145.63 L, equation 20.78	Apr  145.63 L9 or L9a),	79.96  May  145.63  also see Ta  11.76	72.94  Jun  145.63 able 5  9.93	71.48 Jul 145.63	76.47 Aug	75.72 Sep	Oct 145.63	Nov 145.63	91.93  Dec  145.63	(65)
5. Internal gains Metabolic gains Lighting gains (c	93.70  ns  Jan s (Table 5)  145.63 calculated in  28.77	Feb 145.63 Appendix 25.55	Mar  145.63 L, equation 20.78	Apr  145.63 L9 or L9a),	79.96  May  145.63  also see Ta  11.76	72.94  Jun  145.63 able 5  9.93	71.48 Jul 145.63	76.47 Aug	75.72 Sep	Oct 145.63	Nov 145.63	91.93  Dec  145.63	(65)
5. Internal gains Metabolic gains Lighting gains (	93.70  Jan s (Table 5) 145.63 calculated ir 28.77 s (calculated 306.76	Feb  145.63 Appendix 25.55 in Appendi 309.94	Mar  145.63 L, equation 20.78 x L, equation 301.92	Apr  145.63 L9 or L9a), 15.73 on L13 or L: 284.84	May  145.63 also see Ta 11.76 13a), also se 263.29	Jun  145.63 able 5 9.93 ee Table 5 243.03	Jul 145.63	Aug 145.63	75.72 Sep 145.63	Oct 145.63	Nov 145.63 27.73	91.93  Dec  145.63	(65)

	145.03	145.05	145.05	145.05	145.03	145.05	145.05	145.05	145.05	145.05	145.05	145.03	(00)
Lighting gains (c	alculated in	Appendix I	L, equation	L9 or L9a),	also see Ta	able 5							
	28.77	25.55	20.78	15.73	11.76	9.93	10.73	13.94	18.71	23.76	27.73	29.57	(67)
Appliance gains	(calculated	in Appendi	x L, equation	on L13 or L1	L3a), also s	ee Table 5							
	306.76	309.94	301.92	284.84	263.29	243.03	229.49	226.31	234.33	251.41	272.96	293.22	(68)
Cooking gains (c	alculated in	Appendix	L, equation	L15 or L15	a), also see	Table 5							
	37.56	37.56	37.56	37.56	37.56	37.56	37.56	37.56	37.56	37.56	37.56	37.56	(69)
Pump and fan ga	ains (Table !	5a)											
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evap	oration (Tal	ble 5)											
	-116.50	-116.50	-116.50	-116.50	-116.50	-116.50	-116.50	-116.50	-116.50	-116.50	-116.50	-116.50	(71)
Water heating g	ains (Table	5)											
	125.93	123.55	118.59	111.85	107.47	101.31	96.07	102.78	105.17	112.14	120.02	123.56	(72)
Total internal ga	ins (66)m +	+ (67)m + (6	58)m + (69)	m + (70)m	+ (71)m + (	72)m							
	531.15	528.73	510.98	482.11	452.20	423.95	405.98	412.72	427.90	457.00	490.41	516.03	(73)

6. Solar gains															
		Access f Table		Area m²		Solar flux W/m²		•	g fic data ible 6b		FF specific da or Table 6			Gains W	
SouthWest		0.7	7 x	7.50	] x [	36.79	x 0.9 x	0	.63	х	0.70		=	84.34	(79)
NorthWest		0.7	7 x	0.55	] x [	11.28	x 0.9 x	0	.63	х	0.70		=	1.90	(81)
NorthEast		0.7	7 x	13.10	] x [	11.28	x 0.9 x	0	.63	x	0.70		=	45.17	(75)
Solar gains in watts ∑(74)m	(82)m														
131.40	239.46	369.17	527.02	653.84	677	.06 641.1	.3 54	2.24	423.16	5	275.85	160	.24	110.61	(83)
Total gains - internal and sola	ar (73)m +	(83)m													
662.55	768.19	880.15	1009.13	1106.05	1101	1.01 1047.	11 95	4.97	851.06	5	732.85	650	.65	626.65	(84)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Temperature du	ring heating	g periods in	the living a	area from T	able 9, Th1	.(°C)						21.00	(85)
7. Mean interna	al tempera	ture (heatii	ng season)										
				•		•	•						-
	002.55	/00.19	990.12	1009.13	1100.03	1101.01	1047.11	954.97	921.00	/32.63	050.05	020.03	(04)

0.98 0.97 0.95 0.90 0.81 0.68 0.55 0.60 0.80 0.93 0.97 0.98 (86) Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) 18.41 (87) 18.45 18.70 19.15 19.76 20.31 20.71 20.85 20.88 20.52 19.81 19.03 Temperature during heating periods in the rest of dwelling from Table 9, Th2(\*C) 19.98 19.98 19.99 19.99 20.00 20.00 20.01 20.00 19.99 19.99 19.99 (88) Utilisation factor for gains for rest of dwelling n2,m 0.98 0.96 0.94 0.88 0.77 0.61 0.45 0.51 0.75 0.91 0.96 0.98 (89) Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) 16.55 16.91 17.56 18.44 19.21 19.73 19.92 19.89 19.50 18.52 17.39 16.49 (90) Living area fraction Living area ÷ (4) = 0.15 Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 16.83 17.18 17.80 18.64 19.37 19.88 20.07 20.04 19.65 18.71 17.64 16.78 (92) Apply adjustment to the mean internal temperature from Table 4e where appropriate 16.68 17.03 17.65 18.49 19.22 19.73 19.92 19.89 19.50 18.56 17.49 16.63 (93) 8. Space heating requirement Jan Nov Dec Utilisation factor for gains, nm 0.96 0.94 0.91 0.85 0.74 0.59 0.44 0.49 0.71 0.88 0.94 0.96 (94) Useful gains, nmGm, W (94)m x (84)m 636.01 723.98 800.85 853.40 819.56 651.70 462.46 472.18 607.89 643.51 613.80 604.56 (95) Monthly average external temperature from Table U1 4.30 4.90 6.50 8.90 11.70 14.60 16.60 16.40 14.10 10.60 4.20 (96) 7.10 Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] 1927.26 1883.54 1726.77 1466.26 1148.05 774.39 501.01 525.33 819.06 1215.04 1593.14 1915.36 (97) Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m 960.69 779.22 688.88 441.26 244.40 0.00 0.00 425.22 705.12 975.23 0.00 0.00 5220.02 ∑(98)1...5, 10...12 = 37.91 Space heating requirement kWh/m²/year (98) ÷ (4) 9a. Energy requirements - individual heating systems including micro-CHP Space heating Fraction of space heat from secondary/supplementary system (table 11) 0.00 (201)(202) Fraction of space heat from main system(s) 1 - (201) = 1.00 Fraction of space heat from main system 2 0.00 (202) Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204) Fraction of total space heat from main system 2 (202) x (203) = 0.00 (205) Efficiency of main system 1 (%) 93.00 (206) Feb Mar Oct Nov Jan Dec Space heating fuel (main system 1), kWh/month 1033.00 837.87 740.73 474.47 262.79 0.00 457.23 758.20 1048.63 0.00 0.00 0.00  $\Sigma(211)1...5, 10...12 = 5612.92$  (211) Water heating Efficiency of water heater 87.83 87.68 87.36 86.64 85.21 79.30 79.30 86.47 87.43 87.90 (217) 79.30 79.30 Water heating fuel, kWh/month

Utilisation factor for gains for living area n1,m (see Table 9a)

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245.55 216.65 228.06 205.68 204.60 195.94 187.69 206.62 206.47 213.73 224.05 239.31

Dwelling primary energy rate kWh/m2/year

Primary energy kWh/year

Annual totals		
Space heating fuel - main system 1		5612.92
Water heating fuel		2574.35
Electricity for pumps, fans and electric keep-hot (Table 4f)		
central heating pump or water pump within warm air heating unit	30.00	(230c)

45.00 boiler flue fan (230e) Total electricity for the above, kWh/year 75.00 (231) Electricity for lighting (Appendix L) 508.03 (232) Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) = 8770.30 (238)

10a. Fuel costs - individual heating systems including m	icro-CHP					
	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	5612.92	x	3.48	x 0.01 =	195.33	(240)
Water heating	2574.35	x	3.48	x 0.01 =	89.59	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	508.03	x	13.19	x 0.01 =	67.01	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242) +	(245)(254) =	481.82	(255)

11a. SAP rating - individual heating systems including micro-CHP		
Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.11	(257)
SAP value	84.55	
SAP rating (section 13)	85	(258)
SAP band	В	

12a. CO₂ emissions - individual heating systems includi	ng micro-CHP					
	Energy kWh/year		Emission factor kg CO₂/kWh		Emissions kg CO₂/year	
Space heating - main system 1	5612.92	x	0.216	= [	1212.39	(261)
Water heating	2574.35	x	0.216	= [	556.06	(264)
Space and water heating			(261) + (262) + (2	63) + (264) = [	1768.45	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	508.03	x	0.519	= [	263.67	(268)
Total CO <sub>2</sub> , kg/year			(2	65)(271) = [	2071.04	(272)
Dwelling CO₂ emission rate				(272) ÷ (4) = [	15.04	(273)
El value					84.81	]
El rating (section 14)				[	85	(274)
EI band					В	]

13a. Primary energy - individual heating systems including micro-CHP								
	Energy kWh/year	Primary factor			Primary Energy kWh/year			
Space heating - main system 1	5612.92	x	1.22	=	6847.77	(261)		
Water heating	2574.35	x	1.22	=	3140.71	(264)		
Space and water heating			(261) + (262) +	(263) + (264) =	9988.48	(265)		
Pumps and fans	75.00	x	3.07	=	230.25	(267)		
Electricity for lighting	508.03	x	3.07	=	1559.64	(268)		

Sustainable Construction Statement Date: January 2018

## **Appendix E**

Low and Zero Carbon Technologies Summary



## APPENDIX E: LOW CARBON AND RENEWABLE ENERGY TECHNOLOGIES



### 1. INTRODUCTION

- > This Appendix is intended to provide the background information for the low carbon and renewable energy technologies that have been considered in the formulation of this Energy Statement.
- > The information provided here forms the basis for the project specific technical selection of low carbon/renewable energy technologies contained in the main section of this Energy Statement.

## 2. COMBINED HEAT AND POWER (CHP)

> CHP is a form of decentralised energy generation that generally uses gas to generate electricity for local consumption, reducing the need for grid electricity and its associated high CO<sub>2</sub> emissions. As the CHP system is close to the point of energy demand, it is possible to use the heat that is generated during the electricity generation process. As both the electricity and heat from the generator is used, the efficiency of the system is increased above that of a conventional power plant where the heat is not utilised.

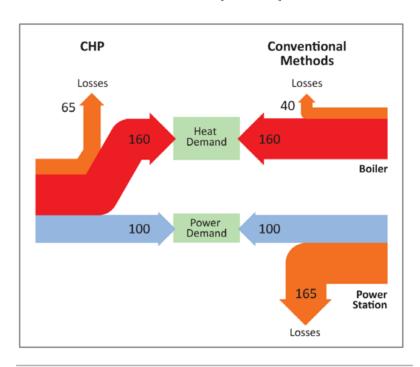


Diagram 1 - CHP Diagram

- > However, the overall efficiency of ~80% is still lower than the ~90% efficiency of a heat only gas boiler.
- > Where there are high thermal loads, CHP can be used within district heating networks to supply the required heat.

#### > Performance and Calculation Methodology: -

- > Most commonly sized on the heat load of a development, not the electrical load. This prevents an over-generation of heat.
- > Require a high and relatively constant heat demand to be viable.
- > CHP engines are best suited to providing the base heating load of a development (~year round hot water demand) with conventional gas boilers responding to the peak heating demand (~winter space heating). CHP engines are not able to effectively respond to peaks in demand.



- > In general, CHP engines have an electrical efficiency of  $\sim$ 30% and a thermal efficiency of  $\sim$ 45%. Larger engines have a better heat to power ratio and are therefore able to reduce CO<sub>2</sub> emissions by greater amount.
- > Electricity produced by the CHP engine displaces grid electricity which is given a carbon intensity of 0.519 kg per kWh.

#### > Capital Cost: -

- > Around £1,000 per kW of electrical output.
- > Relative cost reduces as the size of engine increases.
- > Generally best suited to larger sites, where there is a suitable economy of scale.

#### > Running Costs/Savings: -

- > CHP engines often struggle to provide cost-effective energy to dwellings on smaller residential schemes compared to conventional individual gas boilers.
- > Onsite use of CHP generated electricity; power Purchase Agreement with electricity Supply Company or Private Wire arrangement to local large non-domestic demand enhances economic case.

#### > Land Use Issues and Space Required: -

- > CHP engines require a plant room, and possibly an energy centre for large residential developments.
- > CHP engines require a flue to effectively disperse pollutants. This is best to rise to a minimum of 2m above the roofline of the tallest building.
- > Route for district heating pipe around the site must be safeguarded.

#### > Operational Impacts/Issues: -

- > Often run by Energy Services Company (ESCo) who maybe unenthusiastic about getting involved in small medium scale schemes.
- > Can also be run in-house with specialist maintenance and customer services activities contracted out.
- > Issues with rights to dig up roads for district heating networks.
- > Emissions of oxides of nitrogen ~500mg/kWh 10 times higher than for a gas boiler. Specialist technologies exist (e.g. selective catalytic reduction) to reduce this to ~20mg/kWh if air quality issues require.
- > **Embodied Energy:** Comparable to that of a conventional gas boiler.

#### > Funding Opportunities: -

- > Tax relief for businesses under the Enhanced Capital Allowances scheme..
- > **Reductions in Energy Achievable: -** Can provide some reductions in effective primary energy, but when distribution losses and other local losses are included more fuel is required.

> **Reductions in CO<sub>2</sub> Achievable:** - Can provide greater reductions in CO<sub>2</sub> than energy, aided by the emissions factor of grid displaced electricity of 0.519 kg CO<sub>2</sub>/kWh. CO<sub>2</sub> reduction increase as size of engine increases.

#### > Advantages: -

- > Good reductions in overall primary energy and CO<sub>2</sub> emissions.
- > Most cost effective and appropriate strategy to achieve substantial CO<sub>2</sub> reductions on large schemes.

#### > Disadvantages: -

- > On smaller schemes often do not supply energy cost-effectively in comparison to conventional individual gas boilers.
- > Requires sale of generated electricity to maximise cost effectiveness.

**Application:** - Best suited to larger developments.

# 3. COMBINED COOLING HEAT AND POWER (CCHP)

- > CCHP is a CHP system which additionally has the facility to transform heat into energy for cooling. This is done with an absorption chiller which utilises a heat source to provide the energy needed to drive a cooling system. As absorption chillers are far less efficient than conventional coolers (CoP of 0.7 compared to >4) they are generally only used where there is a current excess generation of heat. New CHP systems are generally sized to provide the year round base heating load only.
- > For this reason it is generally not suitable for new CHP systems to include cooling.
- > Where there are high thermal loads, CCHP can be used within district heating and cooling networks to supply the required heat and coolth.

#### > Performance and Calculation Methodology: -

- > Most commonly sized on the heat load of a development, not the electrical load. This prevents an over-generation of heat.
- > Require a high and relatively constant heat and cooling demand to be viable.
- > CCHP systems are best suited to providing the base loads of a development with conventional gas boilers and chillers responding to the peak demands. CCHP systems are not able to effectively respond to peaks in demand.



- > In general, CHP engines have an electrical efficiency of ~30% and a thermal efficiency of ~45%.
- > Absorption chillers have a CoP of ~0.7.
- > Electricity produced by the CHP engine displaces grid electricity which is given a carbon intensity of 0.519 kg per kWh.

#### > Capital Cost: -

> High in comparison to biomass boilers and increased further by inclusion of absorption chiller.

#### > Running Costs/Savings: -

> Coolth from absorption chillers is more expensive than from conventional systems unless heat used is genuine waste heat.

#### > Land Use Issues and Space Required: -

- > CCHP systems require a plant room, and possibly an energy centre for large residential developments.
- > CHP engines require a flue to effectively disperse pollutants. This is best to rise to a minimum of 2m above the roofline of the tallest building. Additionally the absorption chiller requires either a cooling tower or dry cooler bed for heat rejection purposes.
- > Heating and cooling distribution pipework required around the site.

#### > Operational Impacts/Issues: -

- > Often run by an ESCo who are unenthusiastic about getting involved in small medium scale schemes.
- > Can also be run in-house with specialist maintenance and customer services activities contracted out.
- > Issues with rights to dig up roads for heat networks.
- > Emissions of oxides of nitrogen- ~500mg/kWh 10 times higher than for gas boilers. Specialist technologies exist (e.g. selective catalytic reduction) to reduce this ~20mg/kWh if air quality issues require.
- > Rejection of heat is higher than for conventional cooling, thus enforcing the urban heat island effect.
- > Embodied Energy: Comparable to conventional gas boilers.

#### > Funding Opportunities: -

- > Tax relief for businesses under Enhanced Capital Allowance scheme.
- > Reductions in Energy Achievable: Absorption cooling generally requires more energy than conventional chillers.

> Reductions in  $CO_2$  Achievable: - Can provide greater reductions in  $CO_2$  than energy, aided by the emissions factor of grid displaced electricity of 0.519 kg  $CO_2$ /kWh.

#### > Advantages: -

- > Reasonable reductions in overall primary energy and CO<sub>2</sub> emissions.
- > Disadvantages: More expensive to install than conventional chillers.
- > Operational costs higher than for conventional chillers.
- > **Application: -** Best suited where there is genuine waste heat available.

#### 4. BIOMASS BOILERS

- > Biomass boilers generate heat on a renewable basis as they are run on biomass fuel which is almost carbon neutral. Fuel is generally wood chip or wood pellets. Wood pellets are slightly more expensive than wood chips but have a significantly higher calorific value and enable greater automation of the system.
- > Various other suitable fuels are available including organic materials including straw, dedicated energy crops, sewage sludge and animal litter. Each fuel tends to have its own advantages dependant on site requirements.
- > Can be used with district heating networks or as individual boilers on a house-byhouse basis.

#### > Performance and Calculation Methodology: -

- > Biomass boilers are best suited to providing the base heating load of a development (~year round hot water demand) with conventional gas boilers responding to the peak heating demand (~winter space heating).
- > Operate with an efficiency of around 90%.
- > Small models available.
- > Conflicts with CHP they are both best suited to providing the base heating load of a development. As such they should not be installed in tandem unless surplus hot water capacity is available. Special control measures would be required in this case.

#### > Capital Cost: -

- > Low in comparison to CHP.
- > More suitable to smaller developments than CHP as installed cost is lower.



#### > Running Costs/Savings: -

> Biomass fuel is more expensive than gas and as such heat being provided to dwellings is generally more expensive than alternatives.

#### > Land Use Issues and Space Required: -

- > Biomass boilers require a plant room and possibly separate energy centre for large residential developments.
- > Require a flue to effectively disperse pollutants. This is best to rise to a minimum of 2m above the roofline of the tallest building. Additionally the absorption chiller requires either a cooling tower or dry cooler bed for heat rejection purposes.
- > Fuel store will be required. This should be maximised to reduce fuel delivery frequency.
- > Space must be available for delivery vehicle to park close to plant room.
- > Route for district heating pipe around the site must be safeguarded.

#### > Operational Impacts/Issues: -

- > Normally run on biomass, but can also work with biogas.
- > Require some operational support and maintenance.
- > Fuel deliveries required.
- > Boiler and fuel store must be sited in proximity to space for delivery vehicle to park.
- > Issues with rights to dig up roads, etc (for heat networks).
- > Emissions of oxides of nitrogen ~80-100mg/kWh.
- > Emissions of particulate matter. To minimise this ceramic filter systems are required.
- > Embodied Energy: Comparable to conventional gas boiler.

#### > Funding Opportunities: -

- > Renewable Heat Incentive (RHI) provides incentive funds to developers of small or medium installations with a reasonable heat load that meet a minimum energy efficiency standard & meet the RHI eligibility criteria.
- > Reductions in Energy Achievable: No reduction in energy demand, but energy generated from a renewable fuel. Significant long term running costs (fuel).
- > Reductions in CO<sub>2</sub> Achievable: Can provide significant reductions in CO<sub>2</sub>, but generally limited by the hot water load (base heating load).
- > Advantages: Reductions in CO<sub>2</sub> at low installed cost.

#### > Disadvantages: -

- > High long-term running costs, unless receiving RHI.
- > Often do not supply energy cost-effectively in comparison to gas boilers.

#### 5. SOLAR THERMAL PANELS

> Solar Thermal Heating Systems contribute to the hot water demand of a dwelling or building. Water or glycol (heat transfer fluid) is circulated to roof level where it is heated using solar energy before being returned to a thermal store in the plant room where heat is exchanged with water from the conventional system. Due to the seasonal availability of heat, solar thermal panels should be scaled to provide no more than 1/2 of the hot water load.

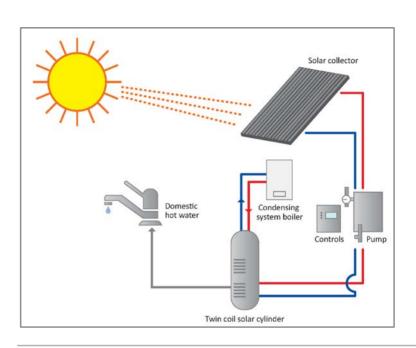


Diagram 2 - Solar Thermal System

- > Can also be used to provide energy for space heating in highly insulated dwellings.
- > There are two types of solar thermal panel: evacuated tube collectors and flat plate collectors.

#### > Performance and Calculation Methodology: -

- > Evacuated Tube Collectors: ~60% efficiency.
- > Flat Plate Collectors: ~50% efficiency.
- > SAP Table H2 used for solar irradiation at different angles.



- > Operate best on south facing roofs angled at 30-450 and free of shading, or on flat roofs on frames. East/West facing panels suffer a loss in performance of 15-20% depending on the angle of installation.
- > Flat plate collectors cannot be installed horizontally as this would prevent operation of the water pump. Must therefore be angled and separated to avoid overshadowing each other.
- > **Capital Cost:** Typically £2,500 per 4m<sup>2</sup> plus installation. Costs higher for evacuated tubes than flat plate collectors.
- > Running Costs/Savings: -
  - > Reduce reliance on gas and therefore reduce costs.
  - > Payback period of ~20 years per dwelling.
- > Land Use Issues and Space Required: -
  - > Installed on roof so no impact on land use.
  - > Requires hot water cylinders in dwellings.
  - > Due to amount of roof space required and distance from tank to panels, less suitable for dense developments of relatively high rise flats.
  - > Within permitted development rights unless in a conservation area where they must not be visible from the public highways.
  - > Dormer and Velux windows may conflict if energy/CO<sub>2</sub> reduction required is large.
- > **Operational Impacts/Issues:** Biggest reductions achieved by people who operate their hot water system with consideration of the panels.
  - > Embodied Energy: Carbon payback is ~2 years.
  - > Funding Opportunities: none
- > **Reductions in Energy Achievable:** Reduce primary energy demand by more per standard panel area than solar PV panels.
  - > Reductions in CO<sub>2</sub> Achievable: Comparable to solar PV per m<sup>2</sup>.
- > **Advantages: -** Virtually free fuel, low maintenance and reductions in energy/CO<sub>2</sub>.
- > **Disadvantages:** Benefits limited to maximum ~50% of hot water load.
  - > Higher Costs in comparison to PV
- > **Application: -** Best suited for small to medium housing developments ~1-100

## 6. SOLAR PHOTOVOLTAIC (PV) PANELS

> Solar PV panels generate electricity by harnessing the power of the sun. They convert solar radiation into electricity which can be used on site or exported to the grid in times of excess generation.

#### > Performance and Calculation Methodology: -

- > The best PV panels operate with an efficiency approaching 20%. ~7m<sup>2</sup> of these high performance panels will produce 1kWp of electricity.
- > Operate best on south facing roofs angled at 30-450 or on flat roofs on frames. Panels orientated east/west suffer from a loss in performance of 15-20% depending on the angle of installation.
- > Must be free of any potential shading.
- > Cannot be installed horizontally as would prevent self-cleaning. Must therefore be angled and separated to avoid overshadowing each other.
- > Electricity produced displaces grid electricity which has a carbon intensity of 0.519 kg CO<sub>2</sub> per kWh.
- > Capital Cost: ~£2,000 per kWp.

#### > Running Costs/Savings: -

- > Reduce reliance on grid electricity and therefore reduce running costs.
- > At current electricity prices, payback period of ~60-70 years per dwelling.
- > Feed-in tariff and Renewables Obligation Certificates (ROCs) payments required for maximum financial benefit.

#### > Land Use Issues and Space Required: -

- > Installed on roof so no impact on land use.
- > Due to amount of roof space required are less suitable for dense developments of relatively high rise flats.
- > Within permitted development rights unless in a conservation area where they must not be visible from the public highways.
- > Dormer and Velux windows may conflict if energy/CO<sub>2</sub> reduction required is large.

#### > Operational Impacts/Issues: -

> Proportionately large arrays may need electrical infrastructure upgrade.



- > Virtually maintenance free and panels are self-cleaning at angles in excess of 10 degrees.
- > Provision for access to solar panels installed on flat roofs needs to be incorporated into the design of PV arrays layout as well as inclusion of spaces for inverters within the development.
- > Quality of PV panels varies dramatically.
- > **Embodied Energy: -** Carbon payback of 2-5 years.
- > Funding Opportunities: Financier utilising Feed-in-Tariffs.
- > **Reductions in Energy Achievable:** Reduce energy demand by less per m<sup>2</sup> than solar thermal panels.
- > Reductions in CO<sub>2</sub> Achievable: Provide greater percentage reductions in CO<sub>2</sub> than energy. Comparable to solar thermal per square metre.
- > Advantages: Virtually free fuel, very low maintenance and good reductions in CO<sub>2</sub>.
  - > Cheaper in comparison to solar thermal panels.
- > Disadvantages: -
  - > Slightly greater loss in performance than solar thermal panels when orientated away from south.
- > **Application:** Best suited for a variety of developments from single houses to multi apartment blocks and even whole estates.

## 7. GROUND SOURCE HEAT PUMPS (GSHPS)

> Ground Source Heat Pumps work in much the same way as a refrigerator, converting low grade heat from a large 'reservoir' into higher temperature heat for input in a smaller space. Electricity drives the pump which circulates a fluid (water/antifreeze mix or refrigerant) through a closed loop of underground pipe. This fluid absorbs the solar

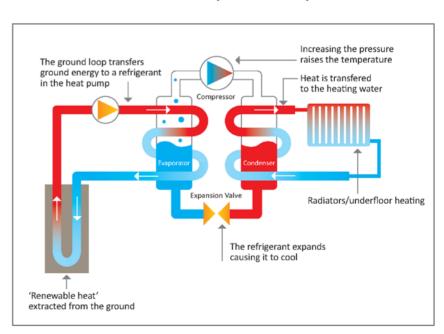


Diagram 3 - Ground Source Heat Pump

energy that is stored in the earth (which in the UK remains at a near constant temperature of 12oC throughout the year) and carries it to a pump. A compressor in the heat pump upgrades the temperature of the fluid which can then be used for space heating and hot water.

#### > Performance and Calculation Methodology: -

- > System requires electricity to drive the pump. Therefore displaces gas heating with electric, which has higher carbon intensity (gas: 0.216; electricity: 0.519).
- > As they are upgrading heat energy from the earth, GSHPs operate at 'efficiencies' in excess of 350%. This is limited in SAP unless Appendix Q rated model used.
- > Due to the lower temperature of the output of GSHPs compared to traditional gas boilers, GSHPs work best in well insulated buildings and with underfloor heating. They can, however, also be installed with oversized radiators, albeit with a consequent reduction in performance.
- > **Capital Cost:** ~£7,500 per house. Additional costs if underfloor heating is to be installed.

#### > Running Costs/Savings: -

- > Electricity more expensive than gas, thus fuel costs not reduced as much as energy is reduced.
- > Payback period of ~20 years per dwelling.

#### > Land Use Issues and Space Required: -

- > Require extensive ground works to bury the coils that extract the low grade heat from the earth. They therefore require a large area for horizontal burial (40-100m long trench) or a vertical bore (50-100m) which is considerably more expensive but can be used where space is limited.
- > Best suited to new developments that have provision for large ground works already in place, to minimise ground work costs.
- > Must be sized correctly to prevent freezing of the ground during winter and consequent shutdown of the system.
- > May require planning permission for engineering works. Once buried, there is no external evidence of the GSHPs.

#### > Operational Impacts/Issues: -

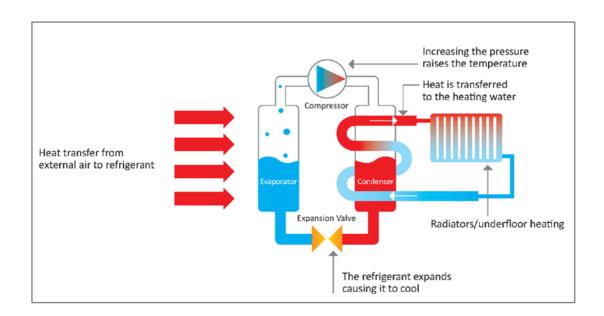
- > Work best in well insulated houses.
- > Need immersion backup for hot water.



- > Highly reliable and require virtually no maintenance.
- > Problems if ground bore fails.
- > **Embodied Energy:** Low, but as gas is being replaced with the more carbon intensive electricity, carbon payback is slowed. Carbon payback depends on CoP.
- > **Funding Opportunities:** Renewable Heat Incentive (RHI) provides incentive funds to developers of small or medium installations with a reasonable heat load that meet a minimum energy efficiency standard & meet the RHI eligibility criteria.
- > **Reductions in Energy Achievable:** Reduce energy demand by less per m<sup>2</sup> than solar thermal panels.
- > **Reductions in CO<sub>2</sub> Achievable:** Provide greater %age reductions in CO<sub>2</sub> than energy. Comparable to solar thermal (esp. in SAP).
- > **Advantages:** Large reductions in Energy. Currently receives benefit from SAP of an electrical baseline rather than gas.
- > Disadvantages: -
  - > Small reduction in CO<sub>2</sub>. CoP limited in SAP. Only small cost savings.
  - > GSHPs are not entirely a 'renewable' technology as they require electricity to drive their pumps or compressors.
- > Application: Best suited for small to medium developments ~1-100

### 8. AIR SOURCE HEAT PUMPS (ASHPS)

> Air Source Heat Pumps work in much the same way as a refrigerator, converting low grade heat from a large 'reservoir' into higher temperature heat for input into a smaller space. Electricity drives the pump which extracts heat from the air as it flows over the coils in the heat pump unit. A compressor in the heat pump upgrades the temperature of the extracted energy which can then be used for space heating and hot water.



> Generally ASHPs are air-to-water devices but can also be air-to-air.

#### > Performance and Calculation Methodology: -

- > System requires electricity to drive the pump. Therefore displaces gas heating with electric, which has higher carbon intensity (gas: 0.216; electricity: 0.519).
- > Performance defined by the Coefficient of Performance (CoP) which is a measure of electricity input to heat output. However, the concept of a CoP must be treated with caution as it is an instantaneous measurement and does not take account of varying external conditions throughout the year.
- > As they are upgrading heat energy from the air, ASHPs operate at 'efficiencies' in excess of 250%. This is limited in SAP unless an Appendix Q rated model is used.
- > British winter conditions (low temperatures and high humidity) lead to freezing of external unit. Reverse cycling defrosts the ASHP, but can substantially reduce performance when it is most needed. Performance under these conditions varies considerably between models. Vital that ASHP that has been proven in British winter conditions is installed.
- > Due to the lower temperature of the output of ASHPs compared to traditional gas boilers, ASHPs work best in well insulated buildings and with underfloor heating. They can, however, also be installed with oversized radiators, albeit with a consequent reduction in performance.
- > **Capital Cost: -** ~£2,000 per house.

#### > Running Costs/Savings: -

- > Electricity more expensive than gas, thus fuel costs not reduced as much as energy is reduced.
- > Payback period of ~10 years per dwelling.

#### > Land Use Issues and Space Required: -

- > No need for external ground works, only a heat pump unit for the air to pass through.
- > Minimal external visual evidence.

#### > Operational Impacts/Issues: -

- > Work best in well insulated houses.
- > Unit must be sized correctly for each dwelling.
- > Vital that ASHP model selected has been proven to maintain performance at the low temperature and high humidity conditions of the British winter.



- > May need immersion backup for hot water.
- > Highly reliable and require virtually no maintenance.
- > Noise from ASHPs must be below 42 dB at a position one metre external to the centre point of any door or window in a habitable room. According to planning standards MCS020.
- > **Embodied Energy:** Low. Carbon payback longer than for GSHPs as the CoP is lower.
- > **Funding Opportunities:** Renewable Heat Incentive (RHI) provides incentive funds to developers of small or medium installations with a reasonable heat load that meet a minimum energy efficiency standard & meet the RHI eligibility criteria.
- > **Reductions in Energy Achievable: -** Large reductions in energy demand. Less so than GSHPs.
- > Reductions in CO<sub>2</sub> Achievable: Provide smaller percentage reductions in CO<sub>2</sub> than energy. Less than GSHPs.
- > **Advantages:** Large reductions in Energy. Currently receives benefit from SAP of an electrical fuel factor rather than a gas baseline.
- > Disadvantages: -
  - > Small reduction in CO<sub>2</sub> CoP limited in SAP. Only small cost savings.
  - > ASHPs are not entirely a 'renewable' technology as they require electricity to drive their pumps or compressors.
- > **Application: -** Best suited for small to medium developments ~1-100

#### 9. WIND POWER

- > Wind energy installations can range from small domestic turbines (1kW) to large commercial turbines (140m tall, 2MW). There are also different designs and styles (horizontal or vertical axis; 1 blade to multiple blades) to suit the location. They generate clean electricity that can be provided for use on-site, or sold directly to the local electricity network
- > Performance and Calculation Methodology: -
  - > Power generated is proportional to the cube of the wind speed. Therefore, wind speed is critical.
  - > Horizontal axis turbines require >~6m/s to operate effectively and vertical axis turbines require >~4.5m/s. The rated power of a turbine is often for wind speeds double these figures.
  - > Wind speeds for area from BERR's Wind Speed Database.
  - > Electricity produced displaces grid electricity which has a carbon intensity of 0.568 kg/kWh.

#### > Capital Cost: -

- > ~£1,000 per kW. Smaller models are more expensive per kW.
- > Vertical axis turbines more expensive than horizontal.

#### > Running Costs/Savings: -

- > Reduce reliance on grid electricity and therefore reduce costs.
- > Payback period of ~15-20 years per dwelling.
- > Feed-in tariff and ROC payments required for maximum financial benefit.

#### > Land Use Issues and Space Required: -

- > Smaller models (<6kW) can be roof mounted.
- > Must be higher than surrounding structures/trees.
- > Planning permission required.

#### > Operational Impacts/Issues: -

- > Urban environments generally have low wind speeds and high turbulence which reduce the effectiveness of turbines.
- > Vertical axis turbines have a lower performance than horizontal axis turbines but work better in urban environments.
- > Annual services required.
- > Turbines rated in excess of 5kW may require the network to be strengthened and arrangements to be made with the local Distribution Network Operator and electricity supplier.
- > Noise.
- > **Embodied Energy:** Carbon payback is ~1 year for most turbines.
- > Funding Opportunities: Financier utilising Feed-in-Tariffs.
- > **Reductions in Energy Achievable:** Significant reduction in reliance on grid electricity.
- > **Reductions in CO<sub>2</sub> Achievable: -** Good. Greater reduction in CO<sub>2</sub> than PV for same investment.
- > **Advantages:** Virtually free fuel; reductions in CO<sub>2</sub>.
- > Disadvantages: -
  - > Expensive, although cheaper than PV for same return.
  - > Lack of suitable sites.



- > Maintenance costs.
- > Often not building integrated.
- > Application: Best suited for small to large developments in rural open areas

#### **10.HYDRO POWER**

> Hydro power harnesses the energy of falling water, converting the potential or kinetic energy of water into electricity through use of a hydro turbine. Micro hydro schemes (<100kW) tend to be 'run-of-river' developments, taking the flow of the river that is available at any given time and not relying on a reservoir of stored water. They generate clean electricity that can be provided for use on-site, or sold directly to the local electricity network.

#### > Performance and Calculation Methodology: -

- > Flow rates at particular sites from National River Flow Archive held by Centre for Ecology and Hydrology.
- > Electricity produced displaces grid electricity which has a carbon intensity of 0.568 kg/kWh.

#### > Capital Cost: -

- > £3,000 £5,000 per kW.
- > Particularly cost effective on sites of old water mills where much of the infrastructure is in place.

#### > Running Costs/Savings: -

- > Reduce reliance on grid electricity and therefore reduce costs.
- > Payback period of ~10-15 years per dwelling
- > Feed-in tariff and ROC payments required for maximum financial benefit.

#### > Land Use Issues and Space Required: -

- > Require suitable water resource.
- > Visual intrusion of scheme.
- > Special requirements where river populated by migrating species of fish.
- > Planning permission will require various consents and licences including an Environmental Statement and Abstraction Licence.

#### > Operational Impacts/Issues: -

- > Routine inspections and annual service required.
- > Automatic cleaners should be installed to prevent intake of rubbish.
- > **Embodied Energy:** Carbon payback for small schemes of ~1 year.

- > **Funding Opportunities: -** Financier utilising Feed-in-Tariffs.
- > **Reductions in Energy Achievable:** significant reduction in reliance on grid electricity.
- > Reductions in CO<sub>2</sub> Achievable: High.
- > Advantages: Virtually free fuel, reductions in CO<sub>2</sub>.
- > Disadvantages: -
  - > Expensive, but good payback period.
  - > Lack of suitable sites.
  - > Planning obstructions.
- > **Application:** Best suited to medium to larger developments in rural places ~ 100+ units

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## **Appendix F**

SAP 2012 PV Calculation and indicative layout

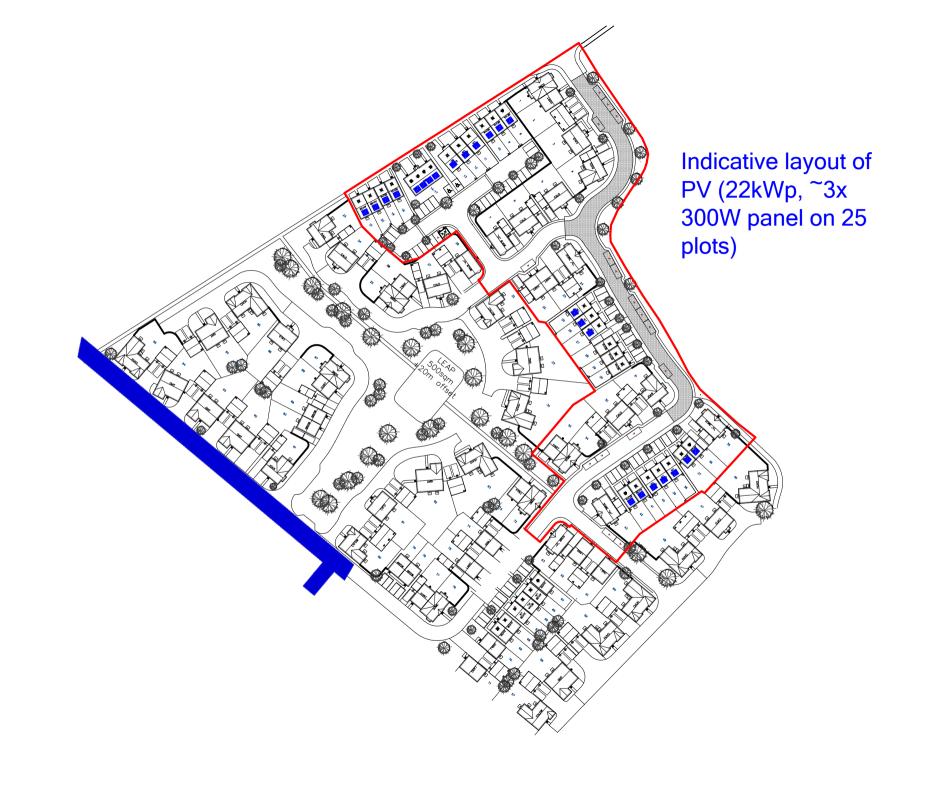


#### Photovoltaic Generation

PV Array 1 (south-east)			
Required Roof Area	128 m <sup>2</sup>	Peak Power Output	16.00 kWp
Overshading	None	Solar Radiation	1,029 kWh/m²
Angle from North	135 °	Energy Generation	13,174 kWh/year
Pitch from Horizontal	30 °	CO <sub>2</sub> Emissions Offset	6,837 kg CO₂/year

PV Array 2 (south-west)						
Required Roof Area	48 m <sup>2</sup>	Peak Power Output	6.00 kWp			
Overshading	None	Solar Radiation	1,029 kWh/m²			
Angle from North	225 °	Energy Generation	4,940 kWh/year			
Pitch from Horizontal	30 °	CO <sub>2</sub> Emissions Offset	2,564 kg CO₂/year			





## **Oxford Road, Bodicote**Crest Nicholson Midlands

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## **Appendix G**

CO<sub>2</sub> Calculations Summary Sheet (With PV)



#### CO <sub>2</sub> Emissions at Low Carbon and Renewable Technologies Stage

		<u>Individual</u>			<u>To</u>	<u>tal</u>		
		Dwelling	Target Emissions			Dwelling	Target Emissions	Emissions Rate
Unit Type Description	Unit Floor Area	Emissions Rate	Rate	Number of Units	Total Floor Area	Emissions Rate	Rate	Improvement
Domestic	m <sup>2</sup>	kg CO <sup>2</sup> /m <sup>2</sup> /year	kg CO <sup>2</sup> /m <sup>2</sup> /year		m <sup>2</sup>	kg CO²/year	kg CO²/year	-
Somerton (semi-detached)	94	17.0	17.9	2	188	3,198	3,372	5.2%
Radley (detached)	152	15.8	16.2	2	304	4,804	4,921	2.4%
Walberswick (detached)	115	16.9	17.0	1	115	1,941	1,947	0.3%
1 bed ground floor appartment	44	20.1	22.3	2	87	1,753	1,944	9.8%
1 bed top floor appartment	55	17.8	20.0	2	110	1,960	2,198	10.8%
HA 2-bed (semi-detached/end-terrace)	78	17.3	18.3	12	938	16,277	17,205	5.4%
HA 3-bed (semi-detached/end-terrace)	93	17.0	17.9	4	370	6,278	6,618	5.1%
Hartly (semi-detached)	93	16.5	17.4	4	372	6,122	6,477	5.5%
Somerton (detached)	94	18.2	19.0	3	282	5,145	5,358	4.0%
HA 2/3-bed (mid-terrace)	78	16.1	17.5	7	547	8,793	9,562	8.0%
Calderwick (detached)	138	15.0	16.2	4	551	8,284	8,894	6.9%
				Total CO <sub>2</sub> Emis	sions Offset by PV	9,401		
			Total for All Units		3,865	55,155	68,497	19.5%



**Oxford Road, Bodicote**Crest Nicholson Midlands

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## **Appendix H**

Water Efficiency Calculator





## Water Efficiency Calculator (Internal: 105 litres/person/day) Oxford Road, Bodicote

	Internal Water Consumption						
Installation Type	Unit of Measure	Capacity / Flow Rate	Litres/person/day	Notes			
We	Full Flush Volume (Litres)	6	8.76	Low flush WCs will be installed to reduce the volume of water consumed during flushing. All			
WC	Part Flush Volume (Litres)	4	11.84	WCs will have dual flush cisterns which will provide both part (4L) and full (6L) flushes.			
Bath	Capacity (Litres to overflow)	160	17.60	All baths will have reduced capacities of 150 litres (excluding displacement). The bath taps are not included in this calculation as they are already incorporated into the use factor for the baths.			
Shower	Flow Rate (Litres/min)	8	34.96	Shower flow rates will be reduced to 8 litres/minute using flow restrictors fixed to the shower heads. These contain precision-made holes or filters to restrict water flow and reduce the outlet flow and pressure.			
Kitchen Tap	Flow Rate (Litres/min)	5	12.12	Kitchen taps will be reduced to 4 litres/minute using flow restrictors which will be fitted within the console of the tap or in the pipework.			
Basin Tap	Flow Rate (Litres/min)	4	7.90	All taps (excluding kitchen taps) will be reduced to 3 litres/minute using flow restrictors.  Where multiple taps are to be provided the average flow rate will be used.			
Washing Machine	Water Consumption (Litres/kg)	8.17	17.16	Water efficient washing machines or washer-dryers will be specified. The make and model numbers of the appliances are unknown at this stage therefore a default figure of 8.17 litres/kg has been assumed.			
Dishwasher	Water Consumption (Litres/place setting)	1.25	4.50	All dishwashers will be water efficient. The make and models numbers are unknown therefore a default figure of 1.25 litres/place setting has been assumed at this stage.			
		ter Consumption tres/person/day)	114.8				
Normalisation Factor		0.91					
		ter Consumption (tres/person/day)	104.5	The internal water consumption target of ≤105 litres/person/day will be achieved.			