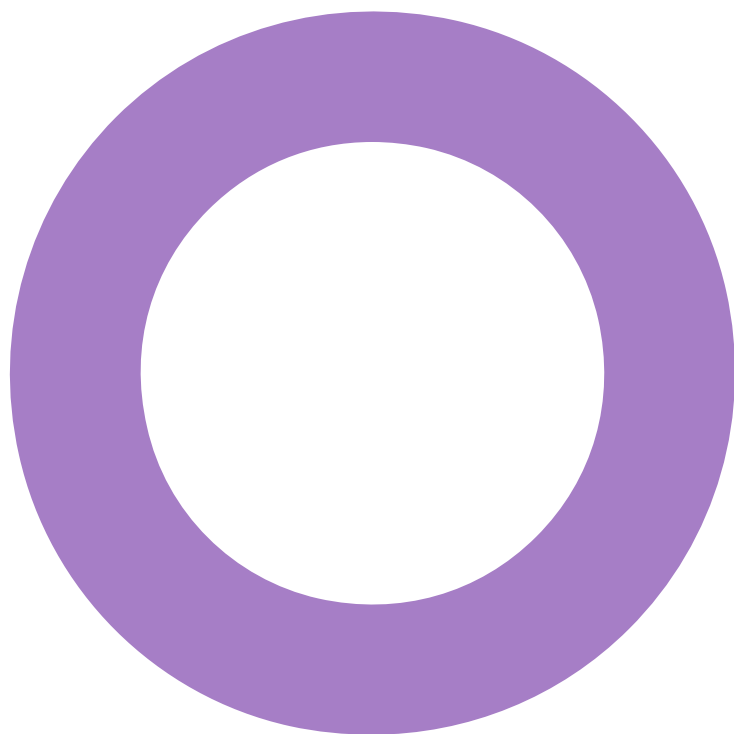


Station Hill - Phase 1. Reading. Lincoln MGT.

ENERGY STRATEGY

14 MARCH 2019



Audit sheet.

Rev.	Date	Description	Prepared	Verified
0	12/12/2018	Draft issue for comment	LH	MW
1	14/12/2018	Draft issue updated with comments	LH	MW
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3	15/02/2019	Final issue for Planning Submission	LH	MW
4	14/03/2019	Final issue updated with comments	LH	MW

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

Document reference: 190314 Station Hill Energy Strategy Rev 4

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Executive Summary.

This Energy Strategy has been prepared to consider the most appropriate approach to energy for Blocks E and F of the Station Hill development in Reading. The way energy is being considered in the UK is changing and this document has been prepared at a time where theory is trying to catch up with fact. There is a recognition that the generation of electricity is much greener than it used to be with many more renewable power stations (wind and solar) contributing to the grid.

As a result of the greener generation of electricity, known as decarbonisation of the electricity grid, the carbon factors associated with electricity are reducing dramatically and in fact have recently halved in the latest iteration of SAP known as SAP 10. The figures have reduced from 0.519 kgCO₂/kWh to 0.233 kgCO₂/kWh.

In the context of the energy strategy for Blocks E and F we feel it would be wise to consider a number of options for generating energy for the development and look at carbon reductions associated with both the current calculation methodology and SAP 10 so the scheme can be future proofed for the long term. When the scheme is being built, SAP 10 will be the adopted standard. The proposals need to respect the potential for this to be a standalone development whilst also not compromising future development across the site. The strategy should reflect the following key principals:

- To create the highest quality residential spaces suitable for the long term that don't suffer from overheating like many modern developments;
- To maximise the carbon reduction over the long-term life of the building;
- To reduce water usage across the development both in construction and use;
- To minimise material wastage; and
- To provide environments that need minimal intervention of engineering systems to create comfortable spaces.

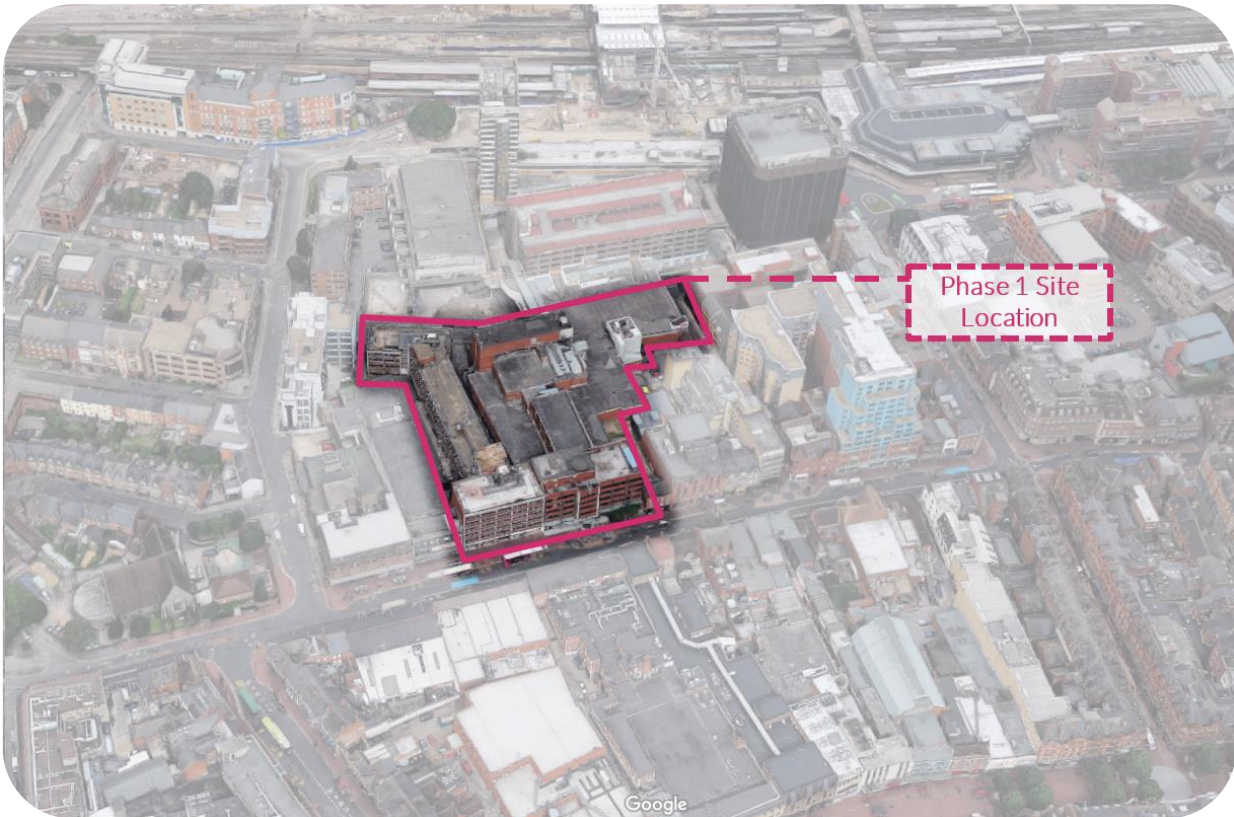


Figure 1 – Site Location

Phase 1 consists of two blocks, E and F, both 12 storeys and connected by two levels of basement below ground. There are a total 538 residential units proposed (370 in Block E and 168 in Block F) with residents' amenity and retail on the ground floor and a community space and car park below.

The site is highlighted in the image above (Figure 1).

A wide range of renewable technologies were appraised and it was decided that there would be a total of four energy strategies that should be considered. Each of the four strategies will be reviewed using both the current SAP 2012 methodology and then using the proposed SAP 10 carbon factors to show how the strategy will likely perform in the future. The four strategies are:

- Option A – Gas-fired boiler, combined heat and power (CHP) unit and PV;
- Option B – Air-source heat pumps (ASHP) and PV;
- Option C – Ground-source heat pump (GSHP) and PV, and
- Option D – All electric with PV.

Table 1 below summarises the performance of each option against the various feasibility measures. As shown in the table, Option D, the all-electric strategy, performs best overall and is the *recommended strategy for this development*.

Table 1 – Summary of Feasibility Table

	SAP 2012 Carbon Savings	SAP 10 Carbon Savings	Technical Feasibility	Practical Feasibility	Financial Feasibility	Overall
Option A – Boiler & CHP						
Option B – ASHP						
Option C – GSHP						
Option D – All Electric						

With a view to the rapid decarbonisation of the grid by utilising a direct electric approach, which is the recommended approach within the Energy Strategy, the development is future-proofed to deliver real, ongoing carbon savings that will assist the Borough in their commitments to reduce their carbon footprint.

1. Introduction.

This Energy Strategy has been prepared to address the requirement of Condition 19 & 20 attached to the Outline Planning Permission ref. – 151427 which requires the submission of an Energy & Sustainability Assessment concurrently with the submission of reserved matters for each plot. This report seeks to consider the most appropriate approach to energy for Blocks E and F of the Station Hill development in Reading. These blocks are part of a wider development site that could be developed over the next 5 years but should be considered as the first phase and therefore must be capable of being self-sufficient. The way energy is being considered in the UK is changing and this document has been prepared at a time where theory is trying to catch up with fact. There is considerable focus on trying to improve air quality and avoid generating further pollutants that contaminate the atmosphere and the ‘fresh air’ we all enjoy. Alongside this, there is a recognition that the generation of electricity is much greener than it used to be with many more renewable power stations (wind and solar) contributing to the grid. This change in approach will affect the way we design buildings in a similar way to how the automotive industry is changing.

As a result of the greener generation of electricity, known as decarbonisation of the electricity grid, the carbon factors associated with electricity are reducing dramatically and in fact have recently halved in the latest iteration of SAP known as SAP 10. The figures have reduced from 0.519 kgCO₂/kWh to 0.233 kgCO₂/kWh. All future indications are that electrical energy carbon factors will continue to drop over time. In parallel with this, energy figures associated with gas generated energy have remained similar. Typically gas fired energy centres also create a negative impact on air quality through the NOX gases generated and discharged via flue systems.

Whilst SAP 10 has been released it is yet to be implemented in the building regulations calculation methodology and although some planning authorities have asked for it to be used when undertaking carbon reduction calculations, the theory will take some time to catch up with reality. The same is also true for district heating networks where the current SAP calculation methodology uses a figure of around 5% to calculate losses through distribution whilst in practice this figure can be as high as 40%. These heat losses can often contribute to overheating in modern domestic buildings that are usually designed with super insulated facades where small amounts of heating can often quickly lead to spaces warming up. Whilst this is all happening Reading are progressing towards adoption of their new Local Plan which advocates buildings to:

- Maximise the use of energy efficiently;
- Adopt energy conservation measures in the design, layout and orientation to reduce overall energy demand;
- Meet the zero-carbon carbon reduction target;
- Consider the provision of decentralised energy; and
- Achieve BREEAM Excellent where possible.

In the context of the energy strategy for Blocks E and F we feel it would be wise to consider a number of options for generating energy for the development and look at carbon reductions associated with both the current calculation methodology and SAP 10 so the scheme can be future proofed for the long term. When the scheme is being built, SAP 10 will be the adopted standard. The proposals need to respect the potential for this to be a standalone development whilst also not compromising future development across the site. The strategy should reflect the following key principals:

- To create the highest quality residential spaces suitable for the long term that don’t suffer from overheating like many modern developments;
- To maximise the carbon reduction over the long-term life of the building;
- To reduce water usage across the development both in construction and use;
- To minimise material wastage; and
- To provide environments that need minimal intervention of engineering systems to create comfortable spaces.

1.1 Site Location

Phase 1 consists of two blocks, E and F, both 12 storeys and connected by two levels of basement below ground. There are a total 538 residential units proposed (370 in Block E and 168 in Block F) with residents’ amenity and retail on the ground floor and a community space and car park below.

The site is highlighted in the image below (Figure 2).

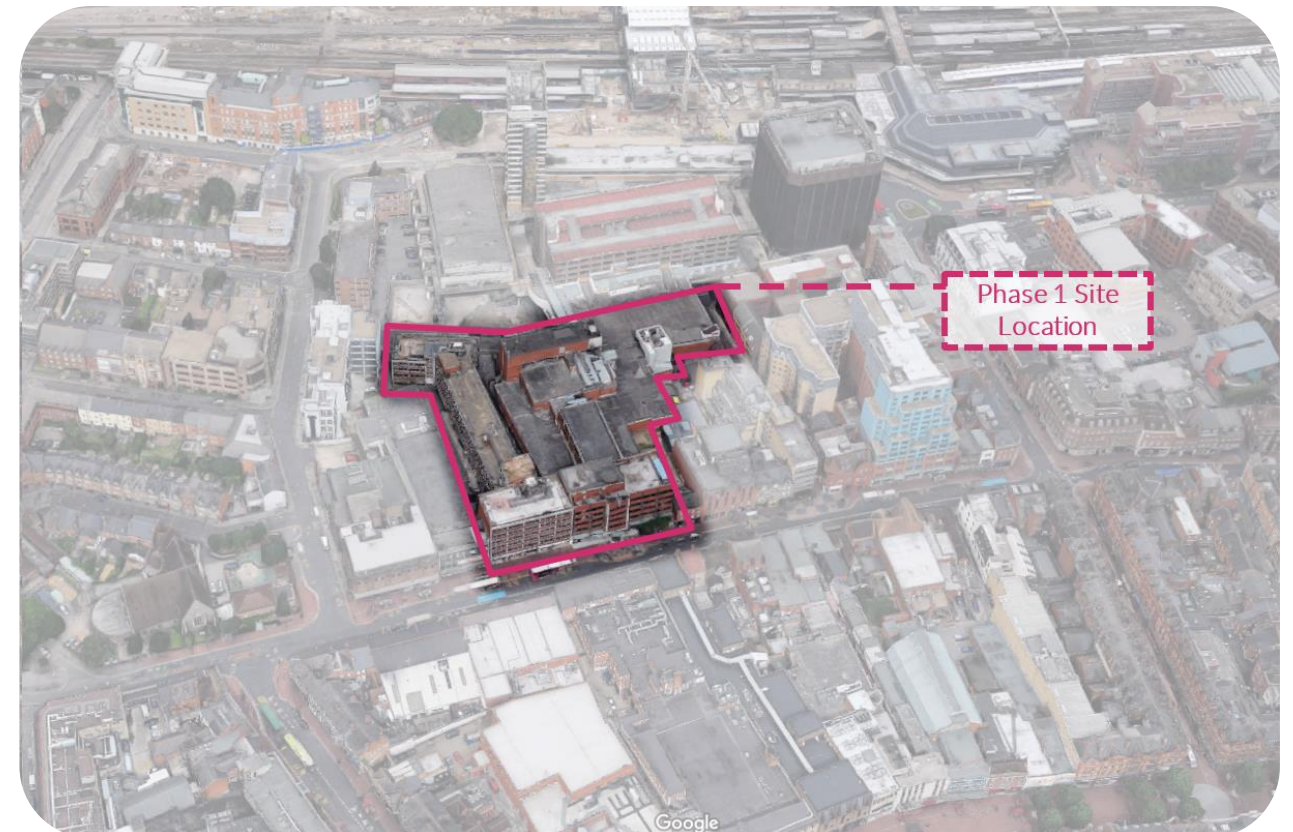


Figure 2 – Site Location

1.2 Policy Requirements

The policies and regulations that are required to be satisfied are summarised as follows. Full information can be found in Appendix A.

- Reading Borough Core Strategy - Policy CS1 “Sustainable Construction and Design” states that all new developments must maximise the use of energy efficiency and energy conservation measures in their design, layout and orientation to reduce overall energy demand.
- Reading Borough Draft Local Plan - Policy H5 “Standards for New Housing” states that all major new-build residential development should be designed to achieve zero carbon homes.
- Reading Borough Draft Local Plan - Policy CC4 “Decentralised Energy” states that any development of more than 20 dwellings shall consider the inclusion of a CHP plant, or other form of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable, feasible or viable for this form of energy provision. Further to this, where there is existing decentralised energy provision, developments of over 10 dwellings will be expected to link into this energy network or demonstrate why this is not feasible.
- Reading Borough Draft Local Plan - Policy CC2 “Sustainable Design and Construction” states that all major non-residential developments are required to meet the most up-to-date BREEAM ‘Excellent’ standards where possible.

2. Energy Efficiency Measures and Heating Infrastructure.

A key principle of the design of this development is to provide environments that need minimal intervention of engineering systems to create comfortable spaces. In addition to this, Reading are calling for all buildings to maximise the use of energy efficiently and to adopt energy conservation measures in the design, layout and orientation to reduce the overall energy demand. To be succinct with the above, this energy strategy has considered passive design and energy efficient solutions at the forefront of the design. The Proposed Development is seeking to maximise the potential of the measures by the strategy outlined in the following sections.

2.1 Passive Measures

The following passive design measures will be used to limit the energy demands and CO₂ emissions for the Proposed Development. The following typical envelope performance characteristics and passive design measures are proposed for the scheme design to limit the building’s energy consumption (see Table 2).

Table 2: Façade Design Criteria

Parameter		Domestic
Floor U - Value (W/m²K)		0.10
Roof U - Value (W/m²K)		0.10
External Walls U - Value (W/m²K)		0.18
Walls between heated spaces (W/m²K)		Solid or Filly filled cavity with sealed edges
Walls between stairs/lifts/risers (W/m²K)		0.18
Walls to unheated spaces (W/m²K)		0.18
Glazing and Glazed doors	U-value (W/m²K)	1.50
	G-value	0.42
	Frame Factor	10%
Opaque Door		1.00
Air permeability (m³/hm² (@ 50Pa)		3
Thermal Bridge Specification		Lintels – psi=0.026 Sills – psi=0.033 Jambs – psi=0.010 Normal corner – psi=0.015 Inverted corner – psi=-0.036 All other junctions – psi=default

2.2 Active Measures

The energy consumption of the development could be further reduced by the incorporation of active energy efficiency measures in the design of the mechanical and electrical engineering systems. The following energy efficiency measures will be considered for this development:

- Efficient mechanical ventilation systems with heat recovery (MVHR);
- Enhanced levels of pipework insulation;
- Variable speed pumping; and
- Low energy lighting throughout.

2.3 Energy Networks and Heating Infrastructure.

There is considerable focus on trying to improve air quality and avoid generating further pollutants that contaminate the atmosphere and the ‘fresh air’ we all enjoy. With this in mind, supplying energy efficiently would be a way to reduce the amount of pollutants contaminating the atmosphere. Heating infrastructure measures are those which demonstrate how their energy systems will supply energy efficiently and reduce

CO₂ emissions. The requirements of Reading Borough Council’s Draft Local Plan, policy CC4 “Decentralised Energy” has been considered and is outlined in the sections below.

2.4 Connection to Nearby District Heating Networks

During the pre-application process, research was undertaken to investigate the possibility of connecting to a nearby district heating network (DHN). Communication was made with Reading Borough Council to discover if a DHN was in close proximity. A response has not been received and so it has been assumed that there is no possibility for a connection, particularly as this site forms a major development site in the area.

2.5 Site Wide Heat Network

With the strategy to connect to a nearby DHN deemed not possible, the next strategy to consider is a site-wide heat network served by a single energy centre. This energy centre should be future proofed to connect to an offside network should one become available. At this stage, a site wide heat network may be considered an appropriate heat infrastructure for this development but this needs to be reviewed in the context of the options available.

2.6 Individual Heating System

An individual gas heating system is only appropriate for low density individual housing where no district heating networks are planned and evidence is provided that a site-wide heat network is uneconomic. As this development is not a low density individual housing scheme, individual gas heating systems are not appropriate.

However, with the recognition that the generation of electricity is much greener now than it used to be due to the decarbonisation of the grid, along with the reduction of the electricity carbon factors, an individual electric heating system is also considered an appropriate heat infrastructure for this development. This can be considered due to the low levels of heat associated with a modern well insulated building and gives an advantage of the distribution not contributing to overheating the dwellings and common spaces.

3. Renewable Technologies.

Another key principle of the design of this development is to maximise the carbon reduction over the long-term life of the building. The most effective way to achieve this is through renewable technologies. These measures are those which serve to reduce the overall emissions of the development through the inclusion of these renewable technologies such as Solar Photovoltaic array (PV panels), Ground Source Heat Pump (GSHP), besides others.

3.1 Appraisal of Renewable Technologies

A number of renewable technologies have been appraised in terms of technical and physical feasibility as potential renewable systems for use on the project.



3.1.1 Solar Photovoltaics

Solar photovoltaic (PV) cells generate electricity from the sun's energy. Solid PV panels can be either roof or façade mounted (although solar modules fitted on a south facing façade have only 75% the output of roof mounted modules).

Solar PV can be seen as an on-site zero carbon energy source as it will produce useable electrical energy without requiring any energy input. Although the output from the panels is unpredictable and weather dependent, the electrical energy produced by Solar PV panels could be used to provide additional carbon emission

reductions and are compatible with the use of other energy generating technologies. Once installed they are very low maintenance and will also have a low visual impact at street level. In addition, this development has suitable south facing roof space available.

Taking the above into account, solar PV is considered an appropriate technology for this development and will be investigated further.



3.1.2 Solar Water Heating Panels

Solar water heating systems use heat from the sun to heat domestic hot water. The system requires solar panels on the roof, ideally south facing, linked to hot water storage cylinders. For solar water panels to be effective the development should have a high hot water demand.

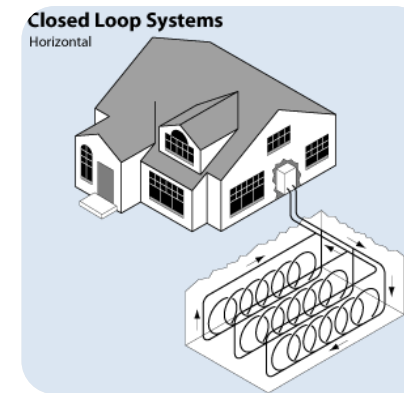
This development has suitable south facing roof space available and has a high hot water demand due to the residential nature of the development, which initially makes this technology suitable for this development. However, solar water panels are more suited to individual/ standalone dwellings as the hot water produced through the panels will feed directly into the hot water

storage for that particular dwelling. For a development like this where there are high-density dwellings, solar water panels would therefore not be suitable. The panels have a higher maintenance than PV and they are highly dependent on the weather/season, arguably more so than photovoltaics, leading to unpredictability with the hot water load. In addition, the heat gained from the panels cannot be sold back to the grid and so if the hot water is not used once it has been produced it will eventually be wasted.

Due to the reasons highlighted above, solar water heating panels are therefore not proposed for this development.

3.1.3 Ground Source Heat Pumps

Ground source heat pumps (GSHP) utilise either water extracted from an aquifer (open loop) or water circulated within underground pipework (closed loop) as the heat source in a refrigeration process. This enables



them to produce hot water, typically at around 45°C that can be used as means of space heating in buildings. Due to the relatively constant temperature of the ground at depth (typically 10-14°C in the UK) this produces heat more efficiently in winter than an air source heat pump, and usually with lower carbon emissions than a gas-fired boiler.

Open loop systems require the water extracted to be re-injected into the aquifer at another borehole on another part of the site. A licence from the Environment Agency (EA) is required for both abstraction and discharge although these licences cannot be obtained until a test borehole has been constructed and the appropriate EA tests undertaken.

GSHP's are suitable for use with a centralised heat network; of which one is proposed for this development. Once installed, this technology will

have a low visual impact as the majority of the pipework and plant will be underground. In addition, GSHP's use electricity as a power source and therefore as the grid decarbonises this technology will have low emissions which will likely decrease over time. However, there is potential for archaeological remains to be present across the Site and therefore, where possible, excavation is to be minimised. The use of GSHP would therefore need to be carefully considered.

Due to the reasons highlighted above, GSHP is considered an appropriate technology for this development and will be included in the energy modelling.



3.1.4 Biomass Boilers

A biomass boiler uses a natural fuel such as wood chips or wood pellets for combustion. Since it uses a natural resource that can be replanted it is considered as a renewable energy source subject to the distance the fuel is transported. The carbon dioxide emitted from burning biomass is balanced by that absorbed during the fuel's production. Biomass heating therefore approaches a carbon neutral process.

The primary disadvantage of a biomass boiler is that it would require a substantial amount of fuel storage for a development of this size, which would make for an inefficient use of space. Further to this, regular deliveries are required to ensure the boiler works as efficiently and continuously as possible and biomass exhaust gases would require significant treatment to avoid degrading local air quality. In addition, the nature of the fuel within the boiler would require regular cleaning which would increase the downtime of the boiler, whilst also effecting air quality through the emissions.

Due to the reasons highlighted above, biomass boilers are therefore not

proposed for the development.



3.1.5 Wind Turbines

Wind turbines use the wind's lift forces to turn aerodynamic blades that turn a rotor thus generating electricity. There are three basic types to consider: horizontal axis (propeller type), vertical access (helical type) and building integrated (where the building design is adapted to suit the wind turbine).

Wind turbines have a significant visual impact and the roof space will be sensitive in townscape terms, which is likely to preclude wind turbines. They can create noise and vibration problems. Additionally, there is limited roof area across the site where clean air flows and good wind speeds can be realised and which are vital to delivering a useful electrical output. Even if a suitable location could be found, the output of a wind

turbine and the consequential carbon dioxide emissions will be very limited when compared to the emissions of the whole development.

Due to the reasons highlighted above, wind turbines are therefore not proposed for the development.



3.1.6 Air Source Heat Pumps

Air source heat pumps absorb heat from the outside air, even if the temperature is as low as -15°C. The air from the outside heats a liquid refrigerant, which is then compressed to increase the temperature. This is then condensed back into a liquid and heat is released. The heat can then be used for heating and hot water systems.

The main benefits of ASHP's are that they can provide both heating and cooling as the heat pump can be operated in reverse, and they are suitable for centralised heat networks. Although the plant space required on the roof would be high, they can be concealed but the overall height of plant would need to be carefully considered in the right of light (ROL) envelope. They are easy to install (more so than GSHP) and require very little maintenance once installed. Similar to GSHP, they will have decreasing emissions as the grid decarbonises.

Taking the above into account, ASHP is considered an appropriate technology for this development and will be investigated further.

3.2 Solar Photovoltaic Feasibility Study

Following the initial appraisal of Solar Photovoltaics (PV), a more detailed feasibility study has taken place to provide a more in-depth look at how this technology could work with this development. The requirement for this study is also in line with the Outline Planning Permission. The most appropriate way to do this is to look at the technical, economic and practical feasibility of solar PV. The following sections look at these factors.

3.2.1 Technical Feasibility

Across the site, there is approximately 350 m² of potential roof space to house roof mounted PV panels. Please see Figure 3 which shows the potential space. This space is distributed as 350m² on Block E and no allowance on Block F due to no available roof space. This space allows for a site wide PV capacity of approximately 30kWp based on 250W panels mounted at a 35 degree angle.

This amount is unlikely to increase due to the plant equipment that is required to be installed at the roof level. A further study will be required to optimise the most efficient orientation of the panels.

The panels are to be supplied to the residents only and not to the Landlord services, meaning additional equipment is required in order to distribute the connections equally throughout.

3.2.2 Economic Feasibility

There will be very little to no feed-in tariff provided to the residents, based on a 30kWp system and 365No. apartments within Block E alone (Block F is to have no PV allowance). This will only provide approximately 80W to each apartment which is likely to be absorbed in the general running loads. There would be no benefit to export the 80W back to the grid.

3.2.3 Practical Feasibility

To supply each apartment with a PV connection, the array will need to feed back in to one of the residential distribution boards located within the basement LV Switchroom. This method is currently not common practice, and therefore there is a risk that it will not be practically feasible. Further study is required to confirm the installation method.

This is the only option because each panel cannot be connected to a dedicated apartment as there are only going to be 120No. panels and 365No. apartments, meaning that the panels cannot be split evenly for this option.

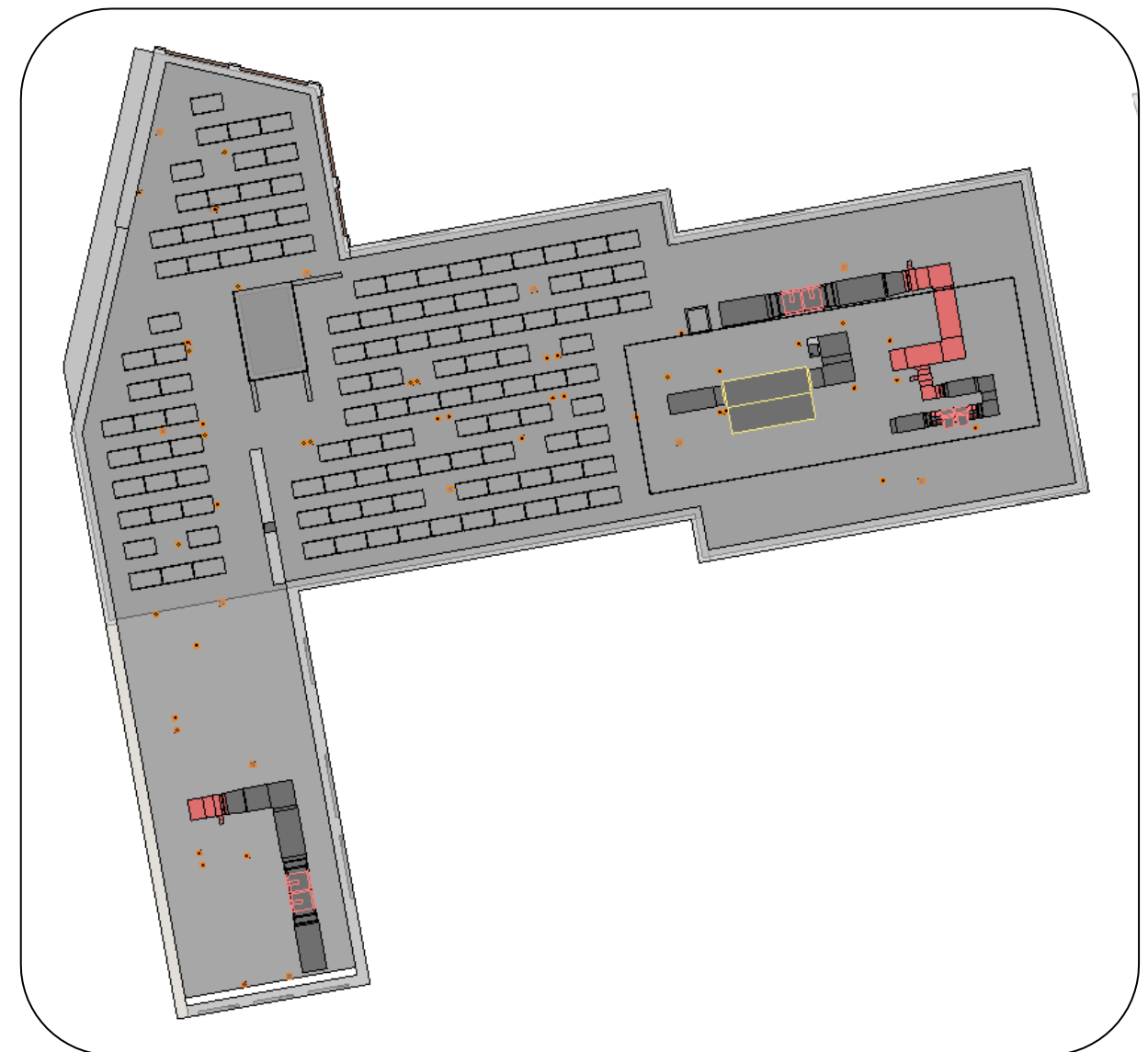


Figure 3 – Available Roof Space for PV

4. Results.

Having appraised a wide range of renewable technologies, it was decided that there would be a total of four energy strategies that should be considered. This section will show the results of each of the four strategies using both the current SAP 2012 methodology and then using the proposed SAP 10 carbon factors to show how the strategy will likely perform in the future. The four strategies are:

- Option A – Gas-fired boiler, combined heat and power (CHP) unit and PV;
- Option B – Air-source heat pumps (ASHP) and PV;
- Option C – Ground-source heat pump (GSHP) and PV, and
- Option D – All electric with PV.

Appendix B includes a sample of DER and TER worksheets from the SAP calculations for each of the 4 options, Appendix C includes the results sheets and Appendix D shows how the results using SAP 10 carbon factors were calculated.

4.1 Option A – Gas-fired Boiler, CHP Unit and PV Panels

The first of these options (Option A) is to house gas-fired boilers and a combined heat and power unit within the site-wide energy centre, along with a PV array on the roof.

4.1.1 Carbon Savings Using SAP 2012

Figure 4 below shows that the domestic regulated carbon dioxide emissions of the Option A are approximately 32% below that of the Baseline Scheme using SAP 2012 methodology.

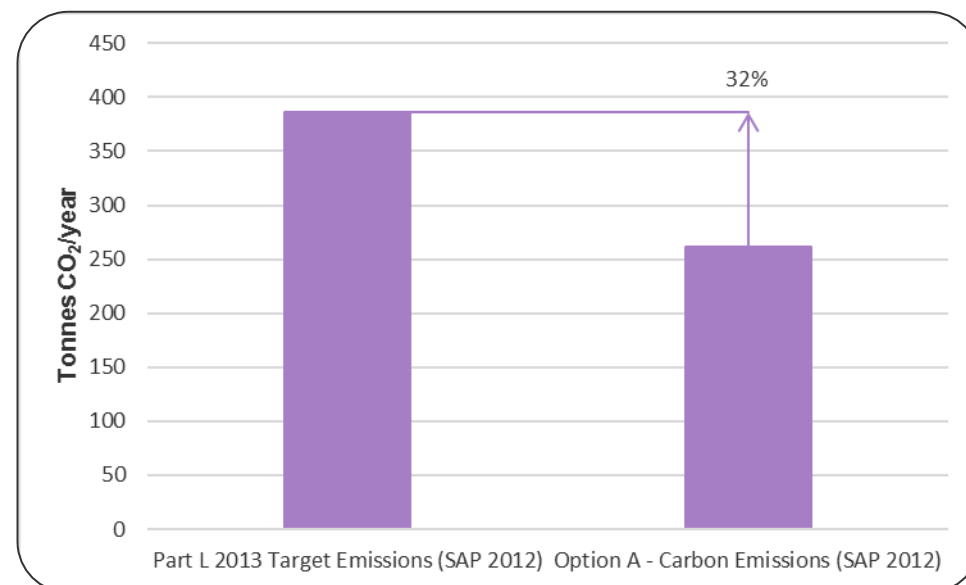


Figure 4 – Domestic Regulated Carbon Dioxide Emissions – Option A

4.1.2 Carbon Savings Using SAP 10 Carbon Factors

Figure 5 below shows that the domestic regulated carbon emissions of Option A using SAP 10 carbon factors are approximately 1% below the Baseline Scheme.

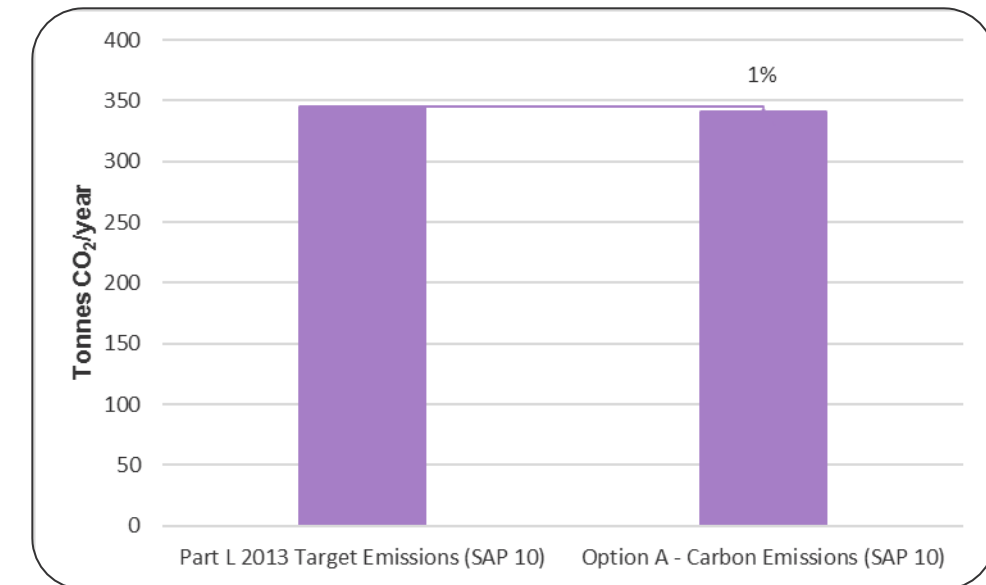


Figure 5 – Domestic Regulated Carbon Dioxide Emissions – Option A

4.2 Option B – Air-source Heat Pump (ASHP) and PV Panels

The second option (Option B) is to provide all heating and cooling demands with the use of air-source heat pumps located on the roof. In addition to this, and if roof space allows, a PV array could also be installed on the roof.

4.2.1 Carbon Savings Using SAP 2012

Figure 6 below shows that the domestic regulated carbon dioxide emissions of the Option B are approximately 37% below that of the Baseline Scheme using SAP 2012 methodology

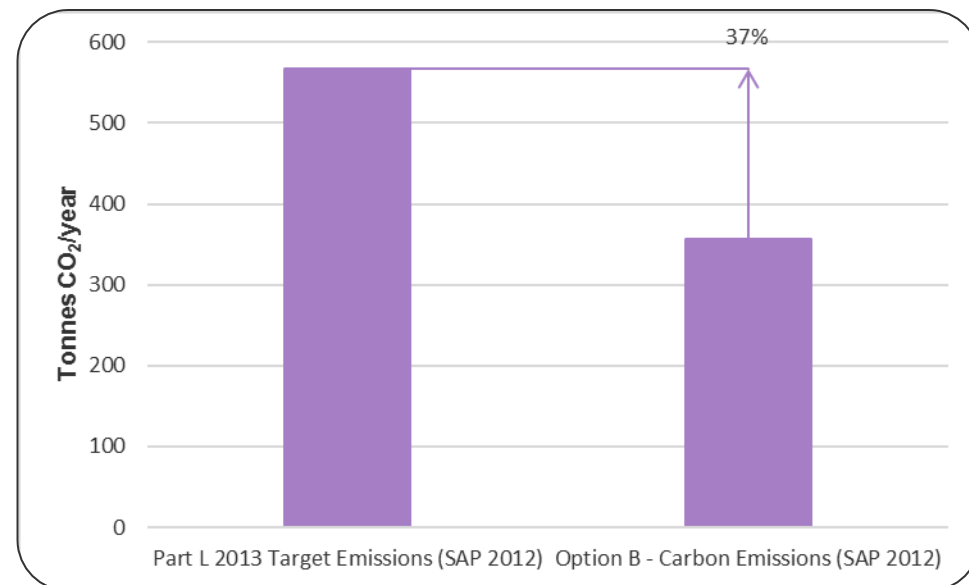


Figure 6 – Domestic Regulated Carbon Dioxide Emissions – Option B

4.2.2 Carbon Savings Using SAP 10 Carbon Factors

Figure 7 below shows that the domestic regulated carbon emissions of Option B using SAP 10 carbon factors are approximately 56% below the Baseline Scheme.

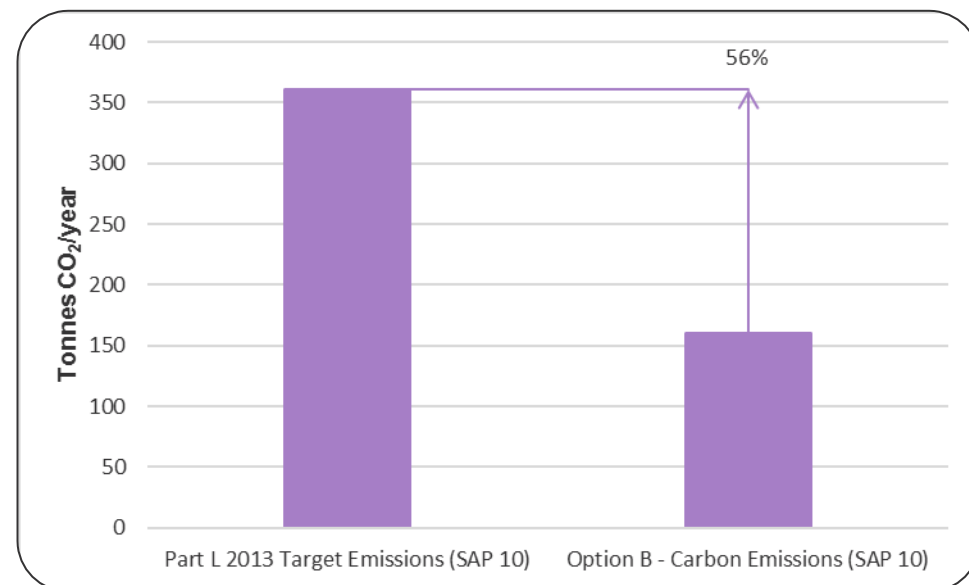


Figure 7 – Domestic Regulated Carbon Dioxide Emissions – Option B

4.3 Option C – Ground-source Heat Pump (GSHP) and PV Panels

The third option (Option C) is to provide all heating and cooling demands with the use of a ground-source heat pump. In addition to this a PV array could also be installed on the roof.

4.3.1 Carbon Savings Using SAP 2012

Figure 8 below shows that the domestic regulated carbon dioxide emissions of the Option C are approximately 52% below that of the Baseline Scheme using SAP 2012 methodology

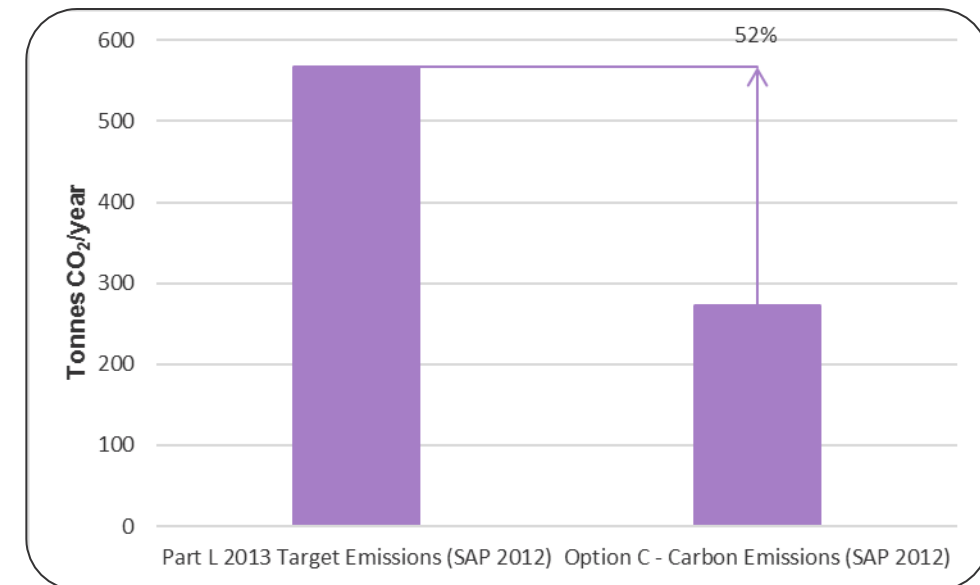


Figure 8 – Domestic Regulated Carbon Dioxide Emissions – Option C

4.3.2 Carbon Savings Using SAP 10 Carbon Factors

Figure 9 below shows that the domestic regulated carbon emissions of Option C using SAP 10 carbon factors are approximately 66% below the Baseline Scheme.

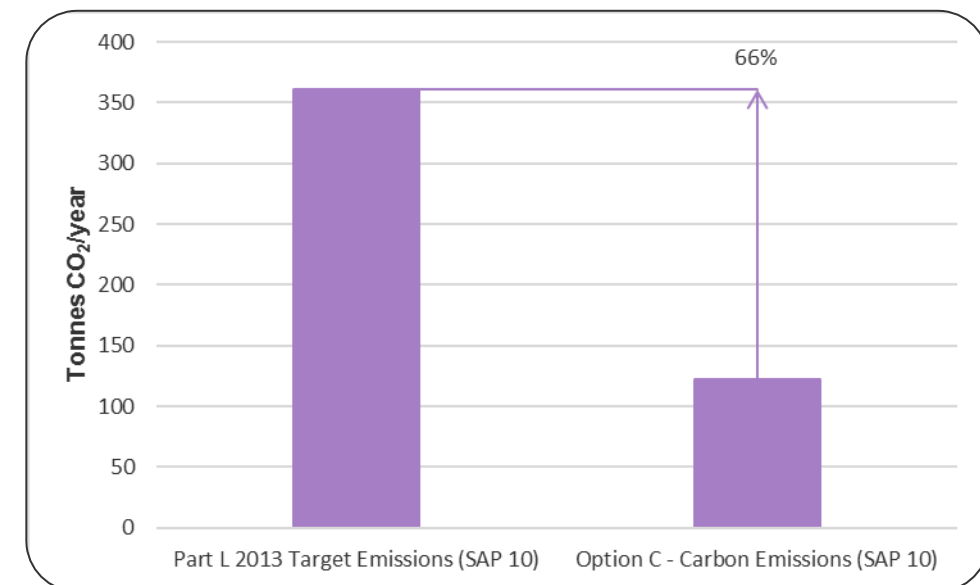


Figure 9 – Domestic Regulated Carbon Dioxide Emissions – Option C

4.4 Option D – All-electric with PV Panels

The fourth option (Option D) is to provide all heating and cooling demands with the use of an all-electric approach with a PV array installed on the roof. This will reduce water and waste as an electrical distribution system is already installed.

4.4.1 Carbon Savings Using SAP 2012

Figure 10 below shows that the domestic regulated carbon dioxide emissions of the Option D are approximately 1% below that of the Baseline Scheme using SAP 2012 methodology

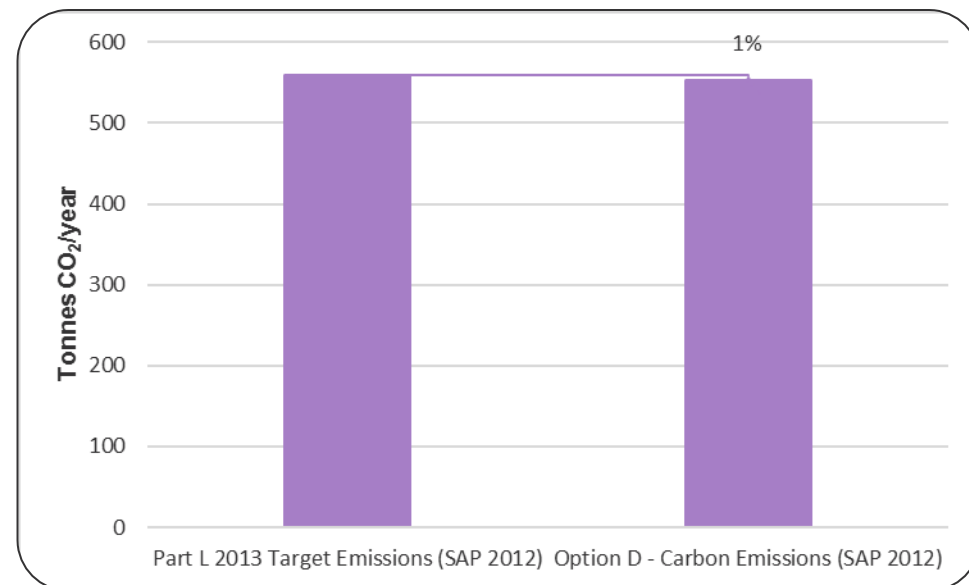


Figure 10 – Domestic Regulated Carbon Dioxide Emissions – Option D

4.4.2 Carbon Savings Using SAP 10 Carbon Factors

Figure 11 below shows that the domestic regulated carbon emissions of Option D using SAP 10 carbon factors are approximately 30% below the Baseline Scheme.

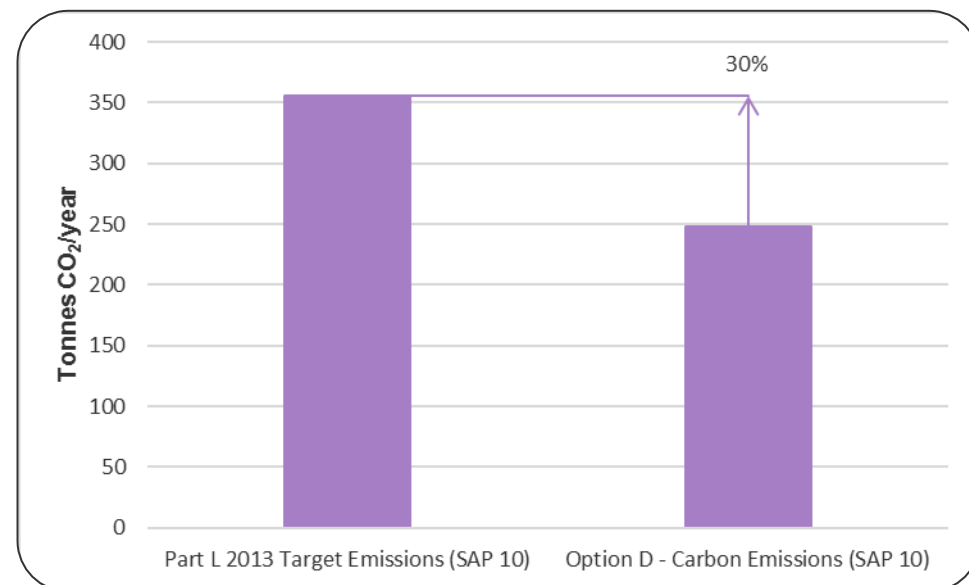


Figure 11 – Domestic Regulated Carbon Dioxide Emissions – Option D

5. Conclusion.

An energy assessment has been undertaken in line with Reading Borough Council's Core Strategy and Draft Local Plan.

A range of passive and active energy efficiency measures will be employed on the Proposed Development for all options considered.

The four strategies are:

- Option A – Gas-fired boiler, combined heat and power (CHP) unit and PV;
- Option B – Air-source heat pumps (ASHP) and PV;
- Option C – Ground-source heat pump (GSHP) and PV, and
- Option D – All electric with PV.

5.1 Summary of Strategies

5.1.1 Option A – Gas-fired boiler, CHP and PV

This first option would use gas-fired boilers and a gas-fired CHP unit within a centralised energy centre to provide the heating and hot water demand. This strategy has been considered the 'norm' for the last 10-15 years, and can be seen to produce high carbon savings using the SAP 2012 approach. However, this methodology has been using carbon factors from over 5 years ago which do not reflect the current state of the grid, nor do they reflect where the carbon factors will be when this development is built or in use.

Using SAP 10 carbon factors will help to show how this strategy will perform as the grid is becoming cleaner. This strategy doesn't perform well with these carbon factors as both the boiler and CHP unit are gas-fired. It is becoming more widely recognised in the industry that energy derived from fossil fuels such as gas is and will continue to be a depleting resource that has a negative impact on the environment.

It is therefore not the recommended strategy for this development.

5.1.2 Option B – Air-source heat pumps (ASHP)

The second option would use air-source heat pumps (ASHP) situated on the roof to provide the heating and hot water demand. This option would also be capable of plugging into a site-wide network in the future, but still ensures that energy resilience in isolation as the first phase of development. Both the SAP 2012 and SAP 10 results show compliance with Part L due to a reduction in carbon emissions. This solution would require a large amount of outdoor space to accommodate enough ASHP to provide heating and hot water. This would either be at roof level and impact the overall height or number of floor levels or in the landscaping and difficult to conceal. Due to the hydraulic restrictions on pipework runs it is likely that the ASHPs would need to be located in a number of different areas to achieve the required pipework runs. This would also increase the bulk and massing of the development, taking away any space for a proposed PV Array.

The use of ASHP will also impact on rights of light and outside space for tenants, whilst also being a source of noise.

In addition, an ASHP strategy would require distribution of pipework in communal corridors. With modern domestic buildings being designed with highly insulating façades, small amounts of heat entering the corridors will often quickly lead to the spaces warming up. This will contribute to overheating within these spaces unless a necessary ventilation or cooling strategy is in place.

Taking everything into consideration, it is therefore not the recommended strategy for this development.

5.1.3 Option C – Ground-source heat pumps (GSHP) and PV

The third option would use ground-source heat pumps to provide the heating and hot water demand for the development. Ground source heat pumps would provide a constant heat source throughout the year due to the low fluctuations in the temperature of the ground. If this development was situated outside an urban area with space below ground then this strategy would be more feasible. This solution could only generate low grade

heat and performance will be subject to testing and agreement of a license. Alongside this, additional boiler plant may be required to generate suitable hot water temperatures.

However, given the archaeological potential of the site and a large sewer system there may be constraints to installing both a horizontal loop system or a borehole system. In addition, to be most efficient, a ground-source heat pump system would require a balance of heating and cooling loads within the development for a scheme of this size. This is to ensure that the ground will be recharged with heat over the summer ready for the following winter. If there is no cooling then the temperature of the ground will slowly reduce and the system will not work as efficiently.

Since this development is predominantly residential and there are no cooling loads, together with the other reasons highlighted above, ground-source heat pumps are therefore not the recommended strategy for this development.

5.1.4 Option D – All-electric approach

The fourth option would use an electric heating and hot water strategy for the development. This would provide more robust and ‘real’ ongoing carbon savings due to the decarbonisation of the grid supply and therefore future proof the development. As expected the carbon saving results for SAP 2012 and the proposed SAP 10 are very different which reflects the change in carbon factors of electricity from 0.519 kg CO₂/kWh to 0.233 kg CO₂/kWh. The results using the SAP 10 carbon factors reflect how the dwelling will perform now and this will only improve in the future as the grid becomes cleaner.

In addition to the clear carbon savings, an all-electric approach will help to reduce the likelihood of overheating due to a lack of heat distribution pipework around the building and in the communal corridors, together with the associated energy for ventilating these spaces. There will also be a space saving, a cost saving of installation and operation, and a reduction of site waste, water use and materials as the heating and power will be provided by the same medium. This development will also not increase NO_x emissions in the centre of Reading from boiler and CHP emissions.

This option is therefore the recommended strategy for this development.

5.2 Summary Table

Table 3 below summarises the performance of each option against the various feasibility measures. As shown in the table, Option D, the all-electric strategy, performs best overall and is the recommended strategy for this development.

Table 3 – Summary of Feasibility Table

	SAP 2012 Carbon Savings	SAP 10 Carbon Savings	Technical Feasibility	Practical Feasibility	Financial Feasibility	Overall
Option A – Boiler & CHP						
Option B – ASHP						
Option C – GSHP						
Option D – All Electric						

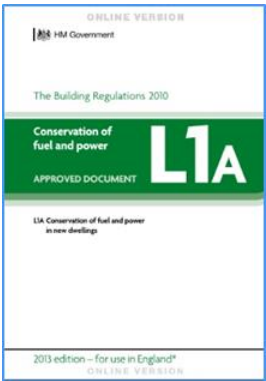
With a view to the rapid decarbonisation of the grid by utilising a direct electric approach, which is the recommended approach within the Energy Strategy, the development is future-proofed to deliver real, ongoing carbon savings that will assist the Borough in their commitments to reduce their carbon footprint.

Appendix A – Policy Requirements, Building Regulations and Targets.

The policies and regulations that are required to be satisfied are summarised as follows.

The Building Regulations

Part L Conservation of Fuel and Power deals with energy efficiency requirements in the Building Regulations. New buildings will be assessed under Approved Document Part L1A (Domestic) and Part L2A (Non-Domestic) of the Building Regulations.

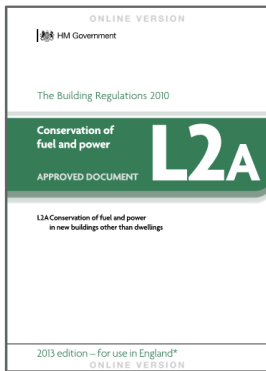


Part L1A 2013 of Building Regulations – New Domestic Elements

On a national level, Part L1A of the Building Regulations sets the energy efficiency requirements in new domestic buildings.

Under Building Regulations Approved Document Part L1A, compliance is achieved by demonstrating that the Dwelling Emission Rate (DER) does not exceed the Target Emission Rate (TER) and that the Dwelling Fabric Efficiency (DFEE) does not exceed the Target Fabric Efficiency (TFEE).

In addition, Part L1A also requires that the fabric elements and the fixed building services all meet minimum energy efficiency standards (Criterion 2), and reasonable provision for limiting solar gain through the building fabric (Criterion 3).

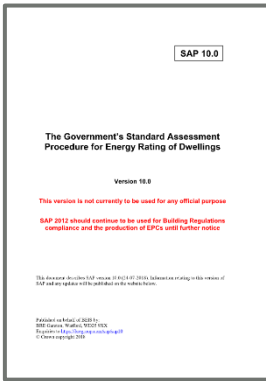


Part L2A 2013 of Building Regulations – New Non-Domestic Elements

On a national level, Part L2A of the Building Regulations sets the energy efficiency requirements in new non-domestic buildings.

Under Building Regulations Approved Document Part L2A: Conservation of Fuel and Power (2013 edition), compliance is achieved by demonstrating that the Building CO₂ Emission Rate (BER) does not exceed the Target CO₂ Emission Rate (TER).

In addition, Part L2A also requires that the fabric elements and the fixed building services all meet minimum energy efficiency standards (Criterion 2), and reasonable provision for limiting solar gain through the building fabric (Criterion 3).

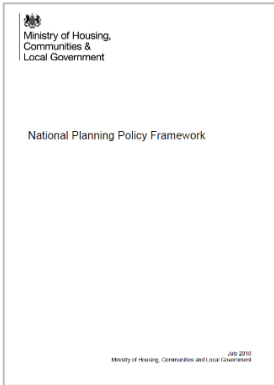


SAP 10.0

The Government's Standard Assessment Procedure for Energy Rating of Dwellings Version 10.0 was released for information in July 2018. It is not currently to be used for any official purpose. However, the GLA will be adopting this from January 2019 prior to it being introduced in the next edition of the Building Regulations Part L.

The carbon factors have been updated to reflect the current decarbonisation of the grid.

National Planning Guidance



The National Planning Policy Framework, July 2018

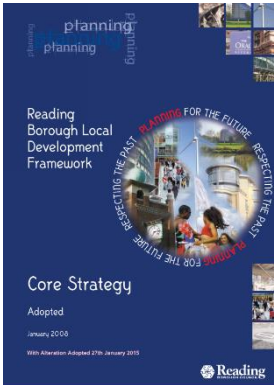
The National Planning Policy Framework (NPPF) was published in July 2018. The NPPF sets out the Government's strategy on the delivery of sustainable development through the planning system. It provides a framework within which locally-prepared plans for housing and other development can be produced.

Planning law requires that applications for planning permission be determined in accordance with the development plan, unless material considerations indicate otherwise. The NPPF must be considered in preparing the development plan, and is a material consideration in planning decisions. Planning policies and decisions must also reflect relevant international obligations and statutory requirements.

The purpose of the planning system is to contribute to the achievement of sustainable development. At a very high level, the objective of sustainable development can be summarised as meeting the needs of the present without compromising the ability of future generations to meet their own needs.

The applicable Development Plan for the Proposed Development is the Reading Borough Draft Local Plan (2018), together with the current Reading Borough Core Strategy (2008). Please refer to the following sections for further details.

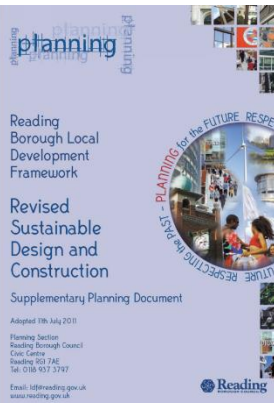
Local Planning Guidance



Core Strategy, Reading Borough (2008, with alteration adopted 2015)

The Core Strategy sets out the Council's adopted planning strategy for the Borough. It sets out how planning and development will achieve the Reading 2020 vision for the town. It provides a framework for how Reading can grow in a sustainable way in the future. It also sets out how Reading will accommodate the growth expected of it in the emerging South East Plan and through the council's commitment to New Growth Point status.

Policy CS1 "Sustainable Construction and Design" states that all new developments must maximise the use of energy efficiency and energy conservation measures in their design, layout and orientation to reduce overall energy demand.



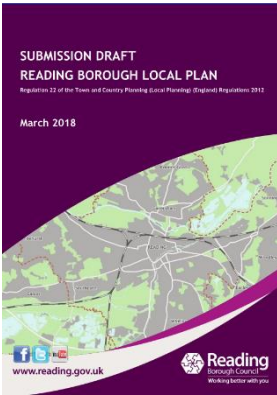
Supplementary Planning Document (SPD) – Revised Sustainable Design and Construction (2011)

This Supplementary Planning Document (SPD) aims to promote high standards of Sustainable Design and Construction, providing detail on how to comply with development plan policies set out in the Reading Borough Local Development Framework Core Strategy (2008).

It also provides practical advice on the forms of sustainable design and construction and how these policy requirements are applied at the local level through policy CS1: Sustainable Construction and Design of the adopted Core Strategy.

This document also states that due to changes to the Building Regulations, the requirement in the Core Strategy's Policy CS1 to 'off-set at least 20% of predicted

carbon dioxide emissions' has now been superseded. This Energy Strategy will therefore not refer to this requirement.



Submission Draft Local Plan, Reading Borough (2018)

This Draft Local Plan identifies the amount of development that will take place, the areas and sites where development is expected to be accommodated, and where it will be restricted, and sets out policies for how planning applications will be decided.

This plan has been prepared in accordance with the National Planning Policy Framework (NPPF) which sets out the overall national approach to planning.

Policy H5 “Standards for New Housing” states that all major new-build residential development should be designed to achieve zero carbon homes.

Policy CC2 “Sustainable Design and Construction” states that all major non-residential developments are required to meet the most up-to-date BREEAM ‘Excellent’ standards where possible. In line with this, the non-residential spaces will be required

to meet the minimum BREEAM ENE01 requirements for an Excellent rating.

Policy CC4 “Decentralised Energy” states that any development of more than 20 dwellings shall consider the inclusion of a CHP plant, or other form of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable, feasible or viable for this form of energy provision.

Further to this, where there is existing decentralised energy provision, developments of over 10 dwellings will be expected to link into this energy network or demonstrate why this is not feasible.

This plan will also replace all existing development plans in Reading once it is adopted. For this planning application, the Core Strategy is still the current development plan, however the Local Plan will also be followed.

Appendix B – DER and TER Worksheets.

FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



Property Reference	Type 08N-N				Issued on Date	12/03/2019
Assessment Reference	V03-1	Prop Type Ref	08			
Property	Type 08N-N					
SAP Rating	85 B	DER	12.84	TER	19.02	
Environmental	91 B	% DER<TER	32.48			
CO ₂ Emissions (t/year)	0.75	DFEE	48.84	TFEE	57.66	
General Requirements Compliance	Pass	% DFEE<TFEE	15.30			
Assessor Details	Mr. Liam Holden, Liam Holden, Tel: 01202 654600, liamholden@hoarelea.com				Assessor ID	P623-0001
Client						

Option A - CHP



FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



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

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

DWELLING AS DESIGNED

Ground-floor flat, total floor area 70 m²

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

1a TER and DER

Fuel for main heating:Mains gas (c)
Fuel factor:1.00 (mains gas)
Target Carbon Dioxide Emission Rate (TER) 19.02 kgCO₂/m²
Dwelling Carbon Dioxide Emission Rate (DER) 12.84 kgCO₂/m²OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)57.7 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)48.8 kWh/m²/yrOK

2 Fabric U-values

Element	Average	Highest	
External wall	0.18 (max. 0.30)	0.18 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor (no floor)			
Roof (no roof)			
Openings	1.43 (max. 2.00)	1.50 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

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

4 Heating efficiency

Main heating system: Community heating scheme -

Secondary heating system: None

5 Cylinder insulation

Hot water storage No cylinder

6 Controls

Space heating controls: Charging system linked to use of community heating, programmer and TRVsOK

Hot water controls: No cylinder

7 Low energy lights

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

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.62	
Maximum	1.5	OK
MVHR efficiency:	93%	
Minimum:	70%	OK

9 Summertime temperature

Overheating risk (Thames Valley): Medium OK

Based on:

Overshading:	Average
Windows facing North:	13.39 m², No overhang
Air change rate:	2.00 ach
Blinds/curtains:	Dark-coloured curtain or roller blind, closed 100% of daylight hours

10 Key features

Party wall U-value	0.00 W/m²K
Door U-value	1.00 W/m²K
Air permeability	3.0 m³/m²h
Community CHP, Mains gas	
Photovoltaic array	



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

2. Ventilation rate							
	main heating		secondary heating		other	total	m3 per hour
Number of chimneys	0	+	0			0 * 40 =	0.0000 (6a)
Number of open flues	0	+	0	+	0	= 0 * 200 =	0.0000 (6b)
Number of intermittent fans						0 * 10 =	0.0000 (7a)
Number of passive vents						0 * 10 =	0.0000 (7b)
Number of flueless gas fires						0 * 40 =	0.0000 (7c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000 (22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infiltr rate												
	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498 (22b)
Balanced mechanical ventilation with heat recovery												
If mechanical ventilation:												0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =												79.0500 (23c)
Effective ac	0.2673	0.2641	0.2609	0.2450	0.2418	0.2259	0.2259	0.2227	0.2323	0.2418	0.2482	0.2546 (25)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		242.2200	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		4.4828	(36)
Total fabric heat loss	(33) + (36) =	39.9966	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP	0.8448	0.8415	0.8382	0.8219	0.8187	0.8024	0.8024	0.7991	0.8089	0.8187	0.8252	0.8317 (40)
HLP (average)												0.8211 (40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31 (41)

Assumed occupancy	2.2464 (42)
Average daily hot water use (litres/day)	87.5512 (43)



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Regs Region: England
 Elmhurst Energy Systems
 SAP2012 Calculator (Design
 System) version 4.09r14

Distribution loss (46)m = 0.15 x (45)m
21.4229 18.7366 19.3345 16.8563 16.1740 13.9570 12.9332 14.8410 15.0183 17.5023 19.1052 20.7470 (46)

Water storage loss:

Internal gains (see Table 5 and 5a)												
Metabolic gains (Table 5), Watts												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(66)m	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184 (66)
Lighting gains	(calculated in Appendix L, equation L9 or L9a), also see Table 5											
	17.5913	15.6244	12.7066	9.6197	7.1909	6.0708	6.5597	8.5266	11.4444	14.5313	16.9601	18.0802 (67)
Appliances gains	(calculated in Appendix L, equation L13 or L13a), also see Table 5											
	197.3204	199.3680	194.2082	183.2235	169.3574	156.3253	147.6190	145.5714	150.7312	161.7158	175.5819	188.6141 (68)
Cooking gains	(calculated in Appendix L, equation L15 or L15a), also see Table 5											
	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318 (69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (70)
Losses e.g. evaporation	(negative values) (Table 5)											
	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547 (71)
Water heating gains	(Table 5)											
	123.2647	121.2423	117.0425	111.3330	107.6262	102.4068	97.9704	103.6546	105.6742	111.5837	118.2565	121.2507 (72)
Total internal gains												
	394.8719	392.9302	380.6528	360.8718	340.8700	321.4984	308.8446	314.4481	324.5453	344.5263	367.4941	384.6405 (73)

6. Solar gains													
[Jan]	Area				Solar flux		g		FF		Access		Gains
	m2				Table 6a		Specific data		Specific data		factor		W
					W/m2		or Table 6b		or Table 6c		Table 6d		
North	13.3900				10.6334		0.4200		0.9000		0.7700		37.2973 (74)
Solar gains	37.2973	71.2771	121.1171	194.5452	262.0702	280.5539	261.9329	207.8103	145.6221	84.8460	46.0110	31.0929 (83)	
Total gains	432.1692	464.2072	501.7700	555.4170	602.9402	602.0523	570.7775	522.2584	470.1673	429.3723	413.5051	415.7334 (84)	

7. Mean internal temperature (heating season)												
Temperature during heating periods in the living area from Table 9, Th1 (C)												
Utilisation factor for gains for living area, nil/m (see Table 9a)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	79.6480	79.9566	80.2676	81.8598	82.1859	83.8559	83.8559	84.1981	83.1798	82.1859	81.5364	80.8970
alpha	6.3099	6.3304	6.3512	6.4573	6.4791	6.5904	6.5904	6.6132	6.5453	6.4791	6.4358	6.3931
util living area	0.9969	0.9944	0.9854	0.9423	0.8074	0.5889	0.4320	0.4904	0.7755	0.9635	0.9932	0.9976 (86)
MIT	20.1879	20.2895	20.4794	20.7467	20.9323	20.9927	20.9992	20.9982	20.9616	20.7326	20.4256	20.1760 (87)
Th 2	20.2147	20.2175	20.2203	20.2344	20.2372	20.2513	20.2513	20.2541	20.2456	20.2372	20.2316	20.2259 (88)
util rest of house	0.9960	0.9927	0.9807	0.9247	0.7615	0.5236	0.3591	0.4122	0.7103	0.9487	0.9907	0.9968 (89)
MIT 2	19.1236	19.2737	19.5507	19.9369	20.1724	20.2465	20.2509	20.2533	20.2153	19.9258	19.4832	19.1150 (90)
Living area fraction										fLA = Living area / (4) =		0.4244 (91)
MIT	19.5753	19.7047	19.9448	20.2805	20.4949	20.5632	20.5685	20.5694	20.5320	20.2682	19.8831	19.5653 (92)
Temperature adjustment												0.0000
adjusted MIT	19.5753	19.7047	19.9448	20.2805	20.4949	20.5632	20.5685	20.5694	20.5320	20.2682	19.8831	19.5653 (93)

Space heating requirement												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9950	0.9913	0.9787	0.9259	0.7778	0.5511	0.3901	0.4454	0.7363	0.9494	0.9893	0.9960 (94)
Useful gains	430.0095	460.1604	491.0783	514.2473	468.9821	331.8185	222.6470	232.6344	346.1794	407.6295	409.0907	414.0703 (95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000 (96)
Heat loss rate W	903.4046	872.1954	789.0076	654.8762	504.0809	334.9738	222.9241	233.2608	364.2490	554.1336	738.5055	894.6944 (97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000 (97a)
Space heating kWh	352.2060	276.8875	221.6594	101.2528	26.1135	0.0000	0.0000	0.0000	0.0000	108.9991	237.1787	357.5844 (98)
Space heating												1681.8814 (98)
Space heating per m2										(98) / (4) =		24.0234 (99)

FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

8c. Space cooling requirement

Not applicable

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (301)
Fraction of space heat from community system	1.0000 (302)
Fraction of heat from community Boilers	0.4000 (303a)
Fraction of heat from community Combined Heat and Power	0.6000 (303b)
Fraction of total space heat from community Boilers	0.4000 (304a)
Fraction of total space heat from community Combined Heat and Power	0.6000 (304b)
Factor for control and charging method (Table 4c(3)) for community space heating	1.0000 (305)
Factor for control and charging method (Table 4c(3)) for community water heating	1.0000 (305a)
Distribution loss factor (Table 12c) for community heating system	1.0500 (306)
Space heating:	
Annual space heating requirement	1681.8814 (98)
Space heat from Boilers = (98) x 0.40 x 1.00 x 1.05	706.3902 (307a)
Space heat from Combined Heat and Power = (98) x 0.60 x 1.00 x 1.05	1059.5853 (307b)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)	0.0000 (308)
Space heating fuel for secondary/supplementary system	0.0000 (309)
Water heating	
Annual water heating requirement	2028.3616 (64)
Water heat from Boilers = (64) x 0.40 x 1.00 x 1.05	851.9119 (310a)
Water heat from Combined Heat and Power = (64) x 0.60 x 1.00 x 1.05	1277.8678 (310b)
Electricity used for heat distribution	38.9576 (313)
Annual totals kWh/year	
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.7750)	
mechanical ventilation fans (SFP = 0.7750)	205.2028 (330a)
Total electricity for the above, kWh/year	205.2028 (331)
Electricity for lighting (calculated in Appendix L)	310.6671 (332)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV Unit 0 (0.80 * 0.07 * 1080 * 0.80) =	-48.3627 (333)
Total delivered energy for all uses	4363.2623 (338)

12b. Carbon dioxide emissions - Community heating scheme

Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Efficiency of heat source Boilers		89.0000 (367a)
Space heating from Boilers	0.2160	378.1947 (367)
Electrical efficiency of CHP unit		31.8000 (361)
Heat efficiency of CHP unit		46.2000 (362)
Space heating from Combined Heat and Power	0.2160	495.3905 (363)
less credit emissions for electricity	0.5190	-378.5196 (364)
Water heating from Combined Heat and Power	0.2160	597.4447 (365)
less credit emissions for electricity	0.5190	-456.4975 (366)
Electrical energy for heat distribution	0.5190	20.2190 (372)
Total CO2 associated with community systems (negative value allowed since DFEE <= TFEE)		656.2317 (373)
Space and water heating		656.2317 (376)
Pumps and fans	0.5190	106.5003 (378)
Energy for lighting	0.5190	161.2362 (379)
Energy saving/generation technologies		
PV Unit	-48.3627	-25.1002 (380)
Total CO2, kg/year		898.8679 (383)
Dwelling Carbon Dioxide Emission Rate (DER)		12.8400 (384)

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

DER	12.8400 ZC1
Total Floor Area	70.0100 TFA
Assumed number of occupants	2.2464 N
CO2 emission factor in Table 12 for electricity displaced from grid	0.5190 EF
CO2 emissions from appliances, equation (L14)	16.7016 ZC2
CO2 emissions from cooking, equation (L16)	2.4698 ZC3
Total CO2 emissions	32.0114 ZC4
Residual CO2 emissions offset from biofuel CHP	0.0000 ZC5
Additional allowable electricity generation, kWh/m²/year	0.0000 ZC6
Resulting CO2 emissions offset from additional allowable electricity generation	0.0000 ZC7
Net CO2 emissions	32.0114 ZC8



FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)	Storey height (m)	Volume (m3)
Ground floor	70.0100 (1b)	x 3.1000 (2b)	= 217.0310 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	70.0100		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =	217.0310 (5)

2. Ventilation rate

	main heating	secondary heating	other	total	m3 per hour
Number of chimneys	0	0	0	0 * 40 =	0.0000 (6a)
Number of open flues	0	0	0	0 * 20 =	0.0000 (6b)
Number of intermittent fans				2 * 10 =	20.0000 (7a)
Number of passive vents				0 * 10 =	0.0000 (7b)
Number of flueless gas fires				0 * 40 =	0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =				20.0000 / (5) =	0.0922 (8)
Pressure test				Yes	
Measured/design AP50					5.0000
Infiltration rate					0.3422 (18)
Number of sides sheltered					2 (19)
Shelter factor			(20) = 1 - [0.075 x (19)] =		0.8500 (20)
Infiltration rate adjusted to include shelter factor			(21) = (18) x (20) =		0.2908 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000 (22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infilt rate	0.3708	0.3635	0.3563	0.3199	0.3126	0.2763	0.2763	0.2690	0.2908	0.3126	0.3272	0.3417 (22b)
Effective ac	0.5687	0.5661	0.5635	0.5512	0.5489	0.5382	0.5382	0.5362	0.5423	0.5489	0.5535	0.5584 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K
TER Opaque door			2.1200	1.0000	2.1200		(26)
TER Opening Type (Uw = 1.40)			13.3900	1.3258	17.7519		(27)
External Wall 1	70.5700	13.3900	57.1800	0.1800	10.2924		(29a)
To Corridor	19.9800	2.1200	17.8600	0.1800	3.2148		(29a)
To Risers	7.0000		7.0000	0.1800	1.2600		(29a)
Total net area of external elements Aum(A, m2)			97.5500				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		34.6391		(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							5.3751 (36)
Total fabric heat loss						(33) + (36) =	40.0142 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat transfer coeff	40.7340	40.5428	40.3553	39.4751	39.3104	38.5437	38.5437	38.4017	38.8390	39.3104	39.6436	39.9919 (38)
Average = Sum(39)m / 12 =	80.7481	80.5570	80.3695	79.4893	79.3246	78.5579	78.5579	78.4159	78.8532	79.3246	79.6577	80.0061 (39)
												79.4885 (39)

HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP (average)	1.1534	1.1506	1.1480	1.1354	1.1330	1.1221	1.1221	1.1201	1.1263	1.1330	1.1378	1.1428 (40)
Days in month												1.1354 (40)
	31	28	31	30	31	30	31	31	30	31	30	31 (41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.2464 (42)
Average daily hot water use (litres/day)												87.5512 (43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Energy conte	96.3064	92.8043	89.3023	85.8002	82.2982	78.7961	78.7961	82.2982	85.8002	89.3023	92.8043	96.3064 (44)
Energy content (annual)	142.8195	124.9109	128.8968	112.3754	107.8269	93.0464	86.2212	98.9400	100.1217	116.6822	127.3677	138.3131 (45)
Distribution loss (46)m = 0.15 x (45)m										Total = Sum(45)m =		1377.5218 (45)
Water storage loss:	21.4229	18.7366	19.3345	16.8563	16.1740	13.9570	12.9332	14.8410	15.0183	17.5023	19.1052	20.7470 (46)
Store volume												1.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):												0.2134 (48)
Temperature factor from Table 2b												0.5400 (49)
Enter (49) or (54) in (55)												0.1152 (55)



FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



CALCULATION OF TARGET EMISSIONS 09 Jan 2014

Total storage loss	3.5715	3.2259	3.5715	3.4563	3.5715	3.4563	3.5715	3.5715	3.4563	3.5715	3.4563	3.5715	(56)
If cylinder contains dedicated solar storage	3.5715	3.2259	3.5715	3.4563	3.5715	3.4563	3.5715	3.5715	3.4563	3.5715	3.4563	3.5715	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month	169.6534	149.1479	155.7307	138.3437	134.6607	119.0147	113.0550	125.7739	126.0900	143.5161	153.3360	165.1470	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
Solar input (sum of months) = Sum (63)m =												0.0000	(63)
Output from w/h	169.6534	149.1479	155.7307	138.3437	134.6607	119.0147	113.0550	125.7739	126.0900	143.5161	153.3360	165.1470	(64)
Heat gains from water heating, kWh/month	68.9546	60.9225	64.3253	58.1394	57.3195	51.7125	50.1356	54.3647	54.0651	60.2639	63.1244	67.4562	(65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	17.8087	15.8176	12.8637	9.7387	7.2798	6.1459	6.6408	8.6320	11.5859	14.7109	17.1698	18.3037	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	197.3204	199.3680	194.2082	183.2235	169.3574	156.3253	147.6190	145.5714	150.7312	161.7158	175.5819	188.6141	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	(71)
Water heating gains (Table 5)	92.6809	90.6585	86.4587	80.7492	77.0424	71.8230	67.3866	73.0708	75.0904	80.9999	87.6728	90.6669	(72)
Total internal gains	367.5056	365.5395	353.2261	333.4069	313.3751	293.9896	281.3419	286.9697	297.1030	317.1222	340.1200	357.2803	(73)

6. Solar gains

[Jan]	Area m2				Solar flux Table 6a W/m2		g Specific data or Table 6b		FF Specific data or Table 6c		Access factor Table 6d		Gains W	
North	13.3900				10.6334		0.6300		0.7000		0.7700		43.5135 (74)	
Solar gains	43.5135	83.1566	141.3033	226.9694	305.7485	327.3129	305.5884	242.4454	169.8924	98.9870	53.6795	36.2750 (83)		
Total gains	411.0191	448.6961	494.5295	560.3763	619.1236	621.3025	586.9303	529.4151	466.9954	416.1092	393.7995	393.5553 (84)		

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)													21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
tau	60.2095	60.3524	60.4931	61.1630	61.2900	61.8882	61.8882	62.0002	61.6564	61.2900	61.0337	60.7680		
alpha	5.0140	5.0235	5.0329	5.0775	5.0860	5.1259	5.1259	5.1333	5.1104	5.0860	5.0689	5.0512		
util living area	0.9982	0.9968	0.9923	0.9721	0.8995	0.7374	0.5722	0.6479	0.8931	0.9845	0.9966	0.9986	(86)	
MIT	19.7422	19.8603	20.0946	20.4390	20.7567	20.9399	20.9868	20.9761	20.8289	20.4411	20.0390	19.7224	(87)	
Th 2	19.9575	19.9597	19.9618	19.9720	19.9739	19.9828	19.9828	19.9845	19.9794	19.9739	19.9701	19.9660	(88)	
util rest of house	0.9976	0.9957	0.9893	0.9608	0.8591	0.6472	0.4485	0.5211	0.8333	0.9763	0.9952	0.9981	(89)	
MIT 2	18.2800	18.4541	18.7970	19.2988	19.7287	19.9418	19.9778	19.9742	19.8325	19.3091	18.7230	18.2572	(90)	
Living area fraction	18.9005	19.0508	19.3477	19.7827	20.1649	20.3654	20.4060	20.3994	FLA = Living area / (4) =	19.7895	19.2815	18.4244	(91)	
MIT	18.9005	19.0508	19.3477	19.7827	20.1649	20.3654	20.4060	20.3994	20.2553	19.7895	19.2815	18.8790	(92)	
Temperature adjustment	18.9005	19.0508	19.3477	19.7827	20.1649	20.3654	20.4060	20.3994	20.2553	19.7895	19.2815	18.8790	(93)	

8. Space heating requirement

Utilisation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Useful gains	409.6580	446.1720	488.1158	536.9325	537.1810	424.5394	294.2941	304.5519	397.9000	405.4434	391.3687	392.5083	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	1178.9654	1139.9488	1032.5604	865.0570	671.4753	452.9149	298.9919	313.6130	485.3646	728.9538	970.3485	1174.4110	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh	572.3647	466.2180	405.0668	236.2496	99.9149	0.0000	0.0000	0.0000	0.0000	240.6917	416.8655	581.7357	(98)
Space heating												3019.1069	(98)
Space heating per m2									(98) / (4) =			43.1239	(99)

8c. Space cooling requirement

Not applicable



FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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

Fraction of space heat from secondary/supplementary system (Table 11)														0.0000	(201)
Fraction of space heat from main system(s)														1.0000	(202)
Efficiency of main space heating system 1 (in %)														93.5000	(206)
Efficiency of secondary/supplementary heating system, %														0.0000	(208)
Space heating requirement														3228.9913	(211)
Space heating requirement	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
572.3647	466.2180	405.0668	236.2496	99.9149	0.0000	0.0000	0.0000	0.0000	0.0000	240.6917	416.8655	581.7357	(98)		
Space heating efficiency (main heating system 1)	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)		
Space heating fuel (main heating system)	612.1547	498.6289	433.2265	252.6734	106.8609	0.0000	0.0000	0.0000	0.0000	257.4243	445.8454	622.1772	(211)		
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)		
Water heating requirement	169.6534	149.1479	155.7307	138.3437	134.6607	119.0147	113.0550	125.7739	126.0900	143.5161	153.3360	165.1470	(64)		
Efficiency of water heater (217)m	87.8081	87.6515	87.2512	86.2299	84.0318	79.8000	79.8000	79.8000	79.8000	86.1834	87.3504	87.8941	(217)		
Fuel for water heating, kWh/month	193.2094	170.1603	178.4854	160.4358	160.2497	149.1412	141.6730	157.6114	158.0075	166.5240	175.5413	187.8931	(219)		
Water heating fuel used												1998.9321	(219)		
Annual totals kWh/year															
Space heating fuel - main system												3228.9913	(211)		
Space heating fuel - secondary												0.0000	(215)		
Electricity for pumps and fans:															
central heating pump												30.0000	(230c)		
main heating flue fan												45.0000	(230e)		
Total electricity for the above, kWh/year												75.0000	(231)		
Electricity for lighting (calculated in Appendix L)												314.5079	(232)		
Total delivered energy for all uses												5617.4313	(238)		

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

Space heating - main system 1	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - secondary	3228.9913	0.2160	697.4621	(261)
Water heating (other fuel)	0.0000	0.0000	0.0000	(263)
Space and water heating	1998.9321	0.2160	431.7693	(264)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	314.5079	0.5190	163.2296	(268)
Total CO2, kg/m2/year			1331.3861	(272)
Emissions per m2 for space and water heating			16.1296	(272a)
Fuel factor (mains gas)			1.0000	
Emissions per m2 for lighting			2.3315	(272b)
Emissions per m2 for pumps and fans			0.5560	(272c)
Target Carbon Dioxide Emission Rate (TER) = (16.1296 * 1.00) + 2.3315 + 0.5560, rounded to 2 d.p.			19.0200	(273)



FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



Property Reference	Type 08N-N			Issued on Date	12/03/2019
Assessment Reference	V03-1-1	Prop Type Ref	08		
Property	Type 08N-N				
SAP Rating	83 B	DER	17.51	TER	27.89
Environmental	87 B	% DER<TER	37.21		
CO ₂ Emissions (t/year)	1.00	DFEE	48.84	TFEE	57.66
General Requirements Compliance	Pass	% DFEE<TFEE	15.30		
Assessor Details	Mr. Liam Holden, Liam Holden, Tel: 01202 654600, liamholden@hoarelea.com			Assessor ID	P623-0001
Client					

Option B - ASHP



FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



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

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

DWELLING AS DESIGNED

Ground-floor flat, total floor area 70 m²

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

1a TER and DER

Fuel for main heating:Electricity (c)
Fuel factor:1.55 (electricity)
Target Carbon Dioxide Emission Rate (TER) 27.89 kgCO₂/m²
Dwelling Carbon Dioxide Emission Rate (DER) 17.51 kgCO₂/m²OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)57.7 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)48.8 kWh/m²/yrOK

2 Fabric U-values

Element	Average	Highest	
External wall	0.18 (max. 0.30)	0.18 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor (no floor)			
Roof (no roof)			
Openings	1.43 (max. 2.00)	1.50 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

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

4 Heating efficiency

Main heating system: Community heating scheme -

Secondary heating system: None

5 Cylinder insulation

Hot water storage No cylinder

6 Controls

Space heating controls: Charging system linked to use of community heating, programmer and TRVsOK

Hot water controls:

No cylinder

7 Low energy lights

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

8 Mechanical ventilation

Continuous supply and extract system	
Specific fan power:	0.62
Maximum	1.5 OK
MVHR efficiency:	93%
Minimum:	70% OK

9 Summertime temperature

Overheating risk (Thames Valley): Medium OK

Based on:

Overshading:	Average
Windows facing North:	13.39 m², No overhang
Air change rate:	2.00 ach
Blinds/curtains:	Dark-coloured curtain or roller blind, closed 100% of daylight hours

10 Key features

Party wall U-value	0.00 W/m²K
Door U-value	1.00 W/m²K
Air permeability	3.0 m³/m²h
Photovoltaic array	



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

2. Ventilation rate							
	main heating		secondary heating		other	total	m3 per hour
Number of chimneys	0	+	0			0 * 40 =	0.0000 (6a)
Number of open flues	0	+	0	+	0	= 0 * 200 =	0.0000 (6b)
Number of intermittent fans						0 * 10 =	0.0000 (7a)
Number of passive vents						0 * 10 =	0.0000 (7b)
Number of flueless gas fires						0 * 40 =	0.0000 (7c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000 (22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infiltr rate												
	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498 (22b)
Balanced mechanical ventilation with heat recovery												
If mechanical ventilation:												0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =												79.0500 (23c)
Effective ac	0.2673	0.2641	0.2609	0.2450	0.2418	0.2259	0.2259	0.2227	0.2323	0.2418	0.2482	0.2546 (25)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		242.2200	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		4.4828	(36)
Total fabric heat loss	(33) + (36) =	39.9966	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP	0.8448	0.8415	0.8382	0.8219	0.8187	0.8024	0.8024	0.7991	0.8089	0.8187	0.8252	0.8317 (40)
HLP (average)												0.8211 (40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31 (41)

Assumed occupancy	2.2464 (42)
Average daily hot water use (litres/day)	87.5512 (43)



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Regs Region: England
 Elmhurst Energy Systems
 SAP2012 Calculator (Design
 System) version 4.09r14

Distribution loss (46)m = 0.15 x (45)m
21.4229 18.7366 19.3345 16.8563 16.1740 13.9570 12.9332 14.8410 15.0183 17.5023 19.1052 20.7470 (46)

Water storage loss:

Internal gains (see Table 5 and 5a)												
Metabolic gains (Table 5), Watts												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(66)m	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184 (66)
Lighting gains	(calculated in Appendix L, equation L9 or L9a), also see Table 5											
	17.5913	15.6244	12.7066	9.6197	7.1909	6.0708	6.5597	8.5266	11.4444	14.5313	16.9601	18.0802 (67)
Appliances gains	(calculated in Appendix L, equation L13 or L13a), also see Table 5											
	197.3204	199.3680	194.2082	183.2235	169.3574	156.3253	147.6190	145.5714	150.7312	161.7158	175.5819	188.6141 (68)
Cooking gains	(calculated in Appendix L, equation L15 or L15a), also see Table 5											
	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318 (69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (70)
Losses e.g. evaporation	(negative values) (Table 5)											
	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547 (71)
Water heating gains	(Table 5)											
	123.2647	121.2423	117.0425	111.3330	107.6262	102.4068	97.9704	103.6546	105.6742	111.5837	118.2565	121.2507 (72)
Total internal gains												
	394.8719	392.9302	380.6528	360.8718	340.8700	321.4984	308.8446	314.4481	324.5453	344.5263	367.4941	384.6405 (73)

6. Solar gains												
[Jan]					Area	Solar flux	g	FF	Access		Gains	
					m2	Table 6a	Specific data	Specific data	factor		W	
						W/m2	or Table 6b	or Table 6c	Table 6d			
North					13.3900	10.6334	0.4200	0.9000	0.7700		37.2973 (74)	
Solar gains	37.2973	71.2771	121.1171	194.5452	262.0702	280.5539	261.9329	207.8103	145.6221	84.8460	46.0110	31.0929 (83)
Total gains	432.1692	464.2072	501.7700	555.4170	602.9402	602.0523	570.7775	522.2584	470.1673	429.3723	413.5051	415.7334 (84)

7. Mean internal temperature (heating season)												
Temperature during heating periods in the living area from Table 9, Th1 (C)												
Utilisation factor for gains for living area, nil/m (see Table 9a)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	79.6480	79.9566	80.2676	81.8598	82.1859	83.8559	83.8559	84.1981	83.1798	82.1859	81.5364	80.8970
alpha	6.3099	6.3304	6.3512	6.4573	6.4791	6.5904	6.5904	6.6132	6.5453	6.4791	6.4358	6.3931
util living area	0.9969	0.9944	0.9854	0.9423	0.8074	0.5889	0.4320	0.4904	0.7755	0.9635	0.9932	0.9976 (86)
MIT	20.1879	20.2895	20.4794	20.7467	20.9323	20.9927	20.9992	20.9982	20.9616	20.7326	20.4256	20.1760 (87)
Th 2	20.2147	20.2175	20.2203	20.2344	20.2372	20.2513	20.2513	20.2541	20.2456	20.2372	20.2316	20.2259 (88)
util rest of house	0.9960	0.9927	0.9807	0.9247	0.7615	0.5236	0.3591	0.4122	0.7103	0.9487	0.9907	0.9968 (89)
MIT 2	19.1236	19.2737	19.5507	19.9369	20.1724	20.2465	20.2509	20.2533	20.2153	19.9258	19.4832	19.1150 (90)
Living area fraction										fLA = Living area / (4) =		0.4244 (91)
MIT	19.5753	19.7047	19.9448	20.2805	20.4949	20.5632	20.5685	20.5694	20.5320	20.2682	19.8831	19.5653 (92)
Temperature adjustment												0.0000
adjusted MIT	19.5753	19.7047	19.9448	20.2805	20.4949	20.5632	20.5685	20.5694	20.5320	20.2682	19.8831	19.5653 (93)

Space heating requirement												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9950	0.9913	0.9787	0.9259	0.7778	0.5511	0.3901	0.4454	0.7363	0.9494	0.9893	0.9960 (94)
Useful gains	430.0095	460.1604	491.0783	514.2473	468.9821	331.8185	222.6470	232.6344	346.1794	407.6295	409.0907	414.0703 (95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000 (96)
Heat loss rate W	903.4046	872.1954	789.0076	654.8762	504.0809	334.9738	222.9241	233.2608	364.2490	554.1336	738.5055	894.6944 (97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000 (97a)
Space heating kWh	352.2060	276.8875	221.6594	101.2528	26.1135	0.0000	0.0000	0.0000	0.0000	108.9991	237.1787	357.5844 (98)
Space heating												1681.8814 (98)
Space heating per m2										(98) / (4) =		24.0234 (99)

FULL SAP CALCULATION PRINTOUT
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CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

8c. Space cooling requirement

Not applicable

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (301)
Fraction of space heat from community system	1.0000 (302)
Fraction of heat from community Heat pump	1.0000 (303a)
Fraction of total space heat from community Heat pump	1.0000 (304a)
Factor for control and charging method (Table 4c(3)) for community space heating	1.0000 (305)
Factor for control and charging method (Table 4c(3)) for community water heating	1.0000 (305a)
Distribution loss factor (Table 12c) for community heating system	1.0500 (306)
Space heating:	
Annual space heating requirement	1681.8814 (98)
Space heat from Heat pump = (98) x 1.00 x 1.00 x 1.05	1765.9755 (307a)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)	0.0000 (308)
Space heating fuel for secondary/supplementary system	0.0000 (309)
Water heating	
Annual water heating requirement	2028.3616 (64)
Water heat from Heat pump = (64) x 1.00 x 1.00 x 1.05	2129.7796 (310a)
Electricity used for heat distribution	38.9576 (313)
Annual totals kWh/year	
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.7750)	
mechanical ventilation fans (SFP = 0.7750)	205.2028 (330a)
Total electricity for the above, kWh/year	205.2028 (331)
Electricity for lighting (calculated in Appendix L)	310.6671 (332)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV Unit 0 (0.80 * 0.07 * 1080 * 0.80) =	-48.3627 (333)
Total delivered energy for all uses	4363.2623 (338)

12b. Carbon dioxide emissions - Community heating scheme

Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Efficiency of heat source Heat pump		210.0000 (367a)
Space heating from Heat pump	0.5190	962.8080 (367)
Electrical energy for heat distribution	0.5190	20.2190 (372)
Total CO2 associated with community systems (negative value allowed since DFEE <= TFEE)		983.0270 (373)
Space and water heating		983.0270 (376)
Pumps and fans	0.5190	106.5003 (378)
Energy for lighting	0.5190	161.2362 (379)
Energy saving/generation technologies		
PV Unit	-48.3627	-25.1002 (380)
Total CO2, kg/year		1225.6633 (383)
Dwelling Carbon Dioxide Emission Rate (DER)		17.5100 (384)

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

DER	17.5100 ZC1
Total Floor Area	70.0100 TFA
Assumed number of occupants	2.2464 N
CO2 emission factor in Table 12 for electricity displaced from grid	0.5190 EF
CO2 emissions from appliances, equation (L14)	16.7016 ZC2
CO2 emissions from cooking, equation (L16)	2.4698 ZC3
Total CO2 emissions	36.6814 ZC4
Residual CO2 emissions offset from biofuel CHP	0.0000 ZC5
Additional allowable electricity generation, kWh/m²/year	0.0000 ZC6
Resulting CO2 emissions offset from additional allowable electricity generation	0.0000 ZC7
Net CO2 emissions	36.6814 ZC8



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CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)	Storey height (m)	Volume (m3)
Ground floor	70.0100 (1b)	x 3.1000 (2b)	= 217.0310 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	70.0100		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 217.0310 (5)

2. Ventilation rate

	main heating	secondary heating	other	total	m3 per hour
Number of chimneys	0	0	0	=	0 * 40 = 0.0000 (6a)
Number of open flues	0	0	0	=	0 * 20 = 0.0000 (6b)
Number of intermittent fans					2 * 10 = 20.0000 (7a)
Number of passive vents					0 * 10 = 0.0000 (7b)
Number of flueless gas fires					0 * 40 = 0.0000 (7c)

Infiltration due to chimneys, flues and fans	= (6a)+(6b)+(7a)+(7b)+(7c) =	Air changes per hour
Pressure test		20.0000 / (5) = 0.0922 (8)
Measured/design AP50		Yes
Infiltration rate		5.0000
Number of sides sheltered		0.3422 (18)
		2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2908 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000 (22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infilt rate	0.3708	0.3635	0.3563	0.3199	0.3126	0.2763	0.2763	0.2690	0.2908	0.3126	0.3272	0.3417 (22b)
Effective ac	0.5687	0.5661	0.5635	0.5512	0.5489	0.5382	0.5382	0.5362	0.5423	0.5489	0.5555	0.5584 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K
TER Opaque door			2.1200	1.0000	2.1200		(26)
TER Opening Type (Uw = 1.40)			13.3900	1.3258	17.7519		(27)
External Wall 1	70.5700	13.3900	57.1800	0.1800	10.2924		(29a)
To Corridor	19.9800	2.1200	17.8600	0.1800	3.2148		(29a)
To Risers	7.0000		7.0000	0.1800	1.2600		(29a)
Total net area of external elements Aum(A, m2)			97.5500				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		34.6391		(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K	250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)	5.3751 (36)
Total fabric heat loss	(33) + (36) = 40.0142 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)	
(38)m	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Heat transfer coeff	40.7340 40.5428 40.3553 39.4751 39.3104 38.5437 38.5437 38.4017 38.8390 39.3104 39.6436 39.9919 (38)
Average = Sum(39)m / 12 =	80.7481 80.5570 80.3695 79.4893 79.3246 78.5579 78.5579 78.4159 78.8532 79.3246 79.6577 80.0061 (39)

HLP	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
HLP (average)	1.1534 1.1506 1.1480 1.1354 1.1330 1.1221 1.1221 1.1201 1.1263 1.1330 1.1378 1.1428 (40)
Days in month	31 28 31 30 31 30 31 31 30 31 30 31 (41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.2464 (42)
Average daily hot water use (litres/day)	87.5512 (43)
Daily hot water use	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Energy conte	96.3064 92.8043 89.3023 85.8002 82.2982 78.7961 78.7961 82.2982 85.8002 89.3023 92.8043 96.3064 (44)
Energy content (annual)	142.8195 124.9109 128.8968 112.3754 107.8269 93.0464 86.2212 98.9400 100.1217 116.6822 127.3677 138.3131 (45)
Distribution loss (46)m = 0.15 x (45)m	21.4229 18.7366 19.3345 16.8563 16.1740 13.9570 12.9332 14.8410 15.0183 17.5023 19.1052 20.7470 (46)
Water storage loss:	
Store volume	1.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):	0.2134 (48)
Temperature factor from Table 2b	0.5400 (49)
Enter (49) or (54) in (55)	0.1152 (55)



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CALCULATION OF TARGET EMISSIONS 09 Jan 2014

Total storage loss	3.5715	3.2259	3.5715	3.4563	3.5715	3.4563	3.5715	3.5715	3.4563	3.5715	3.4563	3.5715	(56)
If cylinder contains dedicated solar storage	3.5715	3.2259	3.5715	3.4563	3.5715	3.4563	3.5715	3.5715	3.4563	3.5715	3.4563	3.5715	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month	169.6534	149.1479	155.7307	138.3437	134.6607	119.0147	113.0550	125.7739	126.0900	143.5161	153.3360	165.1470	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
Solar input (sum of months) = Sum(63)m =												0.0000	(63)
Output from w/h	169.6534	149.1479	155.7307	138.3437	134.6607	119.0147	113.0550	125.7739	126.0900	143.5161	153.3360	165.1470	(64)
Heat gains from water heating, kWh/month	68.9546	60.9225	64.3253	58.1394	57.3195	51.7125	50.1356	54.3647	54.0651	60.2639	63.1244	67.4562	(65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	17.8087	15.8176	12.8637	9.7387	7.2798	6.1459	6.6408	8.6320	11.5859	14.7109	17.1698	18.3037	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	197.3204	199.3680	194.2082	183.2235	169.3574	156.3253	147.6190	145.5714	150.7312	161.7158	175.5819	188.6141	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	(71)
Water heating gains (Table 5)	92.6809	90.6585	86.4587	80.7492	77.0424	71.8230	67.3866	73.0708	75.0904	80.9999	87.6728	90.6669	(72)
Total internal gains	367.5056	365.5395	353.2261	333.4069	313.3751	293.9896	281.3419	286.9697	297.1030	317.1222	340.1200	357.2803	(73)

6. Solar gains

[Jan]	Area m2				Solar Flux Table 6a W/m2		g Specific data or Table 6b		FF Specific data or Table 6c		Access factor Table 6d		Gains W	
North	13.3900				10.6334		0.6300		0.7000		0.7700		43.5135 (74)	
Solar gains	43.5135	83.1566	141.3033	226.9694	305.7485	327.3129	305.5884	242.4454	169.8924	98.9870	53.6795	36.2750	(83)	
Total gains	411.0191	448.6961	494.5295	560.3763	619.1236	621.3025	586.9303	529.4151	466.9954	416.1092	393.7995	393.5553	(84)	

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)													21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
tau	60.2095	60.3524	60.4931	61.1630	61.2900	61.8882	61.8882	62.0002	61.6564	61.2900	61.0337	60.7680		
alpha	5.0140	5.0235	5.0329	5.0775	5.0860	5.1259	5.1259	5.1333	5.1104	5.0860	5.0689	5.0512		
util living area	0.9982	0.9968	0.9923	0.9721	0.8995	0.7374	0.5722	0.6479	0.8931	0.9845	0.9966	0.9986	(86)	
MIT	19.7422	19.8603	20.0946	20.4390	20.7567	20.9399	20.9868	20.9761	20.8289	20.4411	20.0390	19.7224	(87)	
Th 2	19.9575	19.9597	19.9618	19.9720	19.9739	19.9828	19.9828	19.9845	19.9794	19.9739	19.9701	19.9660	(88)	
util rest of house	0.9976	0.9957	0.9893	0.9608	0.8591	0.6472	0.4485	0.5211	0.8333	0.9763	0.9952	0.9981	(89)	
MIT 2	18.2800	18.4541	18.7970	19.2988	19.7287	19.9418	19.9778	19.9742	19.8325	19.3091	18.7230	18.2572	(90)	
Living area fraction	18.9005	19.0508	19.3477	19.7827	20.1649	20.3654	20.4060	20.3994	FLA = Living area / (4) =	19.7895	19.2815	18.4244	(91)	
MIT	18.9005	19.0508	19.3477	19.7827	20.1649	20.3654	20.4060	20.3994	20.2553	19.7895	19.2815	18.8790	(92)	
Temperature adjustment	18.9005	19.0508	19.3477	19.7827	20.1649	20.3654	20.4060	20.3994	20.2553	19.7895	19.2815	18.8790	(93)	
adjusted MIT	18.9005	19.0508	19.3477	19.7827	20.1649	20.3654	20.4060	20.3994	20.2553	19.7895	19.2815	18.8790	(93)	

8. Space heating requirement

Utilisation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Useful gains	409.6580	446.1720	488.1158	536.9325	537.1810	424.5394	294.2941	304.5519	397.9000	405.4434	391.3687	392.5083	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	1178.9654	1139.9488	1032.5604	865.0570	671.4753	452.9149	298.9919	313.6130	485.3646	728.9538	970.3485	1174.4110	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh	572.3647	466.2180	405.0668	236.2496	99.9149	0.0000	0.0000	0.0000	0.0000	240.6917	416.8655	581.7357	(98)
Space heating												3019.1069	(98)
Space heating per m2									(98) / (4) =			43.1239	(99)

8c. Space cooling requirement

Not applicable



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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	93.5000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	3228.9913	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	572.3647	466.2180	405.0668	236.2496	99.9149	0.0000	0.0000	0.0000	0.0000	240.6917	416.8655	581.7357	(98)
Space heating efficiency (main heating system 1)	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)
Space heating fuel (main heating system)	612.1547	498.6289	433.2265	252.6734	106.8609	0.0000	0.0000	0.0000	0.0000	257.4243	445.8454	622.1772	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating	169.6534	149.1479	155.7307	138.3437	134.6607	119.0147	113.0550	125.7739	126.0900	143.5161	153.3360	165.1470	(64)
Water heating requirement	169.6534	149.1479	155.7307	138.3437	134.6607	119.0147	113.0550	125.7739	126.0900	143.5161	153.3360	165.1470	(64)
Efficiency of water heater (217)m	87.8081	87.6515	87.2512	86.2299	84.0318	79.8000	79.8000	79.8000	79.8000	86.1834	87.3504	87.8941	(216)
Fuel for water heating, kWh/month	193.2094	170.1603	178.4854	160.4358	160.2497	149.1412	141.6730	157.6114	158.0075	166.5240	175.5413	187.8931	(219)
Water heating fuel used	193.2094	170.1603	178.4854	160.4358	160.2497	149.1412	141.6730	157.6114	158.0075	166.5240	175.5413	187.8931	(219)
Annual totals kWh/year												1998.9321	(219)
Space heating fuel - main system												3228.9913	(211)
Space heating fuel - secondary												0.0000	(215)

Electricity for pumps and fans:													
central heating pump												30.0000	(230c)
main heating flue fan												45.0000	(230e)
Total electricity for the above, kWh/year												75.0000	(231)
Electricity for lighting (calculated in Appendix L)												314.5079	(232)
Total delivered energy for all uses												5617.4313	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	3228.9913	0.2160	697.4621	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1998.9321	0.2160	431.7693	(264)
Space and water heating			1129.2315	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	314.5079	0.5190	163.2296	(268)
Total CO2, kg/m2/year			1331.3861	(272)
Emissions per m2 for space and water heating			16.1296	(272a)
Fuel factor (electricity)			1.5500	
Emissions per m2 for lighting			2.3315	(272b)
Emissions per m2 for pumps and fans			0.5560	(272c)
Target Carbon Dioxide Emission Rate (TER) = (16.1296 * 1.55) + 2.3315 + 0.5560, rounded to 2 d.p.			27.8900	(273)



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Property Reference	Type 08N-N				Issued on Date	12/03/2019
Assessment Reference	V03-1-1-1	Prop Type Ref	08			
Property	Type 08N-N					
SAP Rating	83 B	DER	13.38	TER	27.89	
Environmental	90 B	% DER<TER	52.02			
CO ₂ Emissions (t/year)	0.77	DFEE	48.84	TFEE	57.66	
General Requirements Compliance	Pass	% DFEE<TFEE	15.30			
Assessor Details	Mr. Liam Holden, Liam Holden, Tel: 01202 654600, liamholden@hoarelea.com				Assessor ID	P623-0001
Client						

Option C - GSHP

FULL SAP CALCULATION PRINTOUT
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REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

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

DWELLING AS DESIGNED

Ground-floor flat, total floor area 70 m²

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

1a TER and DER

Fuel for main heating:Electricity (c)
Fuel factor:1.55 (electricity)
Target Carbon Dioxide Emission Rate (TER) 27.89 kgCO₂/m²
Dwelling Carbon Dioxide Emission Rate (DER) 13.38 kgCO₂/m²OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)57.7 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)48.8 kWh/m²/yrOK

2 Fabric U-values

Element	Average	Highest	
External wall	0.18 (max. 0.30)	0.18 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor	(no floor)		
Roof	(no roof)		
Openings	1.43 (max. 2.00)	1.50 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

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

4 Heating efficiency

Main heating system: Community heating scheme -

Secondary heating system: None

5 Cylinder insulation

Hot water storage No cylinder

6 Controls

Space heating controls: Charging system linked to use of community heating, programmer and TRVsOK

Hot water controls: No cylinder

7 Low energy lights

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

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.62	
Maximum	1.5	OK
MVHR efficiency:	93%	
Minimum:	70%	OK

9 Summertime temperature

Overheating risk (Thames Valley): Medium OK

Based on:

Overshading:	Average
Windows facing North:	13.39 m², No overhang
Air change rate:	2.00 ach
Blinds/curtains:	Dark-coloured curtain or roller blind, closed 100% of daylight hours

10 Key features

Party wall U-value	0.00 W/m²K
Door U-value	1.00 W/m²K
Air permeability	3.0 m³/m²h
Photovoltaic array	

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2. Ventilation rate									
	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0		0		0	=	0 * 40 =	0.0000 (6a)	
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000 (6b)	
Number of intermittent fans							0 * 10 =	0.0000 (7a)	
Number of passive vents							0 * 10 =	0.0000 (7b)	
Number of flueless gas fires							0 * 40 =	0.0000 (7c)	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000 (22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infiltr rate												
	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498 (22b)
Balanced mechanical ventilation with heat recovery												
If mechanical ventilation:												0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =												79.0500 (23c)
Effective ac	0.2673	0.2641	0.2609	0.2450	0.2418	0.2259	0.2259	0.2227	0.2323	0.2418	0.2482	0.2546 (25)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		242.2200	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		4.4828	(36)
Total fabric heat loss	(33) + (36) =	39.9966	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP	0.8448	0.8415	0.8382	0.8219	0.8187	0.8024	0.8024	0.7991	0.8089	0.8187	0.8252	0.8317 (40)
HLP (average)												0.8211 (40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31 (41)

Assumed occupancy	2.2464 (42)
Average daily hot water use (litres/day)	87.5512 (43)

Internal gains (see Table 5 and 5a)												
Metabolic gains (Table 5), Watts												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(66)m	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	(66)
Lighting gains	(calculated in Appendix L, equation L9 or L9a), also see Table 5											
	17.5913	15.6244	12.7066	9.6197	7.1909	6.0708	6.5597	8.5266	11.4444	14.5313	16.9601	18.0802 (67)
Appliances gains	(calculated in Appendix L, equation L13 or L13a), also see Table 5											
	197.3204	199.3680	194.2082	183.2235	169.3574	156.3253	147.6190	145.5714	150.7312	161.7158	175.5819	188.6141 (68)
Cooking gains	(calculated in Appendix L, equation L15 or L15a), also see Table 5											
	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318 (69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (70)
Losses e.g. evaporation (negative values) (Table 5)												
	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547 (71)
Water heating gains (Table 5)												
	123.2647	121.2423	117.0425	111.3330	107.6262	102.4068	97.9704	103.6546	105.6742	111.5837	118.2565	121.2507 (72)
Total internal gains												
	394.8719	392.9302	380.6528	360.8718	340.8700	321.4984	308.8446	314.4481	324.5453	344.5263	367.4941	384.6405 (73)

7. Mean internal temperature (heating season)												
Temperature during heating periods in the living area from Table 9, Th1 (C)												
Utilisation factor for gains for living area, nil,m (see Table 9a)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	79.6480	79.9566	80.2676	81.8598	82.1859	83.8559	83.8559	84.1981	83.1798	82.1859	81.5364	80.8970
alpha	6.3099	6.3304	6.3512	6.4573	6.4791	6.5904	6.5904	6.6132	6.5453	6.4791	6.4358	6.3931
util living area	0.9969	0.9944	0.9854	0.9423	0.8074	0.5889	0.4320	0.4904	0.7755	0.9635	0.9932	0.9976 (86)
MIT	20.1879	20.2895	20.4794	20.7467	20.9323	20.9927	20.9992	20.9982	20.9616	20.7326	20.4256	20.1760 (87)
Th 2	20.2147	20.2175	20.2203	20.2344	20.2372	20.2513	20.2513	20.2541	20.2456	20.2372	20.2316	20.2259 (88)
util rest of house	0.9960	0.9927	0.9807	0.9247	0.7615	0.5236	0.3591	0.4122	0.7103	0.9487	0.9907	0.9968 (89)
MIT 2	19.1236	19.2737	19.5507	19.9369	20.1724	20.2465	20.2509	20.2533	20.2153	19.9258	19.4832	19.1150 (90)
Living area fraction									fLA = Living area / (4) =			
MIT	19.5753	19.7047	19.9448	20.2805	20.4949	20.5632	20.5685	20.5694	20.5320	20.2682	19.8831	19.5653 (92)
Temperature adjustment												0.0000
adjusted MIT	19.5753	19.7047	19.9448	20.2805	20.4949	20.5632	20.5685	20.5694	20.5320	20.2682	19.8831	19.5653 (93)

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CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

8c. Space cooling requirement

Not applicable

9b. Energy requirements

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (301)
Fraction of space heat from community system	1.0000 (302)
Fraction of heat from community Heat pump	1.0000 (303a)
Fraction of total space heat from community Heat pump	1.0000 (304a)
Factor for control and charging method (Table 4c(3)) for community space heating	1.0000 (305)
Factor for control and charging method (Table 4c(3)) for community water heating	1.0000 (305a)
Distribution loss factor (Table 12c) for community heating system	1.0500 (306)
Space heating:	
Annual space heating requirement	1681.8814 (98)
Space heat from Heat pump = (98) x 1.00 x 1.00 x 1.05	1765.9755 (307a)
Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E)	0.0000 (308)
Space heating fuel for secondary/supplementary system	0.0000 (309)
Water heating	
Annual water heating requirement	2028.3616 (64)
Water heat from Heat pump = (64) x 1.00 x 1.00 x 1.05	2129.7796 (310a)
Electricity used for heat distribution	38.9576 (313)
Annual totals kWh/year	
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.7750)	
mechanical ventilation fans (SFP = 0.7750)	205.2028 (330a)
Total electricity for the above, kWh/year	205.2028 (331)
Electricity for lighting (calculated in Appendix L)	310.6671 (332)
Energy saving/generation technologies (Appendices M ,N and Q)	
PV Unit 0 (0.80 * 0.07 * 1080 * 0.80) =	-48.3627 (333)
Total delivered energy for all uses	4363.2623 (338)

12b. Carbon dioxide emissions - Community heating scheme

Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Efficiency of heat source Heat pump		300.0000 (367a)
Space heating from Heat pump	0.5190	673.9656 (367)
Electrical energy for heat distribution	0.5190	20.2190 (372)
Total CO2 associated with community systems (negative value allowed since DFEE <= TFEE)		694.1846 (373)
Space and water heating		694.1846 (376)
Pumps and fans	0.5190	106.5003 (378)
Energy for lighting	0.5190	161.2362 (379)
Energy saving/generation technologies		
PV Unit	-48.3627	-25.1002 (380)
Total CO2, kg/year		936.8208 (383)
Dwelling Carbon Dioxide Emission Rate (DER)		13.3800 (384)

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

DER	13.3800 ZC1
Total Floor Area	70.0100 TFA
Assumed number of occupants	2.2464 N
CO2 emission factor in Table 12 for electricity displaced from grid	0.5190 EF
CO2 emissions from appliances, equation (L14)	16.7016 ZC2
CO2 emissions from cooking, equation (L16)	2.4698 ZC3
Total CO2 emissions	32.5514 ZC4
Residual CO2 emissions offset from biofuel CHP	0.0000 ZC5
Additional allowable electricity generation, kWh/m²/year	0.0000 ZC6
Resulting CO2 emissions offset from additional allowable electricity generation	0.0000 ZC7
Net CO2 emissions	32.5514 ZC8



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CALCULATION OF TARGET EMISSIONS 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
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1. Overall dwelling dimensions

	Area (m2)	Storey height (m)	Volume (m3)
Ground floor	70.0100 (1b)	x 3.1000 (2b)	= 217.0310 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	70.0100		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 217.0310 (5)

2. Ventilation rate

	main heating	secondary heating	other	total	m3 per hour
Number of chimneys	0	0	0	= 0 * 40 =	0.0000 (6a)
Number of open flues	0	0	0	= 0 * 20 =	0.0000 (6b)
Number of intermittent fans				2 * 10 =	20.0000 (7a)
Number of passive vents				0 * 10 =	0.0000 (7b)
Number of flueless gas fires				0 * 40 =	0.0000 (7c)
Infiltration due to chimneys, flues and fans	= (6a)+(6b)+(7a)+(7b)+(7c) =				Air changes per hour 20.0000 / (5) = 0.0922 (8)
Pressure test					Yes
Measured/design AP50					5.0000
Infiltration rate					0.3422 (18)
Number of sides sheltered					2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =				0.8500 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =				0.2908 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000 (22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infilt rate	0.3708	0.3635	0.3563	0.3199	0.3126	0.2763	0.2763	0.2690	0.2908	0.3126	0.3272	0.3417 (22b)
Effective ac	0.5687	0.5661	0.5635	0.5512	0.5489	0.5382	0.5382	0.5362	0.5423	0.5489	0.5535	0.5584 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K
TER Opaque door			2.1200	1.0000	2.1200		(26)
TER Opening Type (Uw = 1.40)			13.3900	1.3258	17.7519		(27)
External Wall 1	70.5700	13.3900	57.1800	0.1800	10.2924		(29a)
To Corridor	19.9800	2.1200	17.8600	0.1800	3.2148		(29a)
To Risers	7.0000		7.0000	0.1800	1.2600		(29a)
Total net area of external elements Aum(A, m2)			97.5500				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		34.6391		(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							5.3751 (36)
Total fabric heat loss						(33) + (36) =	40.0142 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat transfer coeff	40.7340	40.5428	40.3553	39.4751	39.3104	38.5437	38.5437	38.4017	38.8390	39.3104	39.6436	39.9919 (38)
Average = Sum(39)m / 12 =	80.7481	80.5570	80.3695	79.4893	79.3246	78.5579	78.5579	78.4159	78.8532	79.3246	79.6577	80.0061 (39)
												79.4885 (39)
HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HLP (average)	1.1534	1.1506	1.1480	1.1354	1.1330	1.1221	1.1221	1.1201	1.1263	1.1330	1.1378	1.1428 (40)
Days in month												1.1354 (40)
	31	28	31	30	31	30	31	31	30	31	30	31 (41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.2464 (42)
Average daily hot water use (litres/day)												87.5512 (43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Energy conte	96.3064	92.8043	89.3023	85.8002	82.2982	78.7961	78.7961	82.2982	85.8002	89.3023	92.8043	96.3064 (44)
Energy content (annual)	142.8195	124.9109	128.8968	112.3754	107.8269	93.0464	86.2212	98.9400	100.1217	116.6822	127.3677	138.3131 (45)
Distribution loss (46)m = 0.15 x (45)m										Total = Sum(45)m =		1377.5218 (45)
Water storage loss:	21.4229	18.7366	19.3345	16.8563	16.1740	13.9570	12.9332	14.8410	15.0183	17.5023	19.1052	20.7470 (46)
Store volume												1.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):												0.2134 (48)
Temperature factor from Table 2b												0.5400 (49)
Enter (49) or (54) in (55)												0.1152 (55)



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Total storage loss	3.5715	3.2259	3.5715	3.4563	3.5715	3.4563	3.5715	3.5715	3.4563	3.5715	3.4563	3.5715	(56)
If cylinder contains dedicated solar storage	3.5715	3.2259	3.5715	3.4563	3.5715	3.4563	3.5715	3.5715	3.4563	3.5715	3.4563	3.5715	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month	169.6534	149.1479	155.7307	138.3437	134.6607	119.0147	113.0550	125.7739	126.0900	143.5161	153.3360	165.1470	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
Solar input (sum of months) = Sum(63)m =												0.0000	(63)
Output from w/h	169.6534	149.1479	155.7307	138.3437	134.6607	119.0147	113.0550	125.7739	126.0900	143.5161	153.3360	165.1470	(64)
Heat gains from water heating, kWh/month	68.9546	60.9225	64.3253	58.1394	57.3195	51.7125	50.1356	54.3647	54.0651	60.2639	63.1244	67.4562	(65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	112.3184	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	17.8087	15.8176	12.8637	9.7387	7.2798	6.1459	6.6408	8.6320	11.5859	14.7109	17.1698	18.3037	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	197.3204	199.3680	194.2082	183.2235	169.3574	156.3253	147.6190	145.5714	150.7312	161.7158	175.5819	188.6141	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	34.2318	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	-89.8547	(71)
Water heating gains (Table 5)	92.6809	90.6585	86.4587	80.7492	77.0424	71.8230	67.3866	73.0708	75.0904	80.9999	87.6728	90.6669	(72)
Total internal gains	367.5056	365.5395	353.2261	333.4069	313.3751	293.9896	281.3419	286.9697	297.1030	317.1222	340.1200	357.2803	(73)

6. Solar gains

[Jan]	Area m2			Solar flux Table 6a W/m2		g Specific data or Table 6b		FF Specific data or Table 6c		Access factor Table 6d		Gains W	
North	13.3900			10.6334		0.6300		0.7000		0.7700		43.5135 (74)	
Solar gains	43.5135	83.1566	141.3033	226.9694	305.7485	327.3129	305.5884	242.4454	169.8924	98.9870	53.6795	36.2750	(83)
Total gains	411.0191	448.6961	494.5295	560.3763	619.1236	621.3025	586.9303	529.4151	466.9954	416.1092	393.7995	393.5553	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)													21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
tau	60.2095	60.3524	60.4931	61.1630	61.2900	61.8882	61.8882	62.0002	61.6564	61.2900	61.0337	60.7680		
alpha	5.0140	5.0235	5.0329	5.0775	5.0860	5.1259	5.1259	5.1333	5.1104	5.0860	5.0689	5.0512		
util living area	0.9982	0.9968	0.9923	0.9721	0.8995	0.7374	0.5722	0.6479	0.8931	0.9845	0.9966	0.9986	(86)	
MIT	19.7422	19.8603	20.0946	20.4390	20.7567	20.9399	20.9868	20.9761	20.8289	20.4411	20.0390	19.7224	(87)	
Th 2	19.9575	19.9597	19.9618	19.9720	19.9739	19.9828	19.9828	19.9845	19.9794	19.9739	19.9701	19.9660	(88)	
util rest of house	0.9976	0.9957	0.9893	0.9608	0.8591	0.6472	0.4485	0.5211	0.8333	0.9763	0.9952	0.9981	(89)	
MIT 2	18.2800	18.4541	18.7970	19.2988	19.7287	19.9418	19.9778	19.9742	19.8325	19.3091	18.7230	18.2572	(90)	
Living area fraction	18.9005	19.0508	19.3477	19.7827	20.1649	20.3654	20.4060	20.3994	FLA = Living area / (4) =	19.7895	19.2815	18.4244	(91)	
MIT	18.9005	19.0508	19.3477	19.7827	20.1649	20.3654	20.4060	20.3994	20.2553	19.7895	19.2815	18.8790	(92)	
Temperature adjustment	18.9005	19.0508	19.3477	19.7827	20.1649	20.3654	20.4060	20.3994	20.2553	19.7895	19.2815	18.8790	(93)	
adjusted MIT	18.9005	19.0508	19.3477	19.7827	20.1649	20.3654	20.4060	20.3994	20.2553	19.7895	19.2815	18.8790	(93)	

8. Space heating requirement

Utilisation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Useful gains	409.6580	446.1720	488.1158	536.9325	537.1810	424.5394	294.2941	304.5519	397.9000	405.4434	391.3687	392.5083	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	1178.9654	1139.9488	1032.5604	865.0570	671.4753	452.9149	298.9919	313.6130	485.3646	728.9538	970.3485	1174.4110	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh	572.3647	466.2180	405.0668	236.2496	99.9149	0.0000	0.0000	0.0000	0.0000	240.6917	416.8655	581.7357	(98)
Space heating												3019.1069	(98)
Space heating per m2									(98) / (4) =			43.1239	(99)

8c. Space cooling requirement

Not applicable



FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	93.5000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	3228.9913	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	572.3647	466.2180	405.0668	236.2496	99.9149	0.0000	0.0000	0.0000	0.0000	240.6917	416.8655	581.7357	(98)
Space heating efficiency (main heating system 1)	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)
Space heating fuel (main heating system)	612.1547	498.6289	433.2265	252.6734	106.8609	0.0000	0.0000	0.0000	0.0000	257.4243	445.8454	622.1772	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating													
Water heating requirement	169.6534	149.1479	155.7307	138.3437	134.6607	119.0147	113.0550	125.7739	126.0900	143.5161	153.3360	165.1470	(64)
Efficiency of water heater (217)m	87.8081	87.6515	87.2512	86.2299	84.0318	79.8000	79.8000	79.8000	79.8000	86.1834	87.3504	87.8941	(216)
Fuel for water heating, kWh/month	193.2094	170.1603	178.4854	160.4358	160.2497	149.1412	141.6730	157.6114	158.0075	166.5240	175.5413	187.8931	(219)
Water heating fuel used												1998.9321	(219)
Annual totals kWh/year													
Space heating fuel - main system												3228.9913	(211)
Space heating fuel - secondary												0.0000	(215)

Electricity for pumps and fans:													
central heating pump												30.0000	(230c)
main heating flue fan												45.0000	(230e)
Total electricity for the above, kWh/year												75.0000	(231)
Electricity for lighting (calculated in Appendix L)												314.5079	(232)
Total delivered energy for all uses												5617.4313	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	3228.9913	0.2160	697.4621	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1998.9321	0.2160	431.7693	(264)
Space and water heating			1129.2315	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	314.5079	0.5190	163.2296	(268)
Total CO2, kg/m2/year			1331.3861	(272)
Emissions per m2 for space and water heating			16.1296	(272a)
Fuel factor (electricity)			1.5500	
Emissions per m2 for lighting			2.3315	(272b)
Emissions per m2 for pumps and fans			0.5560	(272c)
Target Carbon Dioxide Emission Rate (TER) = (16.1296 * 1.55) + 2.3315 + 0.5560, rounded to 2 d.p.			27.8900	(273)



FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



Property Reference	Type 12-N			Issued on Date	12/03/2019
Assessment Reference	V03	Prop Type Ref	12		
Property	Type 12-N				
SAP Rating	79 C	DER	27.22	TER	27.49
Environmental	81 B	% DER<TER	0.97		
CO ₂ Emissions (t/year)	1.45	DFEE	43.66	TFEE	52.11
General Requirements Compliance	Pass	% DFEE<TFEE	16.22		
Assessor Details	Mr. Liam Holden, Liam Holden, Tel: 01202 654600, liamholden@hoarelea.com			Assessor ID	P623-0001
Client					

Option D - ELECTRIC



FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



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

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

DWELLING AS DESIGNED

Mid-floor flat, total floor area 70 m²

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

1a TER and DER

Fuel for main heating:Electricity
Fuel factor:1.55 (electricity)
Target Carbon Dioxide Emission Rate (TER) 27.49 kgCO₂/m²
Dwelling Carbon Dioxide Emission Rate (DER) 27.22 kgCO₂/m²OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)52.1 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)43.7 kWh/m²/yrOK

2 Fabric U-values

Element	Average	Highest	
External wall	0.17 (max. 0.30)	0.18 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor	(no floor)		
Roof	(no roof)		
Openings	1.42 (max. 2.00)	1.50 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

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

4 Heating efficiency

Main heating system: Electric underfloor heating - Electric
Underfloor heating in thin screed (standard tariff)

Secondary heating system: None

5 Cylinder insulation

Hot water storage	Measured cylinder loss: 0.94 kWh/day
Permitted by DBSCG 1.66	OK
Primary pipework insulated:	No primary pipework

6 Controls

Space heating controls:	Time and temperature zone control	OK
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Hot water controls:	Cylinderstat	OK
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7 Low energy lights

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

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.62	
Maximum	1.5	OK
MVHR efficiency:	93%	
Minimum:	70%	OK

9 Summertime temperature

Overheating risk (Thames Valley):	Not significant	OK
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Based on:

Overshading:	Average
Windows facing North:	10.87 m ² , No overhang
Air change rate:	4.00 ach
Blinds/curtains:	Dark-coloured curtain or roller blind, closed 100% of daylight hours

10 Key features

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



FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

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

1. Overall dwelling dimensions

		Area (m2)	Storey height (m)	Volume (m3)
Ground floor		69.9600 (1b)	x 2.9500 (2b)	= 206.3820 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	69.9600			(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =	206.3820 (5)

2. Ventilation rate

	main heating	secondary heating	other	total	m3 per hour
Number of chimneys	0	+	0	=	0 * 40 = 0.0000 (6a)
Number of open flues	0	+	0	=	0 * 20 = 0.0000 (6b)
Number of intermittent fans					0 * 10 = 0.0000 (7a)
Number of passive vents					0 * 10 = 0.0000 (7b)
Number of flueless gas fires					0 * 40 = 0.0000 (7c)
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =					0.0000 / (5) = 0.0000 (8)
Pressure test					Yes
Measured/design AP50					3.0000
Infiltration rate					0.1500 (18)
Number of sides sheltered					2 (19)
Shelter factor			(20) = 1 - [0.075 x (19)] =		0.8500 (20)
Infiltration rate adjusted to include shelter factor			(21) = (18) x (20) =		0.1275 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000 (22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infilt rate	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498 (22b)
Balanced mechanical ventilation with heat recovery												0.5000 (23a)
If mechanical ventilation:												79.0500 (23c)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =												
Effective ac	0.2673	0.2641	0.2609	0.2450	0.2418	0.2259	0.2259	0.2227	0.2323	0.2418	0.2482	0.2546 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K					
Windows (Uw = 1.50)			10.8700	1.4151	15.3821		(27)					
Doors			2.1200	1.0000	2.1200		(26)					
External Wall 1	50.3600	10.8700	39.4900	0.1800	7.1082		(29a)					
To Corridor	37.6400	2.1200	35.5200	0.1671	5.9343		(29a)					
Total net area of external elements Aum(A, m2)			88.0000				(31)					
Fabric heat loss, W/K = Sum (A x U)			(26)... (30) + (32) =		30.5446		(33)					
To Dwelling			14.9300	0.0000	0.0000		(32)					
Party Floor 1			69.9600				(32d)					
Party Ceilings 1			69.9600				(32b)					
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							228.1300 (35)					
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							4.9487 (36)					
Total fabric heat loss						(33) + (36) =	35.4932 (37)					
Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m	Jan 18.2056	Feb 17.9885	Mar 17.7714	Apr 16.6860	May 16.4689	Jun 15.3835	Jul 15.3835	Aug 15.1664	Sep 15.8176	Oct 16.4689	Nov 16.9031	Dec 17.3372 (38)
Heat transfer coeff	53.6988	53.4817	53.2646	52.1792	51.9621	50.8767	50.8767	50.6596	51.3108	51.9621	52.3963	52.8305 (39)
Average = Sum(39)m / 12 =												52.1249 (39)
HLP	Jan 0.7676	Feb 0.7645	Mar 0.7614	Apr 0.7458	May 0.7427	Jun 0.7272	Jul 0.7272	Aug 0.7241	Sep 0.7334	Oct 0.7427	Nov 0.7489	Dec 0.7552 (40)
HLP (average)												0.7451 (40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31 (41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.2452 (42)
Average daily hot water use (litres/day)												87.5224 (43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Energy conte	96.2746	92.7737	89.2728	85.7719	82.2710	78.7702	78.7702	82.2710	85.7719	89.2728	92.7737	96.2746 (44)
Energy content (annual)	142.7725	124.8697	128.8544	112.3384	107.7913	93.0157	86.1928	98.9074	100.0887	116.6437	127.3258	138.2675 (45)
Distribution loss (46)m = 0.15 x (45)m												Total = Sum(45)m = 1377.0680 (45)



FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

Water storage loss:	21.4159	18.7305	19.3282	16.8508	16.1687	13.9524	12.9289	14.8361	15.0133	17.4966	19.0989	20.7401 (46)
Store volume												120.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):												0.9400 (48)
Temperature factor from Table 2b												0.6000 (49)
Enter (49) or (54) in (55)												0.5640 (55)
Total storage loss	17.4840	15.7920	17.4840	16.9200	17.4840	16.9200	17.4840	17.4840	16.9200	17.4840	16.9200	17.4840 (56)
If cylinder contains dedicated solar storage	17.4840	15.7920	17.4840	16.9200	17.4840	16.9200	17.4840	17.4840	16.9200	17.4840	16.9200	17.4840 (57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (59)
Total heat required for water heating calculated for each month	160.2565	140.6617	146.3384	129.2584	125.2753	109.9357	103.6768	116.3914	117.0087	134.1277	144.2458	155.7515 (62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (63)
Output from w/h	160.2565	140.6617	146.3384	129.2584	125.2753	109.9357	103.6768	116.3914	117.0087	134.1277	144.2458	155.7515 (64)
Heat gains from water heating, kWh/month	61.4591	54.1528	56.8313	50.8885	49.8278	44.4637	42.6463	46.8739	46.8155	52.7712	55.8718	59.9612 (65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(66)m	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	17.7069	15.7271	12.7901	9.6829	7.2381	6.1107	6.6028	8.5826	11.5196	14.6268	17.0716	18.1990 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	197.2037	199.2500	194.0933	183.1152	169.2573	156.2328	147.5316	145.4853	150.6420	161.6202	175.4781	188.5025 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258 (69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (70)
Losses e.g. evaporation (negative values) (Table 5)	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061 (71)
Water heating gains (Table 5)	82.6063	80.5845	76.3861	70.6785	66.9729	61.7552	57.3203	63.0026	65.0215	70.9291	77.5997	80.5930 (72)
Total internal gains	354.1941	352.2389	339.9468	320.1539	300.1456	280.7760	268.1321	273.7478	283.8605	303.8533	326.8267	343.9718 (73)

6. Solar gains

[Jan]			Area m2	Solar flux Table 6a W/m2		g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W			
North			10.8700	10.6334		0.4200	0.9000	0.7700	30.2779 (74)			
Solar gains	30.2779	57.8627	98.3229	157.9318	212.7485	227.7536	212.6371	168.7004	118.2160	68.8780	37.3517	25.2412 (83)
Total gains	384.4720	410.1016	438.2697	478.0857	512.8941	508.5296	480.7692	442.4482	402.0764	372.7313	364.1784	369.2130 (84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Thl (C)												21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	82.5591	82.8942	83.2321	84.9635	85.3184	87.1387	87.1387	87.5121	86.4014	85.3184	84.6115	83.9161
alpha	6.5039	6.5263	6.5488	6.6642	6.6879	6.8092	6.8092	6.8341	6.7601	6.6879	6.6408	6.5944
util living area	0.9977	0.9958	0.9893	0.9568	0.8426	0.6289	0.4643	0.5236	0.8096	0.9725	0.9950	0.9982 (86)
MIT	20.3582	20.4287	20.5619	20.7549	20.8993	20.9532	20.9592	20.9585	20.9261	20.7502	20.5295	20.3503 (87)
Th 2	20.2815	20.2842	20.2869	20.3005	20.3032	20.3168	20.3168	20.3196	20.3114	20.3032	20.2978	20.2924 (88)
util rest of house	0.9970	0.9946	0.9860	0.9437	0.8032	0.5664	0.3929	0.4477	0.7518	0.9617	0.9933	0.9977 (89)
MIT 2	19.4071	19.5123	19.7079	19.9935	20.1832	20.2534	20.2579	20.2604	20.2240	19.9927	19.6708	19.4047 (90)
Living area fraction	19.8183	19.9085	20.0771	20.3227	20.4928	20.5560	20.5612	20.5623	20.5276	20.3202	20.0421	19.8136 (92)
Temperature adjustment												0.0000
adjusted MIT	19.8183	19.9085	20.0771	20.3227	20.4928	20.5560	20.5612	20.5623	20.5276	20.3202	20.0421	19.8136 (93)

8. Space heating requirement

Utilisation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Useful gains	383.1153	407.5802	431.6197	451.3968	417.7968	299.3505	201.2161	210.1596	310.0234	358.5620	361.4388	368.1936 (95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000 (96)
Heat loss rate W	833.3164	802.6831	723.1806	596.0272	456.8929	303.0204	201.5307	210.8585	329.8059	505.0840	678.1167	824.8736 (97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000 (97a)
Space heating kWh	334.9496	265.5091	216.9213	104.1339	29.0875	0.0000	0.0000	0.0000	0.0000	109.0123	228.0080	339.7699 (98)
Space heating												1627.3917 (98)
Space heating per m2										(98) / (4) =		23.2617 (99)



FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)



CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)													0.0000 (201)
Fraction of space heat from main system(s)													1.0000 (202)
Efficiency of main space heating system 1 (in %)													100.0000 (206)
Efficiency of secondary/supplementary heating system, %													0.0000 (208)
Space heating requirement													1627.3917 (211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	334.9496	265.5091	216.9213	104.1339	29.0875	0.0000	0.0000	0.0000	0.0000	109.0123	228.0080	339.7699	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	334.9496	265.5091	216.9213	104.1339	29.0875	0.0000	0.0000	0.0000	0.0000	109.0123	228.0080	339.7699	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating requirement	160.2565	140.6617	146.3384	129.2584	125.2753	109.9357	103.6768	116.3914	117.0087	134.1277	144.2458	155.7515	(64)
Efficiency of water heater (217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(216)
Fuel for water heating, kWh/month	160.2565	140.6617	146.3384	129.2584	125.2753	109.9357	103.6768	116.3914	117.0087	134.1277	144.2458	155.7515	(219)
Water heating fuel used												1582.9280	(219)
Annual totals kWh/year													
Space heating fuel - main system												1627.3917	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans: (BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.7750)													
mechanical ventilation fans (SFP = 0.7750)													195.1342 (230a)
Total electricity for the above, kWh/year													195.1342 (231)
Electricity for lighting (calculated in Appendix L)													312.7086 (232)
Energy saving/generation technologies (Appendices M ,N and Q)													
PV Unit 0 (0.80 * 0.07 * 1080 * 0.80) =													-48.3627 (233)
Total delivered energy for all uses													3669.7998 (238)

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

Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	0.5190	844.6163	(261)
Space heating - secondary	0.0000	0.0000	(263)
Water heating (other fuel)	0.5190	821.5396	(264)
Space and water heating		1666.1559	(265)
Pumps and fans	195.1342	101.2746	(267)
Energy for lighting	312.7086	162.2957	(268)
Energy saving/generation technologies			
PV Unit	-48.3627	0.5190	-25.1002 (269)
Total CO2, kg/year			1904.6261 (272)
Dwelling Carbon Dioxide Emission Rate (DER)			27.2200 (273)

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

DER	TFA	27.2200	ZC1
Total Floor Area	N	69.9600	
Assumed number of occupants	EF	2.2452	
CO2 emission factor in Table 12 for electricity displaced from grid		0.5190	
CO2 emissions from appliances, equation (L14)		16.7037	ZC2
CO2 emissions from cooking, equation (L16)		2.4712	ZC3
Total CO2 emissions		46.3948	ZC4
Residual CO2 emissions offset from biofuel CHP		0.0000	ZC5
Additional allowable electricity generation, kWh/m²/year		0.0000	ZC6
Resulting CO2 emissions offset from additional allowable electricity generation		0.0000	ZC7
Net CO2 emissions		46.3948	ZC8



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CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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

1. Overall dwelling dimensions

Area (m2)	Storey height (m)	Volume (m3)	
Ground floor			
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	69.9600	206.3820	(1b) - (3b)
Dwelling volume		206.3820	(4) (5)

2. Ventilation rate

					main heating	+	secondary heating	+	other	=	total	m3 per hour	
Number of chimneys					0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues					0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans											2 * 10 =	20.0000	(7a)
Number of passive vents											0 * 10 =	0.0000	(7b)
Number of flueless gas fires											0 * 40 =	0.0000	(7c)
												Air changes per hour	
Infiltration due to chimneys, flues and fans	=	(6a)+(6b)+(7a)+(7b)+(7c)	=								20.0000 / (5) =	0.0969	(8)
Pressure test												Yes	
Measured/design AP50												5.0000	
Infiltration rate												0.3469	(18)
Number of sides sheltered												2	(19)
Shelter factor									(20) = 1 - [0.075 x (19)]	=		0.8500	(20)
Infiltration rate adjusted to include shelter factor									(21) = (18) x (20)	=		0.2949	(21)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
adj infilt rate	0.3760	0.3686	0.3612	0.3244	0.3170	0.2801	0.2801	0.2728	0.2949	0.3170	0.3317	0.3465	(22b)
Effective ac	0.5707	0.5679	0.5652	0.5526	0.5502	0.5392	0.5392	0.5372	0.5435	0.5502	0.5550	0.5600	(25)

3. Heat losses and heat loss parameter

Element	Gross m2		Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K					
TER Opaque door				2.1200	1.0000	2.1200		(26)					
TER Opening Type (Uw = 1.40)				10.8700	1.3258	14.4110		(27)					
External Wall 1	50.3600		10.8700	39.4900	0.1800	7.1082		(29a)					
To Corridor	37.6400		2.1200	35.5200	0.1800	6.3936		(29a)					
Total net area of external elements Aum(A, m2)				88.0000				(31)					
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =		30.0328		(33)					
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K								250.0000 (35)					
Thermal bridges (Sum(L x Psi) calculated using Appendix K)								5.9677 (36)					
Total fabric heat loss							(33) + (36) =	36.0005 (37)					
Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)													
(38)m	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat transfer coeff	38.8663	38.6794	38.4962	37.6357	37.4747	36.7252	36.7252	36.5864	37.0139	37.4747	37.8004	38.1409	(38)
Average = Sum(39)m / 12 =	74.8668	74.6799	74.4967	73.6362	73.4752	72.7257	72.7257	72.5869	73.0144	73.4752	73.8009	74.1414	(39)
												73.6354	(39)
HLP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP (average)	1.0701	1.0675	1.0648	1.0525	1.0502	1.0395	1.0395	1.0375	1.0437	1.0502	1.0549	1.0598	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy													2.2452	(42)
Average daily hot water use (litres/day)													87.5224	(43)
Daily hot water use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Energy conte	96.2746	92.7737	89.2728	85.7719	82.2710	78.7702	78.7702	82.2710	85.7719	89.2728	92.7737	96.2746	(44)	
Energy content (annual)	142.7725	124.8697	128.8544	112.3384	107.7913	93.0157	86.1928	98.9074	100.0887	116.6437	127.3258	138.2675	(45)	
Distribution loss (46)m = 0.15 x (45)m	21.4159	18.7305	19.3282	16.8508	16.1687	13.9524	12.9289	14.8361	15.0133	17.4966	19.0989	20.7401	(46)	
Water storage loss:														
Store volume													120.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):													1.2247	(48)
Temperature factor from Table 2b													0.5400	(49)
Enter (49) or (54) in (55)													0.6613	(55)
Total storage loss														



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CALCULATION OF TARGET EMISSIONS 09 Jan 2014

	20.5007	18.5168	20.5007	19.8394	20.5007	19.8394	20.5007	20.5007	19.8394	20.5007	19.8394	20.5007 (56)
If cylinder contains dedicated solar storage	20.5007	18.5168	20.5007	19.8394	20.5007	19.8394	20.5007	20.5007	19.8394	20.5007	19.8394	20.5007 (57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624 (59)
Total heat required for water heating calculated for each month	186.5356	164.3977	172.6175	154.6898	151.5545	135.3671	129.9559	142.6705	142.4401	160.4068	169.6772	182.0306 (62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (63)
								Solar input (sum of months) =	Sum(63)m =			0.0000 (63)
Output from w/h	186.5356	164.3977	172.6175	154.6898	151.5545	135.3671	129.9559	142.6705	142.4401	160.4068	169.6772	182.0306 (64)
Heat gains from water heating, kWh/month	82.4823	73.1416	77.8546	71.2336	70.8511	64.8088	63.6696	67.8972	67.1606	73.7945	76.2169	80.9844 (65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(66)m	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577	112.2577 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	18.4499	16.3871	13.3269	10.0893	7.5419	6.3672	6.8799	8.9428	12.0030	15.2406	17.7880	18.9627 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	197.2037	199.2500	194.0933	183.1152	169.2573	156.2328	147.5316	145.4853	150.6420	161.6202	175.4781	188.5025 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258	34.2258 (69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000 (70)
Losses e.g. evaporation (negative values) (Table 5)	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061	-89.8061 (71)
Water heating gains (Table 5)	110.8634	108.8416	104.6432	98.9356	95.2300	90.0123	85.5774	91.2597	93.2786	99.1862	105.8568	108.8501 (72)
Total internal gains	386.1943	384.1560	371.7407	351.8174	331.7064	312.2895	299.6663	305.3651	315.6010	335.7243	358.8002	375.9926 (73)

6. Solar gains

[Jan]						Area	Solar flux	g	FF			Access	Gains
						m2	Table 6a					factor	W
							W/m2	Specific data	Specific data			Table 6d	
								or Table 6b	or Table 6c				
North						10.8700	10.6334	0.6300	0.7000			0.7700	35.3243 (74)
Solar gains	35.3243	67.5065	114.7100	184.2537	248.2066	265.7125	248.0766	196.8171	137.9186	80.3577	43.5770	29.4481 (83)	
Total gains	421.5186	451.6625	486.4507	536.0711	579.9130	578.0021	547.7429	502.1822	453.5196	416.0819	402.3773	405.4407 (84)	

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	64.8930	65.0554	65.2154	65.9775	66.1221	66.8035	66.8035	66.9312	66.5394	66.1221	65.8303	65.5280
alpha	5.3262	5.3370	5.3477	5.3985	5.4081	5.4536	5.4536	5.4621	5.4360	5.4081	5.3887	5.3685
util living area	0.9980	0.9966	0.9922	0.9733	0.9042	0.7413	0.5708	0.6391	0.8854	0.9826	0.9961	0.9984 (86)
MIT	19.8699	19.9748	20.1852	20.4954	20.7827	20.9494	20.9900	20.9822	20.8600	20.5142	20.1461	19.8524 (87)
Th 2	20.0253	20.0275	20.0296	20.0398	20.0417	20.0505	20.0505	20.0522	20.0471	20.0417	20.0378	20.0338 (88)
util rest of house	0.9973	0.9955	0.9894	0.9627	0.8663	0.6556	0.4546	0.5202	0.8257	0.9738	0.9945	0.9978 (89)
MIT 2	18.5151	18.6699	18.9779	19.4308	19.8204	20.0155	20.0466	20.0444	19.9273	19.4638	18.9280	18.4958 (90)
Living area fraction									FLA = Living area / (4) =			0.4324 (91)
MIT	19.1009	19.2341	19.4999	19.8911	20.2365	20.4193	20.4545	20.4499	20.3306	19.9180	19.4547	19.0824 (92)
Temperature adjustment												0.0000
adjusted MIT	19.1009	19.2341	19.4999	19.8911	20.2365	20.4193	20.4545	20.4499	20.3306	19.9180	19.4547	19.0824 (93)

8. Space heating requirement

Utilisation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Useful gains	0.9964	0.9942	0.9873	0.9607	0.8751	0.6908	0.5052	0.5719	0.8459	0.9723	0.9932	0.9971 (94)
Ext temp.	419.9974	449.0412	480.2796	514.9787	507.4537	399.3078	276.7291	287.2151	383.6435	404.5662	399.6246	404.2508 (95)
Heat loss rate W	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000 (96)
Month fracti	1108.0944	1070.4711	968.4516	809.3441	627.2177	423.2126	280.3227	293.9689	454.9230	684.6429	911.7904	1103.4015 (97)
Space heating kWh	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000 (97a)
Space heating	511.9441	417.6009	363.2000	211.9431	89.1044	0.0000	0.0000	0.0000	0.0000	208.3770	368.7594	520.1681 (98)
Space heating per m2										(98) / (4) =		2691.0970 (98)
												38.4662 (99)

8c. Space cooling requirement

Not applicable



FULL SAP CALCULATION PRINTOUT
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CALCULATION OF TARGET EMISSIONS 09 Jan 2014

9a. Energy requirements - Individual heating systems, including micro-CHP												
Fraction of space heat from secondary/supplementary system (Table 11)												0.0000 (201)
Fraction of space heat from main system(s)												1.0000 (202)
Efficiency of main space heating system 1 (in %)												93.5000 (206)
Efficiency of secondary/supplementary heating system, %												0.0000 (208)
Space heating requirement												2878.1786 (211)
Space heating requirement	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating efficiency (main heating system 1)	511.9441	417.6009	363.2000	211.9431	89.1044	0.0000	0.0000	0.0000	0.0000	208.3770	368.7594	520.1681 (98)
Space heating fuel (main heating system)	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000 (210)
Water heating requirement	547.5338	446.6320	388.4492	226.6771	95.2988	0.0000	0.0000	0.0000	0.0000	222.8631	394.3950	556.3296 (211)
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000 (215)

Water heating requirement	186.5356	164.3977	172.6175	154.6898	151.5545	135.3671	129.9559	142.6705	142.4401	160.4068	169.6772	182.0306 (64)
Efficiency of water heater	87.3713	87.1974	86.7526	85.6543	83.4532	79.8000	79.8000	79.8000	79.8000	85.5127	86.8310	79.8000 (216)
Fuel for water heating, kWh/month	213.4975	188.5351	198.9768	180.5979	181.6041	169.6330	162.8520	178.7851	178.4964	187.5824	195.4108	208.1302 (219)
Water heating fuel used												2244.1011 (219)
Annual totals kWh/year												
Space heating fuel - main system												2878.1786 (211)
Space heating fuel - secondary												0.0000 (215)
Electricity for pumps and fans:												
central heating pump												30.0000 (230c)
main heating flue fan												45.0000 (230e)
Total electricity for the above, kWh/year												75.0000 (231)
Electricity for lighting (calculated in Appendix L)												325.8318 (232)
Total delivered energy for all uses												5523.1115 (238)

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

	Energy	Emission factor	Emissions
	kWh/year	kg CO2/kWh	kg CO2/year
Space heating - main system 1	2878.1786	0.2160	621.6866 (261)
Space heating - secondary	0.0000	0.0000	45.0000 (263)
Water heating (other fuel)	2244.1011	0.2160	484.7258 (264)
Space and water heating			1106.4124 (265)
Pumps and fans			38.9250 (267)
Energy for lighting			169.1067 (268)
Total CO2, kg/m2/year	325.8318	0.5190	1314.4441 (272)
Emissions per m2 for space and water heating			15.8149 (272a)
Fuel factor (electricity)			1.5500
Emissions per m2 for lighting			2.4172 (272b)
Emissions per m2 for pumps and fans			0.5564 (272c)
Target Carbon Dioxide Emission Rate (TER) = (15.8149 * 1.55) + 2.4172 + 0.5564, rounded to 2 d.p.			27.4900 (273)



Appendix C – SAP Results Sheets.

SAP Results Sheet.

Project
Building/Block
Revision
Version
Date

Station Hill - Phase 1
Block E and F
R3
Option A - CHP
12/03/2019

Dwelling Reference	Dwelling Area (m²)	No. of Dwelling Type	TER	DER	Criterion 1 DER/TER Variance	TREE	DFEE	Criterion 1 DFEE/TREE Variance	Criterion 3 Overheating Strategy	Criterion 3 Overheating Risk
Type 01-F	49.61	5	22.55	15.10	-33.04%	67.05	55.70	-16.93%	Openable Windows	Medium
Type 01-N	49.61	29	19.26	13.67	-29.02%	50.39	47.27	-6.19%	Openable Windows	Medium
Type 01-R	49.61	4	21.70	14.71	-32.21%	62.74	51.72	-17.56%	Openable Windows	Medium
Type 02-F	41.69	5	25.96	17.29	-33.40%	79.43	63.25	-20.37%	Openable Windows	Medium
Type 02-N	41.69	20	22.43	15.72	-29.92%	61.29	54.39	-11.26%	Openable Windows	Medium
Type 02-R	41.69	2	24.83	16.58	-33.23%	73.59	57.87	-21.36%	Openable Windows	Medium
Type 03-F	67.03	2	20.27	13.28	-34.48%	62.75	48.76	-22.29%	Openable Windows	Medium
Type 03-FC	67.03	2	20.27	13.07	-35.52%	62.75	46.44	-25.99%	Openable Windows	Medium
Type 03-N	67.03	20	17.21	11.95	-30.56%	46.95	40.89	-12.91%	Openable Windows	Medium
Type 03-R	67.03	3	19.40	12.87	-33.66%	58.21	45.48	-21.87%	Openable Windows	Medium
Type 04N-F	42.07	4	22.07	11.37	-48.48%	59.23	45.85	-22.59%	Openable Windows	Medium
Type 04N-N	42.07	20	19.98	10.46	-47.65%	48.47	40.06	-17.35%	Openable Windows	Medium
Type 04N-R	42.07	4	21.12	11.06	-47.63%	54.35	42.81	-21.23%	Openable Windows	Medium
Type 04S-F	42.07	2	24.70	13.51	-45.30%	72.72	59.80	-17.77%	Openable Windows	Medium
Type 04S-FC	42.07	1	24.70	13.09	-47.04%	72.72	58.64	-23.49%	Openable Windows	Medium
Type 04S-N	42.07	26	22.54	12.39	-45.03%	61.58	53.46	-13.19%	Openable Windows	Medium
Type 04S-R	42.07	3	23.72	12.87	-45.74%	67.69	54.72	-19.16%	Openable Windows	Medium
Type 05-F	48.63	2	24.40	16.15	-33.81%	75.44	60.67	-19.58%	Openable Windows	Medium
Type 05-N	48.63	31	20.81	14.16	-31.96%	57.55	49.54	-13.92%	Openable Windows	Medium
Type 05-R	48.63	2	23.80	15.51	-34.83%	72.38	55.64	-23.13%	Openable Windows	Medium
Type 06-F	69.98	1	22.46	14.62	-34.91%	73.71	58.50	-20.63%	Openable Windows	Slight
Type 07-F	54.33	1	23.99	16.12	-32.81%	76.57	63.26	-17.38%	Openable Windows	Medium
Type 07-N	54.33	9	20.69	14.53	-29.77%	59.75	54.40	-8.95%	Openable Windows	Medium
Type 08N-F	70.01	1	22.12	14.49	-34.49%	73.74	57.44	-22.10%	Openable Windows	Slight
Type 08N-N	70.01	1	19.02	12.92	-32.07%	57.66	48.84	-15.30%	Openable Windows	Slight
Type 08N-R	70.01	9	22.16	13.86	-37.45%	73.93	52.76	-28.64%	Openable Windows	Medium
Type 08S-F	70.01	1	19.48	12.78	-34.39%	60.33	47.19	-21.78%	Openable Windows	Medium
Type 08S-N	70.01	9	16.46	11.39	-30.80%	44.76	38.95	-12.98%	Openable Windows	Medium
Type 08S-R	70.01	9	19.52	12.40	-36.48%	60.52	43.86	-27.53%	Openable Windows	Medium
Type 09-F	84.08	1	19.97	12.96	-38.11%	63.73	48.35	-24.13%	Openable Windows	Slight
Type 09-N	84.08	10	16.83	10.82	-35.71%	47.51	39.64	-16.56%	Openable Windows	Slight
Type 10N-FC	36.86	1	28.15	17.28	-38.61%	85.52	59.62	-30.29%	Openable Windows	Slight
Type 10N-N	36.86	8	23.19	16.19	-30.19%	59.99	54.79	-8.67%	Openable Windows	Slight
Type 10N-R	36.86	1	25.59	17.00	-33.57%	72.34	58.24	-19.49%	Openable Windows	Slight
Type 10S-FC	36.86	1	25.59	15.23	-40.48%	72.32	46.19	-36.13%	Openable Windows	Slight
Type 11-FC	41.63	1	26.28	16.27	-38.09%	80.38	57.95	-27.90%	Openable Windows	Slight
Type 11-N	41.63	3	24.19	15.58	-35.59%	69.59	55.00	-20.97%	Openable Windows	Slight
Type 11-R	41.63	1	25.15	15.82	-37.10%	74.53	55.61	-25.39%	Openable Windows	Slight
Type 12-FC	69.96	1	21.56	13.24	-38.59%	68.96	47.86	-30.60%	Openable Windows	Slight
Type 12-N	69.96	10	18.31	12.21	-33.32%	52.11	43.66	-16.22%	Openable Windows	Slight
Type 12-R	69.96	1	22.48	13.64	-39.32%	73.77	50.21	-31.94%	Openable Windows	Slight
Type 13-FC	48.68	1	21.54	13.42	-37.70%	60.37	42.51	-29.58%	Openable Windows	Slight
Type 14-FC	38.61	2	21.56	13.94	-35.34%	53.71	39.19	-27.08%	Openable Windows	Slight
Type 14-N	38.61	9	20.98	14.13	-32.65%	50.75	43.07	-15.13%	Openable Windows	Slight
Type 14-R	38.61	1	21.62	14.11	-34.74%	54.04	39.85	-26.26%	Openable Windows	Slight
Type 15N-FC	66.90	1	20.89	13.54	-35.18%	65.02	49.43	-23.98%	Openable Windows	Slight
Type 15N-N	66.90	7	15.36	11.36	-26.04%	36.77	37.39	1.69%	Openable Windows	Slight
Type 15N-R	66.90	1	20.17	13.45	-33.32%	61.28	49.13	-19.83%	Openable Windows	Slight
Type 15S-F	66.90	1	18.40	12.55	-31.79%	52.39	44.49	-15.08%	Openable Windows	Slight
Type 15S-FC	66.90	2	18.40	12.24	-33.48%	52.39	41.39	-21.00%	Openable Windows	Slight
Type 15S-N	66.90	26	15.36	11.36	-26.04%	36.77	37.39	1.69%	Openable Windows	Slight
Type 15S-R	66.90	3	17.69	12.13	-31.43%	48.76	40.91	-16.10%	Openable Windows	Slight
Type 16N-F	78.82	1	19.59	13.45	-31.34%	62.74	53.15	-15.29%	Openable Windows	Slight
Type 16N-FC	78.82	1	19.59	13.02	-33.54%	62.74	49.44	-21.20%	Openable Windows	Slight
Type 16N-N	78.82	19	16.66	12.06	-26.28%	42.70	46.50	2.22%	Openable Windows	Slight
Type 16N-R	78.82	2	19.73	13.06	-33.81%	63.44	49.83	-21.45%	Openable Windows	Slight
Type 16S-F	78.82	1	18.05	12.43	-31.14%	55.09	47.03	-14.63%	Openable Windows	Slight
Type 16S-FC	78.82	1	18.05	12.16	-32.63%	55.09	44.35	-19.50%	Openable Windows	Slight
Type 16S-N	78.82	18	15.17	11.32	-25.38%	40.52	40.60	0.20%	Openable Windows	Slight
Type 16S-R	78.82	2	18.18	12.18	-33.00%	55.78	44.61	-20.03%	Openable Windows	Slight
Type 17-N	70.15	3	17.17	12.39	-27.84%	47.10	45.31	-3.80%	Openable Windows	Slight
Type 18-N	48.80	3	16.28	11.25	-30.90%	33.50	29.35	-12.39%	Openable Windows	Slight
Type 19-R	70.81	1	21.43	12.61	-41.16%	69.59	44.68	-35.80%	Openable Windows	Slight
Type 20-R	50.66	1	22.53	14.49	-35.69%	67.54	49.55	-26.64%	Openable Windows	Slight
Type 21-F	54.70	1	25.18	16.71	-33.64%	82.22	63.37	-22.93%	Openable Windows	Not Significant
Type 22-F	69.00	3	21.12	14.54	-31.16%	67.30	55.23	-17.93%	Openable Windows	Slight
Type 22-N	69.00	20	18.03	13.02	-27.79%	51.41	46.84	-8.89%	Openable Windows	Slight
Type 22-R	69.00	2	20.45	13.95	-31.78%	63.83	50.80	-20.41%	Openable Windows	Slight
Type 23-N	38.54	12	24.71	16.17	-34.56%	69.28	55.05	-20.54%	Openable Windows	Slight
Type 23-R	38.54	1	25.30	17.16	-32.17%	72.36	58.72	-18.85%	Openable Windows	Slight
Type 24N-F	70.68	1	21.89	14.57	-33.44%	71.10	57.52	-19.10%	Openable Windows	Slight
Type 24N-N	70.68	10	20.11	13.63	-32.22%	61.82	52.38	-15.27%	Openable Windows	Slight
Type 24N-R	70.68	1	23.36	15.99	-31.55%	78.78	63.51	-19.38%	Openable Windows	Slight
Type 24S-F	70.68	1	19.57	13.10	-33.06%	59.28	48.50	-18.18%	Openable Windows	Slight
Type 24S-N	70.68	10	17.81	12.25	-31.22%	50.20	43.49	-13.37%	Openable Windows	Slight
Type 24S-R	70.68	1	21.03	14.61	-30.53%	66.87	55.48	-17.03%	Openable Windows	Slight
Type 25-F	49.79	1	20.74	14.00	-32.50%	56.84	47.72	-16.05%	Openable Windows	Slight
Type 25-FC	49.79	1	21.98	14.09	-35.90%	63.21	46.40	-26.59%	Openable Windows	Medium
Type 25-N	49.79	20	19.04	13.06	-31.41%	48.15	41.79	-13.21%	Openable Windows	Slight
Type 25-R	49.79	2	20.47	14.01	-31.56%	55.46	46.21	-16.68%	Openable Windows	Medium
Type 26-F	59.38	1	22.00	14.13	-35.77%	66.28	49.37	-25.51%	Openable Windows	Not Significant
Type 26-N	59.38	8	18.39	12.50	-32.03%	47.83	40.06	-16.25%	Openable Windows	Not Significant
Type 26-R	59.38	1	21.67	13.23	-38.75%	64.54	43.28	-32.94%	Openable Windows	Slight
Type 27-FC	78.49	1	19.44	12.90	-36.73%	61.19	42.70	-30.22%	Openable Windows	Slight
Type 27-N	78.49	8	16.17	11.18	-30.86%	44.65	37.53	-15.95%	Openable Windows	Slight
Type 27-R	78.49	1	20.43	12.38	-39.40%	66.26	43.28	-34.68%	Openable Windows	Slight
Type 28-FC	35.96	1	25.88	15.29	-40.92%	60.30	43.57	-27.74%	Openable Windows	Medium
Type 28-N	35.96	8	21.64	14.01	-35.26%	41.75	37.27	-10.73%	Openable Windows	Slight
Type 28-R	35.96	1	27.74	15.83	-42.93%	68.40	46.95	-31.36%	Openable Windows	Slight
Type 29-FC	41.94	4	21.66	14.67	-32.27%	57.16	44.08	-22.88%	Openable Windows	Slight
Type 29-N	41.94	33	18.62	13.81	-25.83%	41.64	40.54	-2.64%	Openable Windows	Slight
Type 29-R	41.94	3	22.69	15.08	-33.54%	62.43	46.61	-25.34%	Openable Windows	Slight
Type 30-FC	72.74	1	18.65	12.41	-33.46%	56.38	42.84	-24.02%	Openable Windows	Slight
Type 30-N	72.74	9	16.13	11.64	-27.84%	43.53	39.15	-10.06%	Openable Windows	Slight
Type 31	131.77	1	16.86	12.00	-28.83%	40.22	46.38	15.42%	Openable Windows	Not Significant
Type 32	159.35	1	15.34	10.25	-33.18%	56.81	44.34	-21.95%	Openable Windows	Not Significant
Type 33	159.35	1	13.11	8.86	-32.42%	45.89	36.27	-20.96%	Openable Windows	Slight
Type 34-R	111.40	1	14.91	9.77	-34.47%	45.12	35.23	-21.92%	Openable Windows	Not Significant
Type 35-R	87.78	1	16.27	10.58	-34.97%	47.51	35.11	-26.10%	Openable Windows	Not Significant
Area Weighted Results	30829.45	538	19.05	12.89	-32.33%	52.58	45.42	-13.62%		0

SAP Results Sheet.

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R3
Option A - CHP
12/03/2019

Parameters Used.

Category	Parameter	Value	Notes
External Fabric	External Wall U-Values (W/m²K)	0.18	As Calculated by BS EN ISO 6946
	Floor U-Values (W/m²K)	0.10	As Calculated by BS EN ISO 6946
	Roof U-Values (W/m²K)	0.10	As Calculated by BS EN ISO 6946
	Standard Glazing U-Value (W/m2K)	1.50	As Calculated by BS EN ISO 12567 or 10077 (U-Value includes glass and frame)
	g-Value (-)	0.42	
	Fraction Glazed (%)	90.00	Proportion of glass to overall opening size
Internal Walls	To Other Apartments	Fully Filled Cavity with Sealed Edges	
	To Corridors (W/m²K)	0.18	As Calculated by BS EN ISO 6946
	To Risers (W/m²K)	0.18	As Calculated by BS EN ISO 6946
	To Lift Shafts (W/m²K)	0.18	As Calculated by BS EN ISO 6946
	To Stair Wells (W/m²K)	0.18	As Calculated by BS EN ISO 6946
Thermal Mass	Thermal Mass Parameter (kJ/m²K)	141.5 - 356.9	
Thermal Bridging	Thermal Bridging y-value Range (Calculated)	Calculated	Thermal bridging calculations required
Thermal Bridging	See notes column	Calculated psi values	E2 - 0.026
			E3 - 0.033
			E4 - 0.010
			E20 - 0.160
			E7 - 0.070
			P7 - 0.080
			E15 - 0.049
			E16 - 0.015
			E17 - (-)0.036
			E18 - 0.060
E25 - 0.060			
P7 - 0.080			
Air Permeability	Air Permeability Rate (m3/hm2 at 50Pa)	3.00	As stated on a test certificate from a person registered by an authorised air pressure testing scheme Note to use the measured air perm rate each dwelling has to be pressure tested. If a dwelling is not pressure tested the value used in the calculation is an average of the tested dwellings of the same type plus 2.
Mechanical Ventilation	Strategy	Balanced with Heat Recovery	
	SFP (W/l/s)	Kitchen +1 (0.62) Kitchen +2 (0.62) Kitchen +3 (0.66)	SAP Appendix Q Test Results
	Heat Exchange Efficiency (%)	Kitchen +1 (94.0) Kitchen +2 (93.0) Kitchen +3 (93.0)	SAP Appendix Q Test Results
	Installer approved	Yes	The installer has been registered with a Government Approved Scheme e.g. BESCA, Blue Flame Certification, Certsure, NAPIT and Stroma
	Duct Type	Rigid	All ductwork is rigid except for occasional flexible ducting to join components together
	Ductwork Insulated	Yes	Ductwork can be assumed to be insulated if all of the ductwork is inside the insulated envelope even if the ductwork itself is uninsulated.
Space Heating	Category	Communal	
	Boilers - Fraction of Heat (-)	0.40	As design specification
	Boilers - Efficiency (%)	89.00	As calculated by SAP Appendix D
	CHP - Fraction of Heat (-)	0.60	As design specification
	CHP - Efficiency (%)	78.00	Gross Efficiency from Manufacturers Literature
	CHP - Heat to Power Ratio (-)	1.45	Heat Supplied / Power Supplied
	Heat Distribution System	Pre-insulated low temperature, variable flow (1991 or later)	District heating specification
	Controls	Charging system linked to use, programmer and TRVs	
	Emitter	Underfloor (Screed)	
Water Heating	Type	From Main System	
	Plate Heat Exchanger Volume (litres)	Yes 1	
	Insulation Type	Spray Foam	
	Insulation Thickness (mm)	30	
	Waste Water Heat Recovery	No	
Renewables	Type	PV Panels	
	Peak Power (kWp)	30.00	Peak power under 1kW/m² of radiation at 25°C
	Orientation	South	
	Tilt	30°	
Summertime Overheating	Openable Windows	Yes	
	Mechanical Ventilation Required	Yes	Applied to selected dwellings (see above)
	Blinds	Dark-coloured curtain or roller blind (Default)	

SAP Results Sheet.

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Option B - ASHP
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Dwelling Reference	Dwelling Area (m²)	No. of Dwelling Type	TER	DER	Criterion 1 DER/TER Variance	TTEE	DFEE	Criterion 1 DFEE/TTEE Variance	Criterion 3 Overheating Strategy	Criterion 3 Overheating Risk
Type 01-F	49.61	5	33.20	20.84	-37.23%	67.05	55.70	-16.93%	Openable Windows	Medium
Type 01-N	49.61	29	28.09	18.71	-33.39%	50.39	47.27	-6.19%	Openable Windows	Medium
Type 01-R	49.61	4	31.88	20.09	-36.98%	62.74	51.72	-17.56%	Openable Windows	Medium
Type 02-F	41.69	5	38.36	23.88	-37.75%	79.43	63.25	-20.37%	Openable Windows	Medium
Type 02-N	41.69	20	32.88	21.60	-34.31%	61.29	54.39	-11.26%	Openable Windows	Medium
Type 02-R	41.69	2	36.60	22.79	-37.73%	73.59	57.87	-21.36%	Openable Windows	Medium
Type 03-F	67.03	2	29.83	18.03	-39.56%	62.75	48.76	-22.29%	Openable Windows	Medium
Type 03-FC	67.03	2	29.83	17.69	-40.70%	62.75	46.44	-25.99%	Openable Windows	Medium
Type 03-N	67.03	20	25.08	16.10	-35.81%	46.95	40.89	-12.91%	Openable Windows	Medium
Type 03-R	67.03	3	28.47	17.41	-38.85%	58.21	45.48	-21.87%	Openable Windows	Medium
Type 04N-F	42.07	4	32.33	16.67	-48.44%	59.23	45.85	-22.59%	Openable Windows	Medium
Type 04N-N	42.07	20	29.10	15.34	-47.29%	48.47	40.06	-17.35%	Openable Windows	Medium
Type 04N-R	42.07	4	30.86	16.20	-47.50%	54.35	42.81	-21.23%	Openable Windows	Medium
Type 04S-F	42.07	2	36.41	19.78	-45.67%	72.72	59.80	-17.77%	Openable Windows	Medium
Type 04S-FC	42.07	1	36.41	19.09	-47.57%	72.72	58.64	-23.49%	Openable Windows	Medium
Type 04S-N	42.07	26	33.06	18.15	-45.10%	61.58	53.46	-13.19%	Openable Windows	Medium
Type 04S-R	42.07	3	34.90	18.80	-46.13%	67.69	54.72	-19.16%	Openable Windows	Medium
Type 05-F	48.63	2	36.05	22.23	-38.34%	75.44	60.67	-19.58%	Openable Windows	Medium
Type 05-N	48.63	31	30.49	19.33	-36.60%	57.55	49.54	-13.92%	Openable Windows	Medium
Type 05-R	48.63	2	35.12	21.24	-39.52%	72.38	55.64	-23.13%	Openable Windows	Medium
Type 06-F	69.98	1	33.18	20.00	-39.72%	73.71	58.50	-20.63%	Openable Windows	Slight
Type 07-F	54.33	1	35.47	22.21	-37.38%	76.57	63.26	-17.38%	Openable Windows	Medium
Type 07-N	54.33	9	30.36	19.89	-34.49%	59.75	54.40	-8.95%	Openable Windows	Medium
Type 08N-F	70.01	1	32.70	19.78	-39.51%	73.74	57.44	-22.10%	Openable Windows	Slight
Type 08N-N	70.01	1	27.89	17.51	-37.22%	57.66	48.84	-15.30%	Openable Windows	Slight
Type 08N-R	70.01	9	32.76	18.81	-42.58%	73.93	52.76	-28.64%	Openable Windows	Medium
Type 08S-F	70.01	1	28.61	17.31	-39.50%	60.33	47.19	-21.78%	Openable Windows	Medium
Type 08S-N	70.01	9	23.92	15.28	-36.12%	44.76	38.95	-12.98%	Openable Windows	Medium
Type 08S-R	70.01	1	28.67	16.72	-41.68%	60.52	43.86	-27.58%	Openable Windows	Medium
Type 09-F	84.08	1	29.32	16.65	-43.21%	63.73	48.35	-24.13%	Openable Windows	Slight
Type 09-N	84.08	10	24.45	14.40	-41.10%	47.51	39.64	-16.56%	Openable Windows	Slight
Type 10N-FC	36.86	1	41.65	23.91	-42.59%	85.52	59.62	-30.29%	Openable Windows	Slight
Type 10N-N	36.86	8	33.96	22.37	-34.13%	59.99	54.79	-8.67%	Openable Windows	Slight
Type 10N-R	36.86	1	37.69	23.52	-37.60%	72.34	58.24	-19.49%	Openable Windows	Slight
Type 10S-FC	36.86	1	37.68	20.95	-44.40%	72.32	46.19	-36.13%	Openable Windows	Slight
Type 11-FC	41.63	1	38.85	22.45	-42.21%	80.38	57.95	-27.90%	Openable Windows	Slight
Type 11-N	41.63	3	35.61	21.46	-39.74%	69.59	55.00	-20.97%	Openable Windows	Slight
Type 11-R	41.63	1	37.10	21.80	-41.24%	74.53	55.61	-25.39%	Openable Windows	Slight
Type 12-FC	69.96	1	31.78	17.93	-43.58%	68.96	47.86	-30.60%	Openable Windows	Slight
Type 12-N	69.96	10	26.74	16.50	-38.29%	52.11	43.66	-16.22%	Openable Windows	Slight
Type 12-R	69.96	1	33.21	18.51	-44.26%	73.77	50.21	-31.94%	Openable Windows	Slight
Type 13-F	48.68	1	31.59	18.27	-42.17%	60.37	42.51	-29.58%	Openable Windows	Slight
Type 14-FC	38.61	2	31.48	19.04	-39.52%	53.71	39.19	-27.08%	Openable Windows	Slight
Type 14-N	38.61	9	30.58	19.33	-36.79%	50.75	43.07	-15.13%	Openable Windows	Slight
Type 14-R	38.61	1	31.58	19.29	-38.92%	54.04	39.85	-26.26%	Openable Windows	Slight
Type 15N-FC	66.90	1	30.75	18.39	-40.20%	65.02	49.43	-23.98%	Openable Windows	Slight
Type 15N-N	66.90	7	22.19	15.27	-31.19%	36.77	37.39	1.69%	Openable Windows	Slight
Type 15N-R	66.90	1	29.64	18.26	-38.39%	61.28	49.13	-19.83%	Openable Windows	Slight
Type 15S-F	66.90	1	26.89	17.00	-36.78%	52.39	44.49	-15.08%	Openable Windows	Slight
Type 15S-FC	66.90	2	26.89	16.53	-38.53%	52.39	41.39	-21.00%	Openable Windows	Slight
Type 15S-N	66.90	26	22.19	15.27	-31.19%	36.77	37.39	1.69%	Openable Windows	Slight
Type 15S-R	66.90	3	25.80	16.37	-36.55%	48.76	40.91	-16.10%	Openable Windows	Slight
Type 16N-F	78.82	1	28.86	18.31	-36.56%	62.74	53.15	-15.29%	Openable Windows	Slight
Type 16N-FC	78.82	1	28.86	17.62	-38.95%	62.74	49.44	-21.20%	Openable Windows	Slight
Type 16N-N	78.82	19	24.27	16.58	-31.69%	42.70	46.50	9.09%	Openable Windows	Slight
Type 16N-R	78.82	2	29.07	17.68	-39.18%	63.44	49.83	-21.45%	Openable Windows	Slight
Type 16S-F	78.82	1	26.46	16.82	-36.43%	55.09	47.03	-14.63%	Openable Windows	Slight
Type 16S-FC	78.82	1	26.46	16.40	-38.02%	55.09	44.35	-19.50%	Openable Windows	Slight
Type 16S-N	78.82	18	22.01	15.21	-30.90%	40.52	40.60	0.20%	Openable Windows	Slight
Type 16S-R	78.82	2	26.67	16.43	-38.40%	55.78	44.61	-20.03%	Openable Windows	Slight
Type 17-N	70.15	3	25.04	16.82	-32.83%	47.10	45.31	-3.80%	Openable Windows	Slight
Type 18-N	48.80	3	23.44	15.15	-35.37%	33.50	29.35	-12.39%	Openable Windows	Slight
Type 19-R	70.81	1	31.63	17.09	-45.97%	69.59	44.68	-35.80%	Openable Windows	Slight
Type 20-R	50.66	1	33.18	19.83	-40.24%	67.54	49.55	-26.64%	Openable Windows	Slight
Type 21-F	54.70	1	37.32	22.86	-38.75%	82.22	63.37	-22.93%	Openable Windows	Not Significant
Type 22-F	69.00	3	31.16	19.69	-36.81%	67.30	55.23	-17.93%	Openable Windows	Slight
Type 22-N	69.00	20	26.37	17.49	-33.67%	51.41	46.84	-8.89%	Openable Windows	Slight
Type 22-R	69.00	2	30.12	18.78	-37.65%	63.83	50.80	-20.41%	Openable Windows	Slight
Type 23-N	38.54	12	36.32	21.86	-39.54%	69.28	55.05	-20.54%	Openable Windows	Slight
Type 23-R	38.54	1	37.24	23.35	-37.30%	72.36	58.72	-18.85%	Openable Windows	Slight
Type 24N-F	70.68	1	32.31	19.60	-39.34%	71.10	57.52	-19.10%	Openable Windows	Slight
Type 24N-N	70.68	10	29.55	18.23	-38.31%	61.82	52.38	-15.27%	Openable Windows	Slight
Type 24N-R	70.68	1	34.58	21.56	-37.65%	78.78	63.51	-19.38%	Openable Windows	Slight
Type 24S-F	70.68	1	28.71	17.46	-39.18%	59.28	48.50	-18.18%	Openable Windows	Slight
Type 24S-N	70.68	10	25.99	16.21	-37.63%	50.20	43.49	-13.37%	Openable Windows	Slight
Type 24S-R	70.68	1	30.97	19.60	-36.71%	66.87	55.48	-17.03%	Openable Windows	Slight
Type 25-F	49.79	1	30.36	18.79	-38.11%	56.84	47.72	-16.05%	Openable Windows	Slight
Type 25-FC	49.79	1	32.28	18.89	-41.48%	63.21	46.40	-26.59%	Openable Windows	Medium
Type 25-N	49.79	20	27.72	17.41	-37.19%	48.15	41.79	-13.21%	Openable Windows	Slight
Type 25-R	49.79	2	29.94	18.79	-37.24%	55.46	46.21	-16.68%	Openable Windows	Medium
Type 26-F	59.38	1	32.29	19.44	-40.72%	66.28	49.37	-25.51%	Openable Windows	Not Significant
Type 26-N	59.38	8	26.69	16.76	-37.30%	47.83	40.06	-16.25%	Openable Windows	Not Significant
Type 26-R	59.38	1	31.77	17.81	-43.94%	64.54	43.28	-32.94%	Openable Windows	Slight
Type 27-FC	78.49	1	28.58	16.48	-42.34%	61.19	42.70	-30.22%	Openable Windows	Slight
Type 27-N	78.49	8	23.52	14.89	-36.69%	44.65	37.53	-15.95%	Openable Windows	Slight
Type 27-R	78.49	1	30.12	16.59	-44.92%	66.26	43.28	-34.68%	Openable Windows	Slight
Type 28-FC	35.96	1	38.04	20.89	-45.08%	60.30	43.57	-27.74%	Openable Windows	Medium
Type 28-N	35.96	8	31.46	19.03	-39.51%	41.75	37.27	-10.73%	Openable Windows	Slight
Type 28-R	35.96	1	40.92	21.68	-47.02%	68.40	46.95	-31.36%	Openable Windows	Slight
Type 29-FC	41.94	4	31.67	19.96	-36.98%	57.16	44.08	-22.88%	Openable Windows	Slight
Type 29-N	41.94	33	26.97	18.73	-30.55%	41.64	40.54	-2.64%	Openable Windows	Slight
Type 29-R	41.94	3	33.27	20.55	-38.23%	62.43	46.61	-25.34%	Openable Windows	Slight
Type 30-FC	72.74	1	27.36	16.64	-39.18%	56.38	42.84	-24.02%	Openable Windows	Slight
Type 30-N	72.74	9	23.45	15.55	-33.69%	43.53	39.15	-10.06%	Openable Windows	Slight
Type 31	131.77	1	24.97	16.05	-35.72%	62.92	46.38	-23.62%	Openable Windows	Not Significant
Type 32	159.35	1	22.71	13.62	-40.03%	56.81	44.34	-21.62%	Openable Windows	Not Significant
Type 33	159.35	1	19.26	11.61	-39.72%	45.89	36.27	-20.96%	Openable Windows	Slight
Type 34-R	111.40	1	21.72	12.81	-41.02%	45.12	35.23	-21.92%	Openable Windows	Not Significant
Type 35-R	87.78	1	23.73	13.94	-41.26%	47.51	35.11	-26.10%	Openable Windows	Not Significant
Area Weighted Results	30829.45	538	27.83	17.53	-37.01%	52.58	45.42	-13.62%		0

SAP Results Sheet.

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Station Hill - Phase 1
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Option B - ASHP
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Parameters Used.

Category	Parameter	Value	Notes
External Fabric	External Wall U-Values (W/m²K)	0.18	As Calculated by BS EN ISO 6946
	Floor U-Values (W/m²K)	0.10	As Calculated by BS EN ISO 6946
	Roof U-Values (W/m²K)	0.10	As Calculated by BS EN ISO 6946
	Standard Glazing U-Value (W/m2K)	1.50	As Calculated by BS EN ISO 12567 or 10077 (U-Value includes glass and frame)
	g-Value (-)	0.42	
	Fraction Glazed (%)	90.00	Proportion of glass to overall opening size
Internal Walls	To Other Apartments	Fully Filled Cavity with Sealed Edges	
	To Corridors (W/m²K)	0.18	As Calculated by BS EN ISO 6946
	To Risers (W/m²K)	0.18	As Calculated by BS EN ISO 6946
	To Lift Shafts (W/m²K)	0.18	As Calculated by BS EN ISO 6946
	To Stair Wells (W/m²K)	0.18	As Calculated by BS EN ISO 6946
Thermal Mass	Thermal Mass Parameter (kJ/m²K)	141.5 - 356.9	
Thermal Bridging	Thermal Bridging y-value Range (Calculated)	Calculated	Thermal bridging calculations required
Thermal Bridging	See notes column	Calculated psi values	E2 - 0.026 E3 - 0.033 E4 - 0.010 E20 - 0.160 E7 - 0.070 P7 - 0.080 E15 - 0.049 E16 - 0.015 E17 - (-)0.036 E18 - 0.060 E25 - 0.060 P7 - 0.080
Air Permeability	Air Permeability Rate (m3/hm2 at 50Pa)	3.00	As stated on a test certificate from a person registered by an authorised air pressure testing scheme Note to use the measured air perm rate each dwelling has to be pressure tested. If a dwelling is not pressure tested the value used in the calculation is an average of the tested dwellings of the same type plus 2.
Mechanical Ventilation	Strategy	Balanced with Heat Recovery	
	SFP (W/l/s)	Kitchen +1 (0.62) Kitchen +2 (0.62) Kitchen +3 (0.66)	SAP Appendix Q Test Results
	Heat Exchange Efficiency (%)	Kitchen +1 (94.0) Kitchen +2 (93.0) Kitchen +3 (93.0)	SAP Appendix Q Test Results
	Installer approved	Yes	The installer has be registered with a Government Approved Scheme e.g. BESCA, Blue Flame Certification, Certsure, NAPIT and Stroma
	Duct Type	Rigid	All ductwork is rigid except for occasional flexible ducting to join components together
	Ductwork Insulated	Yes	Ductwork can be assumed to be insulated if all of the ductwork is inside the insulated envelope even if the ductwork itself is uninsulated.
Space Heating	Category	Communal	
	Air Source Heat Pump - Fraction of Heat (-)	1.00	As design specification
	Air Source Heat Pump - Efficiency (%)	210.00	As calculated by SAP Appendix D
	Heat Distribution System	Pre-insulated low temperature, variable flow (1991 or later)	District heating specification
	Controls	Charging system linked to use, programmer and TRVs	
	Emitter	Underfloor (Screed)	
Water Heating	Type	From Main System	
	Plate Heat Exchanger	Yes	
	Volume (litres)	1	
	Insulation Type	Spray Foam	
	Insulation Thickness (mm)	30	
Renewables	Waste Water Heat Recovery	No	
	Type	PV Panels	
	Peak Power (kWp)	30.00	Peak power under 1kW/m² of radiation at 25°C
	Orientation	South	
	Tilt	30°	
Summertime Overheating	Openable Windows	Yes	
	Mechanical Ventilation Required	Yes	Applied to selected dwellings (see above)
	Blinds	Dark-coloured curtain or roller blind (Default)	

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Dwelling Reference	Dwelling Area (m²)	No. of Dwelling Type	TER	DER	Criterion 1 DER/TER Variance	TREE	DREE	Criterion 1 DREE/TREE Variance	Criterion 3 Overheating Strategy	Criterion 3 Overheating Risk
Type 01-F	49.61	5	33.20	15.76	-52.53%	67.05	55.70	-16.93%	Openable Windows	Medium
Type 01-N	49.61	29	28.09	14.26	-49.23%	50.39	47.27	-6.19%	Openable Windows	Medium
Type 01-R	49.61	4	31.88	15.23	-52.23%	62.74	51.72	-17.56%	Openable Windows	Medium
Type 02-F	41.69	5	38.36	17.93	-53.26%	79.43	63.25	-20.37%	Openable Windows	Medium
Type 02-N	41.69	20	32.88	16.32	-50.36%	61.29	54.39	-11.26%	Openable Windows	Medium
Type 02-R	41.69	2	36.60	17.16	-53.11%	73.59	57.87	-21.36%	Openable Windows	Medium
Type 03-F	67.03	2	29.83	13.75	-53.91%	62.75	48.76	-22.29%	Openable Windows	Medium
Type 03-FC	67.03	2	29.83	13.51	-54.71%	62.75	46.44	-25.99%	Openable Windows	Medium
Type 03-N	67.03	20	25.08	12.39	-50.60%	46.95	40.89	-12.91%	Openable Windows	Medium
Type 03-R	67.03	3	28.47	13.32	-53.21%	58.21	45.48	-21.87%	Openable Windows	Medium
Type 04N-F	42.07	4	32.33	11.94	-63.07%	59.23	45.85	-22.59%	Openable Windows	Medium
Type 04N-N	42.07	20	29.10	11.00	-62.20%	48.47	40.06	-17.35%	Openable Windows	Medium
Type 04N-R	42.07	4	30.86	11.61	-62.38%	54.35	42.81	-21.23%	Openable Windows	Medium
Type 04S-F	42.07	2	36.41	14.14	-61.16%	72.72	59.80	-17.77%	Openable Windows	Medium
Type 04S-FC	42.07	1	36.41	13.81	-62.51%	72.72	58.64	-23.49%	Openable Windows	Medium
Type 04S-N	42.07	26	33.06	12.99	-60.71%	61.58	53.46	-13.19%	Openable Windows	Medium
Type 04S-R	42.07	3	34.90	13.44	-61.49%	67.69	54.72	-19.16%	Openable Windows	Medium
Type 05-F	48.63	2	36.05	16.75	-53.54%	75.44	60.67	-19.58%	Openable Windows	Medium
Type 05-N	48.63	31	30.49	14.70	-51.79%	57.55	49.54	-13.92%	Openable Windows	Medium
Type 05-R	48.63	2	35.12	16.05	-54.30%	72.38	55.64	-23.13%	Openable Windows	Medium
Type 06-F	69.98	1	33.18	15.14	-54.37%	73.71	58.50	-20.63%	Openable Windows	Slight
Type 07-F	54.33	1	35.47	16.71	-52.89%	76.57	63.26	-17.38%	Openable Windows	Medium
Type 07-N	54.33	9	30.36	15.08	-50.33%	59.75	54.40	-8.95%	Openable Windows	Medium
Type 08N-F	70.01	1	32.70	14.99	-54.16%	73.74	57.44	-22.10%	Openable Windows	Slight
Type 08N-N	70.01	1	27.89	13.38	-52.03%	57.66	48.84	-15.30%	Openable Windows	Slight
Type 08N-R	70.01	9	32.76	14.30	-56.35%	73.93	52.76	-28.64%	Openable Windows	Medium
Type 08S-F	70.01	1	28.61	13.24	-53.72%	60.33	47.19	-21.78%	Openable Windows	Medium
Type 08S-N	70.01	9	23.92	11.81	-50.65%	44.76	38.95	-12.98%	Openable Windows	Medium
Type 08S-R	70.01	9	28.67	12.82	-55.38%	60.52	43.86	-27.58%	Openable Windows	Medium
Type 09-F	84.08	1	29.32	12.97	-56.38%	63.73	48.35	-24.13%	Openable Windows	Slight
Type 09-N	84.08	10	24.45	11.20	-54.19%	47.51	39.64	-16.56%	Openable Windows	Slight
Type 10N-FC	36.86	1	41.65	17.94	-56.93%	85.52	59.62	-30.29%	Openable Windows	Slight
Type 10N-N	36.86	8	33.96	16.85	-50.38%	59.99	54.79	-8.67%	Openable Windows	Slight
Type 10N-R	36.86	1	37.69	17.66	-53.14%	72.34	58.24	-19.49%	Openable Windows	Slight
Type 10S-FC	36.86	1	37.68	15.84	-57.96%	72.32	46.19	-36.13%	Openable Windows	Slight
Type 11-FC	41.63	1	38.85	16.90	-56.50%	80.38	57.95	-27.90%	Openable Windows	Slight
Type 11-N	41.63	3	35.61	16.21	-54.48%	69.59	55.00	-20.97%	Openable Windows	Slight
Type 11-R	41.63	1	37.10	16.45	-55.66%	74.53	55.61	-25.39%	Openable Windows	Slight
Type 12-FC	69.96	1	31.78	13.66	-57.02%	68.96	47.86	-30.60%	Openable Windows	Slight
Type 12-N	69.96	10	26.74	12.65	-52.69%	52.11	43.66	-16.22%	Openable Windows	Slight
Type 12-R	69.96	1	33.21	14.07	-57.65%	73.77	50.21	-31.94%	Openable Windows	Slight
Type 13-F	48.68	1	31.59	13.93	-55.90%	60.37	42.51	-29.58%	Openable Windows	Slight
Type 14-F	38.61	2	31.48	14.50	-53.94%	53.71	39.19	-27.08%	Openable Windows	Slight
Type 14-N	38.61	9	30.58	14.70	-51.93%	50.75	43.07	-15.13%	Openable Windows	Slight
Type 14-R	38.61	1	31.58	14.67	-53.55%	54.04	39.85	-26.26%	Openable Windows	Slight
Type 15N-FC	66.90	1	30.75	13.98	-54.54%	65.02	49.43	-23.98%	Openable Windows	Slight
Type 15N-N	66.90	7	22.19	11.78	-46.91%	36.77	37.39	1.69%	Openable Windows	Slight
Type 15N-R	66.90	1	29.64	13.89	-53.14%	61.28	49.13	-19.83%	Openable Windows	Slight
Type 15S-F	66.90	1	26.89	13.01	-51.62%	52.39	44.49	-15.08%	Openable Windows	Slight
Type 15S-FC	66.90	2	26.89	12.67	-52.88%	52.39	41.39	-21.00%	Openable Windows	Slight
Type 15S-N	66.90	26	22.19	11.78	-46.91%	36.77	37.39	1.69%	Openable Windows	Slight
Type 15S-R	66.90	3	25.80	12.56	-51.32%	48.76	40.91	-16.10%	Openable Windows	Slight
Type 16N-F	78.82	1	28.86	13.91	-51.80%	62.74	53.15	-15.29%	Openable Windows	Slight
Type 16N-FC	78.82	1	28.86	13.42	-53.50%	62.74	49.44	-21.20%	Openable Windows	Slight
Type 16N-N	78.82	19	24.27	11.69	-47.71%	42.70	46.50	2.72%	Openable Windows	Slight
Type 16N-R	78.82	2	29.07	13.47	-53.66%	63.44	49.83	-21.45%	Openable Windows	Slight
Type 16S-F	78.82	1	26.46	12.86	-51.40%	55.09	47.03	-14.63%	Openable Windows	Slight
Type 16S-FC	78.82	1	26.46	12.56	-52.53%	55.09	44.35	-19.50%	Openable Windows	Slight
Type 16S-N	78.82	18	22.01	11.72	-46.75%	40.52	40.60	0.20%	Openable Windows	Slight
Type 16S-R	78.82	2	26.67	12.58	-52.83%	55.78	44.61	-20.03%	Openable Windows	Slight
Type 17-N	70.15	3	25.04	12.84	-48.72%	47.10	45.31	-3.80%	Openable Windows	Slight
Type 18-N	48.80	3	23.44	11.69	-50.13%	33.50	29.35	-12.39%	Openable Windows	Slight
Type 19-R	70.81	1	31.63	13.03	-58.80%	69.59	44.68	-35.80%	Openable Windows	Slight
Type 20-R	50.66	1	33.18	15.00	-54.79%	67.54	49.55	-26.64%	Openable Windows	Slight
Type 21-F	54.70	1	37.32	17.29	-53.67%	82.22	63.37	-22.93%	Openable Windows	Not Significant
Type 22-F	69.00	3	31.16	15.03	-51.77%	67.30	55.23	-17.93%	Openable Windows	Slight
Type 22-N	69.00	20	26.37	13.48	-48.88%	51.41	46.84	-8.89%	Openable Windows	Slight
Type 22-R	69.00	2	30.12	14.39	-52.22%	63.83	50.80	-20.41%	Openable Windows	Slight
Type 23-N	38.54	12	36.32	16.78	-53.80%	69.28	55.05	-20.54%	Openable Windows	Slight
Type 23-R	38.54	1	37.24	17.77	-52.28%	72.36	58.72	-18.85%	Openable Windows	Slight
Type 24N-F	70.68	1	32.31	15.06	-53.39%	71.10	57.52	-19.10%	Openable Windows	Slight
Type 24N-N	70.68	10	29.55	14.09	-52.32%	61.82	52.38	-15.27%	Openable Windows	Slight
Type 24N-R	70.68	1	34.58	16.44	-52.46%	78.78	63.51	-19.38%	Openable Windows	Slight
Type 24S-F	70.68	1	28.71	13.55	-52.80%	59.28	48.50	-18.18%	Openable Windows	Slight
Type 24S-N	70.68	10	25.99	12.67	-51.25%	50.20	43.49	-13.37%	Openable Windows	Slight
Type 24S-R	70.68	1	30.97	15.06	-51.37%	66.87	55.48	-17.03%	Openable Windows	Slight
Type 25-F	49.79	1	30.36	14.52	-52.17%	56.84	47.72	-16.05%	Openable Windows	Slight
Type 25-FC	49.79	1	32.28	14.59	-54.80%	63.21	46.40	-26.59%	Openable Windows	Medium
Type 25-N	49.79	20	27.72	13.54	-51.15%	48.15	41.79	-13.21%	Openable Windows	Slight
Type 25-R	49.79	2	29.94	14.51	-51.54%	55.46	46.21	-16.68%	Openable Windows	Medium
Type 26-F	59.38	1	32.29	14.65	-54.65%	66.28	49.37	-25.51%	Openable Windows	Not Significant
Type 26-N	59.38	8	26.69	12.96	-51.44%	47.83	40.06	-16.25%	Openable Windows	Not Significant
Type 26-R	59.38	1	31.77	13.71	-56.85%	64.54	43.28	-32.94%	Openable Windows	Slight
Type 27-FC	78.49	1	28.58	12.70	-55.56%	61.19	42.70	-30.22%	Openable Windows	Slight
Type 27-N	78.49	8	23.52	11.57	-50.81%	44.65	37.53	-15.95%	Openable Windows	Slight
Type 27-R	78.49	1	30.12	12.78	-57.57%	66.26	43.28	-34.68%	Openable Windows	Slight
Type 28-FC	35.96	1	38.04	15.89	-58.23%	60.30	43.57	-27.74%	Openable Windows	Medium
Type 28-N	35.96	8	31.46	14.58	-53.66%	41.75	37.27	-10.73%	Openable Windows	Slight
Type 28-R	35.96	1	40.92	16.45	-59.80%	68.40	46.95	-31.36%	Openable Windows	Slight
Type 29-FC	41.94	4	31.67	15.21	-51.97%	57.16	44.08	-22.88%	Openable Windows	Slight
Type 29-N	41.94	33	26.97	14.35	-46.79%	41.64	40.54	-2.64%	Openable Windows	Slight
Type 29-R	41.94	3	33.27	15.63	-53.02%	62.43	46.61	-25.34%	Openable Windows	Slight
Type 30-FC	72.74	1	27.36	12.82	-53.14%	56.38	42.84	-24.02%	Openable Windows	Slight
Type 30-N	72.74	9	23.45	12.05	-48.61%	43.53	39.15	-10.06%	Openable Windows	Slight
Type 31	131.77	1	24.97	12.94	-47.92%	46.32	46.38	0.12%	Openable Windows	Not Significant
Type 32	159.35	1	22.71	10.54	-53.99%	56.81	44.34	-21.52%	Openable Windows	Not Significant
Type 33	159.35	1	19.26	9.12	-52.65%	45.89	36.27	-20.96%	Openable Windows	Slight
Type 34-R	111.40	1	21.72	10.08	-53.59%	45.12	35.23	-21.92%	Openable Windows	Not Significant
Type 35-R	87.78	1	23.73	10.93	-53.94%	47.51	35.11	-26.10%	Openable Windows	Not Significant
Area Weighted Results	30829.45	538	27.83	13.37	-51.96%	52.58	45.42	-13.62%		0

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Option C - GSHP
12/03/2019

Parameters Used.

Category	Parameter	Value	Notes
External Fabric	External Wall U-Values (W/m²K)	0.18	As Calculated by BS EN ISO 6946
	Floor U-Values (W/m²K)	0.10	As Calculated by BS EN ISO 6946
	Roof U-Values (W/m²K)	0.10	As Calculated by BS EN ISO 6946
	Standard Glazing U-Value (W/m2K)	1.50	As Calculated by BS EN ISO 12567 or 10077 (U-Value includes glass and frame)
	g-Value (-)	0.42	
	Fraction Glazed (%)	90.00	Proportion of glass to overall opening size
Internal Walls	To Other Apartments	Fully Filled Cavity with Sealed Edges	
	To Corridors (W/m²K)	0.18	As Calculated by BS EN ISO 6946
	To Risers (W/m²K)	0.18	As Calculated by BS EN ISO 6946
	To Lift Shafts (W/m²K)	0.18	As Calculated by BS EN ISO 6946
	To Stair Wells (W/m²K)	0.18	As Calculated by BS EN ISO 6946
Thermal Mass	Thermal Mass Parameter (kJ/m²K)	141.5 - 356.9	
Thermal Bridging	Thermal Bridging y-value Range (Calculated)	Calculated	Thermal bridging calculations required
Thermal Bridging	See notes column	Calculated psi values	E2 - 0.026 E3 - 0.033 E4 - 0.010 E20 - 0.160 E7 - 0.070 P7 - 0.080 E15 - 0.049 E16 - 0.015 E17 - (-)0.036 E18 - 0.060 E25 - 0.060 P7 - 0.080
Air Permeability	Air Permeability Rate (m3/hm2 at 50Pa)	3.00	As stated on a test certificate from a person registered by an authorised air pressure testing scheme Note to use the measured air perm rate each dwelling has to be pressure tested. If a dwelling is not pressure tested the value used in the calculation is an average of the tested dwellings of the same type plus 2.
Mechanical Ventilation	Strategy	Balanced with Heat Recovery	
	SFP (W/l/s)	Kitchen +1 (0.62) Kitchen +2 (0.62) Kitchen +3 (0.66)	SAP Appendix Q Test Results
	Heat Exchange Efficiency (%)	Kitchen +1 (94.0) Kitchen +2 (93.0) Kitchen +3 (93.0)	SAP Appendix Q Test Results
	Installer approved	Yes	The installer has be registered with a Government Approved Scheme e.g. BESCA, Blue Flame Certification, Certsure, NAPIT and Stroma
	Duct Type	Rigid	All ductwork is rigid except for occasional flexible ducting to join components together
	Ductwork Insulated	Yes	Ductwork can be assumed to be insulated if all of the ductwork is inside the insulated envelope even if the ductwork itself is uninsulated.
Space Heating	Category	Communal	
	Ground Source Heat Pump - Fraction of Heat	1.00	As design specification
	Ground Source Heat Pump - Efficiency (%)	300.00	As calculated by SAP Appendix D
	Heat Distribution System	Pre-insulated low temperature, variable flow (1991 or later)	District heating specification
	Controls	Charging system linked to use, programmer and TRVs	
	Emitter	Underfloor (Screed)	
Water Heating	Type	From Main System	
	Plate Heat Exchanger	Yes	
	Volume (litres)	1	
	Insulation Type	Spray Foam	
	Insulation Thickness (mm)	30	
Renewables	Waste Water Heat Recovery	No	
	Type	PV Panels	
	Peak Power (kWp)	30.00	Peak power under 1kW/m² of radiation at 25°C
	Orientation	South	
	Tilt	30°	
Summertime Overheating	Openable Windows	Yes	
	Mechanical Ventilation Required	Yes	Applied to selected dwellings (see above)
	Blinds	Dark-coloured curtain or roller blind (Default)	

SAP Results Sheet.

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Dwelling Reference	Dwelling Area (m²)	No. of Dwelling Type	TER	DER	Criterion 1 DER/TER Variance	TREE	DFEE	Criterion 1 DFEE/TREE Variance	Criterion 3 Overheating Strategy	Criterion 3 Overheating Risk
Type 01-F	49.61	5	34.30	34.60	-0.92%	67.05	55.70	-16.93%	Openable Windows	Medium
Type 01-N	49.61	29	29.24	30.16	-3.18%	50.39	47.27	-6.19%	Openable Windows	Medium
Type 01-R	49.61	4	32.99	32.95	-0.12%	62.74	51.72	-17.56%	Openable Windows	Medium
Type 02-F	41.69	5	39.67	40.10	-1.08%	79.43	63.25	-20.37%	Openable Windows	Medium
Type 02-N	41.69	20	34.23	35.35	-3.22%	61.29	54.39	-11.26%	Openable Windows	Medium
Type 02-R	41.69	2	37.92	37.74	-0.47%	73.59	57.87	-21.36%	Openable Windows	Medium
Type 03-F	67.03	2	30.67	29.87	-2.61%	62.75	48.76	-22.29%	Openable Windows	Medium
Type 03-FC	67.03	2	30.67	29.08	-5.18%	62.75	46.44	-25.99%	Openable Windows	Medium
Type 03-N	67.03	20	25.96	25.84	-0.46%	46.95	40.89	-12.91%	Openable Windows	Medium
Type 03-R	67.03	3	29.32	28.52	-2.73%	58.21	45.48	-21.87%	Openable Windows	Medium
Type 04N-F	42.07	4	33.71	28.22	-16.29%	59.23	45.85	-22.59%	Openable Windows	Medium
Type 04N-N	42.07	20	30.51	25.39	-16.78%	48.47	40.06	-17.35%	Openable Windows	Medium
Type 04N-R	42.07	4	32.26	27.08	-16.06%	54.35	42.81	-21.23%	Openable Windows	Medium
Type 04S-F	42.07	2	37.68	35.14	-6.74%	72.72	59.80	-17.77%	Openable Windows	Medium
Type 04S-N	42.07	1	37.68	33.57	-10.91%	72.72	58.64	-23.49%	Openable Windows	Medium
Type 04S-R	42.07	26	34.34	31.74	-7.57%	61.58	53.46	-13.19%	Openable Windows	Medium
Type 04S-R	42.07	3	36.17	32.97	-8.85%	67.69	54.72	-19.16%	Openable Windows	Medium
Type 05-F	48.63	2	37.14	37.58	-1.18%	75.44	60.67	-19.58%	Openable Windows	Medium
Type 05-N	48.63	31	31.62	31.57	-0.16%	57.55	49.54	-13.92%	Openable Windows	Medium
Type 05-R	48.63	2	36.21	35.45	-2.10%	72.38	55.64	-23.13%	Openable Windows	Medium
Type 06-F	69.98	1	33.91	34.34	-1.27%	73.71	58.50	-20.63%	Openable Windows	Slight
Type 07-F	54.33	1	36.45	37.92	-4.03%	76.57	63.26	-17.38%	Openable Windows	Medium
Type 07-N	54.33	9	31.37	33.16	-5.71%	59.75	54.40	-8.95%	Openable Windows	Medium
Type 08N-F	70.01	1	33.44	33.89	-1.35%	73.74	57.44	-22.10%	Openable Windows	Slight
Type 08N-N	70.01	1	28.64	29.22	-2.02%	57.66	48.84	-15.30%	Openable Windows	Slight
Type 08N-R	70.01	9	33.50	31.89	-4.81%	73.93	52.76	-28.64%	Openable Windows	Medium
Type 08S-F	70.01	1	29.41	28.63	-2.65%	60.33	47.19	-21.78%	Openable Windows	Medium
Type 08S-N	70.01	9	24.75	24.40	-1.41%	44.76	38.95	-12.98%	Openable Windows	Medium
Type 08S-R	70.01	1	29.47	27.93	-5.23%	60.52	43.86	-27.53%	Openable Windows	Medium
Type 09-F	84.08	1	29.93	27.85	-6.95%	63.73	48.35	-24.13%	Openable Windows	Slight
Type 09-N	84.08	10	25.07	23.22	-7.38%	47.51	39.64	-16.56%	Openable Windows	Slight
Type 10N-FC	36.86	1	43.09	39.75	-7.75%	85.52	59.62	-30.29%	Openable Windows	Slight
Type 10N-N	36.86	8	35.44	36.65	-3.41%	59.99	54.79	-8.67%	Openable Windows	Slight
Type 10N-R	36.86	1	39.15	38.94	-0.54%	72.34	58.24	-19.49%	Openable Windows	Slight
Type 10S-FC	36.86	1	39.23	33.06	-15.73%	72.32	46.19	-36.13%	Openable Windows	Slight
Type 11-FC	41.63	1	40.12	37.55	-6.41%	80.38	57.95	-27.90%	Openable Windows	Slight
Type 11-N	41.63	3	36.89	35.58	-3.55%	69.59	55.00	-20.97%	Openable Windows	Slight
Type 11-R	41.63	1	38.37	36.22	-5.60%	74.53	55.61	-25.39%	Openable Windows	Slight
Type 12-FC	69.96	1	32.51	30.13	-7.32%	68.96	47.86	-30.60%	Openable Windows	Slight
Type 12-N	69.96	10	27.49	27.22	-0.98%	52.11	43.66	-16.22%	Openable Windows	Slight
Type 12-R	69.96	1	33.94	31.35	-7.63%	73.77	50.21	-31.94%	Openable Windows	Slight
Type 13-FC	48.68	1	32.74	29.19	-10.84%	60.37	42.51	-29.58%	Openable Windows	Slight
Type 14-FC	38.61	2	33.02	29.42	-10.90%	53.71	39.19	-27.08%	Openable Windows	Slight
Type 14-N	38.61	9	32.03	30.55	-4.62%	50.75	43.07	-15.13%	Openable Windows	Slight
Type 14-R	38.61	1	33.11	29.90	-9.69%	54.04	39.85	-26.26%	Openable Windows	Slight
Type 15N-FC	66.90	1	31.53	30.95	-1.84%	65.02	49.43	-23.98%	Openable Windows	Slight
Type 15N-N	66.90	7	23.08	24.33	-5.42%	36.77	37.39	1.69%	Openable Windows	Slight
Type 15N-R	66.90	1	30.42	30.69	0.89%	61.28	49.13	-19.83%	Openable Windows	Slight
Type 15S-F	66.90	1	27.74	27.95	0.76%	52.39	44.49	-15.08%	Openable Windows	Slight
Type 15S-FC	66.90	2	27.74	26.86	-3.17%	52.39	41.39	-21.00%	Openable Windows	Slight
Type 15S-N	66.90	26	23.08	24.33	-5.42%	36.77	37.39	1.69%	Openable Windows	Slight
Type 15S-R	66.90	3	26.66	26.53	-0.49%	48.76	40.91	-16.10%	Openable Windows	Slight
Type 16N-F	78.82	1	29.53	31.76	-7.53%	62.74	53.15	-15.29%	Openable Windows	Slight
Type 16N-FC	78.82	1	29.53	30.25	-2.44%	62.74	49.44	-21.20%	Openable Windows	Slight
Type 16N-N	78.82	19	28.97	28.16	-2.83%	48.70	46.50	-4.58%	Openable Windows	Slight
Type 16N-R	78.82	2	29.74	30.40	-2.22%	63.44	49.83	-21.45%	Openable Windows	Slight
Type 16S-F	78.82	1	27.17	28.53	-5.01%	55.09	47.03	-14.63%	Openable Windows	Slight
Type 16S-FC	78.82	1	27.17	27.53	-1.32%	55.09	44.35	-19.50%	Openable Windows	Slight
Type 16S-N	78.82	18	22.75	25.15	-10.55%	40.52	40.60	0.20%	Openable Windows	Slight
Type 16S-R	78.82	2	27.38	27.61	0.84%	55.78	44.61	-20.03%	Openable Windows	Slight
Type 17-N	70.15	3	25.80	27.99	-8.49%	47.10	45.31	-3.80%	Openable Windows	Slight
Type 18-N	48.80	3	24.70	22.74	-7.94%	33.50	29.35	-12.39%	Openable Windows	Slight
Type 19-R	70.81	1	32.39	28.40	-12.32%	69.59	44.68	-35.80%	Openable Windows	Slight
Type 20-R	50.66	1	34.26	32.76	-4.38%	67.54	49.55	-26.64%	Openable Windows	Slight
Type 21-F	54.70	1	38.27	38.99	1.88%	82.22	63.37	-22.93%	Openable Windows	Not Significant
Type 22-F	69.00	3	31.92	33.22	4.07%	67.30	55.23	-17.93%	Openable Windows	Slight
Type 22-N	69.00	20	27.14	28.69	5.71%	51.41	46.84	-8.89%	Openable Windows	Slight
Type 22-R	69.00	2	30.88	31.33	1.46%	63.83	50.80	-20.41%	Openable Windows	Slight
Type 23-N	38.54	12	37.71	35.32	-6.34%	69.28	55.05	-20.54%	Openable Windows	Slight
Type 23-R	38.54	1	38.62	38.07	-1.42%	72.36	58.72	-18.85%	Openable Windows	Slight
Type 24N-F	70.68	1	33.04	32.85	-0.58%	71.10	57.52	-19.10%	Openable Windows	Slight
Type 24N-N	70.68	10	30.28	30.03	-0.83%	61.82	52.38	-15.27%	Openable Windows	Slight
Type 24N-R	70.68	1	35.31	36.91	4.53%	78.78	63.51	-19.38%	Openable Windows	Slight
Type 24S-F	70.68	1	29.49	28.28	-4.10%	59.28	48.50	-18.18%	Openable Windows	Slight
Type 24S-N	70.68	10	26.78	25.69	-4.07%	50.20	43.49	-13.37%	Openable Windows	Slight
Type 24S-R	70.68	1	31.74	32.67	2.94%	66.87	55.48	-17.03%	Openable Windows	Slight
Type 25-F	49.79	1	31.49	29.70	-5.68%	56.84	47.72	-16.05%	Openable Windows	Slight
Type 25-FC	49.79	1	33.40	29.75	-10.93%	63.21	46.40	-26.59%	Openable Windows	Medium
Type 25-N	49.79	20	28.88	26.77	-7.31%	48.15	41.79	-13.21%	Openable Windows	Slight
Type 25-R	49.79	2	31.08	29.55	-4.92%	55.46	46.21	-16.68%	Openable Windows	Medium
Type 26-F	59.38	1	33.17	31.73	-4.34%	66.28	49.37	-25.51%	Openable Windows	Not Significant
Type 26-N	59.38	8	27.59	26.79	-2.90%	47.83	40.06	-16.25%	Openable Windows	Not Significant
Type 26-R	59.38	1	32.64	28.89	-11.49%	64.54	43.28	-32.94%	Openable Windows	Slight
Type 27-FC	78.49	1	29.26	27.12	-7.31%	61.19	42.70	-30.22%	Openable Windows	Slight
Type 27-N	78.49	8	24.22	23.88	-1.40%	44.65	37.53	-15.95%	Openable Windows	Slight
Type 27-R	78.49	1	30.79	27.36	-11.14%	66.26	43.28	-34.68%	Openable Windows	Slight
Type 28-FC	35.96	1	39.66	32.63	-17.73%	60.30	43.57	-27.74%	Openable Windows	Medium
Type 28-N	35.96	8	33.18	28.84	-13.08%	41.75	37.27	-10.73%	Openable Windows	Slight
Type 28-R	35.96	1	42.52	34.34	-19.24%	68.40	46.95	-31.36%	Openable Windows	Slight
Type 29-FC	41.94	4	33.01	31.73	-3.88%	57.16	44.08	-22.88%	Openable Windows	Slight
Type 29-N	41.94	33	28.37	29.31	3.31%	41.64	40.54	-2.64%	Openable Windows	Slight
Type 29-R	41.94	3	34.59	33.01	-4.57%	62.43	46.61	-25.34%	Openable Windows	Slight
Type 30-FC	72.74	1	28.10	27.19	-3.24%	56.38	42.84	-24.02%	Openable Windows	Slight
Type 30-N	72.74	9	24.22	24.96	3.06%	43.53	39.15	-10.06%	Openable Windows	Slight
Type 31	131.77	1	25.32	27.63	9.12%	67.62	46.38	-31.62%	Openable Windows	Not Significant
Type 32	159.35	1	23.03	23.12	0.40%	56.81	44.34	-21.42%	Openable Windows	Not Significant
Type 33	159.35	1	19.60	18.95	-3.32%	45.89	36.27	-20.96%	Openable Windows	Slight
Type 34-R	111.40	1	22.20	20.45	-7.88%	45.12	35.23	-21.92%	Openable Windows	Not Significant
Type 35-R	87.78	1	24.37	22.00	-9.73%	47.51	35.11	-26.10%	Openable Windows	Not Significant
Area Weighted Results	30829.45	538	28.81	28.64	-0.57%	52.58	45.42	-13.62%		0

SAP Results Sheet.

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Parameters Used.

Category	Parameter	Value	Notes		
External Fabric	External Wall U-Values (W/m²K)	0.18	As Calculated by BS EN ISO 6946		
	Floor U-Values (W/m²K)	0.10	As Calculated by BS EN ISO 6946		
	Roof U-Values (W/m²K)	0.10	As Calculated by BS EN ISO 6946		
	Standard Glazing U-Value (W/m2K)	1.50	As Calculated by BS EN ISO 12567 or 10077 (U-Value includes glass and frame)		
	g-Value (-)	0.42			
	Fraction Glazed (%)	90.00	Proportion of glass to overall opening size		
Internal Walls	To Other Apartments	Fully Filled Cavity with Sealed Edges			
	To Corridors (W/m²K)	0.18	As Calculated by BS EN ISO 6946		
	To Risers (W/m²K)	0.18	As Calculated by BS EN ISO 6946		
	To Lift Shafts (W/m²K)	0.18	As Calculated by BS EN ISO 6946		
	To Stair Wells (W/m²K)	0.18	As Calculated by BS EN ISO 6946		
Thermal Mass	Thermal Mass Parameter (kJ/m²K)	141.5 - 356.9			
Thermal Bridging	Thermal Bridging y-value Range (Calculated)	Calculated	Thermal bridging calculations required		
Thermal Bridging	See notes column	Calculated psi values	E2 - 0.026		
			E3 - 0.033		
Mechanical Ventilation	Strategy	Balanced with Heat Recovery	E4 - 0.010		
			E20 - 0.160		
			E7 - 0.070		
			P7 - 0.080		
			E15 - 0.049		
	SFP (W/l/s)	Kitchen +1 (0.62) Kitchen +2 (0.62) Kitchen +3 (0.66)	E16 - 0.015		
			E17 - (-)0.036		
			E18 - 0.060		
			E25 - 0.060		
			P7 - 0.080		
Air Permeability	Air Permeability Rate (m3/m2 at 50Pa)	3.00	As stated on a test certificate from a person registered by an authorised air pressure testing scheme		
			Note to use the measured air perm rate each dwelling has to be pressure tested. If a dwelling is not pressure tested the value used in the calculation is an average of the tested dwellings of the same type plus 2.		
Mechanical Ventilation	SFP (W/l/s)	Kitchen +1 (0.62) Kitchen +2 (0.62) Kitchen +3 (0.66)	SAP Appendix Q Test Results		
			Heat Exchange Efficiency (%)	Kitchen +1 (94.0) Kitchen +2 (93.0) Kitchen +3 (93.0)	SAP Appendix Q Test Results
	Installer approved	Yes	The installer has been registered with a Government Approved Scheme e.g. BESCA, Blue Flame Certification, Certsure, NAPIT and Stroma		
	Duct Type	Rigid	All ductwork is rigid except for occasional flexible ducting to join components together		
	Ductwork Insulated	Yes	Ductwork can be assumed to be insulated if all of the ductwork is inside the insulated envelope even if the ductwork itself is uninsulated.		
Space Heating	Category	Individual - Room Heaters			
Water Heating	Type	Immersion			
	Cylinder in Dwelling	Yes			
	Loss Factor (kWh/day)	0.94			
	Volume (litres)	120			
	Waste Water Heat Recovery	No			
Renewables	Type	PV Panels			
	Peak Power (kWp)	30.00	Peak power under 1kW/m² of radiation at 25° C		
	Orientation	South			
	Tilt	30°			
Summertime Overheating	Openable Windows	Yes			
	Mechanical Ventilation Required	Yes	Applied to selected dwellings (see above)		
	Blinds	Dark-coloured curtain or roller blind (Default)			

Appendix D – Calculation of Results using SAP 10 Carbon Factors.

SAP Results.

Phase 1 - Station Hill

	Overall Area-weighted		
	DER	TER	DER/TER Variance
Option A - CHP	12.9	19.05	-32.3
Option B - ASHP	17.5	27.8	-37.1
Option C - GSHP	13.4	27.8	-51.8
Option D - Electric	28.6	28.8	-0.7

SAP 2012.

Representative dwelling		
DER	TER	DER/TER Variance
12.8	19.0	-32.5
17.5	27.9	-37.2
13.4	27.9	-52.0
27.2	27.5	-1.0

SAP 10.

Representative dwelling		
DER	TER	DER/TER Variance
16.8	17.0	-1.3
7.9	17.8	-55.8
6.0	17.8	-66.2
12.2	17.5	-30.1

Calculations from DER and TER Worksheets.

Calculation of DER.

SAP 2012.

Carbon Factors		OPTION A		OPTION B		OPTION C		OPTION D	
TFA			70.0100		70.0100		70.0100		69.9600
Space Heating CHP	0.216	2293.4746	495.3905	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Credit Elec	0.519	-729.3249	-378.5196	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Water Heating CHP	0.216	2765.9476	597.4447	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Credit Elec	0.519	-879.5713	-456.4975	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ASHP	0.519	0.000	0.0000	1855.1215	962.8081	0.0000	0.0000	0.0000	0.0000
Boilers (Gas)	0.216	1750.9012	378.1947	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
GSHP	0.519	0.0000	0.0000	0.0000	0.0000	1298.5850	673.9656	0.0000	0.0000
Direct Elec SH	0.519	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1627.3917	844.6163
Direct Elec DHW	0.519	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1582.9280	821.5396
Community	0.519	38.9576	20.2190	38.9576	20.2190	38.9576	20.2190	0.0000	0.0000
Pumps and Fans	0.519	205.2028	106.5003	205.2028	106.5003	205.2028	106.5003	195.1342	101.2746
Lighting	0.519	310.6671	161.2362	310.6671	161.2362	310.6671	161.2362	312.7086	162.2958
PV Savings	0.519	-48.363	-25.1002	-48.3627	-25.1002	-48.3627	-25.1002	-48.3627	-25.1002
			898.8680		1225.6633		936.8208		1904.6261
DER			12.84		17.51		13.38		27.22

SAP 10.

Carbon Factors		OPTION A		OPTION B		OPTION C		OPTION D	
TFA			70.0100		70.0100		70.0100		69.9600
Space Heating CHP	0.210	2293.4746	481.6297	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Credit Elec	0.233	-729.3249	-169.9327	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Water Heating CHP	0.210	2765.9476	580.8490	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Credit Elec	0.233	-879.5713	-204.9401	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ASHP	0.233	0.000	0.0000	1855.1215	432.2433	0.0000	0.0000	0.0000	0.0000
Boilers (Gas)	0.210	1750.9012	367.6893	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
GSHP	0.233	0.0000	0.0000	0.0000	0.0000	1298.5850	302.5703	0.0000	0.0000
Direct Elec SH	0.233	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1627.3917	379.1823
Direct Elec DHW	0.233	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1582.9280	368.8222
Community	0.233	38.9576	9.0771	38.9576	9.0771	38.9576	9.0771	0.0000	0.0000
Pumps and Fans	0.233	205.2028	47.8123	205.2028	47.8123	205.2028	47.8123	195.1342	45.4663
Lighting	0.233	310.6671	72.3854	310.6671	72.3854	310.6671	72.3854	312.7086	72.8611
PV Savings	0.233	-48.363	-11.2685	-48.3627	-11.2685	-48.3627	-11.2685	-48.3627	-11.2685
			1173.3014		550.2496		420.5766		855.0634
DER			16.76		7.86		6.01		12.22

Calculation of TER.

SAP 2012.	Carbon Factors	OPTION A		OPTION B		OPTION C		OPTION D	
TFA			70.0100		70.0100		70.0100		69.9600
Space Heating	0.216	3228.9913	697.4621	3228.9913	697.4621	3228.9913	697.4621	2878.1786	621.6866
Water Heating	0.216	1998.9321	431.7693	1998.9321	431.7693	1998.9321	431.7693	2244.1011	484.7258
Pumps and Fans	0.519		75 38.9250		75 38.9250		75 38.9250		75 38.9250
Lighting	0.519	314.5079	163.2296	314.5079	163.2296	314.5079	163.2296	325.8318	169.1067
			1168.1565		1168.1565		1168.1565		1145.3374
Fuel Factor		1		1.55		1.55		1.55	
TER			19.02		27.89		27.89		27.49

SAP 10.	Carbon Factors	OPTION A		OPTION B		OPTION C		OPTION D	
TFA			70.0100		70.0100		70.0100		69.9600
Space Heating	0.210	3228.9913	678.0882	3228.9913	678.0882	3228.9913	678.0882	2878.1786	604.4175
Water Heating	0.210	1998.9321	419.7757	1998.9321	419.7757	1998.9321	419.7757	2244.1011	471.2612
Pumps and Fans	0.233		75 17.4750		75 17.4750		75 17.4750		75 17.4750
Lighting	0.233	314.5079	73.2803	314.5079	73.2803	314.5079	73.2803	325.8318	75.9188
			1115.3389		1115.3389		1115.3389		1093.1537
Fuel Factor		1		1.05		1.05		1.05	
TER			16.98		17.76		17.76		17.48



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