



#### **Energy Statement**

Warmhaze Ltd.

# 17-27 & 25 Ferdinand Street

Final

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#### **Executive Summary**

The Energy Strategy for the proposed development at 17-27 and 25 Ferdinand Street by Warmhaze Ltd in the London Borough of Camden has been formulated following the London Plan Energy Hierarchy: Be Lean, Be Clean and Be Green. The overriding objective in the formulation of the strategy is to maximise the reductions in  $CO_2$  emissions through the application of this Hierarchy with a cost-effective, viable and technically appropriate approach and to minimise the emission of other pollutants.

The Energy Strategy for the Proposed Development has been formulated following the London Plan Energy Hierarchy: Be Lean, Be Clean and Be Green. The overriding objective in the formulation of the strategy is to maximise the reductions in CO<sub>2</sub> emissions through the application of this Hierarchy with a cost-effective, viable and technically appropriate approach and to minimise the emission of other pollutants.

The Site will be built under Part L 2013 of the Building Regulations; therefore, in line with the London Plan, will target a 35% CO<sub>2</sub> reduction over the Part L 2013 baseline.

A range of advanced **Be Lean** energy efficiency measures are proposed. They enable the proposed development to exceed Part L1A 2013 Target Emission Rate (TER) and Target Fabric Energy Efficiency (TFEE) minimum standards for the residential aspect of the development through energy efficiency measures alone. A site-wide 4% and 2% reduction in regulated and total CO<sub>2</sub> emissions respectively is predicted over the Part L 2013 baseline. This represents a high level of sustainable design and construction.

In line with the London Plan, the feasibility of decentralised energy production as a **Be Clean** measure has been assessed. There are currently no existing or proposed district heat networks in the area. It has been concluded that a communal heating strategy is inappropriate for a development of this size as it would substantially increase capital costs and operational costs (and resident energy bills).

The full spectrum of **Be Green** renewable energy generating technologies has been considered. PV panels are considered the most appropriate but conflicts with the proposed green roofs on the development which are a Camden council preference. The applicant has therefore explored two scenarios:

- > Scenario 1: Green Roofs and Carbon Offsetting Payment (no solar PV) The overall energy strategy measures employed (Be Lean only) will result in a 4% reduction in regulated CO<sub>2</sub> emissions and 2% reduction in total (including unregulated) CO<sub>2</sub> emissions over the Part L 2013 baseline. A carbon offsetting cost of £13,853 will therefore be paid to Camden Borough Council. This strategy complies with the London Plan, Code for Sustainable Homes Level 3 mandatory energy credits and Camden Borough Council policies.
- > Scenario 2: Solar PV but No Green Roofs 16.5kWp solar PV will be installed instead of green roofs to achieve an estimated further regulated and total CO<sub>2</sub> emission reduction of **32%** and **16%** after **Be Lean** emissions. The combination of **Be Lean** and **Be Green** measures will result in a **35%** reduction in regulated CO<sub>2</sub> emissions and **18%** reduction in total (including unregulated) CO<sub>2</sub>



emissions over the Part L 2013 baseline. This strategy complies with the London Plan, Code for Sustainable Homes Level 4 mandatory energy credits and Camden Borough Council policies.

The applicant seeks guidance from Camden Borough Council on which strategy they would favour taking forward.

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## **1. INTRODUCTION**

- 1.1 This Energy Statement has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development, appointed by Warmhaze Ltd (hereafter referred to as 'the Applicant'). This Statement sets out the energy strategy for the proposed development at 17-27 and 25 Ferdinand Street in the London Borough of Camden.
- **1.2** The formulation of the energy strategy for the Proposed Development takes into account several important concerns and priorities. These include:
  - > To achieve the maximum viable reduction in carbon dioxide (CO<sub>2</sub>) emissions through the application of the London Plan Energy Hierarchy with an affordable, deliverable and technically appropriate strategy;
  - > Provision of high quality low energy homes that are adapted to future changes in climate.
- **1.3** This statement first establishes a baseline assessment of the energy demands and associated CO<sub>2</sub> emissions for the Proposed Development based on Building Regulations (2013). The report will then follow The London Plan Energy Hierarchy approach of **Be Lean**, **Be Clean** and **Be Green** to enable the maximum viable reductions in Regulated and Total CO<sub>2</sub> emissions over the baseline.

### 2. DEVELOPMENT PROPOSALS

2.1 The site is located in the London Borough of Camden on Ferdinand Street to the north of Chalk Farm Road as illustrated in Figure 1.





**Figure 1: Site Location** 

## **Background Information**

**2.2** The application site was subject to a previous planning application, reference 2012/4782/P which proposed the following:

Erection of an additional 4<sup>th</sup> and 5<sup>th</sup> floor, erection of a 5 storey extension to courtyard (west) elevation and erection of a single storey extension to east elevation all at 17 and 27 Ferdinand Street, and redevelopment of 25 Ferdinand Street to create a 5 storey building, to provide 9 residential units (Class C3) (2 x 1-bed, 4 x 2-bed, 2 x 3-bed, 1 x 4-bed) and office space (Class B1), including an external terraced area at 5<sup>th</sup> floor level, creation of green roof, and associated alterations.

2.3 In terms of sustainability the application targeted Code for Sustainable Homes Level 3 for the residential units and BREEAM Very Good for the office space. The application was approved in December 2012.

## **Development Proposal**

- **2.4** The proposal consists of the redevelopment of the existing site to provide 20 new residential apartments. It includes outdoor space, cycle parking provision, refuse and recycling storage areas and a green roof.
- **2.5** The built form of the proposed development matches that of the previous application for this site (application reference 2012/4782/P). The predominant change is the alteration to a completely residential use throughout the site to provide the 20 proposed apartments.

## 3. PLANNING POLICIES & DEVELOPMENT REQUIREMENTS

**3.1** The following planning policies and requirements will inform the Energy and Sustainability Strategy for the proposed development.

## **National Planning Policy**

**3.2** The National Planning Policy Framework (NPPF) was published on 27 March 2012. This document sets the overarching policies for development in England and states that:

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

For decision-taking this means:

- > Approving development proposals that accord with the development plan without delay; and
- > Where the development plan is absent, silent or relevant policies are out-of-date, granting permission unless:
- > Any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in this Framework taken as a whole; or
- > Specific policies in this Framework indicate development should be restricted."
- **3.3** Paragraph 95 of the NPPF states that:



"To support the move to a low carbon future, local planning authorities should:

- > Plan for new development in locations and ways which reduce greenhouse gas emissions;
- > Actively support energy efficiency improvements to existing buildings; and
- > When setting any local requirement for a building's sustainability, do so in a way consistent with the Government's zero carbon buildings policy and adopt nationally described standards."
- **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.

## **Regional Policy**

- **3.5 The London Plan (July 2011)** sets out an integrated economic, environmental, transport and social framework for the development of London over the next 20 25 years. On 11 October 2013, the Mayor published Revised Early Minor Alterations to the London Plan (REMA). From this date, the REMA are operative as formal alterations to the London Plan (the Mayor's spatial development strategy) and form part of the development plan for Greater London.
- **3.6** The following outlines key policies set out in the London Plan which must be addressed by new developments and which are relevant to the Proposed Development.
- **3.7 Policy 5.2 Minimising Carbon Dioxide Emissions** requires that all residential buildings between 2013 2016 achieve a 40% improvement on 2010 Building Regulations. The London Plan Sustainable Design and Construction SPG (2014) updates this target stating that the Mayor will adopt a carbon dioxide improvement target beyond Part L 2013 of 35%.
- **3.8 Policy 5.3 Sustainable Design and Construction** states that the highest standards of sustainable design and construction should be achieved in London to improve the environmental performance of new developments. Major development should meet the minimum standards outlined in the London Plan Supplementary Planning Guidance and this should be clearly demonstrated. The standards include the following sustainable design principles (summarised):
  - > Minimising CO<sub>2</sub> emissions;
  - > Avoiding internal overheating and contributing to the urban heat island effect;
  - > Efficient use of natural resources (including water);

- > Minimising pollution (including noise, air and urban run-off);
- > Minimising the generation of waste and maximising reuse and recycling;
- > Avoiding impacts from natural hazards (including flooding);
- > Ensuring developments are comfortable and secure for users;
- > Securing sustainable procurement of materials, using local suppliers where feasible; and
- > Promoting and protecting biodiversity and green infrastructure.
- **3.9 Policy 5.5 Decentralised Energy Networks** states that the Mayor expects 25 per cent of the heat and power used in London to be generated through the use of localised decentralised energy systems by 2025. The Mayor will prioritise the development of decentralised heating and cooling networks at the development and area wide levels, including larger scale heat transmission networks.
- **3.10 Policy 5.6 Decentralised Energy** requires that all developments should evaluate the feasibility of Combined Heat and Power (CHP) systems, and examine the opportunities to extend the system beyond the site boundary to adjacent sites.
- **3.11 Policy 5.7 Renewable Energy** states that within the framework of the energy hierarchy, major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.
- **3.12 Policy 5.8 Innovative Energy Technologies** encourages the more widespread use of innovative energy technologies to reduce use of fossil fuels and carbon dioxide emissions.
- **3.13 Policy 5.9 Overheating and Cooling** seeks to reduce the impact of the urban heat island effect, reduce potential overheating and reduce reliance on air conditioning systems.
- **3.14 Policy 5.10 Urban Greening** encourages new planting in the public realm (including streets, squares and plazas) and green infrastructure, to contribute to the adaptation to, and mitigation of, the effects of climate change.
- **3.15** The London Plan Supplementary Planning Guidance Sustainable Design and Construction (2014) includes relevant energy guidance on:
  - > Energy efficient design;
  - > Meeting carbon dioxide reduction targets;
  - > Decentralised energy;



- > How to off-set carbon dioxide where the targets set out in the London Plan are not met;
- > Retro-fitting measures;
- > Support for monitoring energy use during occupation.
- **3.16** Each section of the Supplementary Planning Guidance sets out the Mayor's priorities for the particular topic area, which the Mayor seeks developers to address in all development proposals. Some sections also contain best practice ambitions, which the Mayor strongly encourages be delivered in appropriate developments. To support these approaches, the Supplementary Planning Guidance includes detailed guidance for boroughs and developers, signposts to further information and best practice examples.
- **3.17** The London Housing Supplementary Planning Guidance (2012) states that designers should seek to achieve a minimum of Level 4 of the Code for Sustainable Homes in all new development.

### **Local Policy: The London Borough of Camden**

#### **Core Strategy**

- **3.18** The Camden Core Strategy was adopted in November 2010. The following policies are considered to be pertinent to this Statement:
- **3.19** Policy CS13 Tackling climate change through promoting higher environmental standards: The Council will require all development to take measures to minimise the effects of, and adapt to, climate change and encourage all development to meet the highest feasible environmental standards that are financially viable during construction and occupation by:
  - Ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;
  - > Promoting the efficient use of land and buildings;
  - > Minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the following energy hierarchy: Ensuring developments use less energy; making use of energy from efficient sources; generating renewable energy on-site;
  - > Ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change.

**3.20** The Council will promote local energy generation and networks by working with partners and developers to implement local energy networks and protecting existing local energy networks where possible.

#### **Development Policies**

- **3.21** Camden's Development Policies were adopted in November 2010. The following policies are considered to be pertinent to this Statement:
- **3.22** The Council will promote and measure sustainable design and construction by:
  - Expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 and Code Level
    4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016;
  - Expecting developments (except new build) of 500sqm of residential floorspace or above or 5 or more dwellings to achieve 'Very Good' in EcoHomes assessments prior to 2013 and encouraging 'Excellent' from 2013.
- **3.23** The Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures such as:
  - > Summer shading and planting;
  - > Limiting run-off;
  - > Reducing water consumption;
  - > Reducing air pollution; and
  - > Not locating vulnerable uses in basements in flood-prone areas.

#### **Camden Policy Guidance - Sustainability**

- 3.24 This Policy Guidance document has been prepared by Camden to support the adopted Core Strategy and Development Policies. This Policy Guidance was last updated in September 2013. Relevant guidance within this document considered pertinent to this Statement includes the following:
  - > All developments are expected to reduce their carbon dioxide emissions by following the steps in the energy hierarchy, Be Lean, Be Clean, Be Green, to reduce energy consumption;



- > Developments are to target a 20% reduction in carbon dioxide emissions from on-site renewable energy technologies unless it can be demonstrated that such provision is not feasible;
- > The performance of water minimisation measures will be assessed against the water category in the Code for Sustainable Homes assessment;
- > Prioritise the reduction, re-use and recycling of materials and sourcing materials responsibly;
- > Code for Sustainable Homes Level 4 should be achieved (2013-2015) achieving 50% of the credits available in the Energy, Water and Materials categories;
- > EcoHomes 'Excellent' should be achieved (2013+) achieving 60% of the credits available in the Energy and Water categories and 40% of the available credits in the Materials category;
- > Green and brown roofs should be incorporated;
- > Drainage and surface water should be managed on-site using Sustainable Drainage Systems (SUDS);
- > Biodiversity considerations should be incorporated into the development.

#### **Summary of Targets**

- 3.25 The following policies will be addressed in this Energy Statement:
  - > London Plan (2011), London Borough of Camden Policy CS13 (2010), and further Camden Sustainability Policy Guidance (2013): Application of the energy hierarchy;
  - > London Plan (2011) Policy 5.2: Reduce Regulated CO<sub>2</sub> emissions by 35% over 2013 Part L baseline;
  - > London Borough of Camden Development Policies (2010): Code for Sustainable Homes Level 4;
  - > London Borough of Camden Sustainability Policy Guidance (2013): 20% reduction in carbon dioxide emissions from on-site renewable energy technologies unless it can be demonstrated that such provision is not feasible.

## 4. BUILDING REGULATIONS PART L 2013 BASELINE

#### Methodology

- In line with London Plan policy, this statement first establishes a baseline assessment of the energy demands and associated CO<sub>2</sub> emissions for the Proposed Development based on Building Regulations (2013). The report will then follow The London Plan Energy Hierarchy approach of **Be** Lean, Be Clean and Be Green to enable the maximum viable reductions in Regulated and Total CO<sub>2</sub> emissions over the baseline.
- **4.2** The estimated annual energy demand for the residential portion of 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. The unregulated energy demands for appliances and cooking are taken from BRE occupancy based calculations.

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

**4.3** The Building Regulations compliant baseline is calculated using the dwelling TER. Table 1 below shows the 2013 Building Regulations compliant Regulated & Total CO<sub>2</sub> emissions for whole site. These are shown in greater detail in Appendix B.

Table 1: Building Regulations Part L 2013 Baseline						
	Regulated CO <sub>2</sub> (kg/yr)	Total CO <sub>2</sub> (kg/yr)				
Building Regulations (2013) Baseline	24,702	48,338				



## 5. BE LEAN: ENERGY EFFICIENCY MEASURES

**5.1** In line with the London Plan Energy Hierarchy, the following energy efficient, **Be Lean** measures are proposed to be applied to the Proposed Development. These measures will ensure that the required reduction in CO<sub>2</sub> emissions is met partly through energy efficiency.

#### **Insulation Standards**

**5.2** The new build 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 Building Regulations. These are likely to include:

Element	Value	Description
Wall U-Value	0.16 W/m <sup>2</sup> K	Approx. 400mm wall.
Curtain Wall Average U-Value (top floor only)	0.80 W/m²K	Includes glazing and opaque system.
Ground Floor U-Value	0.10 W/m <sup>2</sup> K	TBC
Roof U-Value	0.10 W/m <sup>2</sup> K	ТВС
Glazing U-Value	0.90 W/m <sup>2</sup> K	Triple glazing (necessary for TFEE).
Glazing G-Value	General: 0.50 Penthouses: 0.30	For overheating mitigation.
Thermal Bridging	0.15 W/mK	Default value assumed.
Air Permeability	3.0 m <sup>3</sup> /hr/m <sup>2</sup>	Necessary for TFEE.

#### **Air Tightness and Ventilation**

- 5.3 In order to ensure sufficient fresh air is provided to all the homes, it is proposed to install a Parts L & F compliant (System 4) Mechanical Ventilation with Heat Recovery (MVHR). The system will draw in sufficient external fresh air in from a height considered acceptable.
- **5.4** The selected MVHR units will have a Specific Fan Power (SFP) lower than 0.5 W/l/s and heat recovery efficiencies in excess of 90% and will remove stale air and odours from kitchens and bathrooms, whilst retaining the heat within living spaces. In this way, substantial energy savings will be made. This system is illustrated in Figure 2.



Figure 2: MVHR

- **5.5** Additionally, all dwellings will have openable windows and therefore the ability to naturally ventilate should the occupant desire. Convective ventilation, cross ventilation and night purging of heat will therefore be facilitated.
- **5.6** 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 of design air permeability rate from 10m<sup>3</sup>/hm<sup>2</sup> to 3m<sup>3</sup>/hm<sup>2</sup> will further reduce space heating requirements.

#### **Thermal Bridging**

5.7 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. It is proposed that the development will aim to follow Accredited



Construction Details (ACD) for all possible thermal bridges. However, due to the construction of the building which includes retained elements and curtain walling, this will in many cases be unfeasible. Therefore, the default thermal bridging value of 0.15W/mK has been assumed within SAP calculations.

**5.8** To significantly reduce heat loss through thermal bridging split independent lintels will be used over openings. These reduce the heat lost though this junction by 70% compared to a standard construction detail (default psi-value).



**5.9** Figure 3 illustrates the benefits of reducing thermal bridges.



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

- **5.10** The space heating requirement of the Proposed Development will be reduced by the fabric and air tightness measures detailed above. The combination of the above measures will create highly energy efficient dwellings.
- **5.11** High efficiency SEDBUK 'A' rated boilers will be installed in accordance with best practice. These systems have at least an 89% efficiency rating (SAP 2009) and are suited to the size of the dwellings.

**5.12** The Boilers will be fitted with a weather compensator which maintains temperature inside the dwelling in relation to the outside temperature. This senses when heat is required and reduces the demand for unwanted heat.

#### Limiting the Risk of Summer Overheating

- **5.13** 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 Applicant commits to ensuring that all dwellings will not have a high risk of summer overheating and will adopt appropriate measures to ensure this is delivered.
- **5.14** In line with the Cooling Hierarchy within London Plan Policy 5.9, it is proposed to reduce the need for active cooling as far as possible and will remove the requirement for the installation of mechanical cooling. All homes will therefore be subject to measures to minimise the risk of summer overheating to an acceptable level.
- **5.15** This will be done through the specification of non-mechanical measures such as good thermal insulation and air tightness.
- 5.16 Additionally, solar control glazing (low g-value) will be installed to reduce solar heat gains. An initial SAP Appendix P overheating risk assessment has been performed on representative sample homes. This assessment has concluded that glazing with a g-value of 0.50 or less should be used, with a g-value of 0.30 in the heavily glazed penthouse apartments.
- **5.17** In addition to the measures applied to each dwelling, cooling will be facilitated on a community scale through measures which encourage evapotranspiration energy which would otherwise heat the local atmosphere is instead used to evaporate water. Both these measures help to reduce the urban heat island effect.
- **5.18** Open-able windows will be used across the Proposed Development and will enable cross-ventilation (all the dwellings are at least dual aspect), convective-ventilation and night purging. These concepts are illustrated in Figure 4 and will reduce the build-up of heat within homes.







**5.19** The SAP overheating assessments that have been undertaken on the sample home types show that there is not expected to be a high risk of summer overheating.

#### **Lighting and Appliances**

- 5.20 Energy efficient lighting will be installed in 100% of internal fittings in the homes. External lighting will also be low energy lighting and controlled through PIR sensors, or daylight cut-off devices. Kitchen and other pre-installed appliances will be A or A+ rated for energy efficiency.
- **5.21** 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.
- **5.22** 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.

#### **CO2 Emissions Following Be Lean Measures**

5.23 The impact of the above measures on the site-wide Regulated & Total CO<sub>2</sub> emissions of the Proposed Development is shown in Table 3, below. It is evident that the measures detailed above enable 2013 Building Regulations to be achieved for the site as a whole through energy efficiency measures alone. A summary of the SAP calculations for the baseline and **Be Lean** cases are presented in Appendix B. Full SAP DER worksheets for the representative units types assessed are presented in Appendix C.

Table 3: BE LEAN Carbon Dioxide Emissions						
	Carbon dioxide emissions (kgCO <sub>2</sub> .a)					
	Regulated	TOTAL				
TOTAL	23,753	47,389				
CO <sub>2</sub> Reduction from Baseline	950	950				
% Reduction	4%	2%				

5.24 The Dwelling Fabric Energy Efficiency (DFEE) result is a good indicator of the energy efficiency of new homes. The block area weighted average result of the representative dwellings modelled in SAP is 47.5 kWh/m<sup>2</sup>/year, compared to the Target Fabric Energy Efficiency (TFEE) result of 51.4kWh/m<sup>2</sup>/year (see Table 4). This is a 7.5% improvement, surpassing Part L 2013 requirements and representing a high level of fabric energy efficiency.

Table 4: Dwelling Fabric Energy Efficiency								
Dwelling Type	No. Dwell ings	Unit Floor Area (m <sup>2</sup> )	TOTAL Floor Area (m <sup>2</sup> )	DFEE (kWh/m²/yr)	TFEE (kWh/m²/yr)	DFEE Improvement Over TFEE		
Ground Floor 2-bed	3	69	208	60.67	64.71	6.24%		
Mid Floor 1-bed	6	52	312	43.38	48.41	10.39%		
Mid Floor End 2-bed	5	66	331	42.02	47.45	11.44%		
Mid Floor Mid 2-bed	4	60	242	32.95	40.77	19.18%		
Top Floor 3-bed	2	110	220	65.38	60.62	-7.85%		
AREA WEIGHTED AVERAGE				47.54	51.39	7.5%		



## 6. BE CLEAN: DECENTRALISED ENERGY

- 6.1 In line with Policy 5.6 of the London Plan, the feasibility of decentralised heating networks as a Be
  Clean measure has been evaluated. This is the next step in the Energy Hierarchy after Be Lean. The
  London Plan outlines the following order of preference: -
  - > Connection to existing heating or cooling networks;
  - > Site wide CHP network;
  - > Communal heating and cooling.
- **6.2** 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 decentralised heating is the best technology to provide the greatest reductions in CO<sub>2</sub> emissions.
- **6.3** As shown in Figure 5, there is no existing or proposed district heating schemes in proximity to the site in to which the development could connect.



Figure 5: London Heat Map showing no existing or proposed district heat network in close proximity to the site (purple areas indicate future potential opportunity areas only)

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- **6.4** Small Combined Heat and Power (CHP) engines are much less efficient than larger ones, having a worse heat to power ratio. 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. GLA guidance published in April 2014 states that it is not expected, for smaller sites (less than 300 dwellings) to carry out a full feasibility analysis for the use of CHP.
- **6.5** Communal heating is most suitable on larger developments, where advantage can be taken from economies of scale. This is true both in capital cost and operational cost. As an example the cost of gas boilers for a 100 home development would be less than double that for a 50 home scheme. This increases the cost per home for a small scheme such as this. With regard to operational costs, the same is true the maintenance of a plant room for a 100 home scheme. This additional cost so home scheme. The cost per home is therefore double for a small scheme. This additional cost would be passed to residents in their heat bills.
- **6.6** Therefore, it is not feasible to connect into a district heating network and it would not be economically or socially sustainable for a communal heat network to be provided for this development due to its small nature.

## 7. BE GREEN: RENEWABLE ENERGY TECHNOLOGIES

- **7.1** The final part of the London Plan Energy Hierarchy is **Be Green** which seeks for renewable energy technologies to be specified to provide, where feasible, a reduction in expected carbon dioxide emissions (Policy 5.7).
- **7.2** Further details on the renewable energy technologies discussed in this section can be found in Appendix A. Appendix D provides a feasibility study table of the technologies that have been considered.

## **Solar Thermal Panels**

- **7.3** Solar thermal panels generate heat for hot water. The benefits of solar thermal panels are constrained by the seasonal variation in solar radiation. This means that solar thermal panels can only deliver a maximum of 60% of the annual hot water demand.
- **7.4** Whilst technically viable, there are a number of reasons why solar thermal panels are not the favoured technology for this development:



- > Need for hot water cylinders in each home it is likely that due to the size of the units most are best served with combination boilers. Cylinders would reduce internal space;
- > The CO<sub>2</sub> reduction possible is constrained by the hot water demand;
- > Higher cost in comparison to solar PV panels.
- **7.5** Therefore, solar thermal panels are not the preferred technology for the proposed development and are not specified.

## **Wind Turbines**

- 7.6 Wind turbines would be roof mounted and intended to generate electricity. However, urban wind conditions are generally poor and turbulent, adversely affecting the performance of wind turbines. Before specifying or installing wind turbines extensive analysis of the wind resource at the specific site should be undertaken to ensure that wind conditions are suitable.
- **7.7** It has been concluded that wind turbines are not the most appropriate renewable energy technology for the Proposed Development. This is due to the expense of the technology itself and the uncertain CO<sub>2</sub> benefit that they would provide. As such they will not be installed.

## **Biomass Boiler**

- **7.8** Biomass boilers with modern pollution abatement devices such as ceramic filter systems can almost eliminate particulate matter emissions and are also very low on emissions of NO<sub>x</sub>.
- **7.9** However, like CHP engines, biomass boilers require a central plant room and communal heat network. Such a system has been discounted as inappropriate for a development of this size and nature.

## Air & Ground Source Heat Pumps (ASHPs & GSHPs)

**7.10** ASHPs and GSHPs would generate heat for space heating and hot water. However, GSHPs are a very costly technology which would require boreholes due to the space restrictions on the Application Site. Although less expensive, ASHPs are less efficient than GSHPs.

- **7.11** Considering the site is capable of supplying mains gas fuelled heating and hot water, a potential heat pump option must be evaluated against the carbon emissions rate of a mains gas fuelled system. The use of electricity is more carbon intensive than mains gas and therefore switching the fuel type would negate the benefits of a heat pump installation. A heat pump system would be more appropriate at sites where a mains gas connection is not easily accessible.
- **7.12** A heat pump system would not achieve the reduction in carbon emissions required when assessed against a comparable mains gas system. Therefore the technology is not a viable option for the Proposed Development.

## Solar Photovoltaic (PV) Panels

- **7.13** PV panels generate electricity from solar radiation. The generating potential of PV panels is not dependent on development demand, but only on available roofspace for installation and ensuring that they are not overshaded. For this reason and their current low cost, it has been concluded that PV panels are the most appropriate renewable energy technology for this development.
- 7.14 In accordance with Camden Policy and Guidance, the applicant has included extensive green roofs which will significantly reduce the surface water run-off from the development and creates a Sustainable Urban Drainage System. Its presence will minimise the strain on the traditional drainage network thus consequently reducing the risk of flooding in the local area and further afield. However, the presence of green roofs conflicts with the application of solar PV. The applicant therefore proposes two alternative scenarios as detailed below.

#### Scenario 1: Green Roofs and Carbon Offsetting Payment (No Solar PV)

- **7.15** In line with Camden Borough Council Policy and Guidance, the applicant is proposing to install green roofs on the development. This, however, conflicts with the application of solar PV.
- **7.16** The overall energy strategy measures employed (*Be* Lean only) will therefore result in a 4% reduction in regulated CO<sub>2</sub> emissions and 2% reduction in total (including unregulated) CO<sub>2</sub> emissions over the Part L 2013 baseline, as demonstrated in Table 5.



Table 5: SCENARIO 1: Carbon Dioxide Emissions Savings after each stage of the energy hierarchy						
	Regulated Carbon Dioxide Savings		Total Carbon Dioxide Savings			
	(kgCO <sub>2</sub> .a)	(%)	(kgCO <sub>2</sub> .a)	(%)		
Savings from Be Lean (energy demand reduction)	950	4%	950	2%		
Savings from Be Clean (CHP)	0	0%	0	0%		
Savings from Be Green (Solar PV)	0	0%	0	0%		
Total Cumulative Savings	950	4%	950	2%		

- **7.17** Since CO<sub>2</sub> savings are therefore only achievable from *Be Lean* measures, the overall energy strategy results in an annual shortfall of 31% (equivalent to 7.7 tonnesCO<sub>2</sub>/yr) from the London Plan 35% CO<sub>2</sub> reduction requirement. In line with the 'Greater London Authority guidance on preparing energy assessments (April 2014), a £60/tonne carbon abatement cost has therefore been applied to the annual shortfall for a period of 30 years.
- 7.18 As demonstrated in Table 6, it is calculated that the development should thus contribute £13,853.

Table 6: Carbon Abatement Cost Calculations							
Total Cumulative Savings (tonnes CO2/yr)	Total Target Savings to meet London Plan 35% CO2 Reduction (tonnes CO2/yr)	Annual Shortfall CO <sub>2</sub> Emissions (tonnes CO <sub>2</sub> /yr)	Carbon Abatement Cost (£/Tonne CO <sub>2</sub> )	Development Lifetime (years)	Carbon Abatement Cost for Development CO2 Emissions		
0.95	8.65	7.70	£60	30	£13,853		

#### Scenario 2: Solar PV and No Green Roofs

**7.19** There is sufficient space for the application of approximately 106m<sup>2</sup> solar PV panels on the roof of the development.

**7.20** Assuming solar PV panels are orientated facing south and tilted at 20 degrees from horizontal, it is estimated that 16.5kWp could be installed on-site, achieving a saving of 7,690kgCO<sub>2</sub>.a as demonstrated in Table 7 (SAP 2012 compliant PV calculation).

Table 7: Solar PV Calculation	
Roof area available	106m <sup>2</sup>
Solar PV	16.5 kWp
Solar Radiation*	1,120 kWh/m²/yr
Energy Generation	14,820 kWh/yr
CO <sub>2</sub> Emissions Saving	7,690 kg CO <sub>2</sub> /yr

\*Assuming southerly orientation and 20 degrees tilt from horizontal

7.21 Table 8 shows that the specified PV panels reduce Regulated CO<sub>2</sub> emissions by a further 32% and 16% in regulated and total CO<sub>2</sub> emissions respectively after the application of *Be Lean* measures. The combination of *Be Lean* and *Be Green* measures will result in a 35% reduction in regulated CO<sub>2</sub> emissions and 18% reduction in total (including unregulated) CO<sub>2</sub> emissions over the Part L 2013 baseline.

Table 8: SCENARIO 2: Carbon Dioxide Emissions Savings after each stage of the energy hierarchy							
	Regulated Carbon Dioxide Savings		Total Carbon Dioxide Savings				
	(kgCO <sub>2</sub> .a)	(%)	(kgCO <sub>2</sub> .a)	(%)			
Savings from Be Lean (energy demand reduction)	950	4%	950	2%			
Savings from Be Clean (CHP)	0	0%	0	0%			
Savings from Be Green (Solar PV)	7,693	32%	7,693	16%			
Total Cumulative Savings	8,642	35%	8,642	18%			



### 8. SUMMARY

- 8.1 The Energy Strategy for the Proposed Development has been formulated following the London Plan Energy Hierarchy: **Be Lean**, **Be Clean** and **Be Green**. The overriding objective in the formulation of the strategy is to maximise the reductions in CO<sub>2</sub> emissions through the application of this Hierarchy with a cost-effective, viable and technically appropriate approach and to minimise the emission of other pollutants.
- 8.2 The Site will be built under Part L 2013 of the Building Regulations; therefore, in line with the London Plan, will target a 35% CO₂ reduction over the Part L 2013 baseline.
- 8.3 A range of advanced *Be Lean* energy efficiency measures are proposed. They enable the proposed development to exceed Part L1A 2013 Target Emission Rate (TER) and Target Fabric Energy Efficiency (TFEE) minimum standards for the residential aspect of the development through energy efficiency measures alone. A site-wide 4% and 2% reduction in regulated and total CO<sub>2</sub> emissions respectively is predicted over the Part L 2013 baseline. This represents a high level of sustainable design and construction.
- 8.4 In line with the London Plan, the feasibility of decentralised energy production as a **Be Clean** measure has been assessed. There are currently no existing or proposed district heat networks in the area. It has been concluded that a communal heating strategy is inappropriate for a development of this size as it would substantially increase capital costs and operational costs (and resident energy bills).
- 8.5 The full spectrum of **Be Green** renewable energy generating technologies has been considered. PV panels are considered the most appropriate but conflicts with the proposed green roofs on the development which are a Camden council preference. The applicant has therefore explored two scenarios:
  - Scenario 1: Green Roofs and Carbon Offsetting Payment (no solar PV) The overall energy strategy measures employed (*Be* Lean only) will result in a 4% reduction in regulated CO<sub>2</sub> emissions and 2% reduction in total (including unregulated) CO<sub>2</sub> emissions over the Part L 2013 baseline. A carbon offsetting cost of £13,853 will therefore be paid to Camden Borough Council. This strategy complies with the London Plan, Code for Sustainable Homes Level 3 mandatory energy credits and Camden Borough Council policies.
  - Scenario 2: Solar PV but No Green Roofs 16.5kWp solar PV will be installed instead of green roofs to achieve an estimated further regulated and total CO<sub>2</sub> emission reduction of 32% and 16% after Be Lean emissions. The combination of Be Lean and Be Green measures will result in a 35%

reduction in regulated CO<sub>2</sub> emissions and **18%** reduction in total (including unregulated) CO<sub>2</sub> emissions over the Part L 2013 baseline. This strategy complies with the London Plan, Code for Sustainable Homes Level 4 mandatory energy credits and Camden Borough Council policies.

**8.6** The applicant seeks guidance from Camden Borough Council on which strategy they would favour taking forward.



## **APPENDICES**

**Appendix A** Low Carbon & Renewable Energy Technologies

**Appendix B** SAP CO<sub>2</sub> Baseline and Be Lean Calculations

**Appendix C** SAP DER Worksheets

**Appendix D** Feasibility Table of Low Carbon & Renewable Energy Technologies

**17-27 & 25 Ferdinand Street**ErWarmhaze Ltd.Da

Energy Statement Date: January 2015

## APPENDIX A: LOW CARBON AND RENEWABLE ENERGY TECHNOLOGIES



### **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.

### **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



Diagram 1 – CHP Diagram

the system is increased above that of a conventional power plant where the heat is not utilised.

> 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 ~30% and a thermal efficiency of ~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.

### **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 id 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<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.
- > 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.

#### **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-by-house 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.

# **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



Diagram 2 - Solar Thermal System

panels should be scaled to provide no more than 1/2 of the hot water load.

- > 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

# **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.



# **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 energy that is stored in the earth (which in the UK remains at a near constant temperature



Diagram 3 – Ground Source Heat Pump

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

# **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.

Diagram 4 – Air Source Heat Pump

#### > 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

## 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.



# **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.</p>
- > 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



# **APPENDIX B: SAP CO<sub>2</sub> BASELINE AND BE LEAN CALCULATIONS**

					REGULATED CO2 EMISSIONS					ATED CO2 SIONS	TOTAL CO2 EMISSIONS				
				BASE	BASELINE ACTUAL					UAL	BAS	ELINE	AC	ACTUAL	
	No. Dwelli	Unit Floor Area	TOTAL Floor Area	TER (kgCO2/m	BASELINE ACTUAL TER TER *Sq.m DER kgCO2/m (kgCO/yr (kgCO2/ DER *Sq.m			% DER/TER	Unregulated CO2 Emissions (kgCO2/m2/y	Unregulated CO2 Emissions *Sq.m	TOTAL CO2 Emissions (kgCO2/m2/	TOTAL CO2 Emissions *Sq.m	TOTAL CO2 Emissions (kgCO2/m2/	TOTAL CO2 Emissions *Sq.m	% DER/TER
Dwelling Type	ngs	(m2)	(m2)	2/yr)		m2/yr)	(kgCO/yr)	IIVIP	r)	(kgCO/yr)	yr)	(kgCO/yr)	yr)	(kgCO/yr)	IIVIP
Ground Floor 2-bed	3	69.34	208	21.39	4450	21.25	4,420	0.65%	18	3,744	39	8,194	39	8,165	0.36%
Mid Floor 1-bed	6	52.05	312	19.38	6052	18.43	5,756	4.90%	18	5,621	37	11,674	36	11,377	2.54%
Mid Floor End 2-bed	5	66.22	331	18.18	6019	17.14	5,675	5.72%	18	5,960	36	11,979	35	11,635	2.87%
Mid Floor Mid 2-bed	4	60.42	242	17.52	4234	15.69	3,792	10.45%	18	4,350	36	8,584	34	8,142	5.15%
Top Floor 3-bed	2	110	220	17.94	3947	18.68	4,110	-4.12%	18	3,960	36	7,907	37	8,070	-2.06%
TOTAL	20		1,313		24,702		23,753	3.84%		23,636		48,338		47,389	1.96%

# **APPENDIX C: SAP DER WORKSHEETS**

# 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	Miss Cha	arlotte Boo	th				A	ssessor num	ber	6376		
Client	Warmha	aze Ltd					L	ast modified		23/01	/2015	
Address	20 17-27	7 & 25 Ferd	inand Stree	t, Camden	, London, N	IW1 8EX						
1. Overall dwelling dimen	nsions											
				A	Area (m²)		Ave ł	erage storey leight (m)		Va	olume (m³)	
Lowest occupied					110.00	<mark>](1a)</mark> x		3.10	] (2a) =		341.00	(3a)
Total floor area	(1a	) + (1b) + (1	c) + (1d)(	1n) =	110.00	(4)						
Dwelling volume							(3a	a) + (3b) + (3	c) + (3d)(3	sn) =	341.00	(5)
2. Ventilation rate												
										m	<sup>3</sup> per hour	
Number of chimneys								0	] x 40 =		0	(6a)
Number of open flues								0	] x 20 =		0	(6b)
Number of intermittent fa	ns							0	] x 10 =		0	(7a)
Number of passive vents								0	] x 10 =		0	(7b)
Number of flueless gas fire	S							0	] x 40 =		0	(7c)
										Air	changes pe hour	r
Infiltration due to chimney	s, flues, fan	is, PSVs		(6a)	) + (6b) + (7	a) + (7b) + (	7c) =	0	÷ (5) =		0.00	(8)
If a pressurisation test has	been carrie	d out or is i	ntended, p	roceed to (	(17), otherw	ise continu	e from (9)	to (16)	-			
Air permeability value, q50	), expressed	l in cubic m	etres per h	our per sq	uare metre	of envelope	e area				3.00	(17)
If based on air permeabilit	y value, the	n (18) = [(1	7) ÷ 20] + (8	8), otherwi	ise (18) = (1	6)					0.15	(18)
Number of sides on which	the dwellin	g is shelter	ed								3	(19)
Shelter factor								1 -	[0.075 x (1	9)] =	0.78	(20)
Infiltration rate incorporat	ing shelter	factor							(18) x (2	20) =	0.12	(21)
Infiltration rate modified for	or monthly	wind speed	:									
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind spe	ed from Tal	ble 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 (a	allowing for	shelter and	d wind fact	or) (21) x (2	22a)m							_
0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	(22b)
Calculate effective air char	nge rate for	the applica	ble case:									_
If mechanical ventilatio	n: air chang	ge rate thro	ugh system	1							0.50	(23a)
If balanced with heat re	ecovery: eff	iciency in %	allowing for	or in-use fa	actor from T	able 4h					77.35	(23c)
a) If balanced mechanic	al ventilati	on with hea	t recovery	(MVHR) (2	2b)m + (23l	b) x [1 - (230	c) ÷ 100]	_			_	_
0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(24a)
Effective air change rate -	enter (24a)	or (24b) or	(24c) or (24	4d) in (25)	-1	1		-	1		_	_
0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(25)



Element			а	Gross rea, m²	Openings m <sup>2</sup>	Net a A, i	area m²	U-value W/m²K	A x U W/	ΊΚ κ-ν kJ/	value, /m².K	Ахк, kJ/K	
Window						107	.57 x	0.78	= 83.39				(27)
External wall						16.	24 x	0.80	= 12.99				(29a)
Party wall						28.	64 x	0.00	= 0.00	_			(32)
Roof						110	.00 x	0.10	= 11.00	7			(30)
Total area of ext	ernal eleme	ents ∑A, m²	2			233	.81						(31)
Fabric heat loss,	W/K = ∑(A	× U)							(26)	)(30) + (3	32) =	107.38	(33)
Heat capacity Cr	n = ∑(А x к)							(28)	(30) + (32) +	(32a)(32	2e) =	N/A	(34)
Thermal mass pa	arameter (T	MP) in kJ/r	m²K									250.00	(35)
Thermal bridges	: Σ(L x Ψ) ca	alculated us	sing Appen	dix K								35.07	(36)
Total fabric heat	loss									(33) + (3	36) =	142.45	(37)
	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec	-
Ventilation heat	loss calcula	ited month	ily 0.33 x (2	25)m x (5)									
	29.42	29.10	28.77	27.13	26.81	25.17	25.17	24.84	25.83	26.81	27.46	28.11	(38)
Heat transfer co	efficient, W	/K (37)m +	+ (38)m										
	171.87	171.55	171.22	169.58	169.26	167.62	167.62	167.30	168.28	169.26	169.91	170.57	
									Average = ∑(	39)112/	/12 =	169.50	(39)
Heat loss param	eter (HLP),	W/m²K (39	9)m ÷ (4)										
	1.56	1.56	1.56	1.54	1.54	1.52	1.52	1.52	1.53	1.54	1.54	1.55	
									Average = ∑(	40)112/	/12 =	1.54	(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	ng energy r	eauiremen	t						7				
Assumed occupa	ancy. N											2.81	(42)
Annual average	hot water u	sage in litro	es per day '	Vd,average	= (25 x N) +	36						101.05	(43)
0	la a	0										101.05	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	-
Hot water usage	in litres pe	<b>Feb</b> r day for ea	<b>Mar</b> ach month	<b>Apr</b> Vd,m = fact	<b>May</b> or from Tabl	Jun le 1c x (43)	Jul	Aug	Sep	Oct	Nov	Dec	_
Hot water usage	in litres pe	<b>Feb</b> r day for ea 107.12	Mar ach month 103.07	<b>Apr</b> Vd,m = fact 99.03	May or from Tabl 94.99	Jun le 1c x (43) 90.95	Jul 90.95	Aug 94.99	Sep 99.03	<b>Oct</b> 103.07	Nov 107.12	Dec 111.16	]
Hot water usage	in litres pe	Feb r day for ea 107.12	Mar ach month 103.07	<b>Apr</b> Vd,m = fact 99.03	May or from Tabl 94.99	Jun le 1c x (43) 90.95	Jul 90.95	Aug 94.99	<b>Sep</b> 99.03	<b>Oct</b> 103.07 Σ(44)1	Nov 107.12 .12 =	Dec 1111.16 1212.63	]
Hot water usage	in litres pe 111.16	<b>Feb</b> r day for ea 107.12 r used = 4.1	Mar ach month 103.07 18 x Vd,m x	<b>Apr</b> Vd,m = fact 99.03 nm x Tm/3	May or from Tabl 94.99	Jun le 1c x (43) 90.95 onth (see	Jul 90.95 Tables 1b	Aug 94.99 , 1c 1d)	Sep 99.03	Oct 103.07 Σ(44)1	Nov 107.12 12 =	Dec 1111.16	] ] (44)
Hot water usage	yan e in litres pe 111.16 of hot wate 164.84	Feb r day for ea 107.12 r used = 4.1 144.17	Mar ach month 103.07 18 x Vd,m x 148.77	<b>Apr</b> Vd,m = fact 99.03 nm x Tm/3 129.70	May or from Tabl 94.99 600 kWh/m 124.45	Jun le 1c x (43) 90.95 onth (see 107.39	Jul 90.95 Tables 1b 99.52	Aug 94.99 , 1c 1d) 114.20	Sep 99.03	Oct 103.07 Σ(44)1 134.68	Nov 107.12 12 = 147.01	Dec 1111.16 1212.63	_ ] (44) ]
Hot water usage	jan in litres pe 111.16 of hot wate 164.84	Feb r day for ea 107.12 r used = 4.1 144.17	Mar ach month 103.07 18 x Vd,m x 148.77	<b>Apr</b> Vd,m = fact 99.03 nm x Tm/3 129.70	May or from Tabl 94.99 6600 kWh/m 124.45	Jun le 1c x (43) 90.95 onth (see 107.39	Jul 90.95 Tables 1b 99.52	Aug 94.99 , 1c 1d) 114.20	Sep 99.03 115.56	Oct 103.07 Σ(44)1 134.68 Σ(45)1	Nov 107.12 12 = 147.01 12 =	Dec 1111.16 1212.63 159.64 1589.94	] ] (44) ] (45)
Hot water usage Energy content Distribution loss	Jan in litres pe 111.16 of hot wate 164.84 0.15 x (45)	Feb r day for ea 107.12 r used = 4.1 144.17	Mar ach month 103.07 18 x Vd,m x 148.77	<b>Apr</b> Vd,m = fact 99.03 nm x Tm/3 129.70	May or from Tabl 94.99 6600 kWh/m 124.45	Jun le 1c x (43) 90.95 onth (see 107.39	Jul 90.95 Tables 1b 99.52	Aug 94.99 , 1c 1d) 114.20	Sep 99.03 115.56	Oct 103.07 Σ(44)1 134.68 Σ(45)1	Nov 107.12 12 = 147.01 12 =	Dec 111.16 1212.63 159.64 1589.94	] ] (44) ] (45)
Hot water usage Energy content Distribution loss	Jan         : in litres pe         111.16         of hot wate         164.84         0.15 x (45)         24.73	Feb r day for ea 107.12 r used = 4.1 144.17 m 21.63	Mar ach month 103.07 18 x Vd,m x 148.77 22.32	<b>Apr</b> Vd,m = fact 99.03 nm x Tm/3 129.70 19.46	May or from Tabl 94.99 600 kWh/m 124.45 18.67	Jun le 1c x (43) 90.95 onth (see 107.39	Jul 90.95 Tables 1b 99.52 14.93	Aug 94.99 , 1c 1d) 114.20	Sep 99.03 115.56	Oct 103.07 Σ(44)1 134.68 Σ(45)1 20.20	Nov 107.12 12 = 147.01 12 = 22.05	Dec 1111.16 1212.63 159.64 1589.94 23.95	] ] (44) ] (45) ] (46)
Hot water usage Energy content of Distribution loss Storage volume	Jan         in litres pe         111.16         of hot wate         164.84         0.15 x (45)         24.73         (litres) inclu	Feb           r day for ea           107.12           r used = 4.1           144.17           um           21.63           uding any so	Mar ach month 103.07 18 x Vd,m x 148.77 222.32 olar or WW	<b>Apr</b> Vd,m = fact 99.03 nm x Tm/3 129.70 19.46 'HRS storag	May For from Tabl 94.99 6600 kWh/m 124.45 18.67 e within sam	Jun le 1c x (43) 90.95 onth (see 107.39 16.11 ne vessel	Jul 90.95 Tables 1b 99.52 14.93	Aug 94.99 , 1c 1d) 114.20 17.13	Sep 99.03 115.56 17.33	Oct 103.07 Σ(44)1 134.68 Σ(45)1 20.20	Nov 107.12 12 = 147.01 12 = 22.05	Dec           111.16           1212.63           159.64           1589.94           23.95           210.00	] (44) ] (44) ] (45) ] (46) ] (47)
Hot water usage Energy content Distribution loss Storage volume Water storage lo	Jan         in litres pe         111.16         of hot wate         164.84         0.15 x (45)         24.73         (litres) incluoss:	Feb           r day for ea           107.12           r used = 4.1           144.17           m           21.63           uding any so	Mar ach month 103.07 18 x Vd,m x 148.77 22.32 olar or WW	Apr Vd,m = fact 99.03 nm x Tm/3 129.70 19.46 'HRS storag	May or from Tabl 94.99 600 kWh/m 124.45 18.67 e within sam	Jun le 1c x (43) 90.95 onth (see 107.39 16.11 ne vessel	Jul 90.95 Tables 1b 99.52 14.93	Aug 94.99 , 1c 1d) 114.20 17.13	Sep 99.03 115.56 17.33	Oct 103.07 Σ(44)1 134.68 Σ(45)1 20.20	Nov 107.12 12 = 147.01 12 = 22.05	Dec           111.16           1212.63           159.64           1589.94           23.95           210.00	] (44) ] (44) ] (45) ] (46) ] (47)
Hot water usage Energy content of Distribution loss Storage volume Water storage lo a) If manufactur	in litres pe 111.16 of hot wate 164.84 0.15 x (45) 24.73 (litres) inclu oss: er's declare	Feb           r day for ea           107.12           r used = 4.1           144.17           um           21.63           uding any so           d loss factor	Mar ach month 103.07 18 x Vd,m x 148.77 22.32 olar or WW	Apr Vd,m = fact 99.03 nm x Tm/3 129.70 19.46 'HRS storag (kWh/day)	May For from Tabl 94.99 6600 kWh/m 124.45 18.67 e within sam	Jun le 1c x (43) 90.95 onth (see 107.39 16.11 ne vessel	Jul 90.95 Tables 1b 99.52 14.93	Aug 94.99 , 1c 1d) 114.20 17.13	Sep 99.03 115.56 17.33	Oct 103.07 Σ(44)1 134.68 Σ(45)1 20.20	Nov 107.12 12 = 147.01 12 = 22.05	Interview           Dec           111.16           1212.63           159.64           1589.94           23.95           210.00           1.40	] (44) ] (44) ] (45) ] (45) ] (46) ] (47) ] (48)
Hot water usage Energy content Distribution loss Storage volume Water storage lo a) If manufactur Temperature	Jan e in litres pe 111.16 of hot wate 164.84 0.15 x (45) 24.73 (litres) inclu oss: er's declare e factor fron	Feb           r day for ea           107.12           r used = 4.1           144.17           144.17           100           21.63           uding any so           d loss factor           n Table 2b	Mar ach month 103.07 18 x Vd,m x 148.77 22.32 olar or WW	Apr Vd,m = fact 99.03 nm x Tm/3 129.70 19.46 'HRS storag (kWh/day)	May For from Tabl 94.99 600 kWh/m 124.45 18.67 e within sam	Jun le 1c x (43) 90.95 onth (see 107.39 16.11 he vessel	Jul 90.95 Tables 1b 99.52 14.93	Aug 94.99 , 1c 1d) 114.20	Sep 99.03 115.56	Oct 103.07 Σ(44)1 134.68 Σ(45)1 20.20	Nov 107.12 12 = 147.01 12 = 22.05	Dec         111.16         1212.63         159.64         1589.94         23.95         210.00         1.40         0.54	] (44) ] (44) ] (45) ] (45) ] (46) ] (47) ] (48) ] (49)
Hot water usage Energy content of Distribution loss Storage volume Water storage lo a) If manufactur Temperature Energy lost fi	in litres pe 111.16 of hot wate 164.84 0.15 x (45) 24.73 (litres) incluoss: er's declare factor from rom water s	Feb           r day for ea           107.12           r used = 4.1           144.17           144.17           um           21.63           uding any so           d loss factor           n Table 2b           torage (kW)	Mar           ach month           103.07           18 x Vd,m x           148.77           22.32           olar or WW           or is known           /h/day) (48)	Apr Vd,m = fact 99.03 nm x Tm/3 129.70 19.46 'HRS storag (kWh/day) 3) x (49)	May For from Tabl 94.99 8600 kWh/m 124.45 18.67 e within sam	Jun le 1c x (43) 90.95 onth (see 107.39 16.11 ne vessel	Jul 90.95 Tables 1b 99.52 14.93	Aug 94.99 , 1c 1d) 114.20	Sep 99.03 115.56 17.33	Oct 103.07 Σ(44)1 134.68 Σ(45)1 20.20	Nov 107.12 12 = 147.01 12 = 22.05	Interface           Dec           111.16           1212.63           159.64           1589.94           23.95           210.00           1.40           0.54           0.76	] (44) ] (44) ] (45) ] (45) ] (46) ] (47) ] (48) ] (49) ] (50)
Hot water usage Energy content of Distribution loss Storage volume Water storage lo a) If manufactur Temperature Energy lost fi Enter (50) or (54	Jan e in litres pe 111.16 of hot wate 164.84 0.15 x (45) 24.73 (litres) inclu oss: er's declare er's declare factor fron rom water s e) in (55)	Feb           r day for ea           107.12           r used = 4.1           144.17           144.17           um           21.63           uding any so           d loss factor           n Table 2b           torage (kW)	Mar ach month 103.07 18 x Vd,m x 148.77 22.32 olar or WW or is known /h/day) (48	Apr Vd,m = fact 99.03 nm x Tm/3 129.70 19.46 'HRS storag (kWh/day) 3) x (49)	May For from Table 94.99 6600 kWh/m 124.45 18.67 e within sam	Jun le 1c x (43) 90.95 onth (see 107.39 16.11 ne vessel	Jul 90.95 Tables 1b 99.52 14.93	Aug 94.99 , 1c 1d) 114.20	Sep 99.03 115.56 17.33	Oct 103.07 Σ(44)1 134.68 Σ(45)1 20.20	Nov 107.12 12 = 147.01 12 = 22.05	Dec         111.16         1212.63         159.64         1589.94         23.95         210.00         1.40         0.54         0.76         0.76	] (44) ] (44) ] (45) ] (45) ] (46) ] (47) ] (48) ] (49) ] (50) ] (55)
Hot water usage Energy content of Distribution loss Storage volume Water storage lo a) If manufactur Temperature Energy lost fi Enter (50) or (54	Jan in litres pe 111.16 of hot wate 164.84 0.15 x (45) 24.73 (litres) incluoss: er's declare factor from rom water s b) in (55) oss calculate	Feb           r day for ea           107.12           r used = 4.1           144.17           144.17           m           21.63           uding any so           d loss factor           n Table 2b           torage (kW)           ed for each	Mar           ach month           103.07           18 x Vd,m x           148.77           22.32           olar or WW           or is known           /h/day)         (48           month         (55	Apr Vd,m = fact 99.03 nm x Tm/3 129.70 19.46 'HRS storag (kWh/day) 8) x (49) 5) x (41)m	May For from Table 94.99 6600 kWh/m 124.45 18.67 e within sam	Jun le 1c x (43) 90.95 onth (see 107.39 16.11 he vessel	Jul 90.95 Tables 1b 99.52 14.93	Aug 94.99 , 1c 1d) 114.20	Sep 99.03 115.56 17.33	Oct 103.07 Σ(44)1 134.68 Σ(45)1 20.20	Nov 107.12 12 = 147.01 12 = 22.05	Internet           Dec           111.16           1212.63           159.64           1589.94           23.95           210.00           1.40           0.54           0.76           0.76	] (44) ] (44) ] (45) ] (45) ] (46) ] (47) ] (48) ] (49) ] (50) ] (55)
Hot water usage Energy content of Distribution loss Storage volume Water storage lo a) If manufactur Temperature Energy lost fi Enter (50) or (54 Water storage lo	in litres pe 111.16 of hot wate 164.84 0.15 x (45) 24.73 (litres) inclu oss: er's declare factor from rom water s 0) in (55) oss calculate 23.44	Feb           r day for ea           107.12           r used = 4.1           144.17           144.17           m           21.63           uding any so           d loss factor           n Table 2b           torage (kW)           ed for each           21.17	Mar ach month 103.07 18 x Vd,m x 148.77 22.32 olar or WW or is known /h/day) (48 month (55 23.44	Apr Vd,m = fact 99.03 nm x Tm/3 129.70 19.46 HRS storag (kWh/day) 8) x (49) 5) x (41)m 22.68	May for from Tabl 94.99 6600 kWh/m 124.45 18.67 e within sam	Jun le 1c x (43) 90.95 onth (see 107.39 16.11 ne vessel 22.68	Jul 90.95 Tables 1b 99.52 14.93	Aug 94.99 , 1c 1d) 114.20 17.13 23.44	Sep 99.03 115.56 17.33 22.68	Oct 103.07 Σ(44)1 134.68 Σ(45)1 20.20 20.20	Nov 107.12 12 = 147.01 12 = 22.05 22.68	Introduction         Dec         111.16         1212.63         159.64         1589.94         23.95         210.00         1.40         0.54         0.76         0.76         0.76         23.44	] (44) ] (44) ] (45) ] (45) ] (46) ] (47) ] (48) ] (49) ] (50) ] (55) ] (56)
Hot water usage Energy content of Distribution loss Storage volume Water storage lo a) If manufactur Temperature Energy lost fi Enter (50) or (54 Water storage lo If the vessel con	Jan in litres pe 111.16 of hot wate 164.84 0.15 x (45) 24.73 (litres) incluoss: er's declare factor from rom water s e) in (55) oss calculate 23.44 tains dedica	Feb           r day for ea           107.12           r used = 4.1           144.17           144.17           m           21.63           uding any so           d loss factor           n Table 2b           torage (kW)           ed for each           21.17           ated solar s	Mar           ach month           103.07           18 x Vd,m x           148.77           22.32           olar or WW           or is known           /h/day)         (48           month         (55           23.44           torage or d	Apr Vd,m = fact 99.03 nm x Tm/3 129.70 19.46 'HRS storag (kWh/day) 8) x (49) 5) x (41)m 22.68 edicated W	May for from Tabl 94.99 600 kWh/m 124.45 18.67 e within sam e within sam 23.44 /WHRS (56)n	Jun le 1c x (43) 90.95 onth (see 107.39 16.11 ne vessel 22.68 n x [(47) - V	Jul 90.95 Tables 1b 99.52 14.93 14.93 23.44 /s] ÷ (47),	Aug 94.99 , 1c 1d) 114.20 17.13 23.44 else (56)	Sep 99.03 115.56 17.33 22.68	Oct 103.07 Σ(44)1 134.68 Σ(45)1 20.20 23.44	Nov 107.12 12 = 147.01 12 = 22.05 22.68	Introduction         Dec         111.16         1212.63         159.64         1589.94         23.95         210.00         1.40         0.54         0.76         0.76         23.44	] (44) ] (45) ] (45) ] (46) ] (47) ] (48) ] (49) ] (50) ] (55) ] (56)
Hot water usage Energy content of Distribution loss Storage volume Water storage lo a) If manufactur Temperature Energy lost fi Enter (50) or (54 Water storage lo If the vessel con	Jan in litres pe 111.16 of hot wate 164.84 0.15 x (45) 24.73 (litres) inclu oss: er's declare if factor from rom water s on (55) oss calculate 23.44 tains dedica 23.44	Feb           r day for ea           107.12           r used = 4.1           144.17           144.17           m           21.63           uding any so           d loss factor           n Table 2b           torage (kW)           ed for each           21.17           ated solar s           21.17	Mar           ach month           103.07           18 x Vd,m x           148.77           22.32           olar or WW           olar or WW           or is known           /h/day) (48           month (55)           23.44           itorage or d           23.44	Apr Vd,m = fact 99.03 nm x Tm/3 129.70 19.46 HRS storag (kWh/day) 8) x (49) 5) x (41)m 22.68 edicated W 22.68	May for from Tabl 94.99 6600 kWh/m 124.45 18.67 e within sam 23.44 /WHRS (56)n 23.44	Jun le 1c x (43) 90.95 onth (see 107.39 16.11 ne vessel 22.68 n x [(47) - <sup>1</sup> 22.68	Jul 90.95 Tables 1b 99.52 14.93 14.93 23.44 /s] ÷ (47), 23.44	Aug 94.99 1c 1d) 114.20 17.13 23.44 else (56) 23.44	Sep 99.03 115.56 17.33 22.68	Oct 103.07 Σ(44)1 134.68 Σ(45)1 20.20 23.44 23.44	Nov 107.12 12 = 147.01 12 = 22.05 22.68 222.68	Dec         111.16         1212.63         159.64         1589.94         23.95         210.00         1.40         0.54         0.76         0.76         23.44	] (44) ] (44) ] (45) ] (45) ] (46) ] (47) ] (48) ] (49) ] (50) ] (55) ] (56) ] (56) ] (57)



						-			-	-		,	
	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26 (5	59)
Combi loss for e	ach 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 (6	51)
Total heat requi	red for wat	er heating c	alculated f	or each mo	nth 0.85 x	(45)m + (4	6)m + (57)r	n + (59)m +	- (61)m			· · · ·	
lota neut requ			105 47	174.00				100.00	10075	101.27	102.20	200.24	2)
	211.54	186.35	195.47	174.90	1/1.15	152.59	146.22	160.90	160.75	181.37	192.20	206.34 (6	)2)
Solar DHW inpu	t 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 (6	53)
Output from wa	iter heater f	or each mo	nth (kWh/i	month) (62	!)m + (63)n	า							
	211.54	186.35	195.47	174.90	171.15	152.59	146.22	160.90	160.75	181.37	192.20	206.34	
				•			•			Σ(64)1	12 = 2	2139.78 (6	54)
Heat gains from	water heat	ing (kWh/m	(0.0000)	5 x [0 85 x (	'45)m + (61	)m] + 0.8 x	[(46)m + (1	57)m + (59)	ml	2(- )			
ficut guills from				70.20					7450	02.44	05.00		
	92.17	81.68	86.83	79.28	78.74	/1.86	70.45	/5.33	74.58	82.14	85.03	90.44 (6	JS)
5. Internal gair	ns												
of internal gain	lon	<b>Cob</b>	Мак	Аюн	May	1	1.1	A	Con	Oct	Nev	Dee	
		reb	IVIdi	Арг	Ividy	Jun	Jui	Aug	Seh	ott	NOV	Dec	
Metabolic gains	(Table 5)												
	140.74	140.74	140.74	140.74	140.74	140.74	140.74	140.74	140.74	140.74	140.74	140.74 (6	56)
Lighting gains (c	alculated in	Appendix L	, equation	L9 or L9a),	also see Ta	able 5							
	24.21	21.50	17.49	13.24	9.90	8.35	9.03	11.73	15.75	20.00	23.34	24.88 (6	57)
Appliance gains	(calculated	in Appendix	x L, equatio	on L13 or L1	l3a), also s	ee Table 5							
	271 56	274 37	267.27	252 16	233.07	215 14	203 16	200 34	207 44	222 56	241 64	259 57 (6	58)
Cooking gains (c	alculated in	Annendix I	equation	115 or 115		Table 5	200.10	200.51	207.111	222.30	211.01	200.07	,0,
COOKING gains (C													
	37.07	37.07	37.07	37.07	37.07	37.07	37.07	37.07	37.07	37.07	37.07	37.07 (6	59)
Pump and fan g	ains (Table S	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	70)
Losses e.g. evap	oration (Tal	ole 5)											
	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59 (7	71)
Water heating g	ains (Table	5)							•				
	173.88	121 55	116 70	110 11	105.83	99.81	94 69	101 25	103 58	110/0	118 10	121 56 (7	72)
Total internal ga	$\frac{125.00}{(66)m}$	(67)m . (6	8)m + (60)	m + (70)m	105.05	72\m	54.05	101.25	105.50	110.40	110.10	121.50 (/	2)
Total Internal ga			0911 + (09)	iii + (70)iii -	+ (/1)    + (	/2/11						/= /= /=	
	487.87	485.65	469.68	443.73	417.02	391.52	375.09	381.54	394.99	421.18	451.31	474.24 (7	73)
6 Solar gains													
0. Joiai gains			A		A	Col	a <b>f</b> l		_			Coine	
			Access T Table	actor 6d	Area m <sup>2</sup>	5013 W	ar flux //m²	spec	g ific data	specific c	lata	W	
							,	or T	able 6b	or Table	6c		
Fact			0.7	7 V [	19 /1		9.64 Y		1 30 V	1.00		201 75 (7	76)
Lust			0.7		41.72							170.25	
west			0.7		41.72		9.64 X		J.30 X	1.00		170.35 (8	30)
South			0.7	7 X	16.44	x 4	6.75 x	0.9 x 0	0.30 x	1.00	=	159.79 (7	78)
Solar gains in wa	atts ∑(74)m	(82)m											
	531.90	989.61	1532.13	2125.10	2535.26	2571.22	2457.36	2152.24	1742.45	1146.00	653.38	444.08 (8	33)
Total gains - inte	ernal and so	lar (73)m +	(83)m										
	1019.77	1475.26	2001.81	2568.83	2952.29	2962.74	2832.45	2533.78	2137.44	1567.17	1104.68	918.31 (8	34)
		·										· · · · · · · · · · · · · · · · · · ·	
7. Mean intern	al tempera	ture (heatir	ng season)										
Temperature du	uring heating	g periods in	the living a	area from T	able 9, Thi	L(°C)						21.00 (8	35)
	Jan	Feb	Mar	Apr	Mav	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	r for gains f			• Table ()a)	- 1		'	- 0					
		or living are	a nj. m ise	e Tanie var									
			a n1,m (se		0.54	0.20	0.20	0.20	0.52	0.94	0.07	0.00 (0	261
	0.99	0.96	0.87	0.70	0.51	0.36	0.26	0.30	0.52	0.84	0.97	0.99 (8	36)



Mean internal to	emp of livin	g area T1 (s	steps 3 to 7	in Table 90	c)								
	19.52	19.93	20.42	20.80	20.95	20.99	21.00	21.00	20.96	20.65	19.98	19.45	(87)
Temperature du	uring heatin	g periods in	the rest of	f dwelling f	rom Table 9	9, Th2(°C)							
	19.64	19.64	19.65	19.66	19.66	19.67	19.67	19.67	19.67	19.66	19.65	19.65	(88)
Utilisation facto	or for gains f	or rest of d	welling n2,	m									-
	0.99	0.95	0.84	0.65	0.45	0.29	0.18	0.22	0.43	0.79	0.96	0.99	(89)
Mean internal to	emperature	in the rest	of dwelling	z T2 (follow	steps 3 to	7 in Table 9	) )c)	1			1	1	], ,
	17 74	18 33	18.99	19.47	19.62	19.67	19.67	19.67	19 64	19 32	18 41	17 64	] (90)
Living area fract	ion	10.00	10.00	10117	10:01	10.07	10107	10.07	1 20101	ving area -	(A) =	0.33	] (91)
Mean internal to	omnorature	for the wh	ole dwellin	α fl Λ v T1 J	∟(1 _ fl ۸) v	тэ				ving area :	(+) -	0.55	
Mean internal to						20.10	20.10	20.10	20.07	10.75	10.02	10.22	
A	18.33	18.85	19.40	19.90	20.00	20.10	20.10	20.10	20.07	19.75	18.92	18.23	] (92)
Apply adjustme	nt to the m	ean interna	i temperati	ure from Ta	able 4e whe	ere appropr	late				1	1	7
	18.18	18.70	19.31	19.75	19.91	19.95	19.95	19.95	19.92	19.60	18.77	18.08	] (93)
8. Space heating	ng requiren	nent											
	Jan	Feb	Mar	Apr	Mav	Jun	lut	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	r for gains.	nm		•					•				
		0.04	0.02	0.65	0.46	0.20	0.20	0.22	0.45	0.70	0.05	0.00	] (04)
Licoful gains nr	$\frac{0.96}{100}$	1 0.94	0.85	0.05	0.40	0.30	0.20	0.23	0.45	0.79	0.95	0.99	] (94)
Oserui gairis, ijri			1000 70	1071 14	1252.22	001 50	FC1 FC	502.20	056.67	1226 40	1054.01	005.30	
	999.33	1381.22	1008.79	16/1.14	1352.33	891.59	561.56	593.39	956.67	1236.48	1054.81	905.30	] (95)
Monthly average	e external t	emperature										1	7
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	<b>_ (96)</b>
Heat loss rate fo	or mean inte	ernal tempe	erature, Lm	, W [(39)m	ı x [(93)m -	(96)mJ				1	1	1	-
	2384.81	2367.57	2192.82	1840.42	1388.97	896.61	562.22	594.69	980.12	1523.89	1983.04	2367.40	<b>(97)</b>
Space heating re	equirement	, kWh/mon	th 0.024 x	[(97)m - (9	5)m] x (41)	m							_
	1030.80	662.82	389.88	121.88	27.26	0.00	0.00	0.00	0.00	213.83	668.33	1087.80	
									∑(98	8)15, 10	.12 = 4	4202.61	(98)
Space heating re	equirement	kWh/m²/ye	ear							(98)	÷ (4)	38.21	] (99)
0		to alterial cont	h a attan au			CUD							
9a. Energy req	ulrements -	- Individual	neating sys	stems inclu	iding micro	O-CHP							
Space heating													Ъ
Fraction of spac	e heat from	secondary	/suppleme	ntary syste	m (table 11	1)						0.00	] (201) ¬
Fraction of spac	e heat from	n main syste	em(s)							1 - (2	01) =	1.00	(202)
Fraction of spac	e heat from	n main syste	em 2									0.00	(202)
Fraction of total	l space heat	from main	system 1						(20	02) x [1- (20	3)] =	1.00	(204)
Fraction of total	l space heat	from main	system 2							(202) x (2	03) =	0.00	(205)
Efficiency of ma	in system 1	(%)										90.20	(206)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fu	uel (main sy	stem 1), kV	vh/month										
	1142.79	734.84	432.24	135.12	30.22	0.00	0.00	0.00	0.00	237.06	740.94	1205.99	]
									∑(21:	1)15, 10	.12 = 4	4659.21	(211)
Water heating													-
Efficiency of wat	ter heater												
·	88.18	87.61	86.32	83.57	80.82	79.50	79.50	79.50	79.50	84.95	87.57	88.31	(217)
Water heating f	uel, kWh/m	onth		r <u> </u>	<b>.</b> .								, , ,
0	239.90	212.70	226.45	209.28	211.78	191.93	183.92	202.38	202.21	213.50	219.49	233.67	1
		1								5(2192)1	12 =	2547.20	ן   (210)
										۲/۲۰۶۵/۲۰۰			] (213)

## Annual totals



						1
Space heating fuel - main system 1					4659.21	
Water heating fuel					2547.20	
Electricity for pumps, fans and electric keep-hot (Table 4f)						
mechanical ventilation fans - balanced, extract or positive inp	ut from outside		457.62			(230a)
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					532.62	(231)
Electricity for lighting (Appendix L)					427.55	(232)
Total delivered energy for all uses		(21	11)(221) + (231) + (2	232)(237b) =	8166.58	(238)
10a. Fuel costs - individual heating systems including micro-CH	P					
	Fuel kWh/vear		Fuel price		Fuel cost £/vear	
Space heating - main system 1	4659.21	x	3 48	x 0 01 =	162 14	(240)
Water heating	2547.20	Ŷ	3.48	x = 0.01 =	88.64	(247)
	522.62	~	12.10	x 0.01 -	70.25	(247)
	332.02	×	13.19	x 0.01 -	70.25	] (249) ] (250)
	427.55	x	13.19	x 0.01 =	56.39	] (250)
Additional standing charges					120.00	] (251)
Total energy cost			(240)(242) +	(245)(254) =	497.43	(255)
11a. SAP rating - individual heating systems including micro-CH	IP					
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					1.35	(257)
SAP value					81.20	
						-
SAP rating (section 13)					81	(258)
SAP rating (section 13) SAP band					81 B	<b>(258)</b>

12a. CO<sub>2</sub> 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	4659.21	x	0.22	=	1006.39	(261)
Water heating	2547.20	x	0.22	=	550.20	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	1556.59	(265)
Pumps and fans	532.62	x	0.52	= [	276.43	(267)
Electricity for lighting	427.55	x	0.52	=	221.90	(268)
Total CO <sub>2</sub> , kg/year				(265)(271) =	2054.91	(272)
Dwelling CO <sub>2</sub> emission rate				(272) ÷ (4) =	18.68	(273)
El value					82.23	]
El rating (section 14)					82	(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	4659.21	] x	1.22	=	5684.24	(261)
Water heating	2547.20	] x	1.22	=	3107.59	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	8791.83	(265)
Pumps and fans	532.62	] x	3.07	=	1635.15	(267)
Electricity for lighting	427.55	] x	3.07	=	1312.57	(268)
Primary energy kWh/year					11739.54	(272)

**I**F NHER

# 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	Miss Cł	narlotte Boo	th				As	sessor num	nber	6376		
Client	Warmh	aze Ltd					La	st modified	I	23/01	/2015	
Address	12 17-2	27 & 25 Ferd	inand Stree	et. Camden	. London. N	IW1 8EX						
				,	,,,,,,,,,							
1. Overall dwelling d	limensions											
				A	area (m²)		Ave he	rage storey eight (m)		Vo	olume (m³)	
Lowest occupied					60.42	(1a) x		3.13	(2a) =		189.11	(3a)
Total floor area	(1:	a) + (1b) + (1	.c) + (1d)(	1n) = 🗌	60.42	(4)			-			
Dwelling volume						_	(3a)	) + (3b) + (3	c) + (3d)(3	8n) =	189.11	(5)
2. Ventilation rate												
										m	<sup>3</sup> per hour	
Number of chimneys								0	] x 40 =		0	(6a)
Number of open flues								0	] x 20 =		0	(6b)
Number of intermitter	nt fans							0	] x 10 =		0	(7a)
Number of passive ve	nts							0	] x 10 =		0	(7b)
Number of flueless ga	s fires							0	] x 40 =		0	(7c)
										Air	changes pe hour	r
Infiltration due to chir	nneys, flues, fa	ns, PSVs		(6a	) + (6b) + (7	a) + (7b) + (	7c) =	0	÷ (5) =		0.00	(8)
If a pressurisation test	t has been carri	ied out or is i	intended, p	roceed to (	(17), otherw	ise continue	e from (9) i	to (16)	<u> </u>			
Air permeability value	, q50, expresse	d in cubic m	etres per h	our per sq	uare metre	of envelope	e area				3.00	(17)
If based on air permea	ability value, th	en (18) = [(1	7) ÷ 20] + (8	8), otherwi	se (18) = (1	6)					0.15	(18)
Number of sides on w	hich the dwelli	ng is shelter	ed								3	(19)
Shelter factor								1 -	0.075 x (1	9)] =	0.78	(20)
Infiltration rate incorp	orating shelter	factor							(18) x (2	20) =	0.12	(21)
Infiltration rate modif	ied for monthly	wind speed	l:									
st	an Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind	d speed from Ta	able 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 ra	ate (allowing fo	or shelter and	d wind fact	or) (21) x (2	22a)m							_
0.	15 0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	(22b)
Calculate effective air	change rate fo	r the applica	ble case:									_
If mechanical venti	ilation: air chan	ige rate thro	ugh system	ı							0.50	(23a)
If balanced with he	eat recovery: ef	ficiency in %	allowing for	or in-use fa	ictor from T	able 4h					77.35	(23c)
a) If balanced mec	hanical ventilat	ion with hea	t recovery	(MVHR) (2	2b)m + (23	b) x [1 - (230	c) ÷ 100]					_
0.	26 0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(24a)
Effective air change ra	ite - enter (24a	) or (24b) or	(24c) or (24	4d) in (25)	- <u>-</u>							_
0.	26 0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(25)



3. Heat losses and heat loss parameter										
Element	Gross area, m <sup>2</sup>	Openings m <sup>2</sup>	Net a A, r	area m²	U-value W/m²K	A x U W	/К к-v kJ/	alue, /m².K	Ахк, kJ/K	
Window			12.3	12 x	0.87	= 10.53				(27)
External wall			27.0	01 x	0.16	= 4.32				(29a)
Party wall			69.	61 x	0.00	= 0.00				(32)
Total area of external elements ∑A, m <sup>2</sup>			39.:	13						(31)
Fabric heat loss, W/K = $\Sigma(A \times U)$						(26	5)(30) + (3	32) =	14.85	(33)
Heat capacity Cm = ∑(А х к)					(28)	.(30) + (32) +	+ (32a)(32	2e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m <sup>2</sup> K									250.00	(35)
Thermal bridges: $\Sigma(L \times \Psi)$ calculated using App	endix K								5.87	(36)
Total fabric heat loss							(33) + (3	36) =	20.72	(37)
Jan Feb Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	], ,
Ventilation heat loss calculated monthly 0.33	(25)m x (5)				-					
16.32 16.14 15.95	15.05	14.87	13.96	13.96	13.78	14.32	14.87	15.23	15.59	(38)
Heat transfer coefficient, W/K (37)m + (38)m		-								] ( )
37.04 36.86 36.68	35.77	35.59	34.68	34.68	34.50	35.04	35.59	35.95	36.31	]
					1	Average = $\Sigma$	(39)112/	12 =	35.72	(39)
Heat loss parameter (HLP), W/m <sup>2</sup> K (39)m ÷ (4)							.(33)112)		55.72	] (33)
0.61 0.61 0.61	0.59	0.59	0.57	0.57	0.57	0.58	0.59	0.59	0.60	]
						Average = ∑	(40)112/	12 =	0.59	(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 heating energy requirement										
										7
Assumed occupancy, N									1.99	<mark>(42)</mark>
Assumed occupancy, N Annual average hot water usage in litres per da	ny Vd,average	= (25 x N) + 3	36						1.99 81.55	] (42) ] (43)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar	y Vd,average <b>Apr</b>	= (25 x N) + 3 May	36 Jun	Jul	Aug	Sep	Oct	Nov	1.99 81.55 <b>Dec</b>	] (42) ] (43)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon	y Vd,average <b>Apr</b> th Vd,m = fact	= (25 x N) + May for from Tabl	36 Jun le 1c x (43)	Jul	Aug	Sep	Oct	Nov	1.99 81.55 Dec	] (42) ] (43)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 89.70 86.44 83.18	ny Vd,average <b>Apr</b> th Vd,m = fact 79.91	= (25 x N) + <b>May</b> for from Tabl	36 Jun le 1c x (43) 73.39	Jul ) 73.39	Aug 76.65	Sep 79.91	Oct 83.18	Nov 86.44	1.99 81.55 Dec 89.70	] (42) ] (43) ]
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 89.70 86.44 83.18	y Vd,average <b>Apr</b> th Vd,m = fact 79.91	= (25 x N) + May for from Tabl 76.65	36 Jun le 1c x (43) 73.39	Jul ) 73.39	Aug 76.65	Sep 79.91	Oct 83.18 Σ(44)1	Nov 86.44	1.99 81.55 <b>Dec</b> 89.70 978.54	] (42) ] (43) ] ] (44)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 89.70 86.44 83.18 Energy content of hot water used = 4.18 x Vd,r	y Vd,average <b>Apr</b> th Vd,m = fact 79.91	= (25 x N) + May or from Tabl 76.65 8600 kWh/me	36 Jun le 1c x (43) 73.39 onth (see	Jul ) 73.39 Tables 1b,	Aug 76.65 1c 1d)	Sep 79.91	Oct 83.18 Σ(44)1	Nov 86.44 12 =	1.99 81.55 Dec 89.70 978.54	] (42) ] (43) ] ] (44)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 89.70 86.44 83.18 Energy content of hot water used = 4.18 x Vd,r 133.02 116.34 120.00	y Vd,average <b>Apr</b> th Vd,m = fact 79.91 n x nm x Tm/3 5 104.67	= (25 x N) + May for from Tabl 76.65 8600 kWh/me 100.43	36 Jun le 1c x (43) 73.39 onth (see 1 86.66	Jul 73.39 Tables 1b, 80.31	Aug 76.65 1c 1d) 92.15	Sep 79.91 93.25	Oct 83.18 Σ(44)1 108.68	Nov 86.44 12 = 118.63	1.99 81.55 <b>Dec</b> 89.70 978.54 128.82	] (42) ] (43) ] ] (44)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 89.70 86.44 83.18 Energy content of hot water used = 4.18 x Vd,r 133.02 116.34 120.03	y Vd,average <b>Apr</b> th Vd,m = fact 79.91 n x nm x Tm/3 104.67	= (25 x N) + May for from Tabl 76.65 8600 kWh/ma 100.43	36 Jun le 1c x (43) 73.39 onth (see <sup>-</sup> 86.66	Jul 73.39 Tables 1b, 80.31	Aug 76.65 1c 1d) 92.15	Sep 79.91 93.25	Oct 83.18 Σ(44)1 108.68 Σ(45)1	Nov 86.44 12 = 118.63 12 =	1.99 81.55 Dec 89.70 978.54 128.82 1283.02	] (42) ] (43) ] (44) ] (44) ] (45)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 89.70 86.44 83.18 Energy content of hot water used = 4.18 x Vd,r 133.02 116.34 120.00 Distribution loss 0.15 x (45)m	y Vd,average <b>Apr</b> th Vd,m = fact 79.91 n x nm x Tm/3 104.67	= (25 x N) + 1 May for from Tabl 76.65 8600 kWh/mm 100.43	36 Jun le 1c x (43) 73.39 onth (see 1 86.66	Jul 73.39 Tables 1b, 80.31	Aug 76.65 1c 1d) 92.15	Sep 79.91 93.25	Oct 83.18 Σ(44)1 108.68 Σ(45)1	Nov 86.44 12 = 118.63 12 =	1.99 81.55 Dec 89.70 978.54 128.822 1283.02	] (42) ] (43) ] (44) ] (45)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 89.70 86.44 83.18 Energy content of hot water used = 4.18 x Vd,r 133.02 116.34 120.02 Distribution loss 0.15 x (45)m 19.95 17.45 18.01	y Vd,average Apr th Vd,m = fact 79.91 n x nm x Tm/3 104.67 15.70	= (25 x N) + May for from Tabl 76.65 3600 kWh/ma 100.43 15.06	36 Jun e 1c x (43) 73.39 onth (see 86.66	Jul 73.39 Tables 1b, 80.31	Aug 76.65 .1c 1d) 92.15 13.82	Sep 79.91 93.25 13.99	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30	Nov 86.44 12 = 118.63 12 = 17.79	1.99         81.55         Dec         89.70         978.54         128.82         128.82         128.3.02         19.32	] (42) ] (43) ] (44) ] (44) ] (45) ] (46)
Assumed occupancy, N Annual average hot water usage in litres per day I an Feb Mar Hot water usage in litres per day for each mon 89.70 $86.44$ $83.18Energy content of hot water used = 4.18 \times Vd,r133.02$ $116.34$ $120.02Distribution loss 0.15 \times (45)m19.95$ $17.45$ $18.01Water storage loss calculated for each month$	y Vd,average <b>Apr</b> th Vd,m = fact 79.91 n x nm x Tm/3 104.67 15.70 (55) x (41)m	= (25 x N) + 1 May for from Tabl 76.65 8600 kWh/mm 100.43	36 Jun le 1c x (43) 73.39 onth (see 86.66	Jul 73.39 Tables 1b, 80.31 12.05	Aug 76.65 1c 1d) 92.15 13.82	Sep 79.91 93.25 13.99	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30	Nov 86.44 12 = 118.63 12 = 17.79	1.99 81.55 Dec 89.70 978.54 128.822 1283.02 19.32	] (42) ] (43) ] (44) ] (44) ] (45) ] (46)
Assumed occupancy, N Annual average hot water usage in litres per day I an Feb Mar Hot water usage in litres per day for each mon $\boxed{89.70}$ $86.44$ $83.18$ Energy content of hot water used = $4.18 \times Vd$ ,r $\boxed{133.02}$ $116.34$ $120.03$ Distribution loss $0.15 \times (45)m$ $\boxed{19.95}$ $17.45$ $18.01$ Water storage loss calculated for each month $\boxed{0.00}$ $0.00$ $0.00$	y Vd,average Apr th Vd,m = fact 79.91 n x nm x Tm/3 104.67 15.70 (55) x (41)m 0.00	= (25 x N) + May for from Tabl 76.65 8600 kWh/mi 100.43 15.06	36 Jun le 1c x (43) 73.39 onth (see 86.66 13.00	Jul 73.39 Tables 1b, 80.31 12.05 0.00	Aug 76.65 1c 1d) 92.15 13.82	Sep 79.91 93.25 13.99 0.00	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30	Nov 86.44 12 = 118.63 12 = 17.79 0.00	1.99         81.55         Dec         89.70         978.54         128.82         128.82         128.82         19.32         0.000	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56)
Assumed occupancy, N Annual average hot water usage in litres per day Hot water usage in litres per day for each mon 89.70 $86.44$ $83.18Energy content of hot water used = 4.18 \times Vd,r133.02$ $116.34$ $120.02Distribution loss 0.15 \times (45)m19.95$ $17.45$ $18.01Water storage loss calculated for each month0.00$ $0.00$ $0.00If the vessel contains dedicated solar storage of$	y Vd,average Apr h Vd,m = fact 79.91 n x nm x Tm/3 104.67 15.70 (55) x (41)m 0.00 r dedicated W	= (25 x N) + 1 May for from Tabl 76.65 8600 kWh/me 100.43 15.06 0.00 /WHRS (56)n	36 Jun le 1c x (43) 73.39 onth (see 86.66 13.00 0.00 n x [(47) - \	Jul 73.39 Tables 1b, 80.31 12.05 0.00 Vs] ÷ (47),	Aug 76.65 1c 1d) 92.15 13.82 0.00 else (56)	Sep 79.91 93.25 13.99 0.00	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30	Nov 86.44 12 = 118.63 12 = 17.79 0.00	1.99 81.55 Dec 89.70 978.54 128.82 1283.02 19.32 0.00	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56)
Assumed occupancy, NAnnual average hot water usage in litres per dayJanFebMarHot water usage in litres per day for each mon $89.70$ $86.44$ $83.18$ Energy content of hot water used = $4.18 \times Vd$ ,r $133.02$ $116.34$ $120.02$ Distribution loss $0.15 \times (45)m$ $19.95$ $17.45$ $18.01$ Water storage loss calculated for each month $0.00$ $0.00$ $0.00$ If the vessel contains dedicated solar storage of $0.00$ $0.00$ $0.00$ $0.00$	y Vd,average Apr th Vd,m = fact 79.91 n x nm x Tm/3 104.67 15.70 (55) x (41)m 0.00 r dedicated W 0.00	= (25 x N) + May for from Tabl 76.65 8600 kWh/m 100.43 15.06 0.00 /WHRS (56)n 0.00	36 Jun le 1c x (43) 73.39 onth (see 86.66 13.00 0.00 n x [(47) - V 0.00	Jul 73.39 Tables 1b, 80.31 12.05 0.00 Vs] ÷ (47), 0.00	Aug 76.65 1c 1d) 92.15 13.82 13.82 else (56) 0.00	Sep 79.91 93.25 13.99 0.00	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30 0.00	Nov 86.44 12 = 118.63 12 = 17.79 0.00 0.00	1.99 81.55 Dec 89.70 978.54 128.82 128.82 128.82 19.32 0.00	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56) ] (57)
Assumed occupancy, N Annual average hot water usage in litres per day Hot water usage in litres per day for each mon 89.70 86.44 83.18 Energy content of hot water used = $4.18 \times Vd$ ,r 133.02 116.34 120.00 Distribution loss 0.15 x (45)m 19.95 17.45 18.01 Water storage loss calculated for each month 0.00 0.00 0.00 If the vessel contains dedicated solar storage of 0.00 0.00 0.00 Primary circuit loss for each month from Table	Apr Apr th Vd,m = fact 79.91 n x nm x Tm/3 104.67 15.70 (55) x (41)m 0.00 r dedicated W 0.00 3	= (25 x N) + 1 May for from Tabl 76.65 8600 kWh/me 100.43 15.06 0.00 /WHRS (56)n 0.00	36 Jun le 1c x (43) 73.39 onth (see 86.66 13.00 0.00 n x [(47) - V 0.00	Jul 73.39 Tables 1b, 80.31 12.05 0.00 Vs] ÷ (47), 0.00	Aug 76.65 1c 1d) 92.15 13.82 13.82 0.00 else (56) 0.00	Sep 79.91 93.25 13.99 0.00	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30 0.00	Nov 86.44 12 = 118.63 12 = 17.79 0.00 0.00	1.99 81.55 Dec 89.70 978.54 128.82 1283.02 19.32 0.00 0.00	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56) ] (57)
Assumed occupancy, NAnnual average hot water usage in litres per dayJanFebMarHot water usage in litres per day for each mon $89.70$ $86.44$ $83.18$ Energy content of hot water used = $4.18 \times Vd$ ,r $133.02$ $116.34$ $120.02$ Distribution loss $0.15 \times (45)m$ $19.95$ $17.45$ $18.01$ Water storage loss calculated for each month $0.00$ $0.00$ $0.00$ If the vessel contains dedicated solar storage of $0.00$ $0.00$ $0.00$ Primary circuit loss for each month from Table $0.00$ $0.00$ $0.00$	y Vd,average Apr th Vd,m = fact 79.91 n x nm x Tm/3 104.67 15.70 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00	= (25 x N) + 2 May cor from Tabl 76.65 8600 kWh/ma 100.43 15.06 0.00 /WHRS (56)n 0.00	36 Jun le 1c x (43) 73.39 onth (see 86.66 13.00 n x [(47) - V 0.00	Jul 73.39 Tables 1b, 80.31 12.05 0.00 Vs] ÷ (47), 0.00 0.00	Aug 76.65 .1c 1d) 92.15 13.82 13.82 else (56) 0.00	Sep 79.91 93.25 13.99 0.00 0.00	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30 0.00 0.00	Nov 86.44 12 = 118.63 12 = 17.79 0.00 0.00	1.99 81.55 Dec 89.70 978.54 128.82 1283.02 1283.02 0.00 0.00 0.00	) (42) (43) ) (44) ) (44) ) (45) ) (46) ) (56) ) (56) ) (57)
Assumed occupancy, NAnnual average hot water usage in litres per dayJanFebMarHot water usage in litres per day for each mon $89.70$ $86.44$ $83.18$ Energy content of hot water used = $4.18 \times Vd$ ,r $133.02$ $116.34$ $120.02$ Distribution loss $0.15 \times (45)m$ $19.95$ $17.45$ $18.01$ Water storage loss calculated for each month $0.00$ $0.00$ $0.00$ If the vessel contains dedicated solar storage of $0.00$ $0.00$ $0.00$ Primary circuit loss for each month from Table $0.00$ $0.00$ $0.00$	Apr Apr th Vd,m = fact 79.91 n x nm x Tm/3 104.67 15.70 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00 r 3c	= (25 x N) + 1 May for from Tabl 76.65 3600 kWh/m 100.43 15.06 0.00 /WHRS (56)n 0.00	36 Jun le 1c x (43) 73.39 onth (see 7 86.66 13.00 0.00 n x [(47) - V 0.00	Jul 73.39 Tables 1b, 80.31 12.05 0.00 Vs] ÷ (47), 0.00 0.00	Aug 76.65 1c 1d) 92.15 13.82 13.82 0.00 else (56) 0.00	Sep 79.91 93.25 13.99 0.00 0.00	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30 0.00 0.00	Nov 86.44 12 = 118.63 12 = 17.79 0.00 0.00 0.00	1.99 81.55 Dec 89.70 978.54 128.82 1283.02 19.32 0.00 0.00 0.00	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56) ] (57) ] (59)
Assumed occupancy, NAnnual average hot water usage in litres per dayJanFebMarHot water usage in litres per day for each mon $89.70$ $86.44$ $83.18$ Energy content of hot water used = $4.18 \times Vd$ ,r $133.02$ $116.34$ $120.02$ Distribution loss $0.15 \times (45)m$ $19.95$ $17.45$ $18.01$ Water storage loss calculated for each month $0.00$ $0.00$ If the vessel contains dedicated solar storage of $0.00$ $0.00$ Primary circuit loss for each month from Table $0.00$ $0.00$ Combi loss for each month from Table 3a, 3b of $45.71$ $39.79$ $42.39$	Apr Apr th Vd,m = fact 79.91 1 x nm x Tm/3 104.67 15.70 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00 r 3c 39.41	= (25 x N) + 1 May for from Tabl 76.65 8600 kWh/me 100.43 15.06 0.00 /WHRS (56)n 0.00 0.00 39.06	36 Jun le 1c x (43) 73.39 onth (see 86.66 13.00 0.00 n x [(47) - \ 0.00 0.00 36.19	Jul 73.39 Tables 1b, 80.31 12.05 0.00 Vs] ÷ (47), 0.00 0.00 37.40	Aug 76.65 1c 1d) 92.15 13.82 13.82 0.00 else (56) 0.00 else (56) 0.00	Sep 79.91 93.25 13.99 0.00 0.00 0.00	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30 0.00 0.00 0.00 42.39	Nov 86.44 12 = 118.63 12 = 17.79 0.00 0.00 0.00 42.63	1.99 81.55 Dec 89.70 978.54 128.82 1283.02 19.32 0.00 0.00 0.00 45.71	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56) ] (56) ] (57) ] (59) ] (61)
Assumed occupancy, NAnnual average hot water usage in litres per dayJanFebMarHot water usage in litres per day for each mon $89.70$ $86.44$ $83.18$ Energy content of hot water used = $4.18 \times Vd$ ,r $133.02$ $116.34$ $120.02$ Distribution loss $0.15 \times (45)m$ $0.00$ $0.00$ $0.00$ If the vessel contains dedicated solar storage of $0.00$ $0.00$ $0.00$ Primary circuit loss for each month from Table $0.00$ $0.00$ $0.00$ Combi loss for each month from Table 3a, 3b of $45.71$ $39.79$ $42.39$ Total heat required for water heating calculated	Apr Apr th Vd,m = fact 79.91 n x nm x Tm/3 104.67 15.70 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00 r dedicated W 3 0.00 r 3c 39.41 d for each mo	= (25 x N) + 1 May for from Table 76.65 3600 kWh/me 100.43 15.06 0.00 /WHRS (56)m 0.00 0.00 39.06 ponth 0.85 x (4)	36 Jun le 1c x (43) 73.39 onth (see 86.66 13.00 0.00 n x [(47) - \ 0.00 0.00 0.00 36.19 45)m + (46	Jul 73.39 Tables 1b, 80.31 12.05 0.00 Vs] ÷ (47), 0.00 0.00 37.40 5)m + (57)	Aug 76.65 1c 1d) 92.15 13.82 0.00 else (56) 0.00 else (56) 0.00 m + (59)m	Sep 79.91 93.25 13.99 0.00 0.00 0.00 39.41 + (61)m	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30 0.00 0.00 0.00 42.39	Nov 86.44 12 = 118.63 12 = 17.79 0.00 0.00 0.00 42.63	1.99         81.55         Dec         89.70         978.54         128.82         1283.02         19.32         0.00         0.00         0.00         45.71	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56) ] (57) ] (59) ] (61)
Assumed occupancy, NAnnual average hot water usage in litres per dayJanFebMarHot water usage in litres per day for each mon $89.70$ $86.44$ $83.18$ Energy content of hot water used = $4.18 \times Vd$ ,r $133.02$ $116.34$ $120.02$ Distribution loss $0.15 \times (45)m$ $0.00$ $0.00$ $0.00$ If the vessel contains dedicated solar storage of $0.00$ $0.00$ $0.00$ Primary circuit loss for each month from Table $0.00$ $0.00$ $0.00$ Combi loss for each month from Table 3a, 3b of $45.71$ $39.79$ $42.39$ Total heat required for water heating calculated $178.73$ $156.13$ $162.4$	Apr Apr th Vd,m = fact 79.91 n x nm x Tm/3 104.67 15.70 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00 r 3c 39.41 d for each mo 4 144.08	= (25 x N) + 1 May for from Tabl 76.65 3600 kWh/ma 100.43 15.06 0.00 /WHRS (56)m 0.00 0.00 39.06 onth 0.85 x (4 139.49	36 Jun le 1c x (43) 73.39 onth (see 86.66 13.00 0.00 n x [(47) - \ 0.00 0.00 36.19 45)m + (46 122.86	Jul 73.39 Tables 1b, 80.31 12.05 0.00 Vs] ÷ (47), 0.00 0.00 0.00 37.40 5)m + (57) 117.71	Aug 76.65 1c 1d) 92.15 13.82 13.82 0.00 else (56) 0.00 else (56) 0.00 39.06 m + (59)m -	Sep 79.91 93.25 13.99 0.00 0.00 0.00 39.41 + (61)m 132.66	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30 0.00 0.00 0.00 42.39 151.06	Nov 86.44 12 = 118.63 12 = 17.79 0.00 0.00 0.00 42.63 161.26	1.99 81.55 Dec 89.70 978.54 128.82 128.82 128.82 0.00 0.00 0.00 45.71 174.53	) (42) (43) ) (44) ) (44) ) (45) ) (46) ) (56) ) (56) ) (57) ] (59) ] (59) ] (61)
Assumed occupancy, NAnnual average hot water usage in litres per dayJanFebMarHot water usage in litres per day for each mon $89.70$ $86.44$ $83.18$ Energy content of hot water used = $4.18 \times Vd$ ,r $133.02$ $116.34$ $120.02$ Distribution loss $0.15 \times (45)m$ $19.95$ $17.45$ $18.01$ Water storage loss calculated for each month $0.00$ $0.00$ $0.00$ If the vessel contains dedicated solar storage or $0.00$ $0.00$ $0.00$ Primary circuit loss for each month from Table $0.00$ $0.00$ $0.00$ Combi loss for each month from Table 3a, 3b or $45.71$ $39.79$ $42.39$ Total heat required for water heating calculated $178.73$ $156.13$ $162.4$ Solar DHW input calculated using Appendix G or	Apr Apr th Vd,m = fact 79.91 1 x nm x Tm/3 104.67 15.70 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00 r 3c 39.41 d for each mo 4 144.08 pr Appendix H	= (25 x N) + 1 May for from Table 76.65 3600 kWh/me 100.43 15.06 0.00 /WHRS (56)m 0.00 0.00 39.06 onth 0.85 x (4 139.49	36 Jun le 1c x (43) 73.39 onth (see 7 86.66 13.00 0.00 n x [(47) - V 0.00 0.00 36.19 45)m + (46 122.86	Jul 73.39 7ables 1b, 80.31 12.05 0.00 Vs] ÷ (47), 0.00 0.00 37.40 5)m + (57) 117.71	Aug 76.65 1c 1d) 92.15 13.82 0.00 else (56) 0.00 0.00 0.00 39.06 m + (59)m	Sep 79.91 93.25 13.99 0.00 0.00 0.00 39.41 + (61)m 132.66	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30 0.00 0.00 0.00 42.39 151.06	Nov 86.44 12 = 118.63 12 = 17.79 0.00 0.00 0.00 42.63 161.26	1.99         81.55         Dec         89.70         978.54         128.82         128.82         128.3.02         19.32         0.00         0.00         0.00         45.71         174.53	) (42) (43) ) (44) ) (44) ) (45) ) (46) ) (56) ] (57) ] (59) ] (61) ] (62)
Assumed occupancy, NAnnual average hot water usage in litres per dayJanFebMarHot water usage in litres per day for each mon $89.70$ $86.44$ $83.18$ Energy content of hot water used = $4.18 \times Vd$ ,r $133.02$ $116.34$ $120.02$ Distribution loss $0.15 \times (45)m$ $19.95$ $17.45$ $18.01$ Water storage loss calculated for each month $0.00$ $0.00$ If the vessel contains dedicated solar storage of $0.00$ $0.00$ Primary circuit loss for each month from Table $0.00$ $0.00$ Combi loss for each month from Table 3a, 3b of $45.71$ $39.79$ $42.39$ Total heat required for water heating calculated $178.73$ $156.13$ $162.4$ Solar DHW input calculated using Appendix G of $0.00$ $0.00$ $0.00$	Apr Apr th Vd,m = fact 79.91 1 x nm x Tm/3 104.67 104.67 15.70 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00 r 3c 39.41 d for each mo 144.08 pr Appendix H 0.00	<ul> <li>= (25 x N) + 1</li> <li>May</li> <li>for from Table</li> <li>76.65</li> <li>3600 kWh/ma</li> <li>100.43</li> <li>100.43</li> <li>100.43</li> <li>100.43</li> <li>100.43</li> <li>100.43</li> <li>0.00</li> <li>0.00</li> <li>0.00</li> <li>0.00</li> <li>39.06</li> <li>0.00</li> <li>39.06</li> <li>0.00</li> <li>139.49</li> <li>0.00</li> </ul>	36 Jun le 1c x (43) 73.39 onth (see 86.66 13.00 0.00 n x [(47) - \ 0.00 0.00 36.19 45)m + (46 122.86 122.86	Jul 73.39 Tables 1b, 80.31 12.05 0.00 Vs] ÷ (47), 0.00 0.00 37.40 5)m + (57) 117.71 0.00	Aug 76.65 1c 1d) 92.15 13.82 13.82 0.00 else (56) 0.00 else (56) 0.00 39.06 m + (59)m - 131.21	Sep 79.91 93.25 13.99 0.00 0.00 0.00 39.41 + (61)m 132.66 0.00	Oct 83.18 Σ(44)1 108.68 Σ(45)1 16.30 0.00 0.00 0.00 42.39 151.06	Nov 86.44 12 = 118.63 12 = 17.79 0.00 0.00 0.00 42.63 161.26 0.00	1.99 81.55 Dec 89.70 978.54 128.82 128.82 1283.02 0.00 0.00 0.00 45.71 174.53 0.00	] (42) ] (43) ] (43) ] (44) ] (45) ] (45) ] (46) ] (56) ] (57) ] (59) ] (59) ] (61) ] (62) ] (63)



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

Output nom wa					, , ,							
	178.73	156.13	162.44	144.08	139.49	122.86	117.71	131.21	132.66	151.06	161.26	174.53
										∑(64)1	.12 = 🔤	1772.16 ( <mark>64)</mark>
Heat gains from	water hea	ting (kWh/	month) 0.2	5 × [0.85 ×	(45)m + (61	1)m] + 0.8 ×	[(46)m + (	57)m + (59)	m]			
	55.66	48.63	50.51	44.65	43.16	37.86	36.05	40.41	40.86	46.73	50.10	54.26 (65)
								-				
5. Internal gair	ıs											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Metabolic gains	(Table 5)											
0	99.67	99.67	99.67	99.67	99.67	99.67	99.67	99.67	99.67	99.67	99.67	99.67 (66)
Lighting gains (c	valculated in			19 or 19a)		able 5	55.07	55.07	55.07	55.07	55.07	
Lighting gains (C							6.40	0.05	10.00	40.74	46.00	
	16.60	14.74	11.99	9.08	6.79	5.73	6.19	8.05	10.80	13.71	16.00	17.06 (67)
Appliance gains	(calculated	I in Append	lix L, equation	on L13 or L:	13a), also s	ee Table 5						
	174.00	175.81	171.26	161.57	149.35	137.85	130.18	128.37	132.92	142.61	154.84	166.33 (68)
Cooking gains (c	alculated in	n Appendix	L, equatior	1 L15 or L15	a), also see	e Table 5						
	32.97	32.97	32.97	32.97	32.97	32.97	32.97	32.97	32.97	32.97	32.97	32.97 (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 (Ta	ble 5)	-!		!							
0 1	-79 74	-79 74	-79 74	-79 74	-79 74	-79 74	-79 74	-79 74	-79 74	-79 74	-79 74	-79 74 (71)
Water beating a	rains (Table	5)	75.74	75.74	1 75.74	15.74	75.74	75.74	75.74	75.74	75.74	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
water neating g		J 72 27	67.00	62.02	50.01	52.50	10.10	5424	56.75	62.04	co <b>5</b> 0	
	/4.81	/2.3/	67.90	62.02	58.01	52.59	48.46	54.31	56.75	62.81	69.59	/2.93 (/2)
Total internal ga	ains (66)m	+ (67)m + (	68)m + (69)	m + (70)m	+ (71)m + ( -	72)m				<b></b>		
	321.31	318.82	307.05	288.57	270.04	252.07	240.72	246.63	256.37	275.03	296.33	312.22 (73)
6 Solar gains												
6. Solar gains												- ·
6. Solar gains			Access	factor 6d	Area m²	Sol	ar flux //m²	spec	g ific data	FF specific o	lata	Gains W
6. Solar gains			Access Table	factor e 6d	Area m²	Sol W	ar flux V/m²	spec or T	g ific data able 6b	FF specific c or Table	data e 6c	Gains W
6. Solar gains			Access Table	factor e 6d	Area m <sup>2</sup>	Sol M	ar flux V/m <sup>2</sup>	speci or T	g ific data able 6b	FF specific c or Table	data 2 6c	Gains W
6. Solar gains East	atts 5(74)n	n (82)m	Access Table	factor e 6d 4 x	Area m <sup>2</sup> 12.12	Sol M	ar flux V/m² 9.64 x	speci or T 0.9 x	g ific data able 6b 0.50 x	FF specific o or Table 0.70	data e 6c =	Gains W 40.49 (76)
6. Solar gains East Solar gains in wa	atts Σ(74)n	n(82)m	Access Table	factor 2 6d 4 x	Area m <sup>2</sup> 12.12	Sol M	ar flux V/m <sup>2</sup> 9.64 x	speci or T 0.9 x (0)	g ific data able 6b 0.50 x	FF specific c or Table	data 2 6c	Gains W 40.49 (76)
6. Solar gains East Solar gains in wa	atts ∑(74)n 40.49	n(82)m	Access Table	factor e 6d 4 x [ 190.25	Area m <sup>2</sup> 12.12 233.15	Sol W X 1 238.67	ar flux V/m <sup>2</sup> 9.64 x	speci or T 0.9 x () 195.18	g ific data able 6b 0.50 x 151.71	FF specific c or Table 0.70 93.99	data • 6c = 50.49	Gains W 40.49 (76) 33.30 (83)
6. Solar gains East Solar gains in wa Total gains - inte	atts ∑(74)n 40.49 ernal and so	n(82)m 79.21 olar (73)m	Access - Table 0.5 130.44 + (83)m	factor e 6d 4 x [ 190.25	Area m <sup>2</sup> 12.12 233.15	Sol M x 1 238.67	ar flux //m <sup>2</sup> 9.64 x 227.23	speci or T 0.9 x (0) 195.18	g ific data able 6b 0.50 x 151.71	FF specific c or Table 0.70 93.99	data : 6c = 	Gains W 40.49 (76) 33.30 (83)
6. Solar gains East Solar gains in wa Total gains - inte	atts ∑(74)n 40.49 ernal and so 361.81	n(82)m 79.21 olar (73)m 398.03	Access Table 0.5 130.44 + (83)m 437.49	factor 6 d 4 x [ 190.25 478.82	Area m <sup>2</sup> 12.12 233.15 503.20	Sol W X 1 238.67 490.75	ar flux V/m <sup>2</sup> 9.64 x 227.23 467.95	speci or T 0.9 x ( 195.18 441.81	g ific data able 6b 0.50 x 151.71 408.08	FF specific c or Table 0.70 93.99 369.02	data e 6c 50.49 346.81	Gains W 40.49 (76) 33.30 (83) 345.52 (84)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in wa</li> <li>Total gains - interaction</li> <li>7. Mean interaction</li> </ul>	atts ∑(74)n 40.49 ernal and so 361.81	n(82)m 79.21 olar (73)m 398.03	Access Table 0.5 130.44 + (83)m 437.49	factor e 6d 4 x 190.25 478.82	Area m² 12.12 233.15 503.20	Sol M x 1 238.67 490.75	ar flux //m <sup>2</sup> 9.64 x 227.23 467.95	speci or T 0.9 x () 195.18 441.81	g ific data able 6b 0.50 x 151.71 408.08	FF specific c or Table 0.70 93.99 369.02	<b>data</b> e <b>6c</b> 50.49 346.81	Gains W 40.49 (76) 33.30 (83) 345.52 (84)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean interr</li> </ul>	atts ∑(74)n 40.49 ernal and so 361.81 nal tempera	n(82)m 79.21 olar (73)m 398.03 ature (heat	Access Table 0.5 130.44 + (83)m 437.49	factor 6 d 4 x [ 190.25 478.82	Area m <sup>2</sup> 12.12 233.15 503.20	Sol M X 1 238.67 490.75	ar flux //m <sup>2</sup> 9.64 x 227.23 467.95	speci or T 0.9 x () 195.18 441.81	g ific data able 6b 0.50 x 151.71 408.08	FF specific c or Table 0.70 93.99 369.02	<b>Jata</b> <b>6c</b> 50.49 346.81	Gains W 40.49 (76) 33.30 (83) 345.52 (84)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean interr</li> <li>Temperature du</li> </ul>	atts ∑(74)n 40.49 ernal and so 361.81 nal tempera	n(82)m 79.21 olar (73)m 398.03 ature (heat	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living	factor 6 d 4 x [ 190.25 478.82 area from T	Area m <sup>2</sup> 12.12 233.15 503.20 Fable 9, Th1	Sol w x 1 238.67 490.75	ar flux V/m <sup>2</sup> 9.64 x 227.23 467.95	speci or T 0.9 x ( 195.18 441.81	<b>g</b> ific data able 6b 0.50 x 151.71 408.08	FF specific c or Table 0.70 93.99 369.02	data = 6c = [ 50.49 346.81	Gains W (76) 33.30 (83) 345.52 (84) 21.00 (85)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean interr</li> <li>Temperature du</li> </ul>	atts ∑(74)n 40.49 ernal and so 361.81 nal tempera uring heatin Jan	n(82)m 79.21 olar (73)m 398.03 ature (heat ng periods i Feb	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar	factor 6 d 4 x [ 190.25 478.82 area from T Apr	Area m <sup>2</sup> 12.12 233.15 503.20 Fable 9, Th1 May	Sol M 238.67 490.75	ar flux //m <sup>2</sup> 9.64 x 2227.23 467.95 Jul	speci or T 0.9 x (0) 195.18 441.81	g ific data able 6b 0.50 x 151.71 408.08 Sep	FF specific c or Table 0.70 93.99 369.02 369.02	data e 6c 50.49 346.81	Gains W (76) 33.30 (83) 345.52 (84) 21.00 (85) Dec (85)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean interr</li> <li>Temperature du</li> <li>Utilisation facto</li> </ul>	atts ∑(74)n 40.49 ernal and so 361.81 nal tempera uring heatin Jan r for gains f	n(82)m 79.21 olar (73)m 398.03 ature (heat ng periods i Feb for living at	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar rea n1,m (se	factor 6 d 4 x [ 190.25 478.82 area from T Apr the Table 9a)	Area m <sup>2</sup> 12.12 233.15 503.20 Fable 9, Th1 May	Sol W X 1 238.67 490.75 1(°C) Jun	ar flux J/m <sup>2</sup> 9.64 x 227.23 467.95 Jul	speci or T 0.9 x ( 195.18 441.81 441.81	g ific data able 6b 0.50 x 151.71 408.08 Sep	FF specific c or Table 0.70 93.99 369.02 Oct	data e 6c = = [ 50.49 346.81 Nov	Gains W 40.49 (76) 33.30 (83) 345.52 (84) 21.00 (85) Dec
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in water</li> <li>Total gains - inter</li> <li>7. Mean interr</li> <li>Temperature du</li> <li>Utilisation factor</li> </ul>	atts $\Sigma(74)$ n 40.49 ernal and so 361.81 nal tempera uring heatin Jan r for gains f 1.00	n(82)m 79.21 olar (73)m 398.03 ature (heat ag periods i Feb for living an 0.99	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar rea n1,m (se 0.96	factor 6d 4 x [ 190.25 478.82 area from T Apr ee Table 9a) 0.85	Area m <sup>2</sup> 12.12 233.15 503.20 Table 9, Th1 May 0.65	Sol M 238.67 490.75 1(°C) Jun 0.45	ar flux //m <sup>2</sup> 9.64 x 2227.23 467.95 Jul 0.33	speci or T 0.9 x 0 195.18 441.81 Aug 0.36	g ific data able 6b 0.50 x 151.71 408.08 Sep 0.59	FF specific c or Table 0.70 93.99 369.02 369.02 Oct 0.90	data e 6c 50.49 346.81 Nov 0.99	Gains W 40.49 (76) 33.30 (83) 345.52 (84) 21.00 (85) Dec 1.00 (86)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean intern</li> <li>Temperature du</li> <li>Utilisation facto</li> <li>Mean internal to</li> </ul>	atts $\Sigma(74)$ n 40.49 ernal and so 361.81 nal tempera uring heatin Jan r for gains f 1.00 emp of livir	n(82)m 79.21 olar (73)m 398.03 ature (heat ng periods i Feb for living ar 0.99 ng area T1	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar rea n1,m (se 0.96 (steps 3 to 7	factor 6 d 4 x [ 190.25 478.82 478.82 area from 1 Apr ee Table 9a) 0.85 ' in Table 9c	Area m <sup>2</sup> 12.12 233.15 503.20 503.20	Sol M 238.67 490.75 1(°C) Jun 0.45	ar flux //m <sup>2</sup> 9.64 x 227.23 467.95 Jul 0.33	speci or T 0.9 x () 195.18 441.81 Aug 0.36	g ific data able 6b ).50 x 151.71 408.08 Sep 0.59	FF specific c or Table 0.70 93.99 369.02 369.02 Oct 0.90	data e 6c 50.49 346.81 Nov 0.99	Gains W 40.49 (76) 33.30 (83) 345.52 (84) 21.00 (85) Dec 1.00 (86)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in water</li> <li>Total gains - inter</li> <li>7. Mean intern</li> <li>Temperature du</li> <li>Utilisation factor</li> <li>Mean internal term</li> </ul>	atts $\Sigma(74)$ n 40.49 ernal and so 361.81 nal tempera uring heatin Jan r for gains f 1.00 emp of livir 20.56	n(82)m 79.21 olar (73)m 398.03 ature (heat ag periods i <b>Feb</b> for living an 0.99 ng area T1 ( 20.66	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar rea n1,m (se 0.96 (steps 3 to 7 20.81	factor 6d 4 x [ 190.25 478.82 478.82 area from T Apr ee Table 9a) 0.85 7 in Table 90 20.95	Area m <sup>2</sup> 12.12 233.15 503.20 Table 9, Th1 May 0.65 c) 21.00	Sol W X 1 238.67 490.75 (°C) Jun 0.45 21.00	ar flux y/m <sup>2</sup> 9.64 x 227.23 467.95 Jul 0.33 21.00	speci or T 0.9 x () 195.18 441.81 Aug 0.36 21.00	g ific data able 6b 0.50 x 151.71 408.08 Sep 0.59 21.00	FF specific c or Table 0.70 93.99 369.02 369.02 Oct 0.90	data e 6c = = [ 50.49 346.81 Nov 0.99 20.73	Gains W 40.49 (76) 33.30 (83) 345.52 (84) 21.00 (85) Dec 1.00 (86) 20.54 (87)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean interr</li> <li>Temperature du</li> <li>Utilisation facto</li> <li>Mean internal to</li> <li>Temperature du</li> </ul>	atts $\Sigma(74)$ n 40.49 ernal and so 361.81 nal temperation Jan r for gains f 1.00 emp of livir 20.56 uring heatin	n(82)m 79.21 olar (73)m 398.03 ature (heat ag periods i Feb for living an 0.99 ng area T1 20.66 ng periods i	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar rea n1,m (se 0.96 (steps 3 to 7 20.81 n the rest o	factor 6 d 4 x [ 190.25 478.82 478.82 area from T Apr ee Table 9a) 0.85 7 in Table 9c 20.95 f dwelling f	Area m <sup>2</sup> 12.12 233.15 503.20 503.20 Table 9, Th1 May 0.65 c) 21.00 rom Table 9	Sol M 238.67 238.67 490.75 (°C) Jun 0.45 0.45 21.00 9, Th2(°C)	ar flux //m <sup>2</sup> 9.64 x 227.23 467.95 Jul 0.33 21.00	speci or T 0.9 x () 195.18 441.81 441.81 Aug 0.36 21.00	g ific data able 6b 0.50 x 151.71 408.08 Sep 0.59 21.00	FF specific c or Table 0.70 93.99 369.02 369.02 0ct 0.90	data e 6c = = [ 50.49 346.81 Nov 0.99 20.73	Gains W 40.49 (76) 33.30 (83) 345.52 (84) 21.00 (85) Dec 1.00 (86) 20.54 (87)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in wather the solar gains - interperature du</li> <li>7. Mean internation facto</li> <li>Mean internation</li> <li>Mean internation</li> <li>Temperature du</li> </ul>	atts $\Sigma(74)$ n 40.49 ernal and so 361.81 nal tempera uring heatin Jan r for gains f 1.00 emp of livir 20.56 uring heatin 20.42	n(82)m 79.21 olar (73)m 398.03 ature (heat ag periods i <b>Feb</b> for living an 0.99 ng area T1 ( 20.66 ng periods i 20.42	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar rea n1,m (se 0.96 (steps 3 to 7 20.81 n the rest o 20.42	factor 6d 4 x [ 190.25 478.82 478.82 area from T Apr te Table 9a 0.85 7 in Table 9c 20.95 f dwelling f 20.44	Area m <sup>2</sup> 12.12 233.15 503.20 503.20 Table 9, Th1 May 0.65 c) 21.00 rom Table 9	Sol W 238.67 238.67 490.75 1(°C) Jun 0.45 21.00 9, Th2(°C) 20.45	ar flux J/m <sup>2</sup> 9.64 x 227.23 467.95 Jul 0.33 21.00 20.45	speci or T 0.9 x () 195.18 441.81 441.81 0.36 21.00 20.46	g ific data able 6b 0.50 x 151.71 408.08 Sep 0.59 21.00	FF specific c or Table 0.70 93.99 369.02 369.02 0.02 0.02	data e 6c = [ 50.49 346.81 Nov 0.99 20.73 20.43	Gains W 40.49 (76) 33.30 (83) 345.52 (84) 21.00 (85) Dec 1.00 (86) 20.54 (87) 20.43 (88)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in water</li> <li>Total gains - inter</li> <li>7. Mean interres</li> <li>Temperature du</li> <li>Utilisation factor</li> <li>Mean internal to</li> <li>Temperature du</li> <li>Utilisation factor</li> </ul>	atts $\Sigma(74)$ n 40.49 ernal and so 361.81 nal tempera uring heatin Jan r for gains f 1.00 emp of livir 20.56 uring heatin 20.42 r for gains f	n(82)m 79.21 olar (73)m 398.03 ature (heat ag periods i 0.99 ng area T1 ( 20.66 ng periods i 20.42 for rest of	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar rea n1,m (se 0.96 (steps 3 to 7 20.81 n the rest o 20.42 dwelling n2	factor 6d 4 x ( 190.25 478.82 478.82 area from T Apr ee Table 9a 0.85 7 in Table 9a 20.95 f dwelling f 20.44 m	Area m <sup>2</sup> 12.12 233.15 503.20 503.20 Table 9, Th1 May 0.65 c) 21.00 rom Table 9	Sol M 238.67 238.67 490.75 (°C) Jun 0.45 21.00 9, Th2(°C) 20.45	ar flux //m <sup>2</sup> 9.64 x 227.23 467.95 Jul 0.33 21.00 20.45	speci or T 0.9 x () 195.18 441.81 441.81 Aug 0.36 21.00 20.46	g ific data able 6b 0.50 x 151.71 408.08 Sep 0.59 21.00 20.45	FF specific c or Table 0.70 93.99 369.02 369.02 0.ct 0.90 20.93	data e 6c 50.49 346.81 Nov 0.99 20.73 20.43	Gains W 40.49 (76) 33.30 (83) 345.52 (84) 21.00 (85) Dec 1.00 (86) 20.54 (87) 20.43 (88)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in wather the solar gains - internation factor of the solar gains - internation - int</li></ul>	atts $\Sigma(74)$ n 40.49 ernal and so 361.81 nal temperation Jan r for gains f 1.00 emp of livir 20.56 uring heatin 20.42 r for gains f	n(82)m 79.21 olar (73)m 398.03 ature (heat ag periods i Feb for living an 0.99 ng area T1 ( 20.66 ng periods i 20.42 for rest of 0	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar rea n1,m (se 0.96 (steps 3 to 7 20.81 n the rest o 20.42 dwelling n2,	factor 6d 4 x [ 190.25 478.82 478.82 478.82 area from T Apr e Table 9a 0.85 7 in Table 9c 20.95 f dwelling f 20.44 m	Area m <sup>2</sup> 12.12 233.15 503.20 503.20 Fable 9, Th1 May 0.65 c) 21.00 rom Table 9 20.44	Sol M 238.67 238.67 490.75 1(°C) Jun 0.45 21.00 9, Th2(°C) 20.45	ar flux //m <sup>2</sup> 9.64 x 227.23 467.95 Jul 0.33 21.00 20.45	speci or T 0.9 x () 195.18 441.81 441.81 Aug 0.36 21.00 20.46	g ific data able 6b ).50 x 151.71 408.08 Sep 0.59 21.00 20.45	FF specific c or Table 0.70 93.99 369.02 369.02 0.02 0.90 20.93 20.44	data e 6c = = [ 50.49 346.81 Nov 0.99 20.73 20.43	Gains W 40.49 (76) 33.30 (83) 345.52 (84) 21.00 (85) Dec 1.00 (86) 20.54 (87) 20.43 (88)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in water</li> <li>Total gains - inter</li> <li>7. Mean interres</li> <li>7. Mean interres</li> <li>Utilisation facto</li> <li>Mean internal to</li> <li>Temperature du</li> <li>Utilisation facto</li> </ul>	atts $\Sigma(74)$ n 40.49 ernal and so 361.81 nal tempera uring heatin Jan r for gains t 1.00 emp of livir 20.56 uring heatin 20.42 r for gains t 0.99	n(82)m 79.21 olar (73)m 398.03 ature (heat ag periods i Feb for living an 0.99 ng area T1 ( 20.66 ng periods i 20.42 for rest of ( 0.99	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar rea n1,m (se 0.96 (steps 3 to 7 20.81 n the rest o 20.42 dwelling n2, 0.95 t of dwalling	factor 6d 4 x [ 190.25 478.82 478.82 area from T Apr ee Table 9a) 0.85 7 in Table 9c 20.95 f dwelling f 20.44 m 0.82 7 20.44	Area m <sup>2</sup> 12.12 233.15 503.20 Table 9, Th1 May 0.65 c) 21.00 rom Table 9 20.44	Sol W 238.67 238.67 490.75 (°C) Jun 0.45 21.00 9, Th2(°C) 20.45 0.41 7 in Table 2	ar flux J/m <sup>2</sup> 9.64 x 227.23 467.95 Jul 0.33 21.00 20.45 0.29	speci or T 0.9 x () 195.18 441.81 441.81 0.36 21.00 20.46 0.32	g ific data able 6b 0.50 x 151.71 408.08 Sep 0.59 21.00 20.45 0.54	FF specific c or Table 0.70 93.99 369.02 369.02 0.02 0.20 20.93 20.93	data e 6c = [ 50.49 346.81 Nov 0.99 20.73 20.43 0.98	Gains W 40.49 (76) 33.30 (83) 345.52 (84) 21.00 (85) Dec 1.00 (86) 20.54 (87) 20.43 (88) 1.00 (89)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in wather the second second</li></ul>	atts $\Sigma(74)$ n 40.49 ernal and so 361.81 al tempera uring heatin Jan r for gains f 20.56 uring heatin 20.42 r for gains f 0.99 emperature	n(82)m 79.21 olar (73)m 398.03 ature (heat ag periods i Feb for living an 0.99 ng area T1 ( 20.66 ng periods i 20.42 for rest of ( 0.99 e in the res	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar rea n1,m (se 0.96 (steps 3 to 7 20.81 n the rest o 20.42 dwelling n2, 0.95 t of dwelling	factor 6d 4 x [ 190.25 478.82 478.82 area from T Apr e Table 9a) 0.85 7 in Table 9c 20.95 f dwelling f 20.44 m 0.82 g T2 (follow	Area m <sup>2</sup> 12.12 233.15 503.20 50 503.20 50 50 50 50 50 50 50 50 50 50 50 50 50	Sol M 238.67 238.67 490.75 1(°C) Jun 0.45 21.00 9, Th2(°C) 20.45 0.41 7 in Table S	ar flux //m <sup>2</sup> 9.64 x 2227.23 467.95 Jul 0.33 21.00 20.45 0.29 Dc)	speci or T 0.9 x 0 195.18 441.81 Aug 0.36 21.00 20.46 0.32	g ific data able 6b ).50 x 151.71 408.08 Sep 0.59 21.00 20.45 0.54	FF specific c or Table 0.70 93.99 369.02 369.02 0.02 0.90 20.93 20.44	data e 6c = = [ 50.49 346.81 Nov 0.99 20.73 20.43 0.98	Gains W 40.49 (76) 33.30 (83) 345.52 (84) 21.00 (85) Dec 1.00 (86) 20.54 (87) 20.43 (88) 1.00 (89)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in wather the solar gains of t</li></ul>	atts $\Sigma(74)$ n 40.49 ernal and so 361.81 nal tempera uring heatin Jan r for gains f 1.00 emp of livir 20.56 uring heatin 20.42 r for gains f 0.99 emperature 20.01	n(82)m 79.21 olar (73)m 398.03 ature (heat og periods i Feb for living an 0.99 ng area T1 ( 20.66 ng periods i 20.42 for rest of ( 0.99 e in the res 20.11	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar rea n1,m (se 0.96 (steps 3 to 7 20.81 n the rest o 20.42 dwelling n2, 0.95 t of dwelling 20.26	factor 6d 4 x [ 190.25 478.82 478.82 area from T Apr e Table 9a 0.85 7 in Table 9c 20.95 f dwelling f 20.44 m 0.82 g T2 (follow 20.40	Area m <sup>2</sup> 12.12 233.15 503.20 503.20 503.20 503.20 503.20 20.44 20.44	Sol W 238.67 238.67 490.75 1(°C) Jun 0.45 21.00 9, Th2(°C) 20.45 0.41 7 in Table 9 20.45	ar flux J/m <sup>2</sup> 9.64 x 227.23 467.95 Jul 0.33 21.00 20.45 0.29 9c) 20.45	speci or T 0.9 x 0 195.18 441.81 441.81 0.36 21.00 20.46 0.32 20.46	g         ific data         able 6b         0.50       x         151.71         408.08         Sep         0.59         21.00         20.45         0.54         20.45	FF specific c or Table 0.70 93.99 369.02 369.02 0.02 0.02 20.93 20.44 0.87 0.87	<pre>data e 6c</pre>	Gains W 40.49 (76) 33.30 (83) 345.52 (84) 21.00 (85) Dec 1.00 (86) 20.54 (87) 20.43 (88) 1.00 (89) 20.01 (90)
<ul> <li>6. Solar gains</li> <li>East</li> <li>Solar gains in wather a state of the state of the</li></ul>	atts $\Sigma(74)$ n 40.49 ernal and so 361.81 nal temperation Jan r for gains f 1.00 emp of livir 20.56 uring heatin 20.42 r for gains f 0.99 emperature 20.01 ion	n(82)m 79.21 olar (73)m 398.03 ature (heat ag periods i Feb for living an 0.99 ng area T1 ( 20.66 ng periods i 20.42 for rest of ( 0.99 e in the ress 20.11	Access Table 0.5 130.44 + (83)m 437.49 ing season) n the living Mar rea n1,m (se 0.96 (steps 3 to 7 20.81 n the rest o 20.42 dwelling n2, 0.95 t of dwelling 20.26	factor 6d 4 x ( 190.25 478.82 478.82 478.82 area from T Apr ee Table 9a) 0.85 7 in Table 9a 20.95 f dwelling f 20.44 m 0.82 g T2 (follow 20.40	Area m <sup>2</sup> 12.12 233.15 503.20 503.20 Table 9, Th1 May 0.65 c) 21.00 rom Table 9 20.44	Sol M 238.67 238.67 490.75 490.75 0.45 21.00 9, Th2(°C) 20.45 0.41 7 in Table 9 20.45	ar flux //m <sup>2</sup> 9.64 x 2227.23 467.95 Jul 0.33 21.00 20.45 0.29 9c) 20.45	speci or T 0.9 x 0 195.18 441.81 441.81 0.36 21.00 20.46 0.32	g         ific data         able 6b         0.50       x         151.71         408.08         Sep         0.59         21.00         20.45         0.54         20.45         Live	FF specific c or Table 0.70 93.99 369.02 369.02 0.02 0.20.93 20.93 20.44 0.87 20.39 20.39	data e 6c = [ 50.49 346.81 Nov 0.99 20.73 20.43 0.98 20.20 (4) = [	Gains         40.49       (76)         33.30       (83)         345.52       (84)         21.00       (85)         Dec       (86)         1.00       (86)         20.54       (87)         20.43       (88)         1.00       (89)         20.01       (90)         0.41       (91)



Mean internal t	emperature	for the wh	ole dwellin	g fLA x T1 -	+(1 - fLA) >	(T2							
	20.23	20.33	20.48	20.63	20.67	20.68	20.68	20.68	20.67	20.61	20.41	20.22	(92)
Apply adjustme	nt to the m	ean internal	temperati	ure from Ta	able 4e wh	nere appropr	iate						
	20.08	20.18	20.33	20.48	20.52	20.53	20.53	20.53	20.52	20.46	20.26	20.07	(93)
8. Space heati	ng requiren	nent											
	Jan	Feb	Mar	Apr	Mav	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	or for gains.	nm		•					•		_		
	0.99	0.98	0.95	0.82	0.62	0.42	0.29	0.32	0.55	0.87	0.98	1.00	(94)
Useful gains, ŋn	nGm, W (94	1)m x (84)m											
	359.50	391.90	415.42	393.65	311.90	205.51	136.20	142.44	224.59	322.78	340.46	343.90	(95)
Monthly averag	ge external t	emperature	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 fo	or mean inte	ernal tempe	rature, Lm	, W [(39)m	n x [(93)m	- (96)m]							_
	584.57	563.32	507.39	414.12	313.72	205.55	136.20	142.44	225.08	351.02	473.22	576.46	(97)
Space heating r	equirement	, kWh/mon	th 0.024 x	[(97)m - (9	5)m] x (41	L)m						·	
	167.45	115.20	68.43	14.74	1.35	0.00	0.00	0.00	0.00	21.01	95.58	173.02	
									Σ(9)	8)15, 10	.12 =	656.78	(98)
Space heating r	equirement	kWh/m²/ye	ear							(98)	÷ (4)	10.87	(99)
		امريانينامر			uling unio								
Sa. Ellergy req	uirements ·	· maividuai	neating sys	stems inclu		0-CHP							
Space neating	a haat from	cocondanu	/cupplomo	ntany aveta	m (tabla 1	11)						0.00	(201)
Fraction of space	e fieat from	main syste	(suppleme	ntary syste	in (table 1	11)				1 (2)	 11) – [	1.00	(201)
Fraction of space	e heat from	main syste	m 2							1 - (20	J1) – [	0.00	(202)
Fraction of tota	l snace heat	from main	system 1						(20	)2) v [1_ (20	3)] =	1.00	(202)
Fraction of tota	l snace heat	from main	system 2						(20	(202) x (20	)3) = [	0.00	(205)
Efficiency of ma	in system 1	(%)	System 2							(202) x (2		90.00	(206)
,	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating f	uel (main sy	stem 1), kW	/h/month					C C	•				
	186.05	128.00	76.03	16.38	1.50	0.00	0.00	0.00	0.00	23.35	106.21	192.25	7
	L							•	Σ(21)	1)15, 10	.12 =	729.76	(211)
Water heating													_
Efficiency of wa	ter heater												
	84.49	83.90	82.65	80.74	79.99	79.90	79.90	79.90	79.90	81.01	83.38	84.63	(217)
Water heating f	<sup>f</sup> uel, kWh/m	onth											
	211.55	186.09	196.54	178.44	174.39	153.76	147.32	164.22	166.04	186.47	193.39	206.24	
										∑(219a)1	.12 = 2	2164.47	(219)
Annual totals													
Space heating f	uel - main sy	ystem 1										729.76	
Water heating f	uel											2164.47	
Electricity for p	umps, fans a	and electric	keep-hot (	Table 4f)						-			
mechanical	ventilation f	ans - balanc	ced, extract	t or positive	e input fro	om outside			253.79				(230a)
central heat	ing pump or	water pum	ıp within w	arm air hea	ating unit				30.00				(230c)
boiler flue fa	an								45.00				(230e)
Total electricity	for the abo	ve, kWh/ye	ar									328.79	(231)
Electricity for lig	ghting (Appe	endix L)										293.14	(232)
Total delivered	energy for a	all uses						(211)(221	.) + (231) +	(232)(237	7b) =	3516.17	(238)



10a. Fuel costs - individual heating systems including micro-CH	IP					
	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	729.76	x	3.48	x 0.01 =	25.40	(240)
Water heating	2164.47	x	3.48	x 0.01 =	75.32	(247)
Pumps and fans	328.79	x	13.19	x 0.01 =	43.37	(249)
Electricity for lighting	293.14	x	13.19	x 0.01 =	38.67	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242) -	+ (245)(254) =	302.75	(255)
11a. SAP rating - individual heating systems including micro-Cl	ΗP					
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (FCE)					1 21	) (257)
					83.17	] (237)
SAP rating (section 13)					83	] ] (258)
SAP hand					B	] (238)
12a. CO <sub>2</sub> emissions - individual heating systems including micr	o-CHP					
	Energy kWh/year		Emission factor kg CO₂/kWh		Emissions kg CO₂/year	
Space heating - main system 1	729.76	x	0.22	=	157.63	(261)
Water heating	2164.47	x	0.22	=	467.53	(264)
Space and water heating			(261) + (262) +	- (263) + (264) =	625.15	(265)
Pumps and fans	328.79	x	0.52	=	170.64	(267)
Electricity for lighting	293.14	x	0.52	=	152.14	(268)

, , ,			-
Total CO₂, kg/year		(265)(271) =	
Dwelling CO₂ emission rate		(272) ÷ (4) =	
El value			
El rating (section 14)			
El band			

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	729.76	x	1.22	=	890.31	(261)
Water heating	2164.47	x	1.22	=	2640.65	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	3530.96	(265)
Pumps and fans	328.79	x	3.07	=	1009.39	(267)
Electricity for lighting	293.14	x	3.07	=	899.95	(268)
Primary energy kWh/year					5440.31	(272)
Dwelling primary energy rate kWh/m2/year					90.04	(273)

947.94

15.69

87.95

88

В

(272)

(273)

(274)

# 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	Miss Cha	arlotte Boot	:h				As	sessor num	iber	6376		
Client	Warmha	ze Ltd					La	st modified		23/01	/2015	
Address	7 17-27	& 25 Ferdin	and Street	, Camden,	London, NV	V1 8EX						
				, ,	,							
1. Overall dwelling dimen	sions											
				А	area (m²)		Ave he	rage storey eight (m)		Vo	lume (m³)	
Lowest occupied					66.22	] (1a) x		3.13	] (2a) =		207.27	(3a)
Total floor area	(1a	) + (1b) + (1	c) + (1d)(	1n) =	66.22	(4)						
Dwelling volume							(3a)	+ (3b) + (3	c) + (3d)(3	n) =	207.27	(5)
2. Ventilation rate												
										m	<sup>3</sup> per hour	
Number of chimneys								0	x 40 =		0	(6a)
Number of open flues								0	x 20 =		0	(6b)
Number of intermittent far	IS							0	x 10 =		0	(7a)
Number of passive vents								0	x 10 =		0	(7b)
Number of flueless gas fire	S							0	x 40 =		0	(7c)
									-	Air	changes pe hour	r
Infiltration due to chimney	s, flues, fan	s, PSVs		(6a)	+ (6b) + (7	a) + (7b) + (	7c) =	0	÷ (5) =		0.00	(8)
, If a pressurisation test has	, been carrie	d out or is i	ntended, p	roceed to (	17), otherw	ise continue	e from (9) i	to (16)	] ()			
Air permeability value, q50	, expressed	l in cubic m	etres per h	our per squ	uare metre	of envelope	e area				3.00	(17)
If based on air permeability	value, the	n (18) = [(1	7) ÷ 20] + (8	8), otherwi	se (18) = (1	6)					0.15	(18)
Number of sides on which t	the dwellin	g is sheltere	ed								3	(19)
Shelter factor								1 -	[0.075 x (19	9)] =	0.78	(20)
Infiltration rate incorporati	ng shelter i	factor							(18) x (2	0) =	0.12	(21)
Infiltration rate modified for	or monthly	wind speed	:									
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind spee	ed from Tal	ble 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 (a	llowing for	shelter and	d wind fact	or) (21) x (2	22a)m							
0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	(22b)
Calculate effective air chan	ge rate for	the applica	ble case:									_
If mechanical ventilation	n: air chang	ge rate thro	ugh system	ı							0.50	(23a)
If balanced with heat re	covery: eff	iciency in %	allowing for	or in-use fa	ctor from T	able 4h					77.35	(23c)
a) If balanced mechanic	al ventilatio	on with hea	t recovery	(MVHR) (2	2b)m + (23l	b) x [1 - (230	c) ÷ 100]					_
0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(24a)
Effective air change rate - e	enter (24a)	or (24b) or	(24c) or (24	4d) in (25)	1		1	<b>I</b>				_
0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(25)



3. Heat losses and heat loss parameter										
Element	Gross area, m <sup>2</sup>	Openings m <sup>2</sup>	Net a A, ı	area m²	U-value W/m²K	A x U W	/К к-v kJ/	alue, /m².K	Ахк, kJ/K	
Window			25.	90 x	0.87	= 22.50				(27)
External wall			37.	22 x	0.16	= 5.96				(29a)
Party wall			21.	12 x	0.00	= 0.00				(32)
Total area of external elements ∑A, m <sup>2</sup>			63.	12						(31)
Fabric heat loss, W/K = ∑(A × U)						(26	)(30) + (3	32) =	28.46	(33)
Heat capacity Cm = Σ(A x κ)					(28)	(30) + (32) +	· (32a)(32	2e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K									250.00	(35)
Thermal bridges: $\Sigma(L \times \Psi)$ calculated using App	endix K								9.47	(36)
Total fabric heat loss							(33) + (3	36) =	37.92	(37)
Jan Feb Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33	x (25)m x (5)									
17.88 17.69 17.49	16.49	16.29	15.30	15.30	15.10	15.70	16.29	16.69	17.09	(38)
Heat transfer coefficient, W/K $(37)m + (38)m$										
55.81 55.61 55.4	. 54.42	54.22	53.22	53.22	53.02	53.62	54.22	54.61	55.01	]
						Average = ∑	(39)112/	12 =	54.37	(39)
Heat loss parameter (HLP), W/m <sup>2</sup> K (39)m $\div$ (4	1									
0.84 0.84 0.84	0.82	0.82	0.80	0.80	0.80	0.81	0.82	0.82	0.83	]
						Average = ∑	(40)112/	12 =	0.82	(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 heating energy requirement										
Assumed occupancy. N									2.15	(42)
Assumed occupancy, N Annual average hot water usage in litres per d	av Vd.average :	= (25 x N) + 3	36						2.15	] (42) ] (43)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar	ay Vd,average = <b>Apr</b>	= (25 x N) + 3 May	36 Jun	Jul	Aug	Sep	Oct	Nov	2.15 85.29 Dec	] (42) ] (43)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor	ay Vd,average = <b>Apr</b> th Vd,m = facto	= (25 x N) + : <b>May</b> or from Tabl	36 Jun le 1c x (43)	Jul	Aug	Sep	Oct	Nov	2.15 85.29 Dec	] (42) ] (43)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99	ay Vd,average = <b>Apr</b> th Vd,m = facto 83.58	= (25 x N) + <b>May</b> or from Tabl 80.17	36 Jun le 1c x (43) 76.76	Jul ) 76.76	Aug 80.17	Sep 83.58	<b>Oct</b> 86.99	Nov	2.15 85.29 Dec 93.81	] (42) ] (43)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99	ay Vd,average = <b>Apr</b> th Vd,m = facto 83.58	= (25 x N) + <b>May</b> or from Tabl 80.17	36 Jun le 1c x (43) 76.76	Jul ) 76.76	Aug 80.17	<b>Sep</b> 83.58	<b>Oct</b> 86.99 Σ(44)1	Nov 90.40	2.15 85.29 Dec 93.81 1023.43	] (42) ] (43) ] ] (44)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = 4.18 x Vd,	ay Vd,average = <b>Apr</b> th Vd,m = facto 83.58 n x nm x Tm/30	= (25 x N) + <b>May</b> or from Tabl 80.17 600 kWh/ma	36 Jun le 1c x (43) 76.76	Jul ) 76.76 Tables 1b,	Aug 80.17 1c 1d)	<b>Sep</b> 83.58	Oct 86.99 ∑(44)1	<b>Nov</b> 90.40 12 =	2.15 85.29 <b>Dec</b> 93.81 1023.43	] (42) ] (43) ] ] (44)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = 4.18 x Vd, 139.12 121.68 125.5	ay Vd,average = <b>Apr</b> th Vd,m = facto 83.58 n x nm x Tm/30 6 109.47	= (25 x N) + May or from Tabl 80.17 600 kWh/me 105.04	36 Jun le 1c x (43) 76.76 onth (see <sup>-</sup> 90.64	Jul 76.76 Tables 1b, 83.99	Aug 80.17 1c 1d) 96.38	Sep 83.58 97.53	<b>Oct</b> 86.99 Σ(44)1 113.66	Nov 90.40 12 = 124.07	2.15 85.29 Dec 93.81 1023.43 134.73	] (42) ] (43) ] ] (44)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = 4.18 x Vd, 139.12 121.68 125.5	ay Vd,average = <b>Apr</b> th Vd,m = facto 83.58 n x nm x Tm/30 6 109.47	= (25 x N) + <b>May</b> or from Tabl 80.17 600 kWh/ma 105.04	36 Jun le 1c x (43) 76.76 onth (see 90.64	Jul 76.76 Tables 1b, 83.99	Aug 80.17 1c 1d) 96.38	<b>Sep</b> 83.58 97.53	<b>Oct</b> 86.99 Σ(44)1 113.66 Σ(45)1	Nov 90.40 12 = 124.07 12 =	2.15 85.29 Dec 93.81 1023.43 134.73 1341.88	] (42) ] (43) ] (44) ] (44) ] (45)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = 4.18 x Vd, 139.12 121.68 125.5 Distribution loss 0.15 x (45)m	ay Vd,average = <b>Apr</b> th Vd,m = facto 83.58 n x nm x Tm/30 6 109.47	= (25 x N) + May or from Tabl 80.17 600 kWh/ma 105.04	36 Jun le 1c x (43) 76.76 onth (see 90.64	Jul 76.76 Tables 1b, 83.99	Aug 80.17 1c 1d) 96.38	Sep 83.58 97.53	Oct 86.99 Σ(44)1 113.66 Σ(45)1	Nov 90.40 12 = 124.07 12 =	2.15 85.29 Dec 93.81 1023.43 1341.88	] (42) ] (43) ] (44) ] (44) ] (45)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = $4.18 \times Vd$ , 139.12 121.68 125.5 Distribution loss 0.15 x (45)m 20.87 18.25 18.83	ay Vd,average = <b>Apr</b> th Vd,m = factor 83.58 m x nm x Tm/3 6 109.47 16.42	= (25 x N) + 1 May or from Tabl 80.17 600 kWh/m 105.04 15.76	36 Jun le 1c x (43) 76.76 onth (see 90.64 13.60	Jul 76.76 Tables 1b, 83.99 12.60	Aug 80.17 1c 1d) 96.38	Sep 83.58 97.53 14.63	Oct 86.99 Σ(44)1 113.66 Σ(45)1 17.05	Nov 90.40 12 = 124.07 12 = 18.61	2.15 85.29 Dec 93.81 1023.43 1341.88 20.21	] (42) ] (43) ] (44) ] (44) ] (45) ] (46)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = $4.18 \times Vd$ , 139.12 121.68 125.5 Distribution loss 0.15 x (45)m 20.87 18.25 18.85 Water storage loss calculated for each month	ay Vd,average = <b>Apr</b> th Vd,m = facto 83.58 m x nm x Tm/30 6 109.47 6 16.42 (55) x (41)m	= (25 x N) + May or from Tabl 80.17 600 kWh/mm 105.04 15.76	36 Jun 1c x (43) 76.76 0nth (see 90.64 13.60	Jul 76.76 Tables 1b, 83.99 12.60	Aug 80.17 1c 1d) 96.38 14.46	Sep 83.58 97.53 14.63	Oct 86.99 Σ(44)1 113.66 Σ(45)1 17.05	Nov 90.40 12 = 124.07 12 = 18.61	2.15 85.29 Dec 93.81 1023.43 1341.88 20.21	] (42) ] (43) ] (44) ] (44) ] (45) ] (46)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = $4.18 \times Vd$ , 139.12 121.68 125.5 Distribution loss 0.15 x (45)m 20.87 18.25 18.83 Water storage loss calculated for each month 0.00 0.00 0.00	ay Vd,average = <b>Apr</b> th Vd,m = factor 8 83.58 m x nm x Tm/30 6 109.47 8 16.42 (55) x (41)m 0.00	= (25 x N) + 1 May or from Tabl 80.17 600 kWh/mm 105.04 15.76 0.00	36 Jun 16 1c x (43) 76.76 0nth (see 90.64 13.60	Jul 76.76 Tables 1b, 83.99 12.60 0.00	Aug 80.17 1c 1d) 96.38 14.46	Sep 83.58 97.53 14.63 0.00	Oct 86.99 Σ(44)1 113.66 Σ(45)1 17.05 0.00	Nov 90.40 12 = 124.07 12 = 18.61 0.00	2.15 85.29 Dec 93.81 1023.43 1341.88 20.21 0.00	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = $4.18 \times Vd$ , 139.12 121.68 125.5 Distribution loss $0.15 \times (45)m$ 20.87 18.25 18.83 Water storage loss calculated for each month 0.00 0.00 0.00 If the vessel contains dedicated solar storage of	Ay Vd,average = Apr th Vd,m = facto 8 83.58 m x nm x Tm/3 6 109.47 6 109.47 6 16.42 (55) x (41)m 0.00 or dedicated W	= (25 x N) + 1 May or from Tabl 80.17 600 kWh/m 105.04 15.76 0.00 WHRS (56)n	36 Jun le 1c x (43) 76.76 000th (see 90.64 13.60 0.00 n x [(47) - 1	Jul 76.76 Tables 1b, 83.99 12.60 0.00 Vs] ÷ (47),	Aug 80.17 1c 1d) 96.38 14.46 0.00 else (56)	Sep 83.58 97.53 14.63 0.00	Oct 86.99 Σ(44)1 113.66 Σ(45)1 17.05 0.00	Nov 90.40 12 = 124.07 12 = 18.61 0.00	2.15 85.29 Dec 93.81 1023.43 1341.88 20.21 0.00	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = $4.18 \times Vd$ , 139.12 121.68 125.5 Distribution loss 0.15 x (45)m 20.87 18.25 18.85 Water storage loss calculated for each month 0.00 0.00 0.00 If the vessel contains dedicated solar storage of 0.00 0.00 0.00	ay Vd,average = <b>Apr</b> th Vd,m = factor 8 83.58 m x nm x Tm/30 6 109.47 8 16.42 (55) x (41)m 0.00 or dedicated W 0.00	= (25 x N) + 1 May or from Tabl 80.17 600 kWh/m 105.04 15.76 0.00 WHRS (56)n 0.00	36 Jun le 1c x (43) 76.76 00.06 13.60 0.00 n x [(47) - 1 0.00	Jul 76.76 Tables 1b, 83.99 12.60 0.00 Vs] ÷ (47), 0.00	Aug 80.17 1c 1d) 96.38 14.46 0.00 else (56) 0.00	Sep 83.58 97.53 14.63 0.00	Oct 86.99 Σ(44)1 113.66 Σ(45)1 17.05 0.00 0.00	Nov 90.40 12 = 124.07 12 = 18.61 0.00	2.15 85.29 Dec 93.81 1023.43 1341.88 20.21 0.00 0.00	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56) ] (57)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = $4.18 \times Vd$ , 139.12 121.68 125.5 Distribution loss $0.15 \times (45)m$ 20.87 18.25 18.83 Water storage loss calculated for each month 0.00 0.00 0.00 If the vessel contains dedicated solar storage of 0.00 0.00 0.00 Primary circuit loss for each month from Table	Apr Apr th Vd,m = factor 83.58 n x nm x Tm/3 6 109.47 6 109.47 6 55) x (41)m 0.00 or dedicated W 0.00 3	= (25 x N) + 1 May or from Tabl 80.17 600 kWh/m 105.04 15.76 0.00 WHRS (56)n 0.00	36 Jun le 1c x (43) 76.76 000th (see 90.64 13.60 0.00 n x [(47) - 1 0.00	Jul 76.76 Tables 1b, 83.99 12.60 0.00 Vs] ÷ (47), 0.00	Aug 80.17 1c 1d) 96.38 14.46 14.46 else (56) 0.00	Sep 83.58 97.53 14.63 0.00	Oct 86.99 Σ(44)1 113.66 Σ(45)1 17.05 0.00	Nov 90.40 12 = 124.07 12 = 18.61 0.00 0.00	2.15 85.29 Dec 93.81 1023.43 1341.88 20.21 0.00 0.00	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56) ] (57)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = $4.18 \times Vd_{e}$ 139.12 121.68 125.5 Distribution loss $0.15 \times (45)m$ 20.87 18.25 18.83 Water storage loss calculated for each month 0.00 0.00 0.00 If the vessel contains dedicated solar storage of 0.00 0.00 0.00 Primary circuit loss for each month from Table 0.00 0.00 0.00	Apr Apr th Vd,m = facto 83.58 n x nm x Tm/30 109.47 16.42 (55) x (41)m 0.00 or dedicated W 0.00 3 0.00	= (25 x N) + 1 May or from Tabl 80.17 600 kWh/ma 105.04 15.76 0.00 WHRS (56)n 0.00 0.00	36 Jun le 1c x (43) 76.76 0nth (see 90.64 13.60 13.60 n x [(47) - \ 0.00	Jul 76.76 Tables 1b, 83.99 12.60 0.00 Vs] ÷ (47), 0.00 0.00	Aug 80.17 1c 1d) 96.38 14.46 0.00 else (56) 0.00 0.00	Sep 83.58 97.53 14.63 0.00 0.00	Oct 86.99 $\Sigma(44)1$ 113.66 $\Sigma(45)1$ 17.05 0.00 0.00 0.00	Nov 90.40 12 = 124.07 12 = 18.61 0.00 0.00	2.15 85.29 Dec 93.81 1023.43 1341.88 20.21 0.00 0.00	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56) ] (57) ] (59)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = $4.18 \times Vd$ , 139.12 121.68 125.5 Distribution loss $0.15 \times (45)m$ 20.87 18.25 18.83 Water storage loss calculated for each month 0.00 0.00 0.00 If the vessel contains dedicated solar storage of 0.00 0.00 0.00 Primary circuit loss for each month from Table 0.00 0.00 0.00 Combi loss for each month from Table 3a, 3b of	Apr Apr th Vd,m = factor 83.58 n x nm x Tm/30 6 109.47 6 109.47 8 16.42 (55) x (41)m 0.00 10.00	= (25 x N) + 1 May or from Tabl 80.17 600 kWh/m 105.04 15.76 0.00 WHRS (56)n 0.00 0.00	36 Jun [e 1c x (43) 76.76 000th (see 90.64 13.60 0.00 n x [(47) - 1 0.00	Jul 76.76 Tables 1b, 83.99 12.60 0.00 Vs] ÷ (47), 0.00 0.00	Aug 80.17 1c 1d) 96.38 14.46 0.00 else (56) 0.00 0.00	Sep 83.58 97.53 14.63 0.00 0.00	Oct 86.99 Σ(44)1 113.66 Σ(45)1 17.05 0.00 0.00 0.00	Nov 90.40 12 = 124.07 12 = 18.61 0.00 0.00	2.15 85.29 Dec 93.81 1023.43 1341.88 20.21 0.00 0.00	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56) ] (57) ] (59)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = $4.18 \times Vd$ , 139.12 121.68 125.5 Distribution loss $0.15 \times (45)m$ 20.87 18.25 18.8 Water storage loss calculated for each month 0.00 0.00 0.00 If the vessel contains dedicated solar storage of 0.00 0.00 0.00 Primary circuit loss for each month from Table 0.00 0.00 0.00 Combi loss for each month from Table 3a, 3b of 47.81 41.61 44.33	Apr Apr th Vd,m = facto 83.58 m x nm x Tm/30 109.47 16 109.47 55) x (41)m 0.00 0 r dedicated W 0.00 3 0.00 0 3 41.22	= (25 x N) + 4 May or from Tabl 80.17 600 kWh/ma 105.04 15.76 0.00 WHRS (56)n 0.00 0.00 40.85	36 Jun le 1c x (43) 76.76 0nth (see 90.64 13.60 0.00 n x [(47) - \ 0.00 0.00 37.85	Jul 76.76 Tables 1b, 83.99 12.60 0.00 Vs] ÷ (47), 0.00 0.00 39.11	Aug 80.17 1c 1d) 96.38 14.46 0.00 else (56) 0.00 0.00 40.85	Sep 83.58 97.53 14.63 0.00 0.00 41.22	Oct 86.99 Σ(44)1 113.66 Σ(45)1 17.05 0.00 0.00 0.00 44.33	Nov 90.40 12 = 124.07 12 = 18.61 0.00 0.00 0.00 0.00	2.15 85.29 Dec 93.81 1023.43 1341.88 20.21 0.00 0.00 0.00 47.81	] (42) ] (43) ] (44) ] (44) ] (45) ] (45) ] (46) ] (56) ] (57) ] (59) ] (61)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = $4.18 \times Vd$ , 139.12 121.68 125.5 Distribution loss $0.15 \times (45)m$ 20.87 18.25 18.83 Water storage loss calculated for each month 0.00 0.00 0.00 If the vessel contains dedicated solar storage of 0.00 0.00 0.00 Primary circuit loss for each month from Table 0.00 0.00 0.00 Combi loss for each month from Table 3a, 3b of 47.81 41.61 44.33 Total heat required for water heating calculated	Apr Apr th Vd,m = factor 83.58 n x nm x Tm/30 109.47 109.47 109.47 109.47 109.47 109.47 0.00 0.00 0.00 3 0.00 0 41.22 od for each model	= (25 x N) + 1 May or from Tabl 80.17 600 kWh/m 105.04 15.76 0.00 WHRS (56)n 0.00 0.00 40.85 nth 0.85 x (4)	36 Jun le 1c x (43) 76.76 90.64 13.60 13.60 n x [(47) - 1 0.00 0.00 37.85 45)m + (46	Jul 76.76 Tables 1b, 83.99 12.60 0.00 Vs] ÷ (47), 0.00 0.00 39.11 5)m + (57)r	Aug 80.17 1c 1d) 96.38 14.46 0.00 else (56) 0.00 0.00 40.85 m + (59)m -	Sep 83.58 97.53 14.63 0.00 0.00 41.22 + (61)m	Oct 86.99 Σ(44)1 113.66 Σ(45)1 17.05 0.00 0.00 0.00 44.33	Nov 90.40 12 = 124.07 12 = 18.61 0.00 0.00 0.00 44.58	2.15 85.29 Dec 93.81 1023.43 1341.88 20.21 0.00 0.00 47.81	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56) ] (56) ] (57) ] (59) ] (61)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = $4.18 \times Vd$ , 139.12 121.68 125.5 Distribution loss $0.15 \times (45)m$ 20.87 18.25 18.83 Water storage loss calculated for each month 0.00 0.00 0.00 If the vessel contains dedicated solar storage of 0.00 0.00 0.00 Primary circuit loss for each month from Table 0.00 0.00 0.00 Combi loss for each month from Table 3a, 3b of 47.81 41.61 44.33 Total heat required for water heating calculated 186.93 163.29 169.8	Apr Apr th Vd,m = facto 83.58 n x nm x Tm/3 6 109.47 6 109.47 6 109.47 6 109.47 6 109.47 6 109.47 7 0.00 0.00 0 or 3 0.00 0 or 0 or 3 0.00 0 or 3 0 0.00 0 or 3 0.00 0 or 3 0.00 0 or 3 0.00 0 or 3 0.00 0 or 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	= (25 x N) + 1 May or from Tabl 80.17 600 kWh/m 105.04 15.76 0.00 WHRS (56)n 0.00 0.00 40.85 nth 0.85 x (7 145.89	36 Jun le 1c x (43) 76.76 90.64 13.60 0.00 n x [(47) - \ 0.00 0.00 37.85 45)m + (46 128.49	Jul 76.76 Tables 1b, 83.99 12.60 0.00 Vs] ÷ (47), 0.00 0.00 39.11 5)m + (57)r 123.10	Aug 80.17 1c 1d) 96.38 14.46 0.00 else (56) 0.00 0.00 40.85 m + (59)m - 137.23	Sep 83.58 97.53 97.53 14.63 0.00 0.00 0.00 41.22 + (61)m 138.75	Oct 86.99 Σ(44)1 113.66 Σ(45)1 17.05 0.00 0.00 0.00 44.33 157.99	Nov 90.40 12 = 124.07 12 = 18.61 0.00 0.00 0.00 0.00 44.58	2.15 85.29 Dec 93.81 1023.43 1341.88 20.21 0.00 0.00 0.00 47.81 182.54	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56) ] (56) ] (57) ] (59) ] (61) ] (62)
Assumed occupancy, N Annual average hot water usage in litres per d Jan Feb Mar Hot water usage in litres per day for each mor 93.81 90.40 86.99 Energy content of hot water used = $4.18 \times Vd_{e}$ 139.12 121.68 125.5 Distribution loss $0.15 \times (45)m$ 20.87 18.25 18.83 Water storage loss calculated for each month 0.00 0.00 0.00 If the vessel contains dedicated solar storage of 0.00 0.00 0.00 Primary circuit loss for each month from Table 0.00 0.00 0.00 Combi loss for each month from Table 3a, 3b of 47.81 41.61 44.33 Total heat required for water heating calculated 186.93 163.29 169.8 Solar DHW input calculated using Appendix G	Apr Apr th Vd,m = factor 83.58 n x nm x Tm/30 109.47 109.47 16 109.47 16 109.47 16 109.47	= (25 x N) + 1 May or from Tabl 80.17 600 kWh/ma 105.04 15.76 0.00 WHRS (56)n 0.00 0.00 40.85 nth 0.85 x (a 145.89	36 Jun le 1c x (43) 76.76 0nth (see 90.64 13.60 13.60 0.00 n x [(47) - \ 0.00 0.00 37.85 45)m + (46 128.49	Jul 76.76 Tables 1b, 83.99 12.60 0.00 Vs] ÷ (47), 0.00 0.00 0.00 39.11 5)m + (57)r 123.10	Aug 80.17 1c 1d) 96.38 14.46 0.00 else (56) 0.00 0.00 40.85 m + (59)m - 137.23	Sep 83.58 97.53 14.63 0.00 0.00 0.00 41.22 + (61)m 138.75	Oct 86.99 Σ(44)1 113.66 Σ(45)1 17.05 0.00 0.00 0.00 44.33 157.99	Nov 90.40 12 = 124.07 12 = 18.61 0.00 0.00 0.00 0.00 44.58 168.65	2.15 85.29 Dec 93.81 1023.43 1341.88 20.21 0.00 0.00 0.00 47.81 182.54	] (42) ] (43) ] (44) ] (44) ] (45) ] (46) ] (56) ] (56) ] (57) ] (59) ] (61) ] (62)



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

	186.93	163.29	169.89	150.69	145.89	128.49	123.10	137.23	138.75	157.99	168.65	182.54	]
										∑(64)1	.12 =	1853.45	(64)
Heat gains from	water heat	ting (kWh/n	nonth) 0.2	5 × [0.85 ×	(45)m + (62	1)m] + 0.8 ×	[(46)m + (	57)m + (59)	m]				
	58.21	50.86	52.83	46.70	45.14	39.60	37.71	42.26	42.73	48.88	52.40	56.75	(65)
		•	•	•	•		•		•		•	•	-
5. Internal gair	าร												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains	(Table 5)												
	107.55	107.55	107.55	107.55	107.55	107.55	107.55	107.55	107.55	107.55	107.55	107.55	(66)
Lighting gains (c	alculated in	n Appendix	L, equation	1 L9 or L9a),	, also see Ta	able 5							
	16.79	14.91	12.13	9.18	6.86	5.79	6.26	8.14	10.92	13.87	16.19	17.26	(67)
Appliance gains	(calculated	in Appendi	ix L, equati	on L13 or L	13a), also s	ee Table 5							
	188.32	190.27	185.35	174.87	161.63	149.19	140.89	138.93	143.86	154.34	167.57	180.01	(68)
Cooking gains (c	alculated ir	n Appendix	L, equatior	L15 or L15	; a), also see	e Table 5					•		_
	33.75	33.75	33.75	33.75	33.75	33.75	33.75	33.75	33.75	33.75	33.75	33.75	(69)
Pump and fan ø	ains (Table	5a)									1		] ()
	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)
		1 5.00 hle 51	5.00	5.00	1 3.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	
Losses e.g. evap			86.04	86.04	86.04	96.04	96.04	96.04	96.04	86.04	86.04	86.04	] (71)
Mater besting	-80.04	-80.04	-80.04	-80.04	-80.04	-80.04	-80.04	-80.04	-80.04	-80.04	-80.04	-80.04	] (/1)
water neating g		5)								<u> </u>			] (==)
	/8.24	/5.69	/1.01	64.86	60.67	55.00	50.68	56.80	59.35	65.69	/2./8	76.28	] (72)
l otal internal ga	ains (66)m -	+ (67)m + (6 T	58)m + (69)	m + (70)m	+ (71)m + (	72)m				[	1	1	1
	341.61	339.14	326.75	307.18	287.43	268.25	256.09	262.13	272.39	292.16	314.80	331.81	] (73)
6. Solar gains													
6. Solar gains			Access	factor	Area	Sol	ar flux		g	FF		Gains	
6. Solar gains			Access Table	factor e 6d	Area m²	Sol W	ar flux //m²	spec	g ific data	FF specific o	data	Gains W	
6. Solar gains			Access Table	factor e 6d	Area m²	Sol W	ar flux //m²	spec or T	g ific data able 6b	FF specific o or Table	data e 6c	Gains W	
6. Solar gains West			Access Table	factor e 6d 7 x	<b>Area</b> m <sup>2</sup> 7.40	Sol W	ar flux //m² 9.64 x	spec or T 0.9 x (	g ific data able 6b	FF specific o or Table	data 2 6c = [	<b>Gains</b> W 35.25	] (80)
6. Solar gains West North			Access Table 0.7	factor 2 6d 7 x [ 7 x [	Area m <sup>2</sup> 7.40 11.10	Sol W X X	ar flux //m² 9.64 x 0.63 x	spec or T 0.9 x ( 0.9 x (	g ific data able 6b 0.50 x 0.50 x	FF specific o or Table 0.70 0.70	data 2 6c = [ = [	Gains W 35.25 28.63	] (80) ] (74)
6. Solar gains West North NorthEast			Access Table 0.7 0.7 0.7	factor e 6d 7 x [ 7 x [ 7 x [	Area m <sup>2</sup> 7.40 11.10 7.40	Sol W X 1 X 1 X 1 X 1	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x	spec or T 0.9 x ( 0.9 x ( 0.9 x (	g ific data able 6b ).50 x ).50 x ).50 x	FF specific c or Table 0.70 0.70	data e 6c = [ = [ = [	Gains W 35.25 28.63 20.25	] (80) ] (74) ] (75)
6. Solar gains West North NorthEast Solar gains in wa	atts ∑(74)m	n(82)m	Access - Table 0.7 0.7 0.7	factor 2 6d 7 x [ 7 x [ 7 x [	Area m <sup>2</sup> 7.40 11.10 7.40	Sol M x 1 x 1 x 1 x 1	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x	spec or T 0.9 x (0 0.9 x (0 0.9 x (0	<b>g</b> ific data able 6b 0.50 x 0.50 x 0.50 x	FF specific c or Table 0.70 0.70	data 2 6c = [ = [	Gains W 35.25 28.63 20.25	] (80) ] (74) ] (75)
6. Solar gains West North NorthEast Solar gains in wa	atts ∑(74)m	n(82)m	Access Table 0.7 0.7 0.7 0.7	factor e 6d 7 x [ 7 x [ 7 x [ 7 x [ 436.93	Area m <sup>2</sup> 7.40 11.10 7.40 568.10	Sol W X 1 X 1 X 1 597.93	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39	spec or T 0.9 x (0 0.9 x (0 0.9 x (0 459.80	g ific data able 6b 0.50 x 0.50 x 0.50 x 0.50 x	FF specific c or Table 0.70 0.70 0.70	data e 6c = = [ = = [ = = [ 104.75	Gains W 35.25 28.63 20.25 69.39	] (80) ] (74) ] (75) ] (83)
6. Solar gains West North NorthEast Solar gains in wa Total gains - inte	atts ∑(74)m 84.13 ernal and sc	n(82)m 164.89 plar (73)m +	Access - Table 0.7 0.7 0.7 280.80 - (83)m	factor 2 6d 7 x 7 7 x 7 7 x 7 436.93	Area m <sup>2</sup> 7.40 11.10 7.40 568.10	Sol M x 1 x 1 x 1 597.93	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39	spec or T 0.9 x (0 0.9 x (0 0.9 x (0 459.80	<b>g</b> ific data able 6b 0.50 x 0.50 x 0.50 x 0.50 x 334.36	FF specific c or Table 0.70 0.70 0.70 197.33	data e 6c = [ = [ = [ ]	Gains W 35.25 28.63 20.25 69.39	] (80) ] (74) ] (75) ] (83)
6. Solar gains West North NorthEast Solar gains in wa Total gains - inte	atts ∑(74)m 84.13 ernal and sc 425.74	n(82)m 164.89 blar (73)m +	Access Table 0.7 0.7 0.7 280.80 - (83)m	factor e 6d 7 x [ 7 x [ 7 x [ 7 x [ 436.93	Area m <sup>2</sup> 7.40 11.10 7.40 568.10	Sol W X 1 X 1 X 1 597.93	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48	spec or T 0.9 x (0 0.9 x (0 0.9 x (0 459.80	g ific data able 6b 0.50 x 0.50 x 0.50 x 0.50 x 334.36	FF specific c or Table 0.70 0.70 0.70 197.33	data e 6c = = [ = = [ 104.75 419.55	Gains W 35.25 28.63 20.25 69.39 401.20	] (80) ] (74) ] (75) ] (83) ] (84)
6. Solar gains West North NorthEast Solar gains in wa Total gains - inte	atts ∑(74)m 84.13 ernal and sc 425.74	n(82)m 164.89 blar (73)m + 504.03	Access - Table 0.7 0.7 0.7 280.80 - (83)m 607.55	factor 2 6d 7 x 7 7 x 7 7 x 7 436.93 744.11	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 855.53	Sol M x 1 x 1 x 1 597.93	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48	spec or T 0.9 x (0 0.9 x (0 0.9 x (0 459.80 721.93	<b>g</b> ific data able 6b 0.50 x 0.50 x 0.50 x 334.36 606.75	FF specific o or Table 0.70 0.70 0.70 197.33	data e 6c = = [ = = [ = 104.75 419.55	Gains W 35.25 28.63 20.25 69.39 401.20	] (80) ] (74) ] (75) ] (83) ] (84)
<ul> <li>6. Solar gains</li> <li>West</li> <li>North</li> <li>NorthEast</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean interr</li> </ul>	atts $\Sigma(74)$ m 84.13 ernal and sc 425.74 nal tempera	n(82)m 164.89 Dlar (73)m + 504.03	Access Table 0.7 0.7 0.7 280.80 - (83)m 607.55	factor 6 d 7 x [ 7 x [ 7 x [ 436.93 744.11	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 855.53	Sol W X 1 X 1 X 1 597.93	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48	spec or T 0.9 x (0 0.9 x (0 0.9 x (0 459.80 721.93	<b>g</b> ific data able 6b 0.50 x 0.50 x 0.50 x 334.36 606.75	FF specific c or Table 0.70 0.70 0.70 197.33	data e 6c = [ = [ = [ 104.75 419.55	Gains W 35.25 28.63 20.25 69.39 69.39	] (80) ] (74) ] (75) ] (83) ] (84)
<ul> <li>6. Solar gains</li> <li>West</li> <li>North</li> <li>NorthEast</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean interr</li> <li>Temperature du</li> </ul>	atts ∑(74)m 84.13 ernal and sc 425.74 nal tempera uring heatin	n(82)m 164.89 blar (73)m + 504.03 sture (heating periods in	Access Table 0.7 0.7 0.7 0.7 280.80 (83)m 607.55 ng season) n the living	factor e 6d 7 x [ 7 x [ 7 x [ 436.93 744.11 area from 7	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 855.53	Sol M x 1 x 1 x 1 597.93 866.18	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48	spec or T 0.9 x (0 0.9 x (0 0.9 x (0 459.80 721.93	<b>g</b> ific data able 6b 0.50 x 0.50 x 0.50 x 334.36 606.75	FF specific c or Table 0.70 0.70 197.33 489.49	data e 6c = = [ = = [ = 104.75 419.55	Gains W 35.25 28.63 20.25 69.39 69.39 401.20	] (80) ] (74) ] (75) ] (83) ] (84) ] (85)
<ul> <li>6. Solar gains</li> <li>West</li> <li>North</li> <li>NorthEast</li> <li>Solar gains in water</li> <li>Total gains - inter</li> <li>7. Mean interr</li> <li>Temperature due</li> </ul>	atts ∑(74)m 84.13 ernal and sc 425.74 hal tempera uring heatin Jan	n(82)m 164.89 blar (73)m + 504.03 ture (heati g periods ir Feb	Access Table 0.7 0.7 0.7 280.80 (83)m 607.55 ng season) n the living Mar	factor 6 d 7 x [ 7 x [ 7 x [ 436.93 744.11 area from 7 Apr	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 568.10 855.53 Fable 9, Th: May	Sol W X 1 X 1 X 1 597.93 866.18	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48 Jul	spec or T 0.9 x (0 0.9 x (0 0.9 x (0 459.80 721.93	<b>g</b> ific data able 6b ).50 x ).50 x ).50 x ).50 x (x) 334.36 (c) 606.75	FF specific c or Table 0.70 0.70 197.33 489.49 Oct	data e 6c = [ = [ ] = [ ] 104.75 419.55 [ 419.55	Gains W 35.25 28.63 20.25 20.25 69.39 401.20 401.20 21.00 <b>Dec</b>	] (80) ] (74) ] (75) ] (83) ] (84) ] (85)
<ul> <li>6. Solar gains</li> <li>West</li> <li>North</li> <li>NorthEast</li> <li>Solar gains in watering</li> <li>Total gains - intering</li> <li>7. Mean intering</li> <li>Temperature du</li> <li>Utilisation facto</li> </ul>	atts ∑(74)m 84.13 ernal and sc 425.74 hal tempera uring heatin Jan or for gains f	n(82)m 164.89 blar (73)m + 504.03 sture (heating g periods in Feb For living and	Access = Table 0.7 0.7 0.7 280.80 (83)m 607.55 ng season) n the living Mar ea n1,m (se	factor 2 6d 7 x [ 7 x [ 7 x [ 7 x [ 436.93 436.93 744.11 area from 7 Apr re Table 9a)	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 855.53 Table 9, Th: May	Sol M x 1 x 1 x 1 597.93 866.18	ar flux 1/m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48 Jul	spec or T 0.9 x (0 0.9 x (0 0.9 x (0 459.80 721.93	g ific data able 6b 0.50 x 0.50 x 0.50 x 0.50 x 334.36 606.75 Sep	FF specific c or Table 0.70 0.70 0.70 197.33 489.49 0ct	data e 6c = [ = [ = [ 104.75 419.55 Nov	Gains W 35.25 28.63 20.25 69.39 401.20 21.00 Dec	] (80) ] (74) ] (75) ] (83) ] (84) ] (85)
<ul> <li>6. Solar gains</li> <li>West</li> <li>North</li> <li>NorthEast</li> <li>Solar gains in water</li> <li>Total gains - inter</li> <li>7. Mean interr</li> <li>Temperature du</li> <li>Utilisation facto</li> </ul>	atts ∑(74)m 84.13 ernal and sc 425.74 nal tempera uring heatin Jan or for gains f 1.00	n(82)m 164.89 blar (73)m + 504.03 sture (heati g periods in Feb for living are 0.99	Access = Table 0.7 0.7 0.7 280.80 (83)m 607.55 ng season) n the living Mar ea n1,m (se	factor         2         6d         7       ×         7       ×         7       ×         436.93         744.11         area from 1         Apr         ee Table 9a)         0.81	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 855.53 6855.53 Fable 9, Th: May	Sol M x 1 x 1 x 1 597.93 866.18 1(°C) Jun 0.39	ar flux 1/m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48 Jul 0.29	spec or T 0.9 x (0 0.9 x (0 459.80 721.93 Aug 0.34	g         ific data         able 6b         ).50       x         ).50       x         ).50       x         ).50       x         ).50       x         ).50       x         334.36       334.36         606.75       Sep         0.60       0.60	FF specific c or Table 0.70 0.70 197.33 489.49 0ct 0.92	data e 6c = [ = [ ] = [ ] 104.75 419.55 Vov Nov 0.99	Gains W 35.25 28.63 20.25 69.39 69.39 401.20 21.00 Dec 1.00	] (80) ] (74) ] (75) ] (83) ] (83) ] (84) ] (85)
<ul> <li>6. Solar gains</li> <li>West</li> <li>North</li> <li>NorthEast</li> <li>Solar gains in watering</li> <li>Total gains - intering</li> <li>7. Mean intering</li> <li>Temperature du</li> <li>Utilisation factoon</li> <li>Mean internal to</li> </ul>	atts ∑(74)m 84.13 ernal and sc 425.74 al tempera uring heatin Jan or for gains f 1.00 emp of livin	n(82)m 164.89 blar (73)m + 504.03 sture (heating g periods in Feb for living and 0.99 ng area T1 (s	Access = Table 0.7 0.7 0.7 280.80 (83)m 607.55 ng season) n the living Mar ea n1,m (se 0.96 steps 3 to 7	factor 2 6d 7 × [ 7 × [ 7 × [ 7 × [ 7 × [ 7 × [ 436.93 436.93 744.11 area from 7 Apr the Table 9a 0.81 7 in Table 90	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 568.10 855.53 Table 9, Th: May 0 0.58 c)	Sol M x 1 x 1 x 1 597.93 866.18 1(°C) Jun 0.39	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48 Jul 0.29	spec or T 0.9 x (0 0.9 x (0 0.9 x (0 459.80 721.93 Aug 0.34	g         ific data         able 6b         0.50       x         606.75       x         Sep       0.60	FF specific c or Table 0.70 0.70 197.33 489.49 0ct 0.92	data e 6c = [ = [ = [ ] = [ ] 104.75 419.55 [ Nov Nov	Gains W 35.25 28.63 20.25 69.39 401.20 21.00 Dec 1.00	] (80) ] (74) ] (75) ] (83) ] (84) ] (85) ] (86)
<ul> <li>6. Solar gains</li> <li>West</li> <li>North</li> <li>NorthEast</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean interr</li> <li>Temperature du</li> <li>Utilisation facto</li> <li>Mean internal to</li> </ul>	atts $\Sigma(74)$ m 84.13 ernal and sc 425.74 hal tempera uring heatin Jan or for gains f 1.00 emp of livin 20.24	n(82)m 164.89 blar (73)m + 504.03 bture (heati g periods in Feb For living are 0.99 g area T1 (s 20.40	Access Table 0.7 0.7 0.7 0.7 280.80 (83)m 607.55 ng season) n the living Mar ea n1,m (sea 0.96 steps 3 to 7 20.66	factor         6d         7       x         7       x         7       x         7       x         436.93         744.11         area from 1         Apr         ee Table 9a)         0.81         'in Table 9a         20.92	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 855.53 Fable 9, Th: May 0 0.58 c) 20.99	Sol M x 1 x 1 x 1 597.93 866.18 1(°C) Jun 0.39	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48 Jul 0.29 21.00	spec or T 0.9 x (0 0.9 x (0 459.80 721.93 Aug 0.34	g ific data able 6b ).50 x ).50 x ].50 x ].50 x ].50 x ].50 x ].50 x ].50 x ].50 x ].50 x ].50 x x ].50 x x x x x x x x x x x x x x x x x x x	FF specific c or Table 0.70 0.70 197.33 489.49 0ct 0.92	data e 6c = [ = [ ] = [ ] 104.75 419.55 419.55 Nov 0.99 20.48	Gains W 35.25 28.63 20.25 69.39 401.20 21.00 Dec 1.00	] (80) ] (74) ] (75) ] (83) ] (83) ] (84) ] (85) ] (86) ] (86)
<ul> <li>6. Solar gains</li> <li>West</li> <li>North</li> <li>NorthEast</li> <li>Solar gains in watering</li> <li>Total gains - interest</li> <li>7. Mean interest</li> <li>Temperature du</li> <li>Utilisation factor</li> <li>Mean internal to</li> </ul>	atts $\Sigma(74)$ m 84.13 ernal and so 425.74 hal temperation Jan or for gains f 1.00 emp of livin 20.24 uring heatin	n(82)m 164.89 blar (73)m + 504.03 ture (heati g periods in Feb for living are 0.99 g area T1 (s 20.40 g periods in	Access = Table 0.7 0.7 0.7 280.80 (83)m 607.55 ng season) 607.55 ng season) n the living Mar ea n1,m (se 0.96 steps 3 to 7 20.66 n the rest o	factor e dd 7 x [ 7 x [ 7 x [ 7 x [ 7 x [ 436.93 436.93 7 44.11 area from 7 Apr the Table 9a 0.81 7 in Table 9a 20.92 f dwelling f	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 855.53 Fable 9, Th: May 0.58 c) 20.99	Sol M x 1 x 1 x 1 597.93 866.18 1(°C) Jun 0.39 21.00 9. Th2(°C)	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48 Jul 0.29 21.00	spec or T 0.9 x (0 0.9 x (0 0.9 x (0 459.80 721.93 Aug 0.34 21.00	g ific data able 6b 0.50 x 0.50 x 0.50 x 334.36 606.75 Sep 0.60	FF specific c or Table 0.70 0.70 197.33 489.49 0ct 0.92 20.83	data e 6c = [ = [ ] = [ ] 104.75 419.55 419.55 Nov Nov 0.99 20.48	Gains W 35.25 28.63 20.25 69.39 401.20 21.00 Dec 1.00 0 21.00	] (80) ] (74) ] (75) ] (83) ] (83) ] (84) ] (85) ] (85) ] (86) ] (87)
<ul> <li>6. Solar gains</li> <li>West</li> <li>North</li> <li>NorthEast</li> <li>Solar gains in watering</li> <li>Total gains - intering</li> <li>7. Mean internal</li> <li>Utilisation factoon</li> <li>Mean internal to</li> <li>Temperature du</li> </ul>	atts $\Sigma(74)$ m 84.13 ernal and sc 425.74 al tempera uring heatin Jan or for gains f 1.00 emp of livin 20.24 uring heatin	n (82)m 164.89 blar (73)m + 504.03 sture (heati g periods in Feb For living are 0.99 g area T1 (s 20.40 g periods in 20.22	Access Table 0.7 0.7 0.7 0.7 280.80 (83)m 607.55 ng season) n the living Mar ea n1,m (sea 0.96 steps 3 to 7 20.66 n the rest o	factor         a 6d         7       x         7       x         7       x         7       x         436.93         744.11         area from 1         Apr         ee Table 9a)         0.81         'in Table 9c         20.92         f dwelling f         20.23	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 855.53 Table 9, Th: May 0.58 c) 20.99 irom Table	Sol M x 1 x 1 x 1 597.93 866.18 1(°C) Jun 0.39 21.00 9, Th2(°C)	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48 Jul 0.29 21.00	spec or T 0.9 x (0 0.9 x (0 459.80 721.93 Aug 0.34 21.00	g ific data able 6b 0.50 x 0.50 x 0.50 x 0.50 x 334.36 606.75 Sep 0.60 20.99	FF specific c or Table 0.70 0.70 197.33 489.49 0ct 0.92 20.83	data e 6c = [ = [ ] = [ ] 104.75 419.55 ( Nov 0.99 20.48	Gains W 35.25 28.63 20.25 69.39 401.20 21.00 Dec 1.00 0 22.21 20.21	] (80) ] (74) ] (75) ] (83) ] (83) ] (84) ] (85) ] (86) ] (86) ] (87)
<ul> <li>6. Solar gains</li> <li>West</li> <li>North</li> <li>NorthEast</li> <li>Solar gains in watering</li> <li>Total gains - interest</li> <li>7. Mean interest</li> <li>Utilisation facto</li> <li>Mean internal to</li> <li>Temperature du</li> <li>Utilisation facto</li> </ul>	atts $\Sigma(74)$ m 84.13 ernal and sc 425.74 al temperation uring heatin Jan or for gains f 1.00 emp of livin 20.24 uring heatin 20.22 r for gains f	n(82)m 164.89 blar (73)m + 504.03 ture (heati g periods ir Feb for living ard 0.99 g area T1 (s 20.40 g periods ir 20.22 for root of of	Access = Table 0.7 0.7 0.7 280.80 (83)m 607.55 (83)m 607.55 (83)m 607.55 (90,00) the living Mar ea n1,m (se 0.96 steps 3 to 7 20.66 n the rest o 20.22	factor         6d         7       x         7       x         7       x         7       x         7       x         436.93         744.11         area from 7         Apr         ee Table 9a)         0.81         7 in Table 9a         20.92         f dwelling f         20.23	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 855.53 Fable 9, Th: May 0.58 c) 20.99 from Table 20.24	Sol M x 1 x 1 597.93 866.18 1(°C) Jun 0.39 21.00 9, Th2(°C) 20.25	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48 Jul 0.29 21.00 20.25	spec or T 0.9 x (0 0.9 x (0 459.80 721.93 Aug 0.34 21.00 20.25	g         ific data         able 6b         0.50       x         0.50       x         0.50       x         334.36         606.75         Sep         0.60         20.99         20.24	FF specific c or Table 0.70 0.70 197.33 489.49 0ct 0.92 20.83	data e 6c = [ = [ ] = [ ] 104.75 419.55 419.55 Nov 0.99 20.48 20.23	Gains W 35.25 28.63 20.25 69.39 401.20 21.00 Dec 1.00 0 21.00 22.21	] (80) ] (74) ] (75) ] (83) ] (83) ] (84) ] (84) ] (85) ] (85) ] (86) ] (87) ] (88)
<ul> <li>6. Solar gains</li> <li>West</li> <li>North</li> <li>NorthEast</li> <li>Solar gains in watering</li> <li>Total gains - intering</li> <li>7. Mean intering</li> <li>Temperature du</li> <li>Utilisation factoon</li> <li>Mean internal to</li> <li>Temperature du</li> <li>Utilisation factoon</li> </ul>	atts $\Sigma(74)$ m 84.13 ernal and sc 425.74 al tempera uring heating Jan or for gains f 1.00 emp of livin 20.24 uring heating constants 1.00 constan	n (82)m 164.89 blar (73)m + 504.03 iture (heati g periods in Feb for living ard 0.99 g area T1 (s 20.40 g periods in 20.22 for rest of d	Access Table 0.7 0.7 0.7 0.7 280.80 (83)m 607.55 ng season) the living Mar ea n1,m (se 0.96 steps 3 to 7 20.66 n the rest o 20.22 welling n2,	factor a 6d 7 × [ 7 × [ 7 × [ 7 × [ 7 × [ 436.93 7 × [ 436.93 7 × [ 7 × [] 1 × [ 7 × [	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 855.53 (able 9, Th: May 0.58 c) 20.99 from Table 20.24	Sol M x 1 x 1 x 1 597.93 866.18 1(°C) Jun 0.39 21.00 9, Th2(°C) 20.25	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48 Jul 0.29 21.00 20.25	spec or T 0.9 x (0 0.9 x (0 459.80 721.93 Aug 0.34 21.00 20.25	g         ific data         able 6b         0.50       x         606.75       x         Sep       0.60         20.99       20.24	FF specific c or Table 0.70 0.70 197.33 489.49 0ct 0.92 20.83 20.24	data e 6c = [ = [ ] = [ ] 104.75 419.55 [ Nov 0.99 20.48 20.23	Gains W 35.25 28.63 20.25 69.39 401.20 21.00 21.00 Dec 1.00 0 20.21	] (80) ] (74) ] (75) ] (83) ] (83) ] (84) ] (85) ] (86) ] (86) ] (87) ] (88)
<ul> <li>6. Solar gains</li> <li>West</li> <li>North</li> <li>NorthEast</li> <li>Solar gains in wather the set of the set</li></ul>	atts $\Sigma(74)$ m 84.13 ernal and so 425.74 hal temperation Jan or for gains f 1.00 emp of livin 20.24 uring heatin 20.22 or for gains f 1.00	n(82)m 164.89 blar (73)m + 504.03 ture (heati g periods in Feb for living are 0.99 ig area T1 (s 20.40 g periods in 20.22 for rest of d 0.99	Access Table 0.7 0.7 0.7 0.7 280.80 (83)m 607.55 ng season) n the living Mar ea n1,m (se 0.96 steps 3 to 7 20.66 n the rest o 20.22 welling n2, 0.94	factor         a 6d         7       x         7       x         7       x         7       x         436.93         744.11         area from 7         Apr         e Table 9a         0.81         7 in Table 9a         20.92         f dwelling f         20.23         m         0.78	Area m <sup>2</sup> 7.40 11.10 7.40 568.10 855.53 855.53 6 855.53 7 8 568.10 8 568.10 0.58 0.58 c) 20.99 7 com Table 20.24	Sol M x 1 x 1 x 1 597.93 866.18 1(°C) Jun 0.39 21.00 9, Th2(°C) 20.25 0.35	ar flux //m <sup>2</sup> 9.64 x 0.63 x 1.28 x 562.39 818.48 Jul 0.29 21.00 20.25 0.24	spec or T 0.9 x (0 0.9 x (0 459.80 721.93 Aug 0.34 21.00 20.25 0.28	g         ific data         able 6b         ).50       x         334.36       x         606.75       x         Sep       x         0.60       x         20.99       x         20.24       x         0.54       x	FF specific c or Table 0.70 0.70 197.33 489.49 489.49 0.92 20.83 20.24	data e 6c = [ = [ ] = [ ] 104.75 419.55 419.55 Nov 0.99 20.48 20.23 0.99	Gains W 35.25 28.63 20.25 69.39 401.20 21.00 Dec 1.00 0 22.21 20.21 20.23	] (80) ] (74) ] (75) ] (83) ] (83) ] (84) ] (84) ] (85) ] (85) ] (86) ] (87) ] (88) ] (89)

Γ	19.52	19.69	19.94	20.17	20.23	20.25	20.25	20.25	20.24	20.11	19.78	19.50	(90)
Living area fractio	'n			I	1				Liv	ving area ÷	(4) =	0.35	(91)
Mean internal ter	nperature	for the wh	ole dwellin	g fLA x T1 +	-(1 - fLA) x <sup>-</sup>	Т2				-			]
Γ	19.77	19.94	20.19	20.44	20.50	20.51	20.51	20.52	20.50	20.36	20.02	19.75	(92)
Apply adjustment	to the me	an internal	l temperati	ure from Ta	Ible 4e whe	ere appropr	iate						
Γ	19.62	19.79	20.04	20.29	20.35	20.36	20.36	20.37	20.35	20.21	19.87	19.60	(93)
				•	•						•	•	<b>_</b>
8. Space heating	requirem	ent											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor	for gains, r	յՠ										-	-
L	0.99	0.98	0.94	0.78	0.54	0.35	0.24	0.29	0.55	0.89	0.99	1.00	(94)
Useful gains, ηmG	im, W (94	)m x (84)m										-	_
L	423.42	496.05	571.01	578.68	464.98	306.56	200.30	210.22	332.57	438.09	413.64	399.64	(95)
Monthly average	external te	emperature	e from Tabl	e U1									_
L	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 inte	rnal tempe	erature, Lm	, W [(39)m	x [(93)m -	(96)m]							_
	855.04	827.91	750.50	619.53	468.89	306.74	200.31	210.25	335.39	521.21	697.64	847.23	(97)
Space heating req	juirement,	kWh/mon	th 0.024 x	[(97)m - (9	5)m] x (41)	m							_
	321.12	223.01	133.54	29.41	2.91	0.00	0.00	0.00	0.00	61.84	204.48	333.00	]
									∑(98	3)15, 10	.12 =	1309.31	(98)
Space heating req	luirement	kWh/m²/ye	ear							(98)	÷ (4)	19.77	(99)
9a Energy requi	roments -	individual	heating sys	stoms inclu	iding micro	СНР							
Sa. Ellergy requi	rements -	Individual	neating sys	stems mere		РСПР							
Space nearing	host from	cocondaru	launnlama	otoni oveto	m (tabla 11	,						0.00	(201)
Fraction of space	heat from	main syste	(suppleme)	intary syste		. <b>)</b>				1 (2)	 11) – [	1.00	(201)
Fraction of space	heat from	main syste	m 2							1 - (20	)1) = [	0.00	(202)
Fraction of total s	naco hoat	from main	system 1						(20	) v [1 /20	2)] -	1.00	] (202) ] (204)
Fraction of total s	pace heat	from main	system 2						(20	(202) × [1- (20	ן (כר	0.00	) (204) ] (205)
Efficiency of main	system 1	(%)	system 2							(202) X (20	JS) – [	0.00	(205)
Efficiency of main	System 1	(%) Fob	Mar	Apr	May	lun		Aug	Son	Oct	Nov	90.00 Doc	] (200)
Space beating fue			iviai	Арі	Iviay	Juli	Jui	Aug	Seh	001	NOV	Dec	
Space neating rue		247 79	140.27	22.69	2.24	0.00	0.00	0.00	0.00	69.71	227.20	270.00	1
L	330.80	247.78	148.37	32.08	3.24	0.00	0.00	0.00	5(21)		12 -	1454.70	]
Mater bestive									2(21)	1)15, 10	.12 =	1454.79	] (211)
Efficiency of wate	r boator												
		95.42	94.05	91.20	80.08	70.00	70.00	70.00	70.00	82.50	05.14	96.14	(217)
Water beating fu	$\frac{80.00}{1}$	03.43	64.05	01.59	00.00	79.90	79.90	79.90	79.90	82.50	65.14	00.14	] (217)
	217.26	101 12	202 12	10E 14	192.10	160.92	154.07	171 76	172.65	101 50	109.10	211.00	1
L	217.50	191.15	202.15	165.14	102.19	100.82	154.07	1/1./0	175.05	T91.50	12 -	211.90	] ] (210)
										2(2198)1	.12 =	2239.74	] (219)
Annual totals	I main au	ictore 1										1454 70	1
Mater heating fue	si - main Sy	Stelli I										1454.79	]
Floatricity for pup	en and fand a	nd alactric	koon hot (	Table (1f)								2239.74	
	ips, ians a		reep-not (		innut for	- اء:مدري			170 4 5	1			(220-)
mechanical ve	ntilation fa	ans - baland	Leu, extract	or positive	e input fron	n outside			2/8.15	] 1			(230a)
central heating	s pump or	water pum	ip within w	arm air nea	ating unit				30.00	] ]			(230C)
poller flue fan		- 1344 /							45.00	J	<b></b>	252.45	(230e)
I otal electricity fo	or the abov	/e, kWh/ye	ar									353.15	] (231)

### Total delivered energy for all uses

(232) (238)

296.50

4344.18

10a. Fuel costs - individual heating systems including micro-C	HP					
	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1454.79	x	3.48	x 0.01 =	50.63	(240)
Water heating	2239.74	x	3.48	x 0.01 =	77.94	(247)
Pumps and fans	353.15	x	13.19	x 0.01 =	46.58	(249)
Electricity for lighting	296.50	x	13.19	x 0.01 =	39.11	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242) + (	245)(254) =	334.26	(255)
11a. SAP rating - individual heating systems including micro-C	ΉP					
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					1.26	(257)
SAP value					82.39	]
SAP rating (section 13)					82	(258)
SAP band					В	]
SAP band 12a. CO2 emissions - individual heating systems including mic	ro-CHP				В	]
SAP band 12a. CO <sub>2</sub> emissions - individual heating systems including mic	ro-CHP Energy kWh/year		Emission factor kg CO <sub>2</sub> /kWh		B Emissions kg CO <sub>2</sub> /year	]
SAP band 12a. CO <sub>2</sub> emissions - individual heating systems including mic Space heating - main system 1	ro-CHP Energy kWh/year 1454.79	x	Emission factor kg CO <sub>2</sub> /kWh	=	B Emissions kg CO <sub>2</sub> /year 314.23	] (261)
SAP band <b>12a. CO<sub>2</sub> emissions - individual heating systems including mic</b> Space heating - main system 1 Water heating	ro-CHP Energy kWh/year 1454.79 2239.74	x x	Emission factor kg CO <sub>2</sub> /kWh 0.22 0.22	=	B Emissions kg CO <sub>2</sub> /year 314.23 483.78	] ] (261) ] (264)
SAP band 12a. CO <sub>2</sub> emissions - individual heating systems including mic Space heating - main system 1 Water heating Space and water heating	ro-CHP Energy kWh/year 1454.79 2239.74	x x	Emission factor kg CO <sub>2</sub> /kWh 0.22 0.22 (261) + (262) + (20)	= = 263) + (264) =	B Emissions kg CO <sub>2</sub> /year 314.23 483.78 798.02	] (261) ] (264) ] (265)
SAP band 12a. CO <sub>2</sub> emissions - individual heating systems including mic Space heating - main system 1 Water heating Space and water heating Pumps and fans	ro-CHP Energy kWh/year 1454.79 2239.74 353.15	x x x	Emission factor kg CO <sub>2</sub> /kWh 0.22 0.22 (261) + (262) + (2 0.52	= = 263) + (264) = =	B Emissions kg CO <sub>2</sub> /year 314.23 483.78 798.02 183.29	] (261) ] (264) ] (265) ] (267)
SAP band 12a. CO <sub>2</sub> emissions - individual heating systems including mic Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting	ro-CHP Energy kWh/year 1454.79 2239.74 353.15 296.50	x x x x x	Emission factor kg CO <sub>2</sub> /kWh 0.22 0.22 (261) + (262) + (2 0.52 0.52	= = 263) + (264) = = =	B Emissions kg CO <sub>2</sub> /year 314.23 483.78 798.02 183.29 153.88	] (261) ] (264) ] (265) ] (267) ] (268)
SAP band 12a. CO <sub>2</sub> emissions - individual heating systems including mic Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO <sub>2</sub> , kg/year	ro-CHP Energy kWh/year 1454.79 2239.74 353.15 296.50	x x x x	Emission factor kg CO <sub>2</sub> /kWh 0.22 0.22 (261) + (262) + (2 0.52 0.52	= = 263) + (264) = = = 265)(271) =	B Emissions kg CO <sub>2</sub> /year 314.23 483.78 798.02 183.29 153.88 1135.19	] (261) ] (264) ] (265) ] (267) ] (268) ] (272)
SAP band 12a. CO <sub>2</sub> emissions - individual heating systems including mic Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO <sub>2</sub> , kg/year Dwelling CO <sub>2</sub> emission rate	ro-CHP Energy kWh/year 1454.79 2239.74 353.15 296.50	x x x x	Emission factor kg CO <sub>2</sub> /kWh 0.22 0.22 (261) + (262) + (2 0.52 0.52	= = 263) + (264) = = = 265)(271) = (272) ÷ (4) =	B Emissions kg CO <sub>2</sub> /year 314.23 483.78 798.02 183.29 153.88 1135.19 17.14	] (261) ] (264) ] (265) ] (267) ] (268) ] (272) ] (273)
SAP band 12a. CO <sub>2</sub> emissions - individual heating systems including mic Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO <sub>2</sub> , kg/year Dwelling CO <sub>2</sub> emission rate El value	ro-CHP Energy kWh/year 1454.79 2239.74 353.15 296.50	x x x x	Emission factor kg CO <sub>2</sub> /kWh 0.22 0.22 (261) + (262) + (2 0.52 0.52	= = 263) + (264) = = = 265)(271) = (272) ÷ (4) =	B Emissions kg CO <sub>2</sub> /year 314.23 483.78 798.02 183.29 153.88 1135.19 17.14 86.32	] (261) ] (264) ] (265) ] (267) ] (268) ] (272) ] (273) ]
SAP band 12a. CO <sub>2</sub> emissions - individual heating systems including mic Space heating - main system 1 Water heating Space and water heating Pumps and fans Electricity for lighting Total CO <sub>2</sub> , kg/year Dwelling CO <sub>2</sub> emission rate El value El rating (section 14)	ro-CHP Energy kWh/year 1454.79 2239.74 353.15 296.50	x x x x	Emission factor kg CO <sub>2</sub> /kWh 0.22 0.22 (261) + (262) + (2 0.52 0.52	= = 263) + (264) = = = 265)(271) = (272) ÷ (4) =	B Emissions kg CO <sub>2</sub> /year 314.23 483.78 798.02 183.29 153.88 1135.19 17.14 86.32 86	] (261) ] (264) ] (265) ] (267) ] (268) ] (272) ] (273) ] ] (274)

13a. Primary	, energy -	individual heatin	g systems	including	micro-CHP
130. I IIIII I	Circi Sy	main add meaning	is systems	menaams	

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1454.79	х	1.22	=	1774.85	(261)
Water heating	2239.74	х	1.22	=	2732.48	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	4507.33	(265)
Pumps and fans	353.15	x	3.07	=	1084.18	(267)
Electricity for lighting	296.50	х	3.07	=	910.24	(268)
Primary energy kWh/year					6501.75	(272)
Dwelling primary energy rate kWh/m2/year					98.18	(273)

# 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	Miss Cha	arlotte Boot	:h				As	sessor num	ıber	6376		
Client	Warmha	ze Ltd					La	st modified		23/01	/2015	
Address	5 17-27	& 25 Ferdin	and Street	. Camden.	London. NV	V1 8EX						
				, ,	,							
1. Overall dwelling dimen	sions											
				A	area (m²)		Aver he	age storey eight (m)		Va	olume (m³)	
Lowest occupied					52.05	](1a) x		3.13	] (2a) =		162.92	(3a)
Total floor area	(1a)	+ (1b) + (1	c) + (1d)(	1n) =	52.05	(4)						
Dwelling volume							(3a)	+ (3b) + (3	c) + (3d)(3	n) =	162.92	(5)
2. Ventilation rate												
										m	<sup>3</sup> per hour	
Number of chimneys								0	] x 40 =		0	(6a)
Number of open flues								0	] x 20 =		0	(6b)
Number of intermittent far	IS							0	] x 10 =		0	(7a)
Number of passive vents								0	] x 10 =		0	(7b)
Number of flueless gas fire	S							0	] x 40 =		0	(7c)
										Air	changes pe hour	r
Infiltration due to chimney	s, flues, fan	s, PSVs		(6a	) + (6b) + (7	a) + (7b) + (	7c) =	0	÷ (5) =		0.00	(8)
If a pressurisation test has	, been carrie	, d out or is i	ntended, p	roceed to (	17), otherw	vise continue	e from (9) t	o (16)	] ()			
Air permeability value, q50	, expressed	in cubic m	etres per h	our per sq	uare metre	of envelope	area				3.00	(17)
If based on air permeability	value, the	n (18) = [(1 <sup>-</sup>	7) ÷ 20] + (8	8), otherwi	se (18) = (1	6)					0.15	(18)
Number of sides on which	the dwellin	g is sheltere	ed								3	(19)
Shelter factor		-						1 -	[0.075 x (19	9)] =	0.78	(20)
Infiltration rate incorporati	ng shelter f	actor							(18) x (2	0) =	0.12	(21)
Infiltration rate modified for	or monthly	wind speed	:									
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind spee	ed 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	(22a)
Adjusted infiltration rate (a	llowing for	shelter and	d wind fact	or) (21) x (2	22a)m							
0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	(22b)
Calculate effective air chan	ge rate for	the applica	ble case:									
If mechanical ventilation	n: air chang	e rate thro	ugh system	n							0.50	(23a)
If balanced with heat re	covery: effi	ciency in %	allowing for	or in-use fa	ctor from T	able 4h					77.35	(23c)
a) If balanced mechanic	al ventilatio	on with hea	t recovery	(MVHR) (2	2b)m + (23l	o) x [1 - (230	:) ÷ 100]					_
0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(24a)
Effective air change rate - e	enter (24a)	or (24b) or	(24c) or (24	4d) in (25)								
0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(25)



3. Heat losses and heat loss parameter										
Element	Gross area, m <sup>2</sup>	Openings m <sup>2</sup>	Net a A, n	area n²	U-value W/m²K	A x U W	/К к-v kJ/	alue, /m².K	Ахк, kJ/K	
Window			19.6	62 x	0.87	= 17.04				(27)
External wall			44.6	67 x	0.16	= 7.15				(29a)
Party wall			60.5	57 x	0.00	= 0.00				(32)
Total area of external elements $\Sigma A$ , m <sup>2</sup>			64.2	29						(31)
Fabric heat loss, W/K = ∑(A × U)						(26	5)(30) + (3	32) =	24.19	(33)
Heat capacity Cm = Σ(A x κ)					(28)	(30) + (32) +	- (32a)(32	2e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m <sup>2</sup> K									250.00	(35)
Thermal bridges: $\Sigma(L \times \Psi)$ calculated using App	endix K								9.64	(36)
Total fabric heat loss							(33) + (3	36) =	33.84	(37)
Jan Feb Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33	(25)m x (5)									
14.06 13.90 13.74	12.96	12.81	12.03	12.03	11.87	12.34	12.81	13.12	13.43	(38)
Heat transfer coefficient, W/K (37)m + (38)m		· ·	I		1					
47.89 47.74 47.58	46.80	46.64	45.86	45.86	45.70	46.17	46.64	46.95	47.27	
		I			<u> </u>	Average = Σ	(39)112/	12 =	46.76	(39)
Heat loss parameter (HLP), W/m <sup>2</sup> K (39)m $\div$ (4)						2				] (/
0.92 0.92 0.91	0.90	0.90	0.88	0.88	0.88	0.89	0.90	0.90	0.91	
						Average = ∑	(40)112/	12 =	0.90	(40)
Number of days in month (Table 1a)								<u> </u>		
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)
	1		· ·						4	
4. Water heating energy requirement										
Assumed occupancy, N									1.75	(42)
Assumed occupancy, N Annual average hot water usage in litres per da	ay Vd,average	= (25 x N) + 3	36						1.75 75.78	(42) (43)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar	ay Vd,average <b>Apr</b>	= (25 x N) + 3 May	36 Jun	Jul	Aug	Sep	Oct	Nov	1.75 75.78 <b>Dec</b>	(42) (43)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon	ay Vd,average <b>Apr</b> th Vd,m = fact	= (25 x N) + 3 <b>May</b> for from Tabl	36 <b>Jun</b> le 1c x (43)	Jul	Aug	Sep	Oct	Nov	1.75 75.78 <b>Dec</b>	(42) (43)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 83.35 80.32 77.29	ay Vd,average <b>Apr</b> th Vd,m = fact 74.26	= (25 x N) + 3 <b>May</b> for from Tabl	36 Jun le 1c x (43) 68.20	Jul 68.20	Aug 71.23	<b>Sep</b> 74.26	<b>Oct</b> 77.29	Nov	1.75 75.78 Dec 83.35	(42) (43)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 83.35 80.32 77.29	ay Vd,average Apr th Vd,m = fact 74.26	= (25 x N) + : May for from Tabl 71.23	36 Jun le 1c x (43) 68.20	Jul 68.20	Aug 71.23	<b>Sep</b> 74.26	Oct 77.29 ∑(44)1	Nov 80.32 12 =	1.75 75.78 <b>Dec</b> 83.35 909.31	(42) (43)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 83.35 80.32 77.29 Energy content of hot water used = 4.18 x Vd,r	ay Vd,average <b>Apr</b> th Vd,m = fact 74.26 n x nm x Tm/3	= (25 x N) + 3 May for from Tabl 71.23	36 Jun le 1c x (43) 68.20 onth (see 1	Jul 68.20 Tables 1b,	Aug 71.23 1c 1d)	<b>Sep</b> 74.26	Oct 77.29 ∑(44)1	Nov 80.32 12 =	1.75 75.78 <b>Dec</b> 83.35 909.31	(42) (43) (44)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 83.35 80.32 77.29 Energy content of hot water used = 4.18 x Vd,r 123.61 108.11 111.5	Ay Vd,average <b>Apr</b> th Vd,m = fact 74.26 n x nm x Tm/3 5 97.26	= (25 x N) + <b>May</b> for from Tabl 71.23 8600 kWh/mo 93.32	36 Jun le 1c x (43) 68.20 onth (see 1 80.53	Jul 68.20 Tables 1b, 74.62	Aug 71.23 1c 1d) 85.63	Sep 74.26 86.66	Oct 77.29 Σ(44)1 100.99	Nov 80.32 12 = 110.24	1.75 75.78 <b>Dec</b> 83.35 9∪9.31 119.71	) (42) ) (43) ) (44)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 83.35 80.32 77.29 Energy content of hot water used = 4.18 x Vd,r 123.61 108.11 111.50	ay Vd,average <b>Apr</b> th Vd,m = fact 74.26 n x nm x Tm/3 5 97.26	= (25 x N) + 3 May for from Tabl 71.23 8600 kWh/me 93.32	36 Jun le 1c x (43) 68.20 onth (see T 80.53	Jul 68.20 Tables 1b, 74.62	Aug 71.23 1c 1d) 85.63	Sep 74.26 86.66	Oct 77.29 Σ(44)1 100.99 Σ(45)1	Nov 80.32 12 = 110.24 12 =	1.75 75.78 <b>Dec</b> 83.35 909.31 119.71 1192.24	) (42) ) (43) ) (44) ) (45)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon 83.35 80.32 77.29 Energy content of hot water used = 4.18 x Vd,r 123.61 108.11 111.5 Distribution loss 0.15 x (45)m	Ay Vd,average Apr th Vd,m = fact 74.26 n x nm x Tm/3 5 97.26	= (25 x N) + <b>May</b> for from Tabl 71.23 8600 kWh/mo 93.32	36 Jun le 1c x (43) 68.20 onth (see T 80.53	Jul 68.20 Fables 1b, 74.62	Aug 71.23 1c 1d) 85.63	Sep 74.26 86.66	Oct 77.29 Σ(44)1 100.99 Σ(45)1	Nov 80.32 12 = 110.24 12 =	1.75         75.78         Dec         83.35         909.31         119.71         1192.24	(42) (43) (44) (44)
Assumed occupancy, N Annual average hot water usage in litres per day Hot water usage in litres per day for each mon 83.35 80.32 77.29 Energy content of hot water used = 4.18 x Vd,r 123.61 108.11 111.50 Distribution loss 0.15 x (45)m 18.54 16.22 16.73	ay Vd,average <b>Apr</b> th Vd,m = fact 74.26 n x nm x Tm/3 5 97.26 14.59	= (25 x N) + 3 May for from Tabl 71.23 3600 kWh/me 93.32 14.00	36 Jun le 1c x (43) 68.20 onth (see T 80.53	Jul 68.20 Tables 1b, 74.62 11.19	Aug 71.23 1c 1d) 85.63	Sep 74.26 86.66 13.00	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15	Nov 80.32 12 = 110.24 12 = 16.54	1.75 75.78 <b>Dec</b> 83.35 909.31 119.71 1192.24 17.96	) (42) ) (43) ) (44) ) (44) ) (45)
Assumed occupancy, N Annual average hot water usage in litres per da Jan Feb Mar Hot water usage in litres per day for each mon $\boxed{83.35}$ $\boxed{80.32}$ $\boxed{77.29}$ Energy content of hot water used = 4.18 x Vd,r $\boxed{123.61}$ $\boxed{108.11}$ $\boxed{111.5}$ Distribution loss $0.15 \times (45)m$ $\boxed{18.54}$ $\boxed{16.22}$ $\boxed{16.73}$ Water storage loss calculated for each month	ay Vd,average <b>Apr</b> th Vd,m = fact 74.26 n x nm x Tm/3 5 97.26 14.59 (55) x (41)m	= (25 x N) + May for from Tabl 71.23 8600 kWh/me 93.32 14.00	36 Jun e 1c x (43) 68.20 onth (see 1 80.53 12.08	Jul 68.20 Tables 1b, 74.62 11.19	Aug 71.23 1c 1d) 85.63 12.84	Sep 74.26 86.66 13.00	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15	Nov 80.32 12 = 110.24 12 = 16.54	1.75         75.78         Dec         83.35         909.31         119.71         1192.24         17.96	(42) (43) (44) (44) (45) (46)
Assumed occupancy, N Annual average hot water usage in litres per day I an Feb Mar Hot water usage in litres per day for each mon $\boxed{83.35}$ $\boxed{80.32}$ $\boxed{77.29}$ Energy content of hot water used = 4.18 x Vd,r $\boxed{123.61}$ $\boxed{108.11}$ $\boxed{111.50}$ Distribution loss $0.15 \times (45)m$ $\boxed{18.54}$ $\boxed{16.22}$ $\boxed{16.73}$ Water storage loss calculated for each month $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$	ay Vd,average <b>Apr</b> th Vd,m = fact 74.26 n x nm x Tm/3 5 97.26 14.59 (55) x (41)m 0.00	= (25 x N) + 3 May for from Tabl 71.23 8600 kWh/me 93.32 14.00	36 Jun le 1c x (43) 68.20 onth (see T 80.53 12.08	Jul 68.20 Tables 1b, 74.62 11.19 0.00	Aug 71.23 1c 1d) 85.63 12.84	Sep 74.26 86.66 13.00	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15	Nov 80.32 12 = 110.24 12 = 16.54 0.00	1.75 75.78 Dec 83.35 909.31 119.71 1192.24 17.96 0.00	) (42) ) (43) ) (44) ) (44) ) (45) ) (46) ) (56)
Assumed occupancy, N Annual average hot water usage in litres per day Jan Feb Mar Hot water usage in litres per day for each mon $\boxed{83.35}$ $\boxed{80.32}$ $\boxed{77.29}$ Energy content of hot water used = 4.18 x Vd,r $\boxed{123.61}$ $\boxed{108.11}$ $\boxed{111.5}$ Distribution loss $0.15 \times (45)m$ $\boxed{18.54}$ $\boxed{16.22}$ $\boxed{16.73}$ Water storage loss calculated for each month $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$	Ay Vd, average Apr th Vd,m = fact 74.26 n x nm x Tm/3 5 97.26 14.59 (55) x (41)m 0.00 r dedicated W	= (25 x N) + May for from Tabl 71.23 8600 kWh/md 93.32 14.00 0.00 /WHRS (56)m	36 Jun le 1c x (43) 68.20 0nth (see 1 80.53 12.08 12.08 0.00 n x [(47) - V	Jul 68.20 Tables 1b, 74.62 11.19 0.00 /s] ÷ (47),	Aug 71.23 1c 1d) 85.63 12.84 0.00 else (56)	Sep 74.26 86.66 13.00	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15	Nov 80.32 12 = 110.24 12 = 16.54 0.00	1.75 75.78 Dec 83.35 9∪9.31 1192.24 17.96 0.00	(42) (43) (44) (44) (45) (46) (56)
Assumed occupancy, N Annual average hot water usage in litres per day Jan Feb Mar Hot water usage in litres per day for each mon $\boxed{83.35}$ $\boxed{80.32}$ $\boxed{77.29}$ Energy content of hot water used = 4.18 x Vd,r $\boxed{123.61}$ $\boxed{108.11}$ $\boxed{111.50}$ Distribution loss $0.15 \times (45)m$ $\boxed{18.54}$ $\boxed{16.22}$ $\boxed{16.73}$ Water storage loss calculated for each month $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ If the vessel contains dedicated solar storage of $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$	ay Vd,average Apr th Vd,m = fact 74.26 n x nm x Tm/3 97.26 14.59 (55) x (41)m 0.00 r dedicated W 0.00	= (25 x N) + 3 May for from Tabl 71.23 8600 kWh/md 93.32 14.00 0.00 /WHRS (56)m 0.00	36 Jun le 1c x (43) 68.20 000th (see T 80.53 12.08 0.00 n x [(47) - V 0.00	Jul 68.20 Tables 1b, 74.62 11.19 0.00 /s] ÷ (47), 0.00	Aug 71.23 1c 1d) 85.63 12.84 0.00 else (56) 0.00	Sep 74.26 86.66 13.00 0.00	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15 0.00	Nov 80.32 12 = 110.24 12 = 16.54 0.00	1.75 75.78 Dec 83.35 909.31 119.71 1192.24 17.96 0.00 0.00	) (42) ) (43) ) (44) ) (44) ) (45) ) (46) ) (56) ) (57)
Assumed occupancy, N Annual average hot water usage in litres per day I an Feb Mar Hot water usage in litres per day for each mon $\boxed{83.35}$ $\boxed{80.32}$ $\boxed{77.29}$ Energy content of hot water used = 4.18 x Vd,r $\boxed{123.61}$ $\boxed{108.11}$ $\boxed{111.5}$ Distribution loss $0.15 \times (45)m$ $\boxed{18.54}$ $\boxed{16.22}$ $\boxed{16.73}$ Water storage loss calculated for each month $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ If the vessel contains dedicated solar storage of $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Primary circuit loss for each month from Table	Ay Vd, average Apr th Vd,m = fact 74.26 n x nm x Tm/3 5 97.26 14.59 (55) x (41)m 0.00 r dedicated W 0.00 3	= (25 x N) + May for from Tabl 71.23 8600 kWh/md 93.32 14.00 0.00 /WHRS (56)m 0.00	36 Jun le 1c x (43) 68.20 onth (see 1 80.53 12.08 12.08 0.00 n x [(47) - V 0.00	Jul 68.20 Fables 1b, 74.62 11.19 0.00 /s] ÷ (47), 0.00	Aug 71.23 1c 1d) 85.63 12.84 0.00 else (56) 0.00	Sep 74.26 86.66 13.00 0.00	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15 0.00	Nov 80.32 12 = 110.24 12 = 16.54 0.00 0.00	1.75         75.78         Dec         83.35         909.31         1192.24         17.96         0.00         0.00	(42) (43) (44) (44) (45) (46) (56) (57)
Assumed occupancy, N Annual average hot water usage in litres per day Jan Feb Mar Hot water usage in litres per day for each mon $\boxed{83.35}$ $\boxed{80.32}$ $\boxed{77.29}$ Energy content of hot water used = 4.18 x Vd,r $\boxed{123.61}$ $\boxed{108.11}$ $\boxed{111.50}$ Distribution loss $0.15 \times (45)m$ $\boxed{18.54}$ $\boxed{16.22}$ $\boxed{16.73}$ Water storage loss calculated for each month $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ If the vessel contains dedicated solar storage of $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Primary circuit loss for each month from Table $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$	Ay Vd, average Apr th Vd,m = fact 74.26 n x nm x Tm/3 97.26 14.59 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00	= (25 x N) + 3 May or from Tabl 71.23 3600 kWh/md 93.32 14.00 0.00 /WHRS (56)m 0.00 0.00	36 <b>Jun</b> le 1c x (43) 68.20 onth (see T 80.53 12.08 0.00 n x [(47) - V 0.00	Jul 68.20 Tables 1b, 74.62 11.19 0.00 /s] ÷ (47), 0.00 0.00	Aug 71.23 1c 1d) 85.63 12.84 12.84 0.00 else (56) 0.00	Sep 74.26 86.66 13.00 0.00	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15 0.00 0.00	Nov 80.32 12 = 110.24 12 = 16.54 0.00 0.00	1.75 75.78 Dec 83.35 909.31 119.71 1192.24 17.96 0.00 0.00	) (42) ) (43) ) (44) ) (44) ) (45) ) (46) ) (56) ) (57) ) (59)
Assumed occupancy, N Annual average hot water usage in litres per day I an Feb Mar Hot water usage in litres per day for each mon $\boxed{83.35}$ $\boxed{80.32}$ $\boxed{77.29}$ Energy content of hot water used = 4.18 x Vd,r $\boxed{123.61}$ $\boxed{108.11}$ $\boxed{111.5}$ Distribution loss $0.15 \times (45)m$ $\boxed{18.54}$ $\boxed{16.22}$ $\boxed{16.73}$ Water storage loss calculated for each month $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ If the vessel contains dedicated solar storage of $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Primary circuit loss for each month from Table $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$	Ay Vd, average Apr th Vd,m = fact 74.26 n x nm x Tm/3 5 97.26 14.59 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00 r 3c	= (25 x N) + 3 May for from Tabl 71.23 8600 kWh/md 93.32 14.00 0.00 /WHRS (56)m 0.00 0.00	36 Jun le 1c x (43) 68.20 onth (see 1 80.53 12.08 0.00 n x [(47) - V 0.00	Jul 68.20 Tables 1b, 74.62 11.19 0.00 /s] ÷ (47), 0.00 0.00	Aug 71.23 1c 1d) 85.63 12.84 0.00 else (56) 0.00	Sep 74.26 86.66 13.00 0.00	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15 0.00 0.00	Nov 80.32 12 = 110.24 12 = 16.54 0.00 0.00 0.00	1.75         75.78         Dec         83.35         909.31         1192.24         17.96         0.00         0.00         0.00         0.00	(42) (43) (44) (44) (45) (46) (56) (57) (59)
Assumed occupancy, N Annual average hot water usage in litres per day Jan Feb Mar Hot water usage in litres per day for each mon $\boxed{83.35}$ $\boxed{80.32}$ $\boxed{77.29}$ Energy content of hot water used = $4.18 \times Vd$ ,r $\boxed{123.61}$ $\boxed{108.11}$ $\boxed{111.50}$ Distribution loss $0.15 \times (45)m$ $\boxed{18.54}$ $\boxed{16.22}$ $\boxed{16.73}$ Water storage loss calculated for each month $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ If the vessel contains dedicated solar storage of $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Primary circuit loss for each month from Table $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Combi loss for each month from Table 3a, 3b of $\boxed{42.48}$ $\boxed{36.97}$ $\boxed{39.39}$	Apr Apr th Vd,m = fact 74.26 n x nm x Tm/3 97.26 97.26 14.59 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00 r 3c 36.62	= (25 x N) + 3 May for from Tabl 71.23 3600 kWh/md 93.32 14.00 0.00 /WHRS (56)m 0.00 0.00 36.30	36 <b>Jun</b> le 1c x (43) 68.20 onth (see T 80.53 12.08 0.00 n x [(47) - V 0.00 0.00 33.63	Jul 68.20 Tables 1b, 74.62 11.19 0.00 /s] ÷ (47), 0.00 0.00 34.75	Aug 71.23 1c 1d) 85.63 12.84 0.00 else (56) 0.00 0.00	Sep 74.26 86.66 13.00 0.00 0.00	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15 0.00 0.00 0.00	Nov 80.32 12 = 110.24 12 = 16.54 0.00 0.00 0.00 39.61	1.75         75.78         Dec         83.35         909.31         119.71         1192.24         17.96         0.00         0.00         0.00         0.00         42.48	(42) (43) (43) (44) (44) (45) (46) (56) (57) (59) (59)
Assumed occupancy, N Annual average hot water usage in litres per day Jan Feb Mar Hot water usage in litres per day for each mon $\boxed{83.35}$ $\boxed{80.32}$ $\boxed{77.29}$ Energy content of hot water used = 4.18 x Vd,r $\boxed{123.61}$ $\boxed{108.11}$ $\boxed{111.5}$ Distribution loss $0.15 \times (45)m$ $\boxed{18.54}$ $\boxed{16.22}$ $\boxed{16.73}$ Water storage loss calculated for each month $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ If the vessel contains dedicated solar storage of $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Primary circuit loss for each month from Table $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Combi loss for each month from Table 3a, 3b of $\boxed{42.48}$ $\boxed{36.97}$ $\boxed{39.39}$ Total heat required for water heating calculated	Ay Vd, average Apr th Vd,m = fact 74.26 n x nm x Tm/3 5 97.26 14.59 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00 r 3c 36.62 d for each mo	= (25 x N) + 3 May for from Tabl 71.23 8600 kWh/me 93.32 14.00 0.00 /WHRS (56)m 0.00 0.00 36.30 onth 0.85 x (4)	36 Jun le 1c x (43) 68.20 onth (see 1 80.53 12.08 12.08 0.00 n x [(47) - V 0.00 0.00 33.63 45)m + (46	Jul 68.20 Fables 1b, 74.62 11.19 0.00 /s] ÷ (47), 0.00 0.00 34.75 5)m + (57)t	Aug 71.23 1c 1d) 85.63 12.84 0.00 else (56) 0.00 else (56) 0.00 0.00 m + (59)m -	Sep 74.26 86.66 13.00 0.00 0.00 0.00 36.62 + (61)m	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15 0.00 0.00 0.00 39.39	Nov 80.32 12 = 110.24 12 = 16.54 0.00 0.00 0.00 39.61	1.75         75.78         Dec         83.35         9∪9.31         119.71         1192.24         0.00         0.00         0.00         0.00         42.48	(42) (43) (44) (45) (46) (56) (57) (59) (61)
Assumed occupancy, N Annual average hot water usage in litres per day Jan Feb Mar Hot water usage in litres per day for each mon $\boxed{83.35}$ $\boxed{80.32}$ $\boxed{77.29}$ Energy content of hot water used = 4.18 x Vd,r $\boxed{123.61}$ $\boxed{108.11}$ $\boxed{111.50}$ Distribution loss $0.15 \times (45)m$ $\boxed{18.54}$ $\boxed{16.22}$ $\boxed{16.73}$ Water storage loss calculated for each month $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ If the vessel contains dedicated solar storage of $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Primary circuit loss for each month from Table $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Combi loss for each month from Table 3a, 3b of $\boxed{42.48}$ $\boxed{36.97}$ $\boxed{39.39}$ Total heat required for water heating calculated	Apr Apr th Vd,m = fact 74.26 n x nm x Tm/3 97.26 14.59 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00 r 3c 36.62 d for each mo 5 133.88	= (25 x N) + 3 May for from Tabl 71.23 3600 kWh/md 93.32 14.00 0.00 /WHRS (56)m 0.00 0.00 36.30 onth 0.85 x (4 129.62	36 Jun le 1c x (43) 68.20 onth (see T 80.53 12.08 12.08 0.00 n x [(47) - V 0.00 0.00 33.63 45)m + (46 114.16	Jul 68.20 Tables 1b, 74.62 11.19 0.00 /s] ÷ (47), 0.00 0.00 34.75 5)m + (57)n 109.38	Aug 71.23 1c 1d) 85.63 12.84 0.00 else (56) 0.00 else (56) 0.00 36.30 m + (59)m - 121.93	Sep 74.26 86.66 13.00 0.00 0.00 0.00 36.62 + (61)m 123.28	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15 0.00 0.00 0.00 39.39	Nov 80.32 12 = 110.24 12 = 16.54 0.00 0.00 0.00 39.61 149.85	1.75 75.78 Dec 83.35 909.31 119.71 1192.24 17.96 0.00 0.00 0.00 42.48 162.19	(42) (43) (43) (44) (44) (45) (46) (56) (57) (59) (59) (61)
Assumed occupancy, N Annual average hot water usage in litres per day Jan Feb Mar Hot water usage in litres per day for each mon $\boxed{83.35}$ $\boxed{80.32}$ $\boxed{77.29}$ Energy content of hot water used = 4.18 x Vd,r $\boxed{123.61}$ $\boxed{108.11}$ $\boxed{111.5}$ Distribution loss $0.15 \times (45)m$ $\boxed{18.54}$ $\boxed{16.22}$ $\boxed{16.73}$ Water storage loss calculated for each month $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ User storage loss calculated for each month $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Primary circuit loss for each month from Table $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Combi loss for each month from Table 3a, 3b o $\boxed{42.48}$ $\boxed{36.97}$ $\boxed{39.39}$ Total heat required for water heating calculated $\boxed{166.09}$ $\boxed{145.08}$ $\boxed{150.99}$ Solar DHW input calculated using Appendix G of	Ay Vd, average Apr th Vd,m = fact 74.26 n x nm x Tm/3 5 97.26 14.59 (55) x (41)m 0.00 r dedicated W 0.00 3 0.00 r 3c 36.62 d for each mc 5 133.88 pr Appendix H	= (25 x N) + 3 May for from Tabl 71.23 8600 kWh/me 93.32 14.00 0.00 /WHRS (56)m 0.00 0.00 0.00 36.30 onth 0.85 x (4 129.62	36 Jun le 1c x (43) 68.20 onth (see T 80.53 12.08 12.08 0.00 n x [(47) - V 0.00 0.00 33.63 45)m + (46 114.16	Jul 68.20 Tables 1b, 74.62 11.19 0.00 /s] ÷ (47), 0.00 0.00 34.75 5)m + (57)r 109.38	Aug 71.23 1c 1d) 85.63 12.84 0.00 else (56) 0.00 else (56) 0.00 0.00 36.30 m + (59)m - 121.93	Sep 74.26 86.66 13.00 0.00 0.00 0.00 36.62 + (61)m 123.28	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15 0.00 0.00 0.00 39.39 140.37	Nov 80.32 12 = 110.24 12 = 16.54 0.00 0.00 0.00 39.61 149.85	1.75 75.78 Dec 83.35 9∪9.31 1192.24 17.96 0.00 0.00 0.00 42.48 162.19	(42) (43) (44) (45) (46) (56) (57) (59) (61)
Assumed occupancy, N Annual average hot water usage in litres per day Jan Feb Mar Hot water usage in litres per day for each mon $\boxed{83.35}$ $\boxed{80.32}$ $\boxed{77.29}$ Energy content of hot water used = 4.18 x Vd,r $\boxed{123.61}$ $\boxed{108.11}$ $\boxed{111.50}$ Distribution loss $0.15 \times (45)m$ $\boxed{18.54}$ $\boxed{16.22}$ $\boxed{16.73}$ Water storage loss calculated for each month $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ If the vessel contains dedicated solar storage of $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Primary circuit loss for each month from Table $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ $\boxed{0.00}$ Total heat required for water heating calculated $\boxed{166.09}$ $\boxed{145.08}$ $\boxed{150.99}$ Solar DHW input calculated using Appendix G of $\boxed{0.00}$ $\boxed{0.00}$ $\boxed$	Apr Apr th Vd,m = fact 74.26 n x nm x Tm/3 97.26 97.26 14.59 (55) x (41)m 0.00 r dedicated W 0.00 r dedicated W 0.00 r 3c 36.62 d for each mo 5 133.88 pr Appendix H 0.00	= (25 x N) + 3 May for from Table 71.23 3600 kWh/md 93.32 14.00 0.00 /WHRS (56)m 0.00 0.00 36.30 onth 0.85 x (4 129.62 0.00	36 Jun le 1c x (43) 68.20 onth (see T 80.53 12.08 12.08 0.00 n x [(47) - V 0.00 0.00 33.63 45)m + (46 114.16 0.00	Jul 68.20 Tables 1b, 74.62 11.19 0.00 /s] ÷ (47), 0.00 0.00 34.75 5)m + (57)n 109.38 0.00	Aug 71.23 1c 1d) 85.63 12.84 0.00 else (56) 0.00 0.00 36.30 m + (59)m - 121.93	Sep 74.26 86.66 13.00 0.00 0.00 0.00 36.62 + (61)m 123.28	Oct 77.29 Σ(44)1 100.99 Σ(45)1 15.15 0.00 0.00 0.00 39.39 140.37	Nov 80.32 12 = 110.24 12 = 16.54 0.00 0.00 0.00 39.61 149.85 0.00	1.75 75.78 Dec 83.35 909.31 119.71 1192.24 17.96 0.00 0.00 0.00 42.48 162.19	(42) (43) (43) (44) (45) (46) (56) (57) (59) (59) (61) (61) (62)



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

e a cp a c i i e i i i i i i	166.00	145.09	150.05	122.00	120.62	11/ 16	100.20	121.02	172.70	140.27	140.95	162.10	1
	100.09	145.06	150.95	155.88	129.02	114.10	109.58	121.95	125.20	5(64)1	149.05	646 77	] ] (64)
Heat gains from	n water heat	ting (k\M/h/r	nonth) 0.2	5 x [0 85 x	(15)m + (61)	)m] + 0.8 x	(146)m + (1	57)m + (59)	ml	2(04)1	.12 –	.040.77	] (04)
	51 72	45 19	46.94	41 49	40.10	35.18	33 50	37 55	37.97	43 43	46 56	50.42	(65)
	51.72	13.13	10.51	11.13	10.10	33.10	33.30	57.55	37.37	13.13	10.50	30.12	] (03)
5. Internal gai	ns												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains	s (Table 5)												
	87.53	87.53	87.53	87.53	87.53	87.53	87.53	87.53	87.53	87.53	87.53	87.53	(66)
Lighting gains (	calculated in	n Appendix	L, equatior	1 L9 or L9a),	, also see Ta	able 5							
	13.60	12.08	9.82	7.44	5.56	4.69	5.07	6.59	8.85	11.23	13.11	13.98	(67)
Appliance gains	(calculated	in Append	ix L, equati	on L13 or L	13a), also s	ee Table 5							
	152.56	154.14	150.15	141.66	130.94	120.86	114.13	112.55	116.54	125.03	135.75	145.82	(68)
Cooking gains (	calculated ir	n Appendix	L, equatior	1 L15 or L15	ia), also see	Table 5							
	31.75	31.75	31.75	31.75	31.75	31.75	31.75	31.75	31.75	31.75	31.75	31.75	(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. eva	poration (Ta	ble 5)		-									-
	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	(71)
Water heating	gains (Table	5)									•		-
	69.52	67.25	63.09	57.63	53.90	48.87	45.03	50.47	52.73	58.37	64.66	67.77	(72)
Total internal g	ains (66)m -	+ (67)m + (6	68)m + (69)	m + (70)m	+ (71)m + (	72)m							1
	287.93	285.72	275.32	258.98	242.66	226.68	216.49	221.86	230.38	246.89	265.78	279.83	(73)
	L			1							1		]
6. Solar gains						-							
6. Solar gains			Access Table	factor	Area m <sup>2</sup>	Sol	ar flux V/m²	spec	g ific data	FF specific (	lata	Gains W	
6. Solar gains			Access Table	factor e 6d	Area m²	Sol V	ar flux V/m²	speci or T	g ific data able 6b	FF specific o or Table	data e 6c	Gains W	
6. Solar gains			Access Table	factor e 6d 77 x	Area m <sup>2</sup> 19.62	Sol V	lar flux V/m² .9.64 x	speci or T	g ific data able 6b	FF specific o or Table	data e 6c	Gains W 93.46	] (80)
6. Solar gains West Solar gains in w	ratts ∑(74)m	n(82)m	Access Table	factor e 6d 7 x	Area m <sup>2</sup> 19.62	Sol W	ar flux V/m <sup>2</sup> 9.64 x	speci or T 0.9 x (	g ific data able 6b 0.50 x	FF specific o or Table	data : 6c =	<b>Gains</b> W 93.46	] (80)
6. Solar gains West Solar gains in w	ratts Σ(74)m	n(82)m	Access Table 0.7 301.11	factor 2 6d 7 x [ 439.15	Area m <sup>2</sup> 19.62 538.19	Sol V x 1 550.93	lar flux V/m <sup>2</sup> 9.64 x	speci or T 0.9 x (() 450.55	g ific data able 6b ).50 x 350.20	FF specific c or Table 0.70 216.95	data : 6c	Gains W 93.46 76.86	] (80) ] (83)
6. Solar gains West Solar gains in w Total gains - int	ratts ∑(74)m 93.46 ernal and sc	n(82)m 182.84 Dlar (73)m +	Access Table 0.7 301.11	factor 2 6d 7 x ( 439.15	Area m <sup>2</sup> 19.62 538.19	Sol w x 1 550.93	er flux V/m <sup>2</sup> 9.64 x 524.51	speci or T 0.9 x ( 450.55	g ific data able 6b 0.50 x 350.20	FF specific c or Table 0.70 216.95	data e 6c = 116.54	Gains W 93.46 76.86	] (80) ] (83)
6. Solar gains West Solar gains in w Total gains - int	ratts $\Sigma(74)$ m 93.46 ernal and sc 381.39	n(82)m 182.84 Dlar (73)m + 468.56	Access Table 0.7 301.11 - (83)m 576.43	factor e 6d 7 x ( 439.15	Area m <sup>2</sup> 19.62 538.19	Sol w x 1 550.93	ear flux V/m <sup>2</sup> 9.64 x 524.51	speci or T 0.9 x () 450.55	g ific data able 6b 0.50 x 350.20	FF specific c or Table 0.70 216.95	data e 6c 116.54 382.32	Gains W 93.46 76.86	] (80) ] (83) ] (84)
6. Solar gains West Solar gains in w Total gains - int	ratts ∑(74)m 93.46 ernal and sc 381.39	n(82)m 182.84 blar (73)m + 468.56	Access Table 0.7 301.11 (83)m 576.43	factor 2 6d 7 x 439.15 698.13	Area m <sup>2</sup> 19.62 538.19 780.85	Sol W X 1 550.93 777.61	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00	speci or T 0.9 x (0) 450.55 672.41	<b>g</b> ific data able 6b 0.50 x 350.20 580.57	FF specific c or Table 0.70 216.95 463.84	data e 6c ] = 116.54 	Gains W 93.46 76.86 356.69	] (80) ] (83) ] (84)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean inter</li> </ul>	ratts ∑(74)m 93.46 ernal and sc 381.39 nal tempera	n(82)m 182.84 blar (73)m + 468.56 sture (heati	Access Table 0.7 301.11 (83)m 576.43 ng season)	factor 2 6d 7 x ( 439.15 698.13	Area m <sup>2</sup> 19.62 538.19 780.85	Sol v x 1 550.93 777.61	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00	speci or T 0.9 x () 450.55 672.41	g ific data able 6b 0.50 x 350.20 580.57	FF specific c or Table 0.70 216.95 463.84	data e 6c 116.54 382.32	Gains W 93.46 76.86 356.69	] (80) ] (83) ] (84)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean inter</li> <li>Temperature d</li> </ul>	ratts ∑(74)m 93.46 ernal and sc 381.39 nal tempera uring heatin	n(82)m 182.84 blar (73)m + 468.56 sture (heati g periods ir	Access Table 0.7 301.11 (83)m 576.43 ng season) the living	factor 2 6d 7 × ( 439.15 698.13 area from 7	Area m <sup>2</sup> 19.62 538.19 780.85	Sol w x 1 550.93 777.61	er flux V/m <sup>2</sup> 9.64 x 524.51 741.00	speci or T 0.9 x (0) 450.55 672.41	<b>g</b> ific data able 6b 0.50 x 350.20 580.57	FF specific c or Table 0.70 216.95 463.84	data e 6c = = [ 116.54 382.32	Gains W 93.46 76.86 356.69 21.00	] (80) ] (83) ] (84) ] (85)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean inter</li> <li>Temperature d</li> </ul>	ratts ∑(74)m 93.46 ernal and sc 381.39 nal tempera uring heatin, Jan	n(82)m 182.84 blar (73)m + 468.56 sture (heati g periods ir Feb	Access Table 0.7 301.11 (83)m 576.43 ng season) the living Mar	factor 6 d 7 x 439.15 698.13 area from 7 Apr	Area m <sup>2</sup> 19.62 538.19 780.85 Fable 9, Th1 May	Sol v v x 1 550.93 777.61	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00	speci or T 0.9 x () 450.55 672.41	g ific data able 6b 0.50 x 350.20 580.57	FF specific c or Table 0.70 216.95 463.84	data e 6c 116.54 382.32 Nov	Gains W 93.46 76.86 356.69 21.00 Dec	] (80) ] (83) ] (84) ] (85)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean inter</li> <li>Temperature d</li> <li>Utilisation factor</li> </ul>	ratts ∑(74)m 93.46 ernal and sc 381.39 nal tempera uring heatin Jan or for gains f	n(82)m 182.84 blar (73)m + 468.56 sture (heati g periods in Feb For living are	Access Table 0.7 301.11 (83)m 576.43 ng season) n the living Mar ea n1,m (se	factor 2 6d 7 × 439.15 698.13 area from T Apr ee Table 9a)	Area m <sup>2</sup> 19.62 538.19 780.85 Table 9, Th1 May	Sol w x 1 550.93 777.61	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00	speci or T 0.9 x () 450.55 672.41 Aug	g ific data able 6b 0.50 x 350.20 580.57 Sep	FF specific c or Table 0.70 216.95 463.84 Oct	data e 6c 116.54 382.32	Gains W 93.46 76.86 356.69 21.00 Dec	] (80) ] (83) ] (84) ] (85)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean inter</li> <li>Temperature d</li> <li>Utilisation factor</li> </ul>	ratts ∑(74)m 93.46 ernal and sc 381.39 nal tempera uring heatin, Jan or for gains f 0.99	n(82)m 182.84 blar (73)m + 468.56 sture (heating periods in Feb For living are 0.98	Access Table 0.7 301.11 (83)m 576.43 ng season) the living Mar ea n1,m (se 0.92	factor 6 d 7 x 439.15 698.13 area from 7 Apr ee Table 9a) 0.76	Area m <sup>2</sup> 19.62 538.19 780.85 Fable 9, Th1 May	Sol v v x 1 550.93 777.61	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00 Jul 0.27	speci or Tr 0.9 x () 450.55 672.41 Aug 0.31	g ific data able 6b 0.50 x 350.20 580.57 580.57	FF specific c or Table 0.70 216.95 463.84 0ct	data e 6c 116.54 382.32 Nov 0.98	Gains W 93.46 76.86 356.69 21.00 Dec 1.00	] (80) ] (83) ] (84) ] (85) ] (85)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean intern</li> <li>Temperature d</li> <li>Utilisation factor</li> <li>Mean internal t</li> </ul>	ratts $\Sigma(74)$ m 93.46 ernal and so 381.39 nal tempera uring heatin Jan or for gains f 0.99 semp of livin	n(82)m 182.84 blar (73)m + 468.56 ture (heati g periods in Feb for living and 0.98 g area T1 (s	Access Table 0.7 301.11 (83)m 576.43 ng season) n the living Mar ea n1,m (se 0.92 steps 3 to 7	factor 2 6d 7 × [ 439.15 698.13 area from T Apr 2 Table 9a) 0.76 7 in Table 90	Area m <sup>2</sup> 19.62 538.19 780.85 780.85 Table 9, Th1 May 0 0.55	Sol w x 1 550.93 777.61	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00 Jul 0.27	speci or T 0.9 x () 450.55 672.41 Aug 0.31	g ific data able 6b 0.50 x 350.20 580.57 580.57 Sep 0.54	FF specific c or Table 0.70 216.95 463.84 0ct 0.88	data e 6c 116.54 382.32 Nov 0.98	Gains W 93.46 76.86 356.69 21.00 Dec 1.00	] (80) ] (83) ] (84) ] (85) ] (86)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean inter</li> <li>Temperature d</li> <li>Utilisation factor</li> <li>Mean internal t</li> </ul>	ratts $\Sigma(74)$ m 93.46 ernal and sc 381.39 nal tempera uring heatin, Jan or for gains f 0.99 cemp of livin 20.21	n(82)m 182.84 blar (73)m + 468.56 ture (heating periods in Feb For living area 0.98 g area T1 (state) 20.42	Access Table 0.7 301.11 (83)m 576.43 ng season) the living Mar ea n1,m (se 0.92 steps 3 to 7 20.70	factor 6 d 7 x 439.15 698.13 area from 7 Apr ee Table 9a 0.76 7 in Table 9a 20.93	Area m <sup>2</sup> 19.62 538.19 780.85 780.85 able 9, Th1 May 0.55 c) 20.99	Sol v v x 1 550.93 777.61 (°C) Jun 0.38 21.00	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00 Jul 0.27 21.00	speci or T 0.9 x () 450.55 672.41 Aug 0.31 21.00	g ific data able 6b 0.50 x 350.20 580.57 580.57	FF specific c or Table 0.70 216.95 463.84 463.84	data e 6c 116.54 382.32 Nov 0.98 20.48	Gains W 93.46 76.86 356.69 21.00 Dec 1.00	] (80) ] (83) ] (84) ] (85) ] (85) ] (86) ] (87)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean intern</li> <li>Temperature d</li> <li>Utilisation factor</li> <li>Mean internal t</li> <li>Temperature d</li> </ul>	ratts $\Sigma(74)$ m 93.46 ernal and so 381.39 nal tempera uring heatin Jan or for gains f 0.99 cemp of livin 20.21 uring heatin	n(82)m 182.84 blar (73)m + 468.56 ture (heati g periods in Feb for living are 0.98 g area T1 (s 20.42 g periods in	Access Table 0.7 301.11 (83)m 576.43 ng season) the living Mar ea n1,m (se 0.92 steps 3 to 7 20.70 n the rest o	factor 2 6d 7 × [ 439.15 698.13 698.13 area from T Apr ee Table 9a) 0.76 7 in Table 9c 20.93 f dwelling f	Area m <sup>2</sup> 19.62 538.19 780.85 780.85 780.85 0 538.19 0 0 538.19 0 0 538.19 0 0 538.19 0 0 538.19 0 0 538.19 0 0 538.19 0 0 538.19 0 0 0 5 5 0 0 0 5 0 0 0 0 0 0 0 0 0 0	Sol W x 1 550.93 777.61 (°C) Jun 0.38 21.00 9, Th2(°C)	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00 Jul 0.27 21.00	speci or T 0.9 x () 450.55 672.41 Aug 0.31 21.00	g ific data able 6b 0.50 x 350.20 580.57 580.57 580.57 0.54 0.54 20.99	FF specific c or Table 216.95 463.84 463.84 0ct 0.88	<pre>data e 6c</pre>	Gains W 93.46 76.86 356.69 21.00 Dec 1.00 20.17	] (80) ] (83) ] (84) ] (85) ] (85) ] (86) ] (87)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean interr</li> <li>Temperature d</li> <li>Utilisation factor</li> <li>Mean internal t</li> <li>Temperature d</li> </ul>	ratts $\Sigma(74)$ m 93.46 ernal and sc 381.39 nal tempera uring heatin, Jan or for gains f 0.99 cemp of livin 20.21 uring heatin, 20.15	n(82)m 182.84 blar (73)m + 468.56 ture (heati g periods ir Feb for living are 0.98 g area T1 (s 20.42 g periods ir 20.15	Access Table 0.7 301.11 (83)m 576.43 ng season) the living Mar ea n1,m (se 0.92 steps 3 to 7 20.70 the rest o 20.16	factor a 6d 7 × [ 439.15 698.13 area from 7 Apr ee Table 9a) 0.76 7 in Table 9a 20.93 f dwelling f 20.17	Area m <sup>2</sup> 19.62 538.19 780.85 780.85 780.85 0.55 0.55 20.99 rom Table 9	Sol v x 1 550.93 777.61 (°C) Jun 0.38 21.00 9, Th2(°C) 20.18	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00 Jul 0.27 21.00	speci or T 0.9 x () 450.55 672.41 Aug 0.31 21.00	g ific data able 6b 0.50 x 350.20 580.57 580.57 580.57 0.54 0.54 20.99	FF specific c or Table 0.70 216.95 463.84 463.84 0.88 0.88 20.85	<pre>data e 6c</pre>	Gains W 93.46 76.86 356.69 21.00 Dec 1.00 20.17	] (80) ] (83) ] (84) ] (85) ] (85) ] (86) ] (87) ] (88)
<ul> <li>G. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean intern</li> <li>Temperature d</li> <li>Utilisation factor</li> <li>Mean internal t</li> <li>Temperature d</li> <li>Utilisation factor</li> </ul>	ratts $\Sigma(74)$ m 93.46 ernal and so 381.39 nal tempera uring heatin Jan or for gains f 0.99 emp of livin 20.21 uring heatin, 20.15 or for gains f	n(82)m 182.84 olar (73)m + 468.56 ture (heati g periods in Feb for living an 0.98 g area T1 (s 20.42 g periods in 20.15 for rest of d	Access Table 0.7 301.11 (83)m 576.43 ng season) the living Mar ea n1,m (se 0.92 steps 3 to 7 20.70 n the rest o 20.16 welling n2,	factor a factor a factor a factor 439.15 698.13 698.13 698.13 area from 1 Apr area from 1 Apr 20.93 f dwelling f 20.17 m	Area m <sup>2</sup> 19.62 538.19 780.85 780.85 780.85 0 538.19 0 780.85 0 780 0 780.85 0 780.85 0 780.85 0 780.85 780.85 780 780.85 780.85 780.85 780.85 780.85 780.85 780.85 780.85 780 780.85 780.85 780 780.85 780.85 780 780.85 780.85 780 780.85 780 780.85 780.85 780 780.85 780.85 780.85 780 780.85 780.85 780 780.85 780.85 780 780.85 780.85 780.85 780 780.85 7800	Sol w x 1 550.93 777.61 (°C) Jun 0.38 21.00 9, Th2(°C) 20.18	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00 Jul 0.27 21.00 20.18	speci or T 0.9 x () 450.55 672.41 <b>Aug</b> 0.31 21.00 20.19	g ific data able 6b ).50 x 350.20 580.57 580.57 580.57 20.99 20.18	FF specific c or Table 216.95 463.84 463.84 0ct 0.88 20.85	<pre>data e 6c</pre>	Gains W 93.46 76.86 356.69 21.00 Dec 1.00 1.00 20.17	] (80) ] (83) ] (84) ] (85) ] (85) ] (86) ] (87) ] (88)
<ul> <li>G. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean intern</li> <li>Temperature di</li> <li>Utilisation factor</li> <li>Mean internal ti</li> <li>Temperature di</li> <li>Utilisation factor</li> </ul>	ratts $\Sigma(74)$ m 93.46 ernal and so 381.39 nal tempera uring heatin Jan or for gains f 0.99 temp of livin 20.21 uring heatin 20.15 or for gains f 0.99	n(82)m 182.84 blar (73)m + 468.56 ture (heati g periods ir Feb for living are 0.98 g area T1 (s 20.42 g periods ir 20.15 for rest of d 0.97	Access Table 0.7 301.11 (83)m 576.43 ng season) the living Mar ea n1,m (se 0.92 steps 3 to 7 20.70 the rest o 20.16 welling n2, 0.90	factor a 6d 7 × [ 439.15 698.13 area from 7 Apr ee Table 9a) 0.76 7 in Table 9a 20.93 f dwelling f 20.17 m 0.72	Area m <sup>2</sup> 19.62 538.19 780.85 780.85 780.85 0 50 0.55 c) 20.99 rom Table 9 20.17	Sol v x 1 550.93 777.61 (°C) Jun 0.38 21.00 9, Th2(°C) 20.18 0.33	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00 Jul 0.27 21.00 20.18	speci or T 0.9 x (0) 450.55 672.41 Aug 0.31 21.00 20.19 0.26	g ific data able 6b 0.50 x 350.20 580.57 580.57 580.57 0.54 20.99 20.18	FF specific c or Table 0.70 216.95 463.84 463.84 0.88 0.88 20.85 20.17	<pre>data e 6c</pre>	Gains W 93.46 76.86 356.69 21.00 Dec 1.00 20.17 20.16	] (80) ] (83) ] (83) ] (84) ] (85) ] (85) ] (86) ] (87) ] (88) ] (88)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean intern</li> <li>Temperature d</li> <li>Utilisation factor</li> <li>Mean internal t</li> <li>Temperature d</li> <li>Utilisation factor</li> <li>Mean internal t</li> </ul>	ratts $\Sigma(74)$ m 93.46 ernal and so 381.39 nal tempera uring heatin Jan or for gains f 0.99 emp of livin 20.21 uring heatin 20.15 or for gains f 0.99 emperature	n(82)m 182.84 olar (73)m + 468.56 ture (heati g periods in Feb for living an 0.98 g area T1 (s 20.42 g periods in 20.42 g periods in 20.15 for rest of d 0.97 e in the rest	Access Table 0.7 301.11 (83)m 576.43 ng season) the living Mar ea n1,m (se 0.92 steps 3 to 7 20.70 n the rest o 20.16 welling n2, 0.90 c of dwelling	factor a factor a factor a factor 7 × [ 439.15 698.13 698.13 area from 1 Apr area from 1 Apr 20.93 f dwelling f 20.17 m 0.72 g T2 (follow	Area m <sup>2</sup> 19.62 538.19 780.85	Sol w x 1 550.93 7777.61 (°C) Jun 0.38 21.00 9, Th2(°C) 20.18 0.33 7 in Table 9	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00 Jul 0.27 21.00 20.18 0.22 90)	speci or T 0.9 x () 450.55 672.41 <b>Aug</b> 0.31 21.00 20.19 0.26	g ific data able 6b ).50 x 350.20 580.57 580.57 580.57 20.99 20.18	FF specific c or Table 216.95 463.84 463.84 0.88 0.88 20.85 20.17	<pre>data e 6c</pre>	Gains W 93.46 76.86 356.69 21.00 Dec 1.00 1.00 20.17 20.17	] (80) ] (83) ] (84) ] (85) ] (85) ] (86) ] (87) ] (88) ] (89)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean intern</li> <li>Temperature di</li> <li>Utilisation factor</li> <li>Mean internal ti</li> <li>Temperature di</li> <li>Utilisation factor</li> <li>Mean internal ti</li> </ul>	ratts $\Sigma(74)$ m 93.46 ernal and so 381.39 nal tempera uring heatin Jan or for gains f 0.99 cemp of livin 20.21 uring heatin 20.15 or for gains f 0.99 cemperature 19.43	n(82)m 182.84 blar (73)m + 468.56 ture (heati g periods ir Feb for living are 0.98 g area T1 (s 20.42 g periods ir 20.15 for rest of d 0.97 e in the rest 19.64	Access Table 0.7 301.11 (83)m 576.43 ng season) the living Mar ea n1,m (se 0.92 steps 3 to 7 20.70 the rest o 20.16 welling n2, 0.90 of dwelling	factor a dd 7 x [ 439.15 698.13 area from 7 Apr ee Table 9a) 0.76 7 in Table 9a 20.93 f dwelling f 20.17 m 0.72 g T2 (follow 20.12	Area m <sup>2</sup> 19.62 538.19 780.85 780.85 780.85 0.55 0.55 20.99 rom Table 9 20.17 0.50 (steps 3 to 20.17	Sol v x 1 550.93 777.61 (°C) Jun 0.38 21.00 9, Th2(°C) 20.18 0.33 7 in Table 9 20.18	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00 Jul 0.27 21.00 20.18 0.22 9c) 20.18	speci or T 0.9 x 0 450.55 672.41 Aug 0.31 21.00 20.19 0.26	g         ific data         able 6b         0.50       x         350.20         580.57         580.57         0.54         20.99         20.18         0.48         20.18	FF specific c or Table 0.70 216.95 463.84 463.84 0.88 20.85 20.17 20.17	<pre>data e 6c</pre>	Gains W 93.46 76.86 356.69 21.00 Dec 1.00 20.17 20.16 20.16	] (80) ] (83) ] (83) ] (84) ] (85) ] (85) ] (86) ] (87) ] (88) ] (89) ] (90)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in w</li> <li>Total gains - int</li> <li>7. Mean intern</li> <li>Temperature d</li> <li>Utilisation factor</li> <li>Mean internal t</li> <li>Temperature d</li> <li>Utilisation factor</li> <li>Mean internal t</li> <li>Living area fract</li> </ul>	ratts $\Sigma(74)$ m 93.46 ernal and so 381.39 nal temperation Jan or for gains f 0.99 emp of livin 20.21 uring heatin 20.15 or for gains f 0.99 emperature 19.43 tion	n(82)m 182.84 blar (73)m + 468.56 ture (heati g periods in Feb for living are 0.98 g area T1 (s 20.42 g periods in 20.42 g periods in 20.15 for rest of d 0.97 a in the rest 19.64	Access Table 0.7 301.11 (83)m 576.43 ng season) the living Mar ea n1,m (se 0.92 steps 3 to 7 20.70 n the rest o 20.16 welling n2, 0.90 of dwelling	factor a factor a factor a factor a factor 439.15 698.13 698.13 area from T Apr e Table 9a 0.76 7 in Table 9a 0.76 7 in Table 9a 10.76 7 in Table 9a 10.72 g T2 (follow 20.12	Area m <sup>2</sup> 19.62 538.19 780.85 780.85 780.85 780.85 0.55 0.55 20.99 7000 Table 9 20.17 0.50 7 steps 3 to 20.17	Sol v x 1 550.93 7777.61 (°C) Jun 0.38 21.00 9, Th2(°C) 20.18 0.33 7 in Table 9 20.18	ar flux V/m <sup>2</sup> 9.64 x 524.51 741.00 Jul 0.27 21.00 20.18 0.22 9c) 20.18	speci or T 0.9 x 0 450.55 672.41 <b>Aug</b> 0.31 21.00 20.19 0.26 20.19	g ific data able 6b ).50 x 350.20 580.57 580.57 580.57 20.99 20.18 0.48	FF specific c or Table 0.70 216.95 463.84 463.84 0.88 0.88 20.85 20.85 20.17 0.84 20.07	<pre>data e 6c</pre>	Gains W 93.46 76.86 356.69 21.00 Dec 1.00 20.17 20.17 20.16 0.99 19.41 0.49	] (80) ] (83) ] (83) ] (84) ] (85) ] (85) ] (86) ] (87) ] (88) ] (89) ] (89) ] (90) ] (91)



Mean internal t	emperature	for the wh	ole dwellin	g fLA x T1 ·	+(1 - fLA) x	: T2							
	19.81	20.02	20.30	20.51	20.57	20.58	20.58	20.58	20.57	20.45	20.09	19.78	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
	19.66	19.87	20.15	20.36	20.42	20.43	20.43	20.43	20.42	20.30	19.94	19.63	(93)
8. Space heati	ng requirem	nent											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	r for gains,	ηm						U	•				
	0.99	0.97	0.90	0.73	0.52	0.34	0.24	0.27	0.50	0.85	0.98	0.99	(94)
Useful gains, ŋn	nGm, W (94	1)m x (84)m					_	-					
	377.87	455.32	521.19	507.45	403.08	267.19	175.70	184.28	289.97	394.04	373.40	354.35	(95)
Monthly averag	e external t	emperature	e from Tabl	e U1	1							1	
	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	or mean inte	ernal tempe	erature, Lm	, W [(39)m	n x [(93)m	- (96)m]							
	735.67	714.57	649.37	536.45	406.60	267.42	175.72	184.31	292.01	452.44	602.71	729.30	(97)
Space heating re	equirement	. kWh/mon	th 0.024 x	[(97)m - (9	5)ml x (41	.)m		10.001			002//2	/ _0.00	
opace nearing r	266.20	174 22	95 37	20.88	2 62	0.00	0.00	0.00	0.00	43 44	165 10	278.96	7
	200.20	174.22	55.57	20.00	2.02	0.00	0.00	0.00	5(9)	8)1 5 10	12 = 12	046 79	] ] (98)
Space beating r	auirement	$kWh/m^2/w$	aar						2(5)	(08)	12 - <u></u>	20 11	] (00)
Space nearing in	equitement	KVV11/111/90	201							(38)	• (4)	20.11	
9a. Energy req	uirements -	individual	heating sys	stems inclu	uding micr	o-CHP							
Space heating													
Fraction of space	e heat from	secondary,	/suppleme	ntary syste	m (table 1	.1)						0.00	(201)
Fraction of space	e heat from	i main syste	em(s)							1 - (20	01) =	1.00	(202)
Fraction of space	e heat from	i main syste	em 2									0.00	(202)
Fraction of tota	l space heat	from main	system 1						(20	02) x [1- (20	3)] =	1.00	(204)
Fraction of tota	l space heat	from main	system 2							(202) x (20	)3) =	0.00	(205)
Efficiency of ma	in system 1	(%)										90.00	(206)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating for	uel (main sy	stem 1), kW	/h/month										
	295.78	193.58	105.96	23.20	2.91	0.00	0.00	0.00	0.00	48.27	183.45	309.96	1
									Σ(21)	1)15, 10	12 = 1	163.10	(211)
Water heating													
Efficiency of wa	ter heater												
	85.83	85.11	83.53	81.13	80.08	79.90	79.90	79.90	79.90	82.08	84.89	86.00	(217)
Water heating f	uel, kWh/m	onth											
	193.50	170.46	180.71	165.03	161.87	142.88	136.89	152.60	154.29	171.03	176.51	188.58	7
							Į			Σ(219a)1	12 = 1	1994.35	(219)
Annual totals										20			
Space heating fu	uel - main sv	vstem 1										163.10	7
Water heating f	uel											994.35	]
Electricity for p	umps, fans a	and electric	keep-hot (	Table 4f)									
mechanical	ventilation f	ans - haland	red extract	or positive	e innut fro	m outside			218 63	1			(230a)
central heati		water num	n within w	arm air he	ating unit				30.00	_ ]			(230c)
hoiler flue fo	n panip ol	water pull	ννιτιπι W		ating unit				45.00	_ T			(2200)
Total electricity	for the aba	ve kwh/ue	ar						-5.00	L	[	203 63	(221)
Electricity for lic		andiy L)	ai									275.05	(222)
	anore (Appe							(211) (221	) . (224)	(222) (222	/h) =	240.19	_ (232) _ (220)
Total delivered energy for all uses $(211)(221) + (232)(237b) = 3691.28$ (238)									_ (238)				



10a. Fuel costs - individual heating systems inc	luding micro-CHP					
	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1163.10	x	3.48	x 0.01 =	40.48	(240)
Water heating	1994.35	x	3.48	x 0.01 =	69.40	(247)
Pumps and fans	293.63	x	13.19	x 0.01 =	38.73	(249)
Electricity for lighting	240.19	x	13.19	x 0.01 =	31.68	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242) + (2	45)(254) =	300.29	(255)
11a. SAP rating - individual heating systems ind	cluding micro-CHP					
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					1.30	(257)
SAP value					81.87	]
SAP rating (section 13)					82	(258)
SAP band					В	]
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	1163.10	x	0.22	=	251.23	(261)
Water heating	1994.35	x	0.22	=	430.78	(264)
Space and water heating			(261) + (262) + (26	63) + (264) =	682.01	(265)
Pumps and fans	293.63	x	0.52	=	152.40	(267)

Total CO₂, kg/year		(265)(271) =
Dwelling CO <sub>2</sub> emission rate		(272) ÷ (4) =
El value		
El rating (section 14)		
El band		

240.19

х

0.52

=

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1163.10	x	1.22	=	1418.98	(261)
Water heating	1994.35	x	1.22	=	2433.11	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	3852.09	(265)
Pumps and fans	293.63	x	3.07	=	901.46	(267)
Electricity for lighting	240.19	x	3.07	=	737.38	(268)
Primary energy kWh/year					5490.93	(272)
Dwelling primary energy rate kWh/m2/year					105.49	(273)

Electricity for lighting

(268)

(272)

(273)

(274)

124.66

959.06

18.43

86.76

87

В
## 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	Miss Cha	arlotte Boot	:h				As	sessor num	iber	6376		
Client	Warmha	ize Ltd					La	st modified		23/01	/2015	
Address	3 17-27	& 25 Ferdin	and Street	. Camden.	London. NV	V1 8EX						
				, ,	,							
1. Overall dwelling dimer	sions											
				A	area (m²)		Aver he	age storey eight (m)		Va	olume (m³)	
Lowest occupied					69.34	](1a) x		3.49	(2a) =		242.00	(3a)
Total floor area	(1a)	) + (1b) + (1	c) + (1d)(	1n) =	69.34	(4)						
Dwelling volume							(3a)	+ (3b) + (3d	c) + (3d)(3	n) = 🗌	242.00	(5)
2. Ventilation rate												
										m	<sup>3</sup> per hour	
Number of chimneys								0	] x 40 =		0	(6a)
Number of open flues								0	] x 20 =		0	(6b)
Number of intermittent far	าร							0	] x 10 =		0	(7a)
Number of passive vents								0	] x 10 =		0	(7b)
Number of flueless gas fire	S							0	] x 40 =		0	(7c)
										Airo	changes pe hour	r
Infiltration due to chimney	s, flues, fan	s, PSVs		(6a	) + (6b) + (7	a) + (7b) + (	7c) =	0	÷ (5) =		0.00	(8)
, If a pressurisation test has	been carrie	d out or is i	ntended, p	roceed to (	(17), otherw	vise continue	e from (9) t	o (16)	] ()			
Air permeability value, q50	, expressed	l in cubic m	etres per h	our per sq	uare metre	of envelope	area				3.00	(17)
If based on air permeability	value, the	n (18) = [(1 <sup>-</sup>	7) ÷ 20] + (8	8), otherwi	se (18) = (1	6)					0.15	(18)
Number of sides on which	the dwellin	g is sheltere	ed								3	(19)
Shelter factor								1 -	[0.075 x (19	9)] =	0.78	(20)
Infiltration rate incorporation	ng shelter f	actor							(18) x (2	0) =	0.12	(21)
Infiltration rate modified for	or monthly	wind speed	:							·		
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind spe	ed from Tal	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	(22a)
Adjusted infiltration rate (a	allowing for	shelter and	d wind fact	or) (21) x (2	22a)m			•				
0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	(22b)
Calculate effective air char	ge rate for	the applica	ble case:									
If mechanical ventilatio	n: air chang	e rate thro	ugh system	ı							0.50	(23a)
If balanced with heat re	covery: effi	iciency in %	allowing for	or in-use fa	ictor from T	able 4h					77.35	(23c)
a) If balanced mechanic	al ventilatio	on with hea	t recovery	(MVHR) (2	2b)m + (23l	o) x [1 - (23d	:) ÷ 100]					
0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(24a)
Effective air change rate - e	enter (24a)	or (24b) or	(24c) or (24	4d) in (25)								
0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(25)



3. Heat losses a	and heat lo	ss paramet	er										
Element			а	Gross rea, m²	Openings m <sup>2</sup>	Net a	area m²	U-value W/m²K	A x U W	//К к-v kJ,	value, /m².K	Ахк, kJ/K	
Window						26.	71 x	0.87	= 23.20	)			(27)
Ground floor						69.	34 x	0.10	= 6.93				(28a)
External wall						45.	39 x	0.16	= 7.26				(29a)
Party wall						70.	22 x	0.00	= 0.00				(32)
Total area of ext	ernal eleme	ents ∑A, m²	:			141	.44						(31)
Fabric heat loss,	W/K = ∑(A	× U)							(2	6)(30) + (3	32) =	37.40	] (33)
Heat capacity Cr	m = ∑(А x к)							(28)	.(30) + (32)	+ (32a)(32	2e) =	N/A	] (34)
Thermal mass pa	arameter (T	MP) in kJ/n	n²K									250.00	_ ] (35)
Thermal bridges	: Σ(L x Ψ) ca	alculated us	sing Appen	dix K								21.22	] (36)
Total fabric heat	loss									(33) + (3	36) =	58.62	(37)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat	loss calcula	ited month	ly 0.33 x (2	25)m x (5)									
	20.88	20.65	20.42	19.26	19.02	17.86	17.86	17.63	18.33	19.02	19.49	19.95	(38)
Heat transfer co	efficient, W	' //K (37)m +	- (38)m									-	
	79.50	79.26	79.03	77.87	77.64	76.48	76.48	76.25	76.94	77.64	78.10	78.57	7
									Average = 2	5(39)112/	/12 =	77.81	] (39)
Heat loss param	eter (HLP),	W/m²K (39	9)m ÷ (4)										_
	1.15	1.14	1.14	1.12	1.12	1.10	1.10	1.10	1.11	1.12	1.13	1.13	7
	L								Average = 2	Σ(40)112/	/12 =	1.12	] (40)
Number of days	in month (1	Fable 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	<mark>] (40)</mark>
	L	•	·		· ·			·			·	•	_
4. Water heati	ng energy r	equiremen	t										_
Assumed occupa	ancy, N											2.23	(42)
Annual average	hot water u	isage in litro	es per day '	Vd,average	= (25 x N) +	36						87.16	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage	in litres pe	r day for ea	ach month	Vd,m = fact	tor from Tab	le 1c x (43	)		1	1		-	_
	95.88	92.39	88.91	85.42	81.93	78.45	78.45	81.93	85.42	88.91	92.39	95.88	
										∑(44)1	.12 =	1045.95	(44)
Energy content	of hot wate	r used = 4.1	L8 x Vd,m x	nm x Tm/3	3600 kWh/m	onth (see	Tables 1b,	1c 1d)					_
	142.19	124.36	128.32	111.88	107.35	92.63	85.84	98.50	99.68	116.16	126.80	137.70	
										∑(45)1	.12 =	1371.40	(45)
Distribution loss	0.15 x (45)	)m							-			-	_
	21.33	18.65	19.25	16.78	16.10	13.89	12.88	14.78	14.95	17.42	19.02	20.65	(46)
Water storage lo	oss calculate	ed for each	month (55	5) x (41)m								- <b>i</b>	_
	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	tains dedica	ated solar s	torage or d	ledicated W	/WHRS (56)n	n x [(47) -	Vs] ÷ (47),	else (56)				_	_
	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	oss for each	month fro	m Table 3										_
	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	ach month	from Table	3a, 3b or 3	lc									_
Combi loss for e	ach month 48.86	from Table 42.53	3a, 3b or 3 45.31	42.12	41.75	38.69	39.98	41.75	42.12	45.31	45.56	48.86	] (61)
Combi loss for e Total heat requi	ach month 48.86 red for wate	from Table 42.53 er heating o	3a, 3b or 3 45.31 calculated f	42.12 or each mc	41.75 onth 0.85 x (	38.69 45)m + (46	39.98 6)m + (57)	41.75 m + (59)m	42.12 + (61)m	45.31	45.56	48.86	] <b>(61)</b>
Combi loss for e Total heat requi	ach month 48.86 red for wate 191.04	from Table 42.53 er heating o 166.88	3a, 3b or 3 45.31 calculated f 173.63	42.12 for each mc 154.00	41.75 onth 0.85 x ( 149.10	38.69 45)m + (46 131.32	39.98 6)m + (57) 125.81	41.75 m + (59)m 140.25	42.12 + (61)m 141.80	45.31	45.56	48.86	] (61) ] (62)



	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	ter heater f	or each mo	onth (kWh/i	month) (62	2)m + (63)n	י ז		I				
·	191 04	166.88	173.63	154.00	149 10	131 32	125.81	140.25	141 80	161 47	172 37	186 56
	151.04	100.00	175.05	134.00	145.10	131.32	125.01	140.25	141.00	5(64)1	12 - 12	1804.22 (64)
Host gains from	wator boat	ing (k)Mh/m	anth = 0.21		$(15)m \pm (61)$	$(m) \pm 0.8 \times$	[(16)m + (1)]	(50)	ml	2(04)1	.12	(04)
fieat gains from				47 70				42.10	42.67	40.05		
	59.49	51.98	53.99	47.73	46.13	40.47	38.54	43.19	43.67	49.95	53.55	58.00 (65)
5. Internal gain	s											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Metabolic gains	(Table 5)			•	•			Ū				
	111 50	111 50	111 50	111 50	111 50	111 50	111 50	111 50	111 50	111 50	111 50	111 50 (66)
Lighting gains (c	alculated in		equation	19 or 19a)		hle 5	111.50	111.50	111.50	111.50	111.50	
Lighting gains (co							6.51	9.46	11.25	14.42	16.02	17.04 (67)
	17.45	15.50	12.61	9.54	/.13	0.02	0.51	8.46	11.35	14.42	16.83	17.94 (67)
Appliance gains	(calculated	In Appendi	x L, equatio	on L13 or L.								
	195.75	197.78	192.66	181.77	168.01	155.08	146.45	144.41	149.53	160.43	174.19	187.11 (68)
Cooking gains (c	alculated ir	Appendix	L, equation	L15 or L15	a), also see	e Table 5						
	34.15	34.15	34.15	34.15	34.15	34.15	34.15	34.15	34.15	34.15	34.15	34.15 (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. evap	oration (Tal	ble 5)										
	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20 (71)
Water heating g	ains (Table	5)										
	79.96	77.35	72.57	66.29	62.00	56.21	51.79	58.05	60.66	67.14	74.38	77.96 (72)
Total internal ga	ins (66)m -	+ (67)m + (6	58)m + (69)	m + (70)m ·	+ (71)m + (	72)m						
-				· · ·								
	352.61	350.08	337.29	317.05	296.60	276.77	264.20	270.37	280.99	301.43	324.84	342.46 (73)
	352.61	350.08	337.29	317.05	296.60	276.77	264.20	270.37	280.99	301.43	324.84	342.46 (73)
6. Solar gains	352.61	350.08	337.29	317.05	296.60	276.77	264.20	270.37	280.99	301.43	324.84	342.46 (73)
6. Solar gains	352.61	350.08	337.29 Access f	317.05	296.60 Area	276.77 Sol	264.20 ar flux	270.37	280.99 <b>g</b>	301.43	324.84	342.46 (73) Gains
6. Solar gains	352.61	350.08	337.29 Access f Table	317.05 actor 6d	296.60 Area m <sup>2</sup>	276.77 Sol	264.20 ar flux //m²	270.37 speci	g ific data	301.43 FF specific c	324.84	342.46 (73) Gains W
6. Solar gains	352.61	350.08	337.29 Access f Table	317.05 factor 6d	296.60 Area m <sup>2</sup>	276.77 Sol W	264.20 ar flux //m <sup>2</sup>	270.37 speci or T	280.99 g ific data able 6b	301.43 FF specific c or Table	324.84 data e 6c	342.46 (73) Gains W
6. Solar gains West	352.61	350.08	337.29 Access f Table	317.05 Factor 6d	296.60 Area m <sup>2</sup> 26.71	276.77 Sol W	264.20 ar flux //m <sup>2</sup> 9.64 x	270.37 speci or T	g ific data able 6b	301.43 FF specific c or Table 0.70	324.84 data e 6c	342.46 (73) Gains W 89.23 (80)
6. Solar gains West Solar gains in wa	352.61 Itts ∑(74)m	350.08	337.29 Access f Table	317.05	296.60 Area m <sup>2</sup> 26.71	276.77 Sol. X 1	264.20 ar flux //m <sup>2</sup> 9.64 x	270.37 speci or T 0.9 x	g ific data able 6b	301.43 FF specific c or Table 0.70	324.84	342.46 (73) Gains W 89.23 (80)
6. Solar gains West Solar gains in wa	352.61 tts Σ(74)m 89.23	350.08 (82)m 174.56	337.29 Access f Table 0.5 287.47	317.05 Factor 6d 4 x ( 419.26	296.60 Area m <sup>2</sup> 26.71 513.82	276.77 Sol. X 1 525.99	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76	270.37 speci or T 0.9 x () 430.15	280.99 g ific data able 6b 0.50 x 334.34	301.43 FF specific c or Table 0.70 207.13	324.84 data e 6c 1111.26	342.46 (73) Gains W 89.23 (80) 73.38 (83)
6. Solar gains West Solar gains in wa Total gains - inte	352.61 Itts ∑(74)m 89.23 rnal and sc	350.08 (82)m 174.56 plar (73)m +	337.29 Access f Table 0.54 287.47 (83)m	317.05 actor 6d 4 x [ 419.26	296.60 Area m <sup>2</sup> 26.71 513.82	276.77 Sol X 1 525.99	264.20 ar flux //m <sup>2</sup> 9.64 x	270.37 speci or T 0.9 x () 430.15	<b>g</b> ific data able 6b 0.50 x 334.34	301.43 FF specific c or Table 0.70 207.13	324.84	342.46 (73) Gains W 89.23 (80) 73.38 (83)
6. Solar gains West Solar gains in wa Total gains - inte	352.61 atts Σ(74)m 89.23 rnal and sc 441.85	350.08 a(82)m 174.56 olar (73)m + 524.64	337.29 Access f Table 0.5 287.47 (83)m 624.77	317.05 actor 6d 4 x [ 419.26 736.31	296.60 Area m <sup>2</sup> 26.71 513.82 810.42	276.77 Sol. X 1 525.99 802.75	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96	270.37 speci or T 0.9 x ( 430.15 700.52	280.99 g ific data able 6b 0.50 x 334.34 615.34	301.43 FF specific c or Table 0.70 207.13 508.56	324.84 data e 6c 1111.26 436.10	342.46 (73) Gains W 89.23 (80) 73.38 (83) 415.84 (84)
6. Solar gains West Solar gains in wa Total gains - inte	352.61 tts ∑(74)m 89.23 rnal and so 441.85	350.08 (82)m 174.56 blar (73)m + 524.64 ture (besti	337.29 Access f Table 0.54 287.47 (83)m 624.77	317.05 actor 6d 4 x [ 419.26 736.31	296.60 Area m <sup>2</sup> 26.71 513.82 810.42	276.77 Sol W X 1 525.99 802.75	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96	270.37 speci or T 0.9 x (0 430.15 700.52	<b>g</b> <b>ific data</b> <b>able 6b</b> 0.50 x 334.34 615.34	301.43 FF specific c or Table 0.70 207.13 508.56	324.84 data e 6c 1111.26 436.10	342.46       (73)         Gains       W         89.23       (80)         73.38       (83)         415.84       (84)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean intern</li> </ul>	352.61 atts ∑(74)m 89.23 rnal and sc 441.85 al tempera	350.08 n(82)m 174.56 olar (73)m + 524.64 ture (heati	337.29 Access f Table 0.5 287.47 (83)m 624.77 ng season)	317.05 actor 6d 4 x [ 419.26 736.31	296.60 Area m <sup>2</sup> 26.71 513.82 810.42	276.77 Sol. M x 1 525.99 802.75	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96	270.37 speci or T 0.9 x ( 430.15 700.52	280.99 g ific data able 6b 0.50 x 334.34 615.34	301.43 FF specific c or Table 0.70 207.13 508.56	324.84 data e 6c 1111.26 436.10	342.46 (73) Gains W 89.23 (80) 73.38 (83) 415.84 (84)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean intern</li> <li>Temperature du</li> </ul>	352.61 al tempera	350.08 (82)m 174.56 lar (73)m + 524.64 ture (heating periods in	337.29 Access f Table 0.5 287.47 (83)m 624.77 ng season) the living a	317.05 actor 6d 4 x [ 419.26 736.31 area from 1	296.60 Area m <sup>2</sup> 26.71 513.82 810.42 able 9, Th1	276.77 Sol M 3 x 1 525.99 802.75	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96	270.37 speci or T 0.9 x (0 430.15 700.52	<b>g</b> <b>ific data</b> <b>able 6b</b> 0.50 x 334.34 615.34	301.43 FF specific c or Table 0.70 207.13 508.56	324.84 data e 6c 111.26 436.10	342.46       (73)         Gains       (73)         89.23       (80)         73.38       (83)         415.84       (84)         21.00       (85)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean intern</li> <li>Temperature du</li> </ul>	352.61 atts $\Sigma(74)$ m 89.23 and and so 441.85 al temperation ring heating Jan	350.08 a(82)m 174.56 blar (73)m + 524.64 ture (heating g periods in Feb	337.29 Access f Table 0.5 287.47 (83)m 624.77 (83)m 624.77 the living a Mar	317.05 actor 6d 4 x ( 419.26 736.31 area from T Apr	296.60 Area m <sup>2</sup> 26.71 513.82 810.42 810.42	276.77 Sol. X 1 525.99 802.75 802.75	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96	270.37 speci or T 0.9 x () 430.15 700.52 Aug	280.99 g ific data able 6b 0.50 x 334.34 615.34 Sep	301.43 FF specific c or Table 0.70 207.13 508.56 Oct	324.84 data e 6c 1111.26 436.10	342.46       (73)         Gains       (80)         89.23       (80)         73.38       (83)         415.84       (84)         21.00       (85)         Dec       (85)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in wa</li> <li>Total gains - intern</li> <li>7. Mean intern</li> <li>Temperature du</li> <li>Utilisation factor</li> </ul>	352.61 al tempera ring heating Jan	350.08 (82)m 174.56 blar (73)m + 524.64 ture (heating periods in Feb or living are	337.29 Access f Table 0.5 287.47 (83)m 624.77 ng season) the living a Mar ea n1,m (se	317.05         actor         6d         4       x         419.26         736.31         area from 1         Apr         e Table 9a)	296.60 Area m <sup>2</sup> 26.71 513.82 810.42 810.42 able 9, Th1 May	276.77 Sol M 3 x 1 525.99 802.75 802.75	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96	270.37 speci or T 0.9 x () 430.15 700.52 Aug	280.99 g ific data able 6b 0.50 x 334.34 615.34 Sep	301.43 FF specific c or Table 0.70 207.13 508.56 Oct	324.84 data e 6c 1111.26 436.10	342.46       (73)         Gains       (73)         89.23       (80)         73.38       (83)         415.84       (84)         21.00       (85)         Dec       (85)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean intern</li> <li>Temperature du</li> <li>Utilisation factor</li> </ul>	atts $\Sigma(74)$ m 89.23 arnal and sc 441.85 al tempera ring heating Jan for gains f 1.00	350.08 a(82)m 174.56 blar (73)m + 524.64 ture (heating g periods in Feb or living area 0.99	337.29 Access f Table 0.5 287.47 (83)m 624.77 (83)m 624.77 the living a Mar ea n1,m (se 0.98	317.05 actor 6d 4 x [ 419.26 736.31 area from T Apr e Table 9a) 0.92	296.60 Area m <sup>2</sup> 26.71 513.82 810.42 810.42	276.77 Sol. X 1 525.99 802.75 802.75	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96 Jul 0.44	270.37 spect or T 0.9 x () 430.15 700.52 Aug 0.49	280.99 g ific data able 6b 0.50 x 334.34 615.34 Sep 0.77	301.43 FF specific c or Table 0.70 207.13 508.56 Oct 0.96	324.84 data e 6c 1111.26 436.10 Nov 0.99	342.46       (73)         Gains       (73)         89.23       (80)         73.38       (83)         415.84       (84)         21.00       (85)         Dec       1.00         1.00       (86)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in wa</li> <li>Total gains - international gains - internation</li> <li>7. Mean internation</li> <li>Utilisation factor</li> <li>Mean internal ternation</li> </ul>	atts $\Sigma(74)$ m 89.23 rnal and so 441.85 al tempera ring heating Jan for gains f 1.00 emp of livin	350.08 (82)m 174.56 blar (73)m + 524.64 ture (heating g periods in Feb or living area 0.99 g area T1 (s	337.29 Access f Table 0.5 287.47 (83)m 624.77 (83)m 624.77 the living a Mar ea n1,m (se 0.98 tteps 3 to 7	317.05         actor         6d         4       x         419.26         736.31         area from T         Apr         e Table 9a)         0.92         in Table 9c	296.60 Area m <sup>2</sup> 26.71 513.82 810.42 810.42 able 9, Th1 May 0.79	276.77 Sol M 3 x 1 525.99 802.75 802.75	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96 Jul 0.44	270.37 speci or T 0.9 x () 430.15 700.52 Aug 0.49	280.99 g ific data able 6b 0.50 x 334.34 615.34 Sep 0.77	301.43 FF specific c or Table 0.70 207.13 508.56 Oct 0.96	324.84 data e 6c 1111.26 436.10 Nov 0.99	342.46       (73)         Gains       (80)         89.23       (80)         73.38       (83)         415.84       (84)         21.00       (85)         Dec       1.00         1.00       (86)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in wa</li> <li>Total gains - intern</li> <li>7. Mean intern</li> <li>Temperature du</li> <li>Utilisation factor</li> <li>Mean internal tern</li> </ul>	atts $\Sigma(74)$ m 89.23 arnal and sc 441.85 al tempera ring heating Jan for gains f 1.00 emp of livin 19.80	350.08 a(82)m 174.56 blar (73)m + 524.64 ture (heating g periods in Feb or living area 0.99 g area T1 (s 19.98	337.29         Access f         Table         0.5         287.47         (83)m         624.77         ng season)         the living a         Mar         ea n1,m (see         0.98         .teps 3 to 7         20.27	317.05         actor         6d         4       x         419.26         736.31         area from T         Apr         e Table 9a         0.92         in Table 9c         20.64	296.60 Area m <sup>2</sup> 26.71 513.82 810.42 able 9, Th1 May 0.79 :) 20.88	276.77 Sol. W 3 x 1 525.99 802.75 802.75 (°C) Jun 0.59 20.98	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96 Jul 0.44 21.00	270.37 speci or T: 0.9 x () 430.15 700.52 Aug 0.49 20.99	280.99 g ific data able 6b 0.50 x 334.34 615.34 Sep 0.77 20.92	301.43 FF specific c or Table 0.70 207.13 508.56 0ct 0.96 20.57	324.84 data e 6c 111.26 436.10 Nov 0.99 20.11	342.46       (73)         Gains       (73)         89.23       (80)         73.38       (83)         415.84       (84)         21.00       (85)         Dec       1.00         1.00       (86)         19.77       (87)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in wa</li> <li>Total gains - intern</li> <li>7. Mean intern</li> <li>Temperature du</li> <li>Utilisation factor</li> <li>Mean internal tern</li> <li>Temperature du</li> </ul>	atts $\Sigma(74)$ m 89.23 rnal and so 441.85 al tempera ring heating Jan for gains f 1.00 emp of livin 19.80 ring heating	350.08 (82)m 174.56 blar (73)m + 524.64 ture (heating g periods in Feb or living area 0.99 g area T1 (s 19.98 g periods in	337.29         Access f         Table         0.5/         287.47         (83)m         624.77         ng season)         the living a         Mar         ea n1,m (see         0.98         tteps 3 to 7         20.27         the rest of	317.05         actor         6d         4       x         419.26         736.31         area from T         Apr         e Table 9a)         0.92         in Table 9c         20.64	296.60 Area m <sup>2</sup> 26.71 513.82 810.42 810.42 able 9, Th1 May 0.79 :) 20.88 rom Table 9	276.77 Sol M 3 x 1 525.99 802.75 802.75 (°C) Jun 0.59 20.98 9, Th2(°C)	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96 Jul 0.44 21.00	270.37 speci or T 0.9 x () 430.15 700.52 Aug 0.49 20.99	280.99 g ific data able 6b 0.50 x 334.34 615.34 Sep 0.77 20.92	301.43 FF specific c or Table 0.70 207.13 508.56 Oct 0.96 20.57	324.84 data e 6c 1111.26 436.10 Nov 0.99 20.11	342.46       (73)         Gains       (80)         89.23       (80)         73.38       (83)         415.84       (84)         21.00       (85)         Dec       (86)         1.00       (86)         19.77       (87)
6. Solar gains West Solar gains in wa Total gains - inter 7. Mean intern Temperature du Utilisation factor Mean internal te Temperature du	352.61atts $\Sigma(74)$ m89.23rnal and so441.85at temperaring heatingJanfor gains f1.00emp of livin19.80ring heating19.96	350.08 (82)m 174.56 Jar (73)m + 524.64 ture (heati g periods in Feb or living are 0.99 g area T1 (s 19.98 g periods in 19.97	337.29 Access f Table 0.5 287.47 (83)m 624.77 (83)m 624.77 (83)m 624.77 the living a Mar ea n1,m (se 0.98 teps 3 to 7 20.27 the rest of 19.97	317.05         actor         6d         4       x         419.26         736.31         area from T         Apr         e Table 9a)         0.92         in Table 9c         20.64         f dwelling f         19.98	296.60 Area m <sup>2</sup> 26.71 513.82 810.42 able 9, Th1 May 0.79 c) 20.88 rom Table 9	276.77 Sol. X 1 525.99 802.75 802.75 (°C) Jun 0.59 20.98 9, Th2(°C) 20.00	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96 Jul 0.44 21.00	270.37 speci or T. 0.9 x () 430.15 700.52 Aug 0.49 20.99	280.99 g ific data able 6b 0.50 x 334.34 615.34 615.34 0.77 20.92 19.99	301.43 FF specific c or Table 0.70 207.13 508.56 0 0.96 0.96 20.57 19.98	324.84 data e 6c 111.26 436.10 436.10 Nov 0.99 20.11 19.98	342.46       (73)         Gains       (73)         89.23       (80)         73.38       (83)         415.84       (84)         21.00       (85)         Dec       1.00         1.00       (86)         19.77       (87)         19.97       (88)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in wa</li> <li>Total gains - inter</li> <li>7. Mean intern</li> <li>Temperature du</li> <li>Utilisation factor</li> <li>Mean internal ter</li> <li>Temperature du</li> <li>Utilisation factor</li> </ul>	352.61 atts $\Sigma(74)$ m 89.23 rnal and so 441.85 al tempera ring heating Jan for gains f 1.00 emp of livin 19.80 ring heating 19.96 for gains f	350.08 (82)m 174.56 olar (73)m + 524.64 ture (heating g periods in Feb or living area 0.99 g area T1 (s 19.98 g periods in 19.97 or rest of d	337.29         Access f         Table         0.5/         287.47         (83)m         624.77         (83)m         624.77         ng season)         the living a         Mar         ea n1,m (se         0.98         tteps 3 to 7         20.27         the rest of         19.97         welling n2,	317.05         actor         6d         4       x         419.26         736.31         area from T         Apr         e Table 9a)         0.92         in Table 9c         20.64         dwelling f         19.98         m	296.60 Area m <sup>2</sup> 26.71 513.82 810.42 810.42 able 9, Th1 May 0.79 c) 20.88 rom Table 9 19.98	276.77 Sol. X 1 525.99 802.75 802.75 802.75 .(°C) Jun 0.59 20.98 9, Th2(°C) 20.00	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96 Jul 0.44 21.00 20.00	270.37 speci or T 0.9 x () 430.15 700.52 Aug 0.49 20.99 20.00	280.99 g ific data able 6b 0.50 x 334.34 615.34 615.34 0.77 20.92 19.99	301.43 FF specific c or Table 0.70 207.13 508.56 Oct 0.96 20.57 19.98	324.84 data e 6c 1111.26 436.10 436.10 Nov 0.99 20.11 19.98	342.46       (73)         Gains       (80)         89.23       (80)         73.38       (83)         415.84       (84)         21.00       (85)         Dec       (86)         1.00       (86)         19.77       (87)         19.97       (88)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in wa</li> <li>Total gains - internal</li> <li>7. Mean internal</li> <li>Utilisation factor</li> <li>Mean internal ternal</li> <li>Temperature du</li> <li>Utilisation factor</li> </ul>	352.61atts $\Sigma(74)$ m89.23rnal and so441.85at temperaring heatingJanfor gains f1.00ring heating19.80ring heating19.96for gains f1.00	350.08 (82)m 174.56 lar (73)m + 524.64 ture (heatil g periods in Feb or living are 0.99 g area T1 (s 19.98 g periods in 19.97 or rest of d 0.99	337.29 Access f Table 0.5 287.47 (83)m 624.77 (83)m 624.77 (83)m 624.77 ng season) the living a Mar ea n1,m (se 0.98 teps 3 to 7 20.27 the rest of 19.97 welling n2, 0.97	317.05         actor         6d         4       x         419.26         736.31         area from 1         Apr         e Table 9a)         0.92         in Table 9a         20.64         dwelling f         19.98         m         0.90	296.60 Area m <sup>2</sup> 26.71 513.82 810.42 810.42 able 9, Th1 May 0.79 c) 20.88 rom Table 9 19.98	276.77 Sol. X 1 525.99 802.75 802.75 (°C) Jun 0.59 20.98 9, Th2(°C) 20.00 0.51	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96 Jul 0.44 21.00 20.00	270.37 speci or T 0.9 x () 430.15 700.52 Aug 0.49 20.99 20.00 0.39	280.99 <b>g</b> ific data able 6b 0.50 x 334.34 615.34 615.34 0.77 20.92 19.99 0.69	301.43 FF specific c or Table 0.70 207.13 508.56 0.0 0.96 20.57 19.98	324.84 data e 6c 111.26 436.10 436.10 Nov 0.99 20.11 19.98 0.99	342.46       (73)         Gains       (73)         89.23       (80)         73.38       (83)         415.84       (84)         21.00       (85)         Dec       (86)         1.00       (86)         19.77       (87)         19.97       (88)         1.00       (89)
<ul> <li>6. Solar gains</li> <li>West</li> <li>Solar gains in wa</li> <li>Total gains - intern</li> <li>7. Mean intern</li> <li>Temperature du</li> <li>Utilisation factor</li> <li>Mean internal tern</li> <li>Temperature du</li> <li>Utilisation factor</li> <li>Mean internal tern</li> </ul>	atts $\Sigma(74)$ m 89.23 rnal and so 441.85 al tempera ring heating Jan for gains f 1.00 ring heating 19.96 for gains f 1.00 ring heating 19.96 for gains f 1.00 response for gains f	350.08 (82)m 174.56 blar (73)m + 524.64 ture (heating g periods in Feb or living area 0.99 g area T1 (s 19.98 g periods in 19.97 or rest of d 0.99 in the rest	337.29         Access f         Table         0.5         287.47         (83)m         624.77         (83)m         624.77         ng season)         the living a         Mar         ea n1,m (see         0.98         .teps 3 to 7         20.27         the rest of         19.97         welling n2,         0.97         of dwelling	317.05         actor         6d         4       x         419.26         736.31         area from T         Apr         e Table 9a)         0.92         in Table 9c         20.64         dwelling f         19.98         m         0.90         372 (follow	296.60 Area m <sup>2</sup> 26.71 513.82 810.42 810.42 810.42 810.42 0.79 c) 20.88 rom Table 9 19.98 0.73 steps 3 to	276.77 Sol. X 1 525.99 802.75 802.75 (°C) Jun 0.59 20.98 9, Th2(°C) 20.00 20.00 0.51 7 in Table S	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96 Jul 0.44 21.00 20.00 20.00	270.37 speci or T 0.9 x () 430.15 700.52 Aug 0.49 20.99 20.00 0.39	280.99 g ific data able 6b 0.50 x 334.34 615.34 615.34 0.77 20.92 19.99 0.69	301.43 FF specific c or Table 0.70 207.13 508.56 0 0.96 20.57 19.98 0.95	324.84 data 6c 1111.26 436.10 436.10 Nov 0.99 20.11 19.98 0.99	342.46       (73)         Gains       (80)         89.23       (80)         73.38       (83)         415.84       (84)         21.00       (85)         Dec       (86)         1.00       (86)         19.77       (87)         19.97       (88)         1.00       (89)
6. Solar gains West Solar gains in wa Total gains - inter 7. Mean intern Temperature du Utilisation factor Mean internal te Utilisation factor Mean internal te	atts $\Sigma(74)$ m 89.23 rnal and so 441.85 al tempera ring heating for gains f 1.00 ring heating 19.96 r for gains f 1.00 emperature 18.87	350.08 (82)m 174.56 blar (73)m + 524.64 ture (heatii g periods in Feb or living area 0.99 g area T1 (s 19.98 g periods in 19.97 or rest of dr 0.99 in the rest 19.05	337.29 Access f Table 0.5 287.47 (83)m 624.77 (83)m 7 (83)m 624.77 (83)m 7 (83)m 624.77 (83)m 624.77 (83)m 624.77 (83)m 624.77 (83)m 7 (83)m 7 (83)m 7 (83)m 7 (83)m (84)m 7 (83)m (84	317.05         actor         6d         4       x         419.26         736.31         area from 1         Apr         e Table 9a)         0.92         in Table 9c         20.64         dwelling f         19.98         m         0.90         gT2 (follow         19.70	296.60 Area m <sup>2</sup> 26.71 513.82 810.42 810.42 810.42 0.79 0.79 20.88 rom Table 9 19.98 19.98 0.73 steps 3 to 19.91	276.77 Sol. X 1 525.99 802.75 802.75 10°C) Jun 0.59 20.98 9, Th2(°C) 20.00 0.51 7 in Table 9	264.20 ar flux //m <sup>2</sup> 9.64 x 500.76 764.96 Jul 0.44 21.00 20.00 0.34 9c)	270.37 speci or T: 0.9 x () 430.15 700.52 Aug 0.49 20.99 20.00 0.39	280.99 <b>g</b> ific data able 6b 0.50 x 334.34 615.34 615.34 0.77 20.92 19.99 0.69 0.69	301.43 FF specific c or Table 0.70 207.13 508.56 0 0.96 20.57 19.98 0.95 19.65	324.84 data 6c 1111.26 436.10 436.10 0.99 20.11 19.98 0.99 0.99	342.46       (73)         Gains       (80)         89.23       (80)         73.38       (83)         415.84       (84)         21.00       (85)         Dec       (86)         19.77       (87)         19.97       (88)         1.00       (89)         1.00       (89)



Living area fract	ion								Liv	ving area ÷	(4) =	0.37	(91)
Mean internal t	emperature	for the wh	ole dwellin	g fLA x T1 +	+(1 - fLA) x <sup>-</sup>	Т2							
	19.21	19.39	19.69	20.05	20.27	20.35	20.36	20.36	20.31	19.99	19.54	19.19	(92)
Apply adjustme	nt to the me	ean interna	l temperatu	ure from Ta	ble 4e whe	ere appropr	iate						
	19.06	19.24	19.54	19.90	20.12	20.20	20.21	20.21	20.16	19.84	19.39	19.04	(93)
0 Crease head		t											
8. Space neat	ng requirem	ient		-					_	<u>.</u> .		_	
	Jan	Feb	Mar	Apr	Ivlay	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation facto	or for gains,	ηm											1 (
	1.00	0.99	0.97	0.89	0.74	0.52	0.36	0.41	0.70	0.94	0.99	1.00	(94)
Useful gains, nn	nGm, W (94	l)m x (84)m	1									L	1 ()
	439.83	518.90	604.24	657.43	596.42	420.74	275.57	289.13	433.44	479.73	431.84	414.42	(95)
Monthly averag	e external t	emperatur	e from Tabl	e U1	-						-		1
	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	or mean inte	ernal tempe	erature, Lm	, W [(39)m	ı x [(93)m -	(96)mJ						1	1
	1173.58	1136.77	1030.44	856.49	653.66	428.55	276.46	290.88	466.26	717.09	959.55	1166.02	] (97)
Space heating r	equirement	, kWh/mon	1th 0.024 x	[(97)m - (9	5)m] x (41)	m			r	_		T	1
	545.91	415.21	317.10	143.33	42.59	0.00	0.00	0.00	0.00	176.60	379.95	559.19	]
									∑(98	3)15, 10	.12 = 2	2579.87	(98)
Space heating r	equirement	kWh/m²/y	ear							(98)	÷ (4)	37.21	(99)
9a. Energy reg	uirements -	individual	heating sv	stems inclu	iding micro	-CHP							
Space heating			0,										
Fraction of space	e heat from	secondary	/suppleme	ntarv svste	m (table 11	)						0.00	(201)
Fraction of space	e heat from	main syste	em(s)			-,				1 - (2)	01) =	1.00	(202)
Fraction of space	e heat from	main syste	2 m 2							1 (2)		0.00	(202)
Fraction of tota	l snace heat	from main	system 1						(20	)2) x [1- (20	3)] =	1.00	(204)
Fraction of tota	l snace heat	from main	system 2						(20	(202) x (2)	)3) = [	0.00	(205)
Efficiency of ma	in system 1	(%)	System 2							(202) × (2)	[] []	90.00	(206)
	Jan	Feb	Mar	Apr	May	Jun	lut	Aug	Sep	Oct	Nov	Dec	] (200)
Space heating f	uel (main sv	stem 1). kV	Vh/month										
	606 57	461 35	352 33	159 25	47 32	0.00	0.00	0.00	0.00	196.22	422 17	621 32	1
	000.07	101.55	332.33	133.23	17.52	0.00	0.00	0.00	<u>5(211</u>	1)1 5 10	12 = 2	2866 52	(211)
Water heating									2(21)	.,, 10			] (===)
Efficiency of wa	ter heater												
	87.14	86.85	86.15	84.47	81.94	79.90	79.90	79.90	79.90	84.88	86.58	87.24	(217)
Water heating f	uel. kWh/m	onth											] (,
	219 23	192 14	201 55	182 32	181.96	164 35	157 46	175 54	177 47	190.24	199.07	213 84	1
	213.23	152.11	201.55	102.52	101.50	101.55	137.10	1, 5.5 1	177.17	Σ(219a)1	12 = 22	255 17	(219)
Annual totals										2(			](===)
Snace heating f	uel - main sv	vstem 1										2866 52	1
Water heating f	uel	Stern 1										255 17	]
Electricity for p	umps, fans a	nd electric	keep-hot (	Table 4f)									]
mechanical	ventilation f	ans - halan	ced extract	or positive	e innut fror	n outside			324 76	1			(230a)
central heat		water nun	nn within w	arm air he	ating unit				30.00	]			(230c)
boiler flue fa	in								45.00	]			(230e)
Total electricity	for the abo	ve. kWh/ve	ar							1	[	399.76	(231)
Electricity for lig	shting (Anne	endix L)										308.20	(232)
Electricity for lig	ghting (Appe	endix L)										308.20	(232)

10a. Fuel costs - individual heating systems incl	uding micro-CHP					
	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2866.52	x	3.48	x 0.01 =	99.75	(240)
Water heating	2255.17	x	3.48	x 0.01 =	78.48	(247)
Pumps and fans	399.76	x	13.19	x 0.01 =	52.73	(249)
Electricity for lighting	308.20	x	13.19	x 0.01 =	40.65	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)(242) +	+ (245)(254) =	391.61	(255)
11a. SAP rating - individual heating systems inc	luding micro-CHP					
Energy cost deflator (Table 12)					0.42	(256)
Energy cost factor (ECF)					1.44	(257)
SAP value					79.93	]
SAP rating (section 13)					80	(258)
SAP band					C	]
12a. CO2 emissions - individual heating systems	s including micro-CHP					
	Energy kWh/year		Emission factor kg CO₂/kWh		Emissions kg CO₂/year	
Space heating - main system 1	2866.52	x	0.22	=	619.17	(261)
Water heating	2255.17	x	0.22	=	487.12	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	1106.29	(265)
Pumps and fans	399.76	x	0.52	=	207.48	(267)
Electricity for lighting	308.20	x	0.52	=	159.95	(268)
Total CO₂, kg/year				(265)(271) =	1473.72	(272)
Dwelling CO₂ emission rate				(272) ÷ (4) =	21.25	(273)
El value					82.73	]

El rating (section 14)

EI band

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	2866.52	х	1.22	=	3497.15	(261)
Water heating	2255.17	х	1.22	=	2751.31	(264)
Space and water heating			(261) + (262) +	(263) + (264) =	6248.47	(265)
Pumps and fans	399.76	x	3.07	=	1227.26	(267)
Electricity for lighting	308.20	x	3.07	=	946.17	(268)
Primary energy kWh/year					8421.90	(272)
Dwelling primary energy rate kWh/m2/year					121.46	(273)

(274)

83

В



## APPENDIX D: FEASIBILITY TABLE OF LOW CARBON & RENEWABLE ENERGY TECHNOLOGIES

Feasibility Study Tak	ole							
Technology	Payback	Land Use Issues	Local Planning Requirements	Noise	Carbon Payback	Available Grants	Feasible?	Reason not Feasible or Selected
								Development too small.
Combined Heat &		Air quality in						Insufficient space for
Power (CHP)	Medium	residential area	None	In Plant Room	Yes	Tax Relief - ECA	No	plant room.
								Development too small.
		Air quality in	Encouraged for large			Bio-energy Capital		Insufficient space for
Biomass	None	residential area	scale developments	In Plant Room	Yes	Grants Scheme	No	plant room.
		Sufficient roof space						
Solar Thermal	High	required	Encouraged	None	~2 years	None	No	PV more appropriate
								Selected if roof space is
Solar Photovoltaic		Sufficient roof space						prioritised over green
(PV)	High	required	Encouraged	None	2-5 years	None	Yes	roofs.
Ground Source Heat		Requires large area						
Pumps (GSHPs)	High	for coils or borehole	Encouraged	None	Low	None	No	PV more appropriate
Air Source Heat		Visual intrusion of						
Pumps (ASHPs)	Very High	external units	None	Low	Low	None	No	PV more appropriate
		Urban Area - Iow						Monitoring needed to
		and turbulent wind;	Encouraged for large					assess wind speeds.
Wind Power	Low	Visual impact	scale developments	Yes	~1 year	None	No	Expensive
		Requires suitable						
		water resource;						
Hydro Power	Medium	Visual impact	None	Low	~1 year	None	No	-