

71-73 CAVERSHAM ROAD

Reading

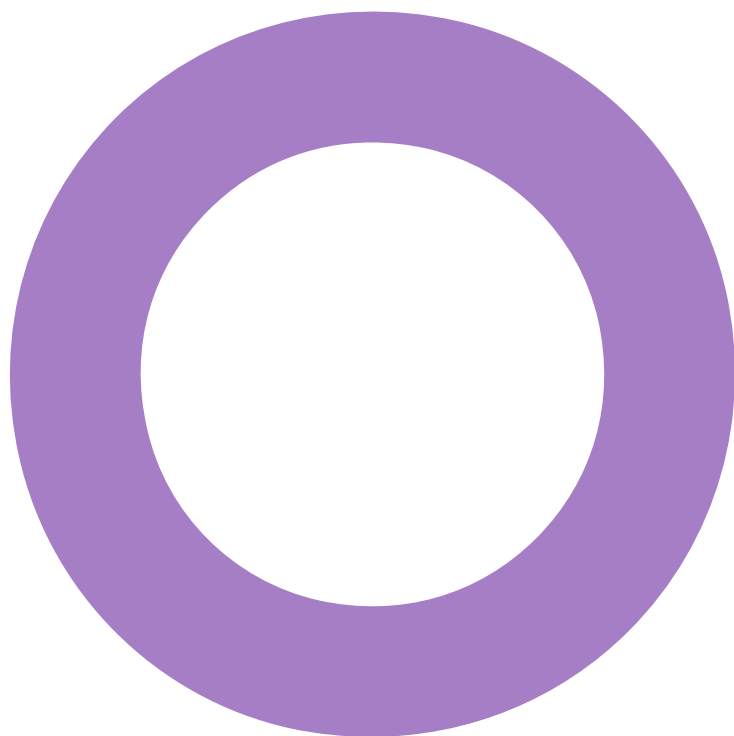
Energy Strategy



**71-73 Caversham Rd.
Reading.
S2 Estates.**

SUSTAINABILITY
ENERGY STRATEGY

REVISION 01 – 06 OCTOBER 2022



Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
00	11/03/2022	Initial Issue	JP	JT	KC
01	06/10/2022	Attached calculation documents	JP	JT	JN

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Executive Summary.

The following provides a summary of the Energy Strategy for the proposed Caversham Rd development located in Reading.

The proposed development

The proposed development of a ground floor commercial unit and 29 apartments. The commercial unit will be developed as a ‘shell only’ assessment.

Targets

A policy review has been undertaken and the details are outlined in Section 2 of this document. Reading Borough Council local plan was updated in 2019 to reflect their emerging strategy. This will manage developments in the reading area until 2036. To this end, this Energy Strategy has been developed to meet the requirements of the recently adopted plan. The Proposed Development is targeting:

- Zero Carbon Homes for the residential section.
- Maximisation of energy efficient features and the integration of renewable and low carbon energy.
- Compliance with Part L2A of the building regulations for the commercial unit.

The Sustainable Design and Construction SPD states that where it is not possible to achieve Zero Carbon on site, an S106 contribution can be made towards the remaining tonnes of CO₂ produced on site.

Energy strategy summary: Residential

The strategy has been developed using the ‘Be Lean, Clean, and Green’ energy hierarchy which utilises a fabric first approach to maximise the reduction in energy through passive design measures.

The following table provides a summary of the energy strategy for the Proposed Development:

No L2C	13.5% betterment achieved against a Part L baseline. High energy efficient building fabric and building services have been utilised to reduce carbon emissions and energy demand through good practice passive and energy efficiency measures.
With ASHP	A further 63.4% betterment is achieved through the use of ASHP. Air source heat pumps are proposed to be installed to provide space heating as well as domestic hot water.
With PV	A further 12.5% betterment is achieved through Solar PV. Renewable energy from the proposed PV's is to be implemented in the scheme. It has been estimated that a 164 m ² of PV would provide 28,800 kWh/year, depending on the efficiency of the PV panel.

Table 1: Energy strategy summary – Residential.

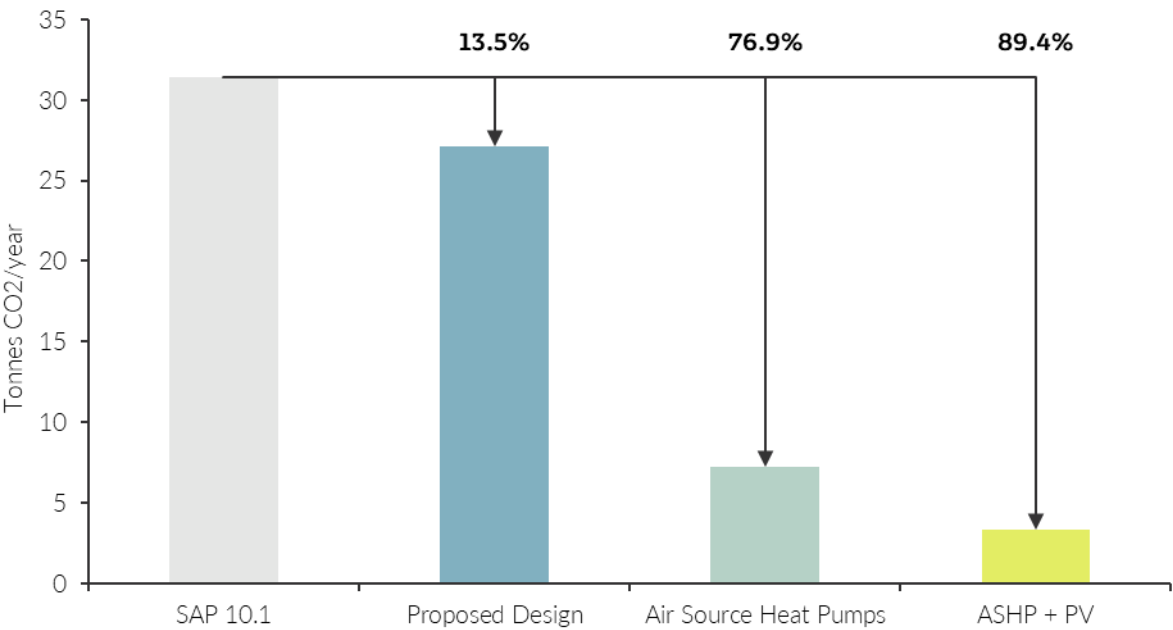


Figure 1: Summary of the estimated carbon reduction by the Proposed Development - Residential:

Results: Residential

Through the measures outlined in the energy strategy, it is anticipated that a 89.4% reduction in CO₂ emissions can be achieved in comparison to a Building Regulations Part L compliant baseline. In line with the Sustainable Design and Construction SPD, an S106 contribution will be provided to offset the remaining tonnes of CO₂ – this is estimated to be £6,001.

Energy strategy summary: Commercial

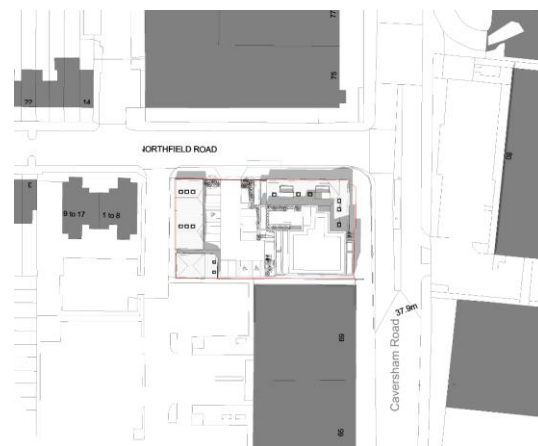
As discussed in Section 3.2 the commercial areas of the Proposed Development have been assessed as ‘shell only’. Initial simulations based on the inputs provided in Appendix B show that the commercial unit could achieve a Building Emission Rate (BER) of 29.2 kgCO₂/m² when compared to the Notional Building’s Target Emission Rate (TER) of 30.7 kgCO₂/m², leading to a 5% decrease in carbon emissions when compared to a Part L 2013 baseline.

1. Introduction.

This strategy has been prepared on behalf S2 Estates in support of the proposed Caversham Rd development located in Reading. This strategy summarises the relevant regulatory and planning policies applicable to the proposed development and sets out how the proposed development will address and achieve the relevant policy targets.



Northfield Road Elevation



Caversham Road Elevation

Figure 2 Proposed Development Location

The Caversham Rd development consists of a mixture of residential and commercial units. The commercial unit is located on the ground floor with 6 stories of residential apartments.

The residential development consists of 29 apartments located above a commercial unit, associated services and stores.

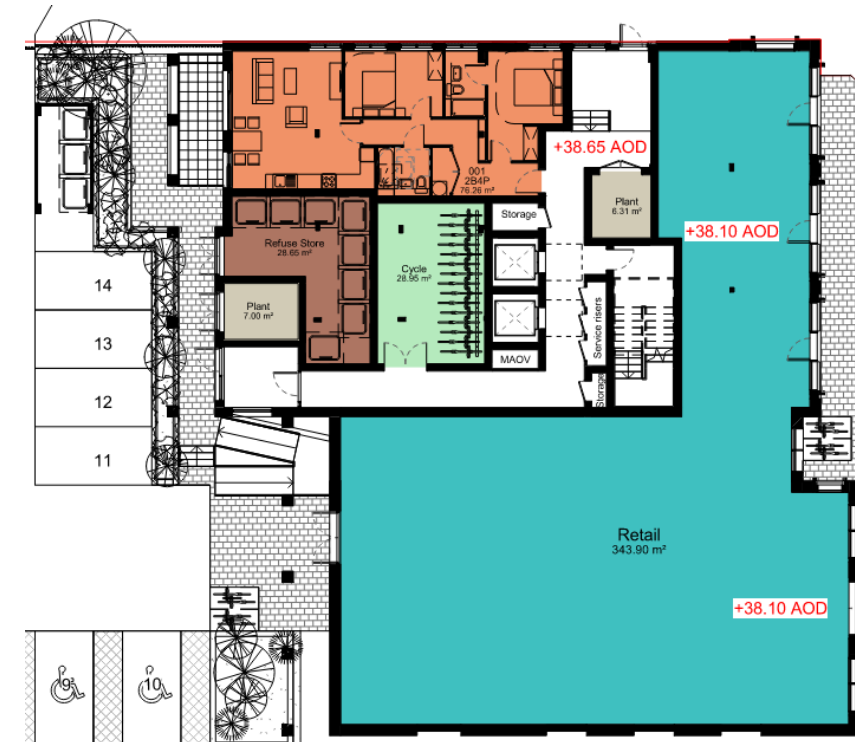


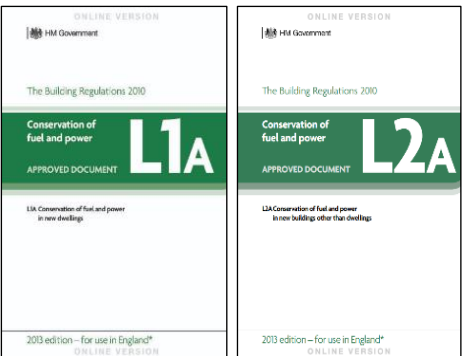
Figure 3: Proposed Ground floor commercial space

The commercial unit will be developed as “shell only”.

2. Policy and Drivers

The following section outlines the national and local policies and drivers.

2.1 Building Regulations Part L (2013)

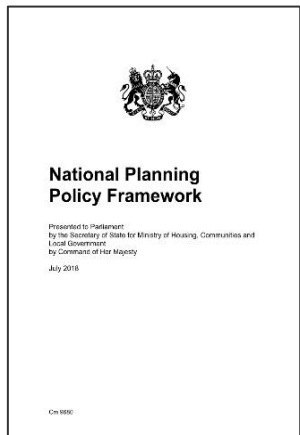


Part L of the Building Regulations is the mechanism by which UK central government is driving reductions in the regulated CO₂ emissions from new buildings. It consists of 5 criteria (listed below) It is split into 2 documents for domestic and non-domestic developments. Each document addresses the same first three criteria, which are applicable in the design stage of a project

- Criterion 1 – Achieving the Target CO₂ Emission Rate (TER) & Fabric Efficiency targets (TFEE)
 - Criterion 2 – Limits on design flexibility
 - Criterion 3 – Limiting the effects of solar gain in summer
 - Criterion 4 – Building performance consistent with BER
 - Criterion 5 – Providing information
- } Design Stage
- } Post Construction Stage

Part L1A is concerned with domestic buildings while Part L2A covers all non-domestic buildings.

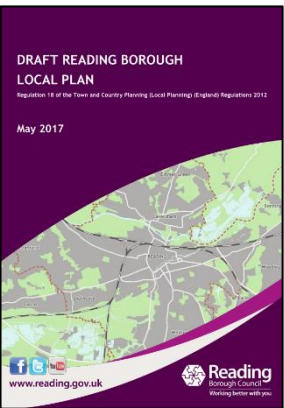
2.2 National Planning Policy Framework



The National Planning Policy Framework (NPPF) was revised in July 2021 and superseded all Planning Policy Statements (PPS) and Planning Policy Guidance (PPG) documents. The National Planning Policy Framework sets out the Government's economic, environmental and social planning policies for England. In combination, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations.

It provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities. The NPPF states that: "Planning law requires that applications for permission be determined in accordance with the development plan [local plans], unless material considerations indicate otherwise".

2.3 Reading Borough Local Plan and Updated SPD



The planning policy identifies that all major residential new housing is built to a zero carbon homes standard. Major developments consist of developments greater than 10 dwellings or over 1000 sqm of non-residential floorspace. Under this definition the site is considered to be a Major development.

Whilst there are carbon emission targets for residential development there are no specific targets for non-domestic development and therefore, as above, the targets are achieved through compliance with Building Regulations Part L2A.

Policy CC4 requires that assessment of decentralised heating energy technologies are to be considered, for developments over 20 dwellings and/or non-residential development of over 1,000 sqm. These technologies are identified to include a variety of technologies, including Low and Zero Carbon (LZC) technologies such as heat pumps.

The Sustainable Design and Construction SPD (2019) further details the target for major developments to achieve zero carbon and states that should a development fail to reach Zero Carbon on site, the remaining tonnes of CO₂ can be offset via Section 106 contributions of £1,800 per remaining tonne towards carbon offsetting within the Borough (calculated as £60/tonne over a 30 year period).

3. Energy Modelling -Approach and Methodology.

3.1 Energy Hierarchy

This strategy outlines how the proposed development will have a reduced impact on climate change by reducing CO₂ emissions associated with energy use in buildings.

Figure 4 below outlines the route followed by the proposed development when reducing CO₂ emissions and defines the structure of this statement.

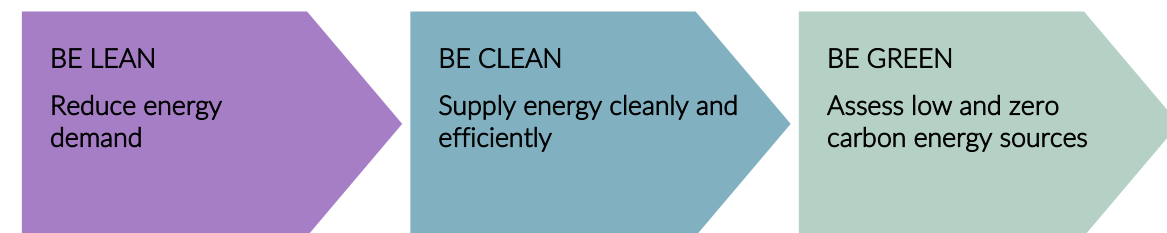


Figure 4: Energy Hierarchy

The strategic approach to the design of the proposed scheme has been to reduce demand for energy prior to the consideration of integrating Low or Zero Carbon (LZC) technologies, since controlling demand is the most effective way of reducing energy requirements and CO₂ emissions.

Further reductions are ensured through the specification of high-efficiency building services and controls to limit losses in energy supply, storage and distribution.

After the inclusion of passive design and energy efficiency measures, various options have been investigated to reduce CO₂ emissions associated with energy supply. The feasibility of LZC technologies has been investigated in line with the policy aspirations and as part of the Energy Strategy submitted in support of the application.

3.2 Methodology & Limitations

Assessments of the energy requirements and associated CO₂ emissions for the proposed development have been carried out using 'Standard Assessment Procedure' (SAP) calculations for a number of sample dwellings within the Proposed Development.

It is assumed that the commercial unit will achieve compliance with Part L2A of the Building Regulations. Initial calculations using Part L2A complaint modelling software have been conducted to demonstrate that compliance can be achieved through passive and active design measures.

The appraisals within this strategy should not be understood as a predictive assessment of likely future energy requirements or otherwise.

Occupants may operate their systems differently, and / or the weather may be different from the assumptions made by Part L approved calculation methods, leading to differing energy requirements.

3.3 Fabric First Approach

A 'fabric first' approach has been taken in order to reduce the energy demand and CO₂ emissions from the Proposed Development. The overriding objective for the façade design of the building will be to achieve the optimum balance between providing natural daylighting benefits to reduce the use of artificial lighting and limiting summertime solar gains to reduce space cooling demands.

Part L1A 2013 of the Building Regulations introduced criteria referred to as the 'FEE'. The Fabric Energy Efficiency (FEE) is influenced by factors such as glazing proportion, solar energy, air leakage and thermal bridges.

The FEE accounts for the dwelling's combined annual heating and cooling load. For reference the 'Notional' dwelling uses a glazing ratio of 25% (of the floor area). It should be noted that for FEE compliance, each dwelling does not need to comply on an individual basis, as the assessment can be aggregated over the whole building on an area weighted (average) basis.

Similarly, Part L2A details minimum fabric performance targets for non-domestic developments.

Appendix B details the target fabric and system performance parameters.

3.4 Grid decarbonisation

The UK has seen substantial progress transitioning from an energy supply sector served primarily from burning coal to a wide scale uptake of both grid- and local-scale renewable energy. The Future Energy Scenarios are produced annually by the National Grid and discusses how the UK's energy landscape is likely to change between now and 2050. These scenarios are shown in the figure below. As shown, the carbon factor for electricity has reduced by two thirds since 2012, reflecting the significant uptake of renewable energy on the UK electricity grid. As a consequence of decarbonisation to date, and further expected in the future, there is typically a shift away from traditional means of servicing buildings (such as gas boilers and CHP) to all electric solutions such as air source heat pumps.

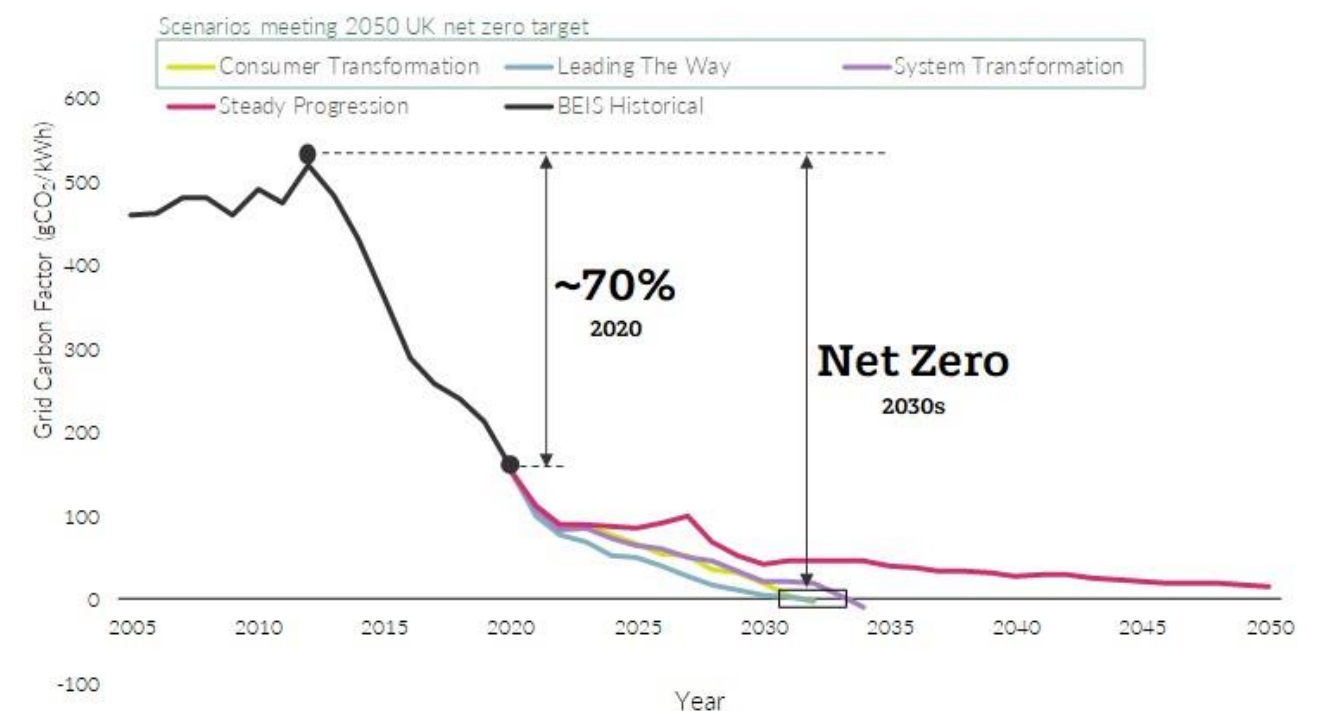


Figure 5: Historic and future projected carbon factor for the National Grid. Transmission and distribution losses are included. Sources: BEIS Green Book (historic carbon factors); National Grid Future Energy Scenarios (FES) 2020 (future projected carbon factors).

Part L 2021 regulation changes

The Approved Document's Part L1 2021 and Part L2 2021 were publicly released on the 15th December 2021 and will come into force on the 15th June 2022. Due to the magnitude of the changes, this is likely to stimulate one of the most significant changes in non-domestic construction strategy that has ever occurred. England's Building Regulations were last updated eight years ago. With the substantive changes to the UK energy landscape, Part L 2013 is misrepresentative and no longer fit-for-purpose. The Part L 2021 will act as an interim update to the Future Home Standard and Future Building Standards which are expected to come into full application by 2025.

The main updates to Part L 2021 are as follows:

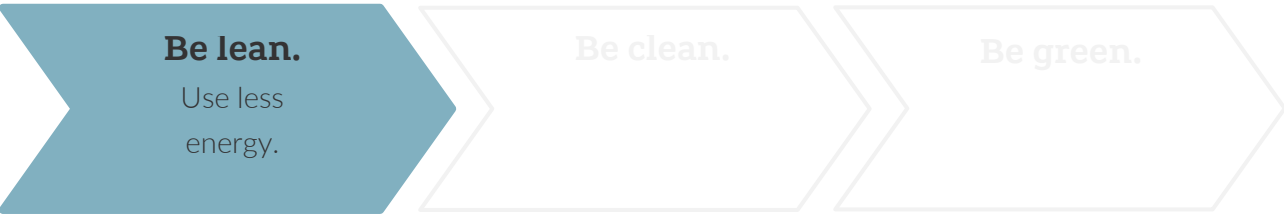
- No gas boiler ‘ban’ in 2025, but regulations such that fossil fuel heating will not achieve compliance.
- Local planning authorities will retain powers to set higher energy efficiency targets than building regulations.
- A home built to Part L 2021 standards will emit 31% less CO₂ on average than one built to current standards (Part L 2013).
- A new non-domestic building built to Part L 2021 standards (NCM 2021) will deliver a 27% reduction in CO₂ emissions on average across the new non-domestic building mix relative to Part L 2013.
- Primary energy target introduced. Fabric Energy Efficiency target retained.
- A varying carbon factor associated with grid electricity which is 73% lower on average than Part L 2013.
- Heat network ‘technology factors’ scrapped – homes connected to heat networks will need to meet the full primary energy, emission, and fabric energy efficiency rate.
- All new homes to be air tightness tested.
- Transitional arrangement will be valid for 12 months from adoption of Part L 2021, but apply to individual buildings, rather than development sites.

The formal calculation methodology and associated software for this version of building regulations has not yet been issued (March 2022) and therefore, implications for the project's performance against building regulations compliance cannot be appraised.

For the purpose of this energy strategy, the updated SAP 10.1 carbon factors have been used in order to quantify the carbon emission targets. As previously discussed, these carbon factors are a closer representation of the current carbon intensity of the electricity grid and therefore would be more appropriate than the Part L 2013 carbon factors for estimating potential carbon emission savings.

4. Be Lean.

Passive design and energy efficiency measures form the basis for the reduction in overall energy demand and carbon emissions for the proposed development. This energy strategy aims to reduce the energy demand initially by optimising the envelope and building services within the development.



4.1 Passive Design and energy efficiency

Passive Design measures are those which reduce the demand for energy within buildings, without consuming energy in the process.

These are the most robust and effective measures for reducing CO₂ emissions as the performance of the solutions, such as wall insulation, is unlikely to deteriorate significantly with time, or be subject to change by future property owners. In this sense, it is possible to have confidence that the benefits provided by these measures will continue at a similar level for the duration of their installation.

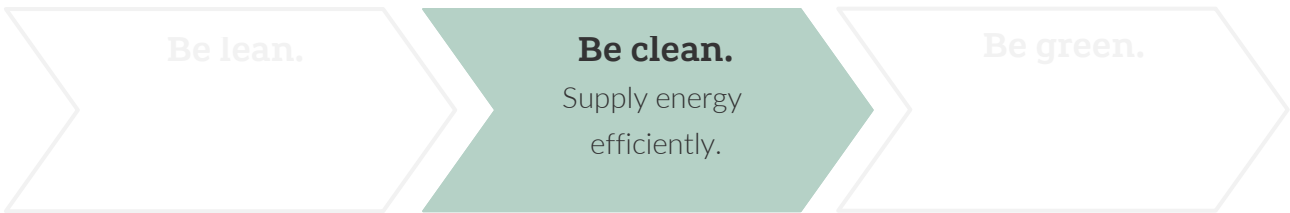
	Thermal Insulation The Proposed Development will benefit from an efficient thermal envelope. Heat losses and gains will be controlled by the optimisation of the fabric of each building, i.e. ensuring appropriate levels of glazing to control winter heat loss and summer heat gain. Reducing the thermal transmittance of the building envelope where appropriate will help to reduce both heating and cooling requirement and result in lower energy requirements. As some elements of the existing façade are being retained, an improved thermal performance of these elements are targeted.
	Ventilation Both the residential and commercial areas will utilise mechanical ventilation to provide fresh air to the occupied spaces. In order to reduce the energy consumption associated with the ventilation, the following measures are proposed: - High efficiency ventilation units with low SFPs. - High efficiency heat recovery systems.
	Lighting Lighting loads are also expected to be significant. Therefore, it is anticipated that the Proposed Development will be supplied with efficient electric lighting fittings such as ‘Light Emitting Diodes’ (LED) and will incorporate automatic lighting controls including presence or absence detection and daylight dimming. High efficiency display lighting will be required for the commercial space.

Table 2: Be lean measures

Appendix B contains the targets for fabric and system performance.

5. Be Clean.

This stage of the energy hierarchy refers to the use of heat networks or on-site Combined Heat and Power (CHP) in order to provide energy and reduce consumption from the national grid and gas networks, through the generation of electricity, heating and cooling on-site.



5.1 Development Demand

The proposed domestic development's approximated thermal demand has been initially calculated to be approximately 80% compared to 20% for non-thermal demand.

5.2 Be Clean: Network and technologies

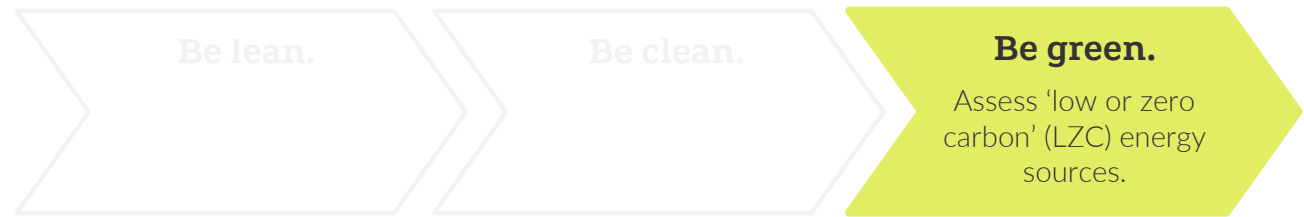
Due the proposed changes to the carbon emission factors in future revisions of Part L – the use of Combined Heat and Power (CHP) is likely to offer a 'negative benefit' within the next five years and therefore has not been explored as part of the energy strategy.

	District heat networks No suitable district heat networks have been identified for this site.
	Combined heat and power (CHP) The rapid decarbonisation of the electricity grid, as explained in Section 3.4, has greatly reduced the carbon emission saving potential of CHP, as it relies on burning fossil fuel to generate electricity. Using the SAP10.1 carbon emission factors, which are a closer representation of the current carbon intensity of the electricity grid than those in Part L 2013, the use of CHP would result in an increase in the carbon emissions when compared to a traditional arrangement of gas boilers and grid electricity. As the carbon intensity of the grid electricity decreases, the use of CHP will become less favourable. Therefore, a CHP is not proposed for be installed in the development.

Table 3: Be Clean measures

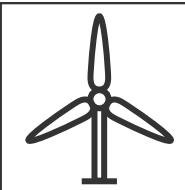
6. Be Green.

The final step of the energy hierarchy explores the feasibility of Low and Zero Carbon (LZC) technologies to allow for the production of renewable energy onsite in order to offer a further reduction in carbon emissions.



6.1 Be Green: Low and Zero Carbon Technologies (LZC)

	Photovoltaics Photovoltaic panels harness energy from daylight and convert this into useful energy in the form of electricity. A PV system requires viable roof space in order for the system array to be installed and function effectively. Suitability to proposed development: With developments moving towards more electric based schemes, PV has become the most suitable for LZC technologies. The PV will help reduce the energy demand of the development meaning that less money will need to be put towards offsetting the remaining carbon emissions of the site.
	Solar thermal 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. Suitability to proposed development: Solar thermal technology would have a peak output in summer when less heat is needed, while the output would be significantly reduced in the winter months when the demand is higher, which would affect the carbon saving potential of the system. Additionally, the available roof area would be better utilised for the installation of PV panels.
	Air source heat pump Air Source Heat Pumps (ASHP) use a refrigeration cycle to extract heat from the air. The efficiency of the system is therefore dependent on outside air temperature. Suitability to proposed development: Air source heat pumps (ASHP) are an efficient way of providing both space heating and domestic hot water. Given the primary thermal demand of the site a community ASHP system with heat exchange units would be one of the most effective ways to provide a significant reduction in the domestic carbon emissions. However, external plant would be required and noise from the external units would also require consideration.

	Ground source heat pump Ground source heat pumps utilise either water extracted from an aquifer (open loop) or a fluid circulated within underground pipework (closed loop) as the heat source in a refrigeration process enabling them to produce hot water, typically at around 45°C, that can be used as a heating medium 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. Suitability to proposed development: While GSHP typically offer better efficiencies than ASHP, the capacity will be limited by the number and depth of the boreholes. Additionally, an annual balance between heating and cooling demand is generally recommended in order to ‘recharge’ the ground in the summer by pumping heat back to the ground when the heat pumps are running in cooling mode. Installation of a ground energy system would require a high capital cost and would have an impact on the construction programme. The lack of a cooling demand to provide adequate recharge serves as an additional barrier to the implementation of GSHP on this scheme. For these reasons, this technology has not been proposed for the scheme.
	Wind turbine 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). For efficient operation and to yield high energy output, wind turbines require a smooth laminar flow of air. Suitability to proposed development: The installation of wind turbines will have a considerable visual impact on the site. Moreover, mounting wind turbines on the roofs of the Proposed Development could result in unacceptable vibration and resonance being felt within the occupied spaces. The turbines are also likely to generate noise which may be a nuisance to neighbouring properties. This scenario could result in the turbines being switched off. Even if a suitable location could be found, the output of a wind turbine and the consequential carbon dioxide savings are likely to be very limited when compared to the emissions of the whole development. Considering the impacts described above, the use of wind turbines is not proposed for the proposed development.
	Biomass 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. Suitability to proposed development: Large fuel storage volumes are required to maintain continuous operation during the winter months. As such, area take for such plant is high. Fuel deliveries and security of fuel supply are

	also important considerations. Additionally, exhaust gases would require significant treatment to avoid degrading local air quality. Biomass boilers are therefore not proposed for the development.
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Table 4: Be Green measures

6.2 Proposed Technologies

When addressing the third tier of the Energy Hierarchy, the aim is to integrate low and zero carbon technologies that are appropriate to the design of the buildings at the development. Furthermore, the integration of renewables must not compromise or detract from the adoption of energy efficiency measures and decentralised energy infrastructure.

The 2035 plan was addressed when evaluating the suitable LZO for site. As the site is considered a “major” development under the Reading plan, a Zero Carbon strategy must be targeted for site. A community ASHP system for heating and DHW generation has been selected as the most suitable LZO technology for site. It is important to note that some roof space will be required for the deployment of ASHPs.

Furthermore, PV has been determined to be a suitable technology to support the ASHP system in achieving a Zero Carbon strategy.

The technologies defined here are based on indicative levels of performance. As the design progresses, a full MEP design review should be completed to validate the intended approach.

7. Results

7.1 Criterion 1a: Achieving the Carbon Emissions Target

The SAP calculations undertaken as part of this energy strategy indicates that the evaluated development meets the targets defined within the Building Regulations Part L1A.

Through the uses of fabric first measures and high efficiency systems the proposed domestic development has been shown to achieve a 12.3% reduction in regulated carbon emissions when compared to a SAP 10.1 baseline building.

ASHPs have been identified as the most suitable technology for the scheme. Based on initial design estimates (detailed in Appendix B) it has been shown that ASHPs would achieve a further 63.4% reduction in regulated carbon emissions, bringing the total building regulated carbon reduction to an 85.7% improvement.

Site		Carbon Dioxide Emissions (tonnes CO2 per annum)	Regulated Carbon Dioxide Emission Savings (tonnes CO2 per annum)	Percentage improvement (%)
SAP 10.1	(Part L Compliant)	31	-	0
Be Lean	(Proposed)	27	4	13.5
Be Clean	(N/A)	27	-	0
Be Green	(Air Source Heat Pumps)	7	20	63.4
Total			24	76.9

Table 5: Reduction in carbon emissions.

It has been estimated that approximately 164m² is available for PV panel deployment on the roof of the proposed development. A PV array of this size could generate ~32 kWp depending on the efficiency of the installed panel. With an assumed solar irradiance of 900 kWh/m²/year and panel efficiency of 0.32 kWp/panel it is estimated that the proposed PV array could generate 28,800 kWh/year.

The effects of the PV have been demonstrated below showing that with the use of a roof mounted PV array in conjunction with the proposed ASHP the onsite carbon emission could be reduced by 89.4% when compared to a Part L compliance baseline.

Site		Carbon Dioxide Emissions (tonnes CO2 per annum)	Regulated Carbon Dioxide Emission Savings (tonnes CO2 per annum)	Percentage improvement (%)
SAP 10.1	(Part L Compliant)	31	-	0
Be Green	(Air Source Heat Pumps)	7	24	76.9
Be Green	(ASHP+Roof PV)	3	28	89.4

Table 6: PV Reduction

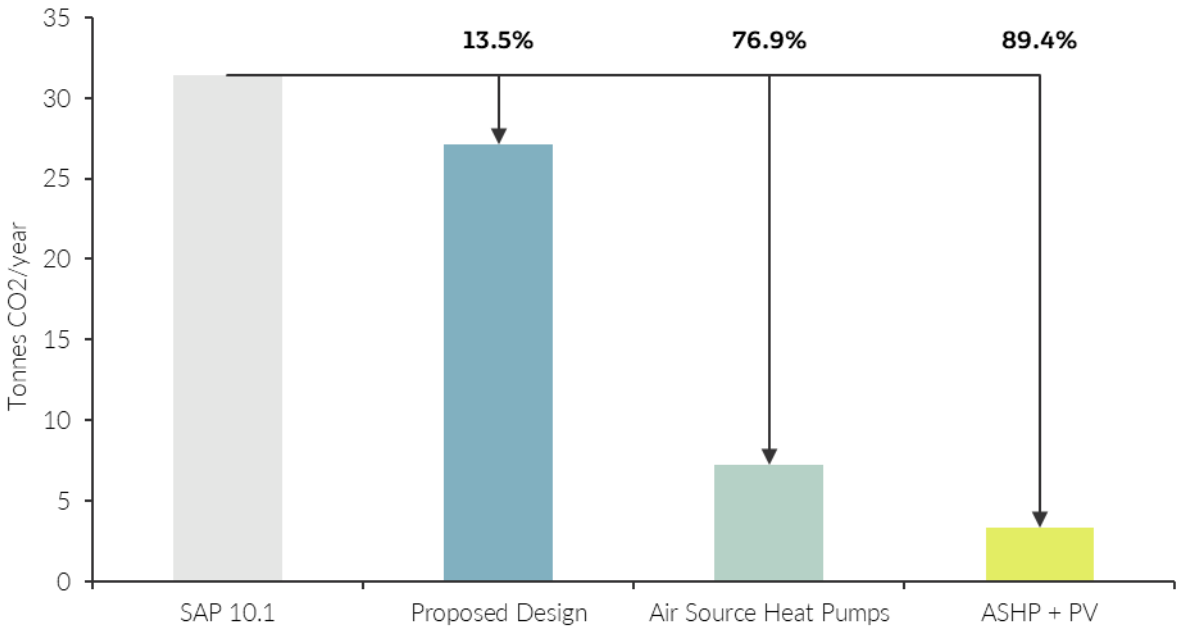


Figure 6: Summary of the estimated total carbon reduction achieved by the Proposed Development – Residential

The Sustainable Construction Supplementary Planning Document for the Reading Borough confirms that if achieving Zero Carbon is not possible on site, a Section 106 contribution can be provided. The rate of this S106 contribution is £1,800 per remaining tonne of carbon emissions.

The proposed development achieves an 89.4% improvement over a Part L compliant baseline emission of 31 TonnesCO₂/year. The remaining 10.6% (3.3 tonnesCO₂/year) could be offset via a S106 contribution approximately equal to £6,001.

If a more efficient PV panel were to be used the amount of carbon offset on site would increase and the S106 contribution required would be reduced accordingly. Inversely, if a less efficient panel was to be used the S106 contribution may increase.

As discussed in Section 3.2 the commercial areas of the Proposed Development have been assessed as ‘shell only’. Initial simulations based on the inputs provided in Appendix B show that the commercial unit could achieve a Building Emission Rate (BER) of 29.2 kgCO₂/m² when compared to the Notional Building’s Target Emission Rate (TER) of 30.7 kgCO₂/m², leading to a 5% decrease in carbon emissions when compared to a Part L 2013 baseline.

7.2 Criterion 2: Limits on Design Flexibility

Criterion 2 sets minimum efficiency targets for building fabric and building services efficiencies. Generally, achieving the Fabric Energy Efficiency (FEE) results in the building fabric performance going beyond the minimum targets defined in Part L.

The Fabric Energy Efficiency (FEE) is approximately 6.6% better than the Target Fabric Energy Efficiency (TFEE).

7.3 Criterion 3: Limiting the Effects of Heat Gain in Summer

The Standard Assessment Procedure (SAP) calculations undertakes a simple assessment of summertime temperatures – using averaged data over the summer months. Criterion 3 of the Building Regulations is not to be taken as a summertime overheating risk assessment. A separated overheating risk assessment has been completed as per REP-2324398-05-JP-20220311-Overheating Risk Assessment-Rev00

8. Conclusion.

This strategy summarises the relevant regulatory and planning policies applicable to the proposed development and sets out how the proposed development will address and achieve the relevant policy targets. The strategy responds to the UK planning and regulatory framework, and specifically to the Reading Core Strategy policy documentation.

8.1 Planning Policy

The policy states that applications for residential development should achieve the following targets:

Policy	Requirement
Policy H5	All major new-build residential developments should be designed to achieve zero carbon homes

Table 7: Domestic CO₂ Emission Reduction Targets, Reading Core Strategy

The Reading Borough Council; Sustainable Design and Construction Supplementary Planning Document (SPD) confirms that Zero Carbon should be targeted for the residential development.

There are no specific targets for non-domestic development and therefore, as above, the targets are achieved through compliance with Building Regulations Part L2A.

8.2 Approach

This report evaluates the proposed development against the energy hierarchy; Be lean, Be clean and Be green. The building fabric performance was informed by the Part L1A 2013 Target Fabric Energy Efficiency (TFEE) criteria. In the latest edition to the Building Regulations, dwellings must demonstrate that the fabric efficiency is equal to or better than the 'notional' building.

The commercial unit of the proposed development has been assessed as a 'shell only' assessment in lieu of the fit-out details for these areas. An initial simulation has been evaluated using standard fabric and system performance values.

Combining passive design and energy efficiency measures with ASHPs and PV, the Proposed Development demonstrates that the annual regulated carbon dioxide emissions are 89.4% less than the Part L 2013 Target Emission Rate (TER) and the Fabric Energy Efficiency (FEE) is approximately 6.6% better than the Target Fabric Energy Efficiency (TFEE).

Furthermore, an S106 contribution is required to satisfy the SPD (2019). This has been estimated to be £6,001.

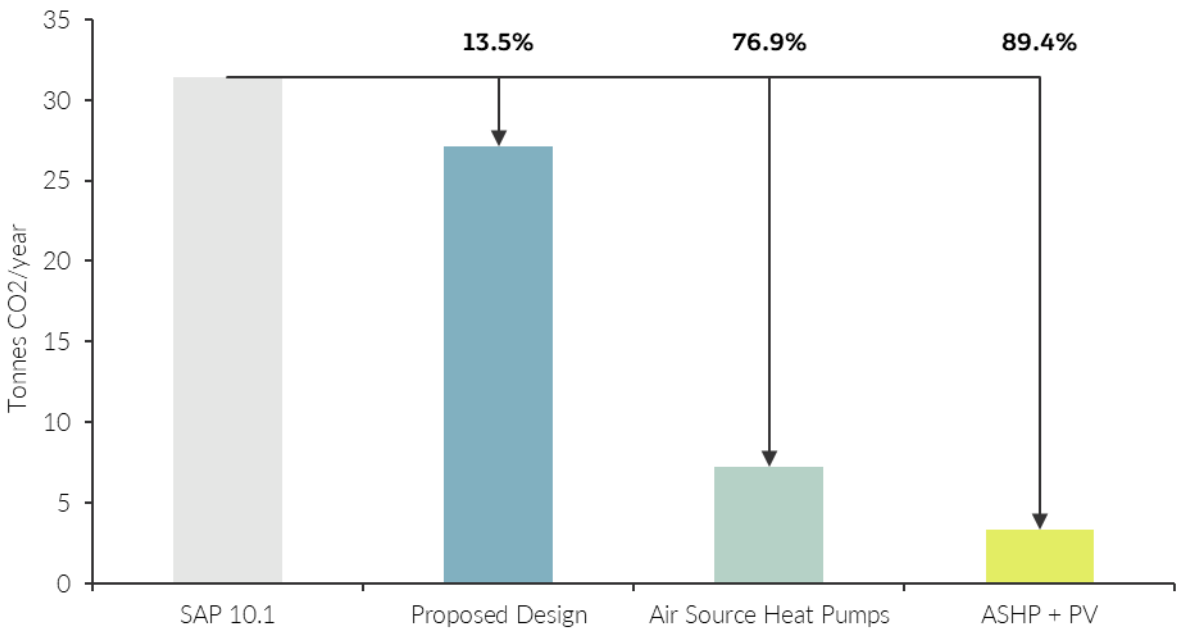


Figure 7: Summary of the estimated total carbon reduction achieved by the Proposed Development - Residential

8.3 Commercial Areas

As discussed in Section 3.2 the commercial areas of the Proposed Development have been assessed as 'shell only'. Initial simulations based on the inputs provided in Appendix B show that the commercial unit could achieve a Building Emission Rate (BER) of 29.2 kgCO₂/m² when compared to the Notional Building's Target Emission Rate (TER) of 30.7 kgCO₂/m², leading to a 5% decrease in carbon emissions when compared to a Part L 2013 baseline.

8.4 Proposed Development

Through the use of efficient building fabric and building services, Air Source Heat pumps, PV and an S106 Contribution, the Caversham Road development can meet the requirements of the Reading Borough Local Plan.

Appendix A: Grid Decarbonisation.

Historic progress.

The carbon factor of the National Grid – the amount of carbon dioxide released per kilowatt hour of electricity produced and distributed – is recognised in current Building Regulations as being 0.519 kgCO₂/kWh. However, the national mix of electricity generation methods is progressing towards greener solutions with renewable sources accounting for 29.4% of the electricity generated in the UK in 2017; up from 24.5% in 2016.

As a consequence, the Building Regulations Part L 2013 value of the National Grid carbon factor has been shown to be substantially higher than how the grid is performing in reality. This severely impacts the calculated emissions produced by all heat raising plant which use electricity directly or generate it to offset other emissions. The figure below shows how the mix of generation techniques serving the National Grid, as well as the associated carbon factor, has varied over the past six years – encouragingly, the carbon intensity of the grid has reduced to less than half its value in 2012 [HM Government, “Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal”, 02 January 2018]. The carbon emissions associated with electricity consumption are therefore much lower than reported in Building Regulations. This means that, under the Part L 2013 methodology the CO₂ emissions associated with electrically-driven plant are being overestimated by over 200%.

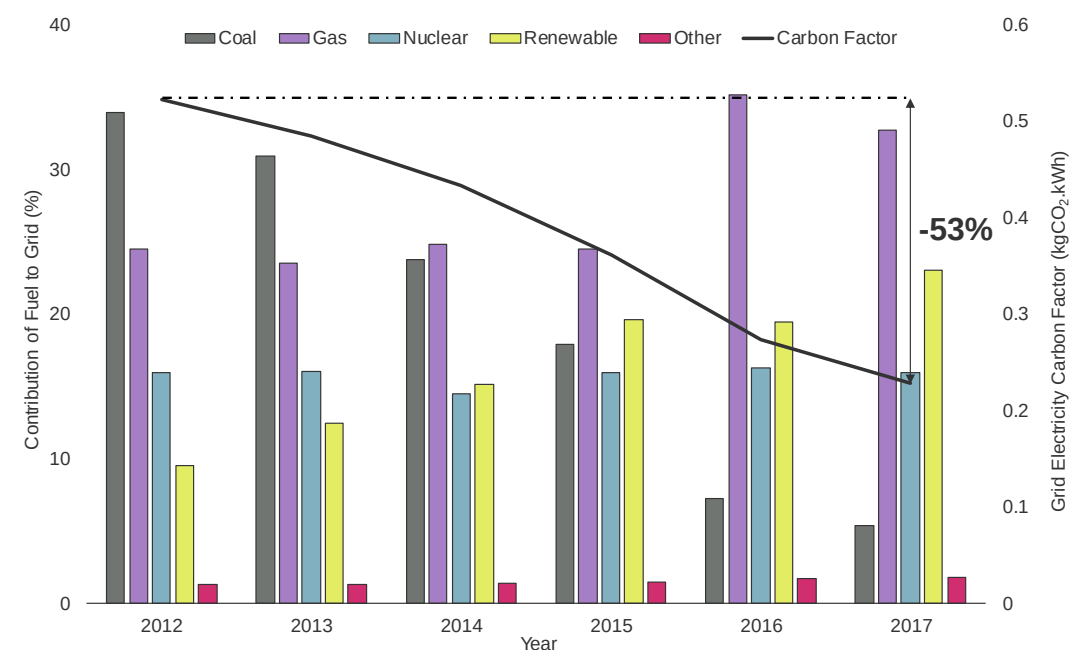


Figure 8: Historic mix of generation methods and associated carbon factor for the National Grid. 8% transmission and distribution losses are included. Sources: *electricityinfo.org* (generation mix); *BEIS Green Book* (historic carbon factors).

Future projections.

The Future Energy Scenarios (FES) document, produced by the National Grid, discusses how the UK's energy landscape is changing. The FES 2021 makes projections of how the mix of generation in the grid is likely to change between now and 2050 – the year by which the Climate Change Act 2008 set the target of reducing the UK's CO₂ emissions by 80% from 1990 levels. This target has now been revised to be Net Zero in light of the Committee on Climate Change's recent report and the declaration of a Climate Emergency.

The latest version, FES 2021, discusses these projections in four scenarios and Figure 9 combines these future trajectories with the actual carbon intensity of the National Grid over the past 12 years. The reported emissions associated with electricity generation have fallen steeply since 2012 and in three cases, the FES 2021 scenarios see carbon factors trending towards zero by the early 2030s. This is on the basis that FES 2021 have deemed it necessary to offset other industries such as freight, shipping and aviation, which will be unable to reduce their carbon emissions to zero. Offsetting the emissions of other industries will involve Carbon Capture and Storage (CCS) technologies on a significant scale in order for the UK as a nation to meet net zero carbon by 2050. It is important to note that CCS technology is not currently commercially demonstrated at a large scale, but the FES 2020 studies are useful as future forecasts.

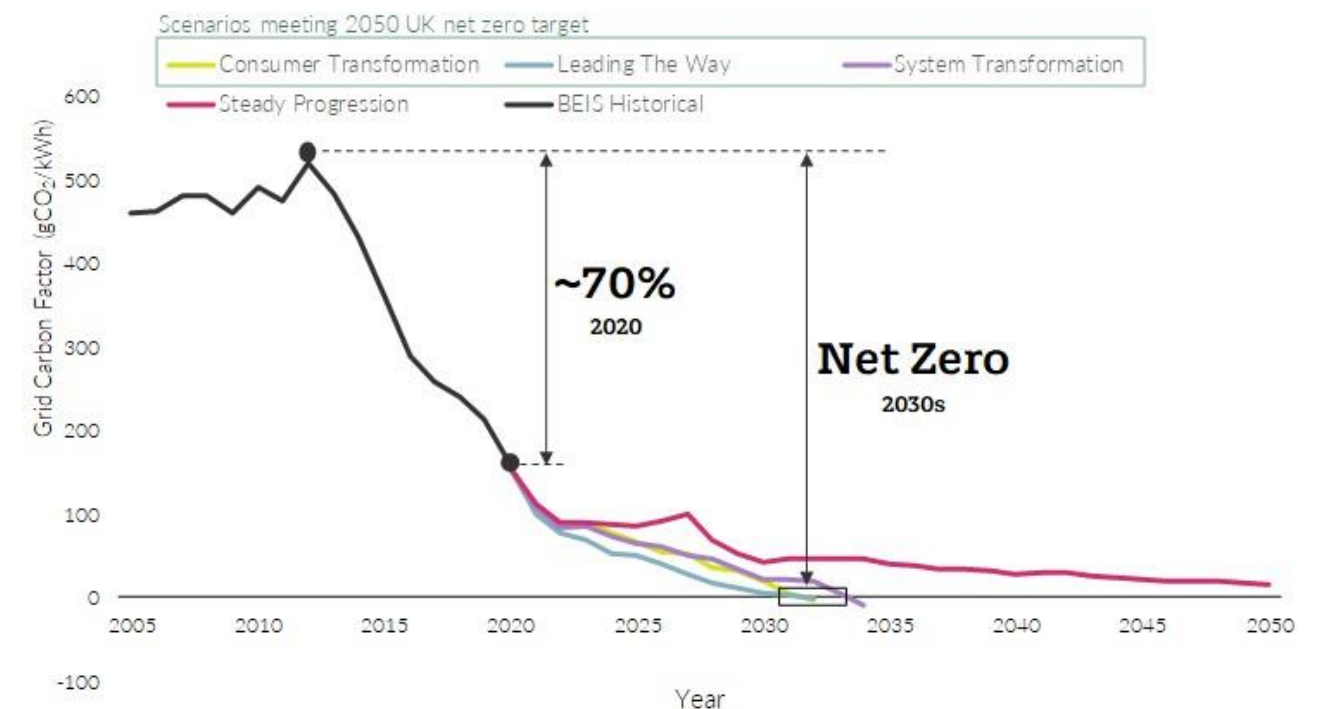


Figure 9: Historic and future projected carbon factor for the National Grid. Sources: *BEIS Green Book* (historic carbon factors); *National Grid Future Energy Scenarios (FES) 2021* (future projected carbon factors).

Net Zero 2050.

The driving force behind the proposals is the UK's legally-binding obligation to reach net zero by 2050. Figure 10 shows the dwelling emission rate for the typical terraced dwelling under a variety of carbon factor scenarios.

The results under Part L 2013 reinforce the current approach to servicing dwellings, with gas-CHP often favoured for providing emissions reductions of 20% to 50%. Direct electric strategies must be supported by high performance fabric and other mitigation measures to achieve compliance.

As presented in the previous section, the situation is drastically different under the new proposals, with electric strategies offering marked improvements over a gas boiler.

Looking to the future, the benefit of electric systems at reducing regulated emissions becomes ever more apparent. National Grid ESO concluded in their 2020 Future Energy Scenarios (FES) report that, in order for the UK to meet its 2050 net zero target, the energy supply sector (i.e. the carbon intensity of electricity) must achieve net zero emissions by the early- to mid-2030s.

As such, using the approximate projected carbon factor for electricity in 2030 for the scenarios which meet the 2050 target, the heat pump strategy is anticipated to demonstrate ~90% fewer emissions than a gas boiler

strategy, with no other fabric or services improvements, and will operate at net zero operational carbon by around 2035.

This highlights the challenge of decarbonising fossil fuel-heated buildings: where all-electric strategies continue to leverage improvements in national- and regional-scale infrastructure, gas strategies must employ rigorous local mitigation (in the form of fabric improvements and renewable generation) to offset their remaining emissions. Even this becomes ever more challenging using electricity-generating technologies such as solar PV, as the emissions which can be displaced by these technologies reduces as the grid decarbonises.

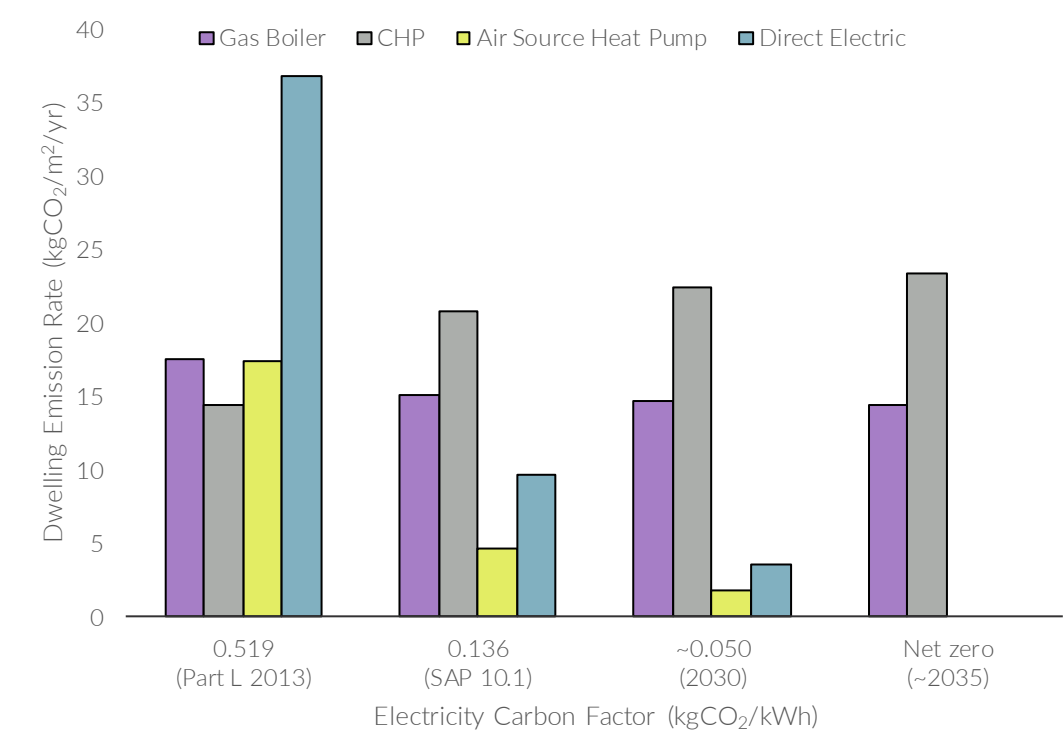


Figure 10: Dwelling emission rate for a typical terraced home for a variety of servicing strategies using carbon factors from current building regulations (Part L 2013) and proposed building regulations (Part L 2021), as well as the projected carbon factor for 2030. The grid is anticipated to be operating at zero carbon from ~2035. Source: National Grid ESO Future Energy Scenarios 2020.

Whilst electricity offers increasing benefits from an emissions perspective, the operational cost of such a strategy is also considered. With electricity currently costing around four times more than natural gas to a typical consumer, meaning that simply substituting a direct electric strategy for a gas-boiler based one would see consumers’ energy bills nearly quadruple. With 11% of households in the UK living in fuel poverty, this cannot be an acceptable solution. However, with improvements to building fabric reducing demand and highly efficient heating systems such as heat pumps offering efficiencies of 300% or more, the operational cost of such a strategy should be comparable to a typical gas boiler.

Shifting focus.

As the carbon emissions associated with the generation of electricity continue to reduce, the proportion of the UK’s overall greenhouse gas emissions for which the electricity sector is responsible will fall.

The carbon factor of natural gas is likely to remain relatively static. With 85% of homes in the UK relying on gas to supply their heating and hot water, as well as a significant proportion of commercial buildings, heating

buildings and industry represents an ever-greater proportion of UK emissions – 32% in 2015 [HM Government, “Clean Growth Strategy,” October 2017].

In order for the UK to maintain a trajectory sufficient to meet the 2050 Paris Agreement decarbonisation target of an 80% reduction in annual greenhouse gas emissions over 1990 levels, focus must necessarily shift to other contributors. The BEIS Clean Growth Strategy provides an indication of the direction the UK’s energy policy is likely to take and “...sets out [the government’s] proposals for decarbonising all sectors of the UK economy through the 2020s.” This includes investing in infrastructure and mechanisms to facilitate a transition to low emission vehicles and strengthening the energy performance requirements of new and existing buildings.

Updates to the Standard Assessment Procedure (SAP10.1)

The most suitable figures to use for carbon factors is SAP 10.1 which is what the updated Part L, due out in the latter half of 2022, will use. These figures represent how the grid is moving towards lower carbon intensive energy sources. Table 2 shows the values used in this assessment.

Fuel	Part L 2013 Carbon Factor (kgCO ₂ /kWh)	SAP 10.1 Carbon Factor (kgCO ₂ /kWh)
Main Gas	0.216	0.216
Electricity	0.519	0.136

Table 8: Current (Part L 2018) and proposed (SAP10.1) carbon factors for natural gas and grid-supplied electricity

Due to the significant decrease in the carbon emission factor of electricity, the use of Combined Heat and Power (CHP) is likely to offer a ‘negative benefit’ within the next five years and therefore has not been explored as part of the energy strategy.

For the purpose of this energy strategy, the updated SAP 10.1 carbon factors have been used in order to quantify the carbon emission targets. As previously discussed, these carbon factors are a closer representation of the current carbon intensity of the electricity grid and therefore would be more appropriate than the Part L 2013 carbon factors for estimating potential carbon emission savings.

Appendix B: Part L Model Inputs

Fabric parameters + System inputs - Residential

Parameter	Building Regulations Part L1A Limit	Notional Building	Proposed Design
New External Wall U-value (W/m².K)	0.30	0.18	0.15
Existing External Wall U-value (W/m².K)	0.30	0.18	0.20
Roof U-value (W/m².K)	0.20	0.13	0.12
Floor above commercial U-value (W/m².K)	0.25	0.13	0.12
Party Wall (W/m²K)	0.00	0.00	0.00 (Fully filled cavity with edge sealing)
Window U-value (inc. frame) (W/m².K)	2.00	1.40	1.40
Entrance Doors	-	-	2.20
Air Permeability (m³/h.m² at 50Pa)	10.0	3.00	3.00

Table 9: Proposed fabric elements

A G-value of 0.5 has been targeted for the glazing.

Thermal bridge has been calculated using Accredited Construction Details (ACDs). As the design progresses the design team will ensure ACDs or similar are utilised to minimise potential heat loss as a result of thermal bridging.

Light colour roller blinds have been assumed for all apartments.

Heating, cooling and ventilation plant	
Space Heating plant	Radiators supplied by Community Air Source Heat pump Heating SCOP: 3.0 System: Pre-insulated medium temp variable flow Controls: Use, Programmer and TRVS
DHW	Heat Interface unit connected to Air Source Heat Pump DHW SCOP: 3.0 Loss factor: 1.85 kWh/day Volume: 180 litres
Ventilation	SFP dependent on number of wet rooms per apartment 1 wet room – SFP=0.47 l/s 2 wet rooms – SFP=0.5 l/s 3 wet rooms – SFP=0.58 l/s;

Heating, cooling and ventilation plant	
	All HR eff=91%
Lighting	100% Energy Efficient Light Bulbs
System zones	
Circulation	It has been assumed that the central core areas (corridors between apartments) are heated.

Table 10: Residential system performances

Fabric parameters + system inputs – Commercial

Parameter	Building Regulations Part L1BLimit	Notional Building	Proposed Design
External Wall U-value (W/m².K)	0.35	0.18	0.20
Ceiling U-value (W/m².K)	-	-	0.12
Floor U-value (W/m².K)	0.25	0.22	0.15
Window U-value (inc. frame) (W/m².K)	2.20	1.60	1.60
Glazed Doors U-value (inc. frame) (W/m².K)	2.20	1.60	1.60
Air Permeability (m³/h.m² at 50Pa)	10.0	5.00	3.00

Table 11: Proposed fabric elements – commercial

A G-value of 0.35 has been targeted for the glazing

Heating, cooling and ventilation plant	
Space Heating/Cooling plant	DX unit: SCOP 4.0 SEER 5
DHW	Point of use electric water heater. Eff 100%
Ventilation	Centralised SFP 1.6W/(l/s); HR eff 85%
Lighting	Display lighting 70 lm/W, Lighting 100 lm/W

Table 12: Proposed system efficiencies – commercial.

Appendix C: Example SAP calculation

This output is from the SAP compliant calculation tool, Elmhurst. These figures have then been converted using the SAP 10.1 carbon emission factors.

FULL SAP CALCULATION PRINTOUT

Calculation Type: New Build (As Designed)

Property Reference	Unit 001			Issued on Date	08/03/2022
Assessment Reference	Unit 001	Prop Type Ref			
Property					
SAP Rating	78 C	DER	19.30	TER	35.51
Environmental	85 B	% DER<TER	45.65		
CO ₂ Emissions (t/year)	1.24	DFEE	77.91	TFEE	81.66
General Requirements Compliance	Pass	% DFEE<TFEE	4.59		
Assessor Details	Mr. James Pincott, James Pincott, Tel: 01223556862, jamespincott@hoarelea.com			Assessor ID	Q290-0001
Client					

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 77 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) 35.51 kgCO₂/m²

Dwelling Carbon Dioxide Emission Rate (DER) 19.30 kgCO₂/m²OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)81.7 kWh/m²/yr

Dwelling Fabric Energy Efficiency (DFEE)77.9 kWh/m²/yrOK

2 Fabric U-values

Element	Average	Highest	
External wall	0.17 (max. 0.30)	0.20 (max. 0.70)	OK
Floor	0.12 (max. 0.25)	0.12 (max. 0.70)	OK
Roof	(no roof)		
Openings	1.45 (max. 2.00)	2.20 (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	Measured cylinder loss: 1.85 kWh/day	
Permitted by DBSCG 2.10	OK	
Primary pipework insulated:	Yes (assumed)	OK

6 Controls

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

Hot water controls: Cylinderstat OK

7 Low energy lights

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

8 Mechanical ventilation

Continuous supply and extract system	
Specific fan power:	0.50
Maximum	1.5 OK
MVHR efficiency:	91%
Minimum:	70% OK

9 Summertime temperature

Overheating risk (Thames Valley): Medium OK

Based on:

Overshading:	Average
Windows facing North:	19.50 m ² , No overhang
Windows facing West:	8.89 m ² , No overhang
Air change rate:	2.00 ach
Blinds/curtains:	None

10 Key features

Floor U-value	0.12 W/m ² K
Air permeability	3.0 m ³ /m ² h

FULL SAP CALCULATION PRINTOUT

Calculation Type: New Build (As Designed)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m ²)	Storey height (m)	Volume (m ³)
Ground floor	76.6800 (1b)	x 3.7500 (2b)	= 287.5500 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	76.6800		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 287.5500 (5)

2. Ventilation rate

	main heating	secondary heating	other	total	m ³ per hour
Number of chimneys	0	+	0	=	0 * 40 = 0.0000 (6a)
Number of open flues	0	+	0	=	0 * 20 = 0.0000 (6b)
Number of intermittent fans					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					1 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =				0.9250 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =				0.1388 (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	0.1769	0.1734	0.1700	0.1526	0.1492	0.1318	0.1318	0.1283	0.1388	0.1492	0.1561	0.1630 (22b)
Balanced mechanical ventilation with heat recovery												0.5000 (23a)
If mechanical ventilation:												77.3500 (23c)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =												
Effective ac	0.2902	0.2867	0.2832	0.2659	0.2624	0.2451	0.2451	0.2416	0.2520	0.2624	0.2693	0.2763 (25)

3. Heat losses and heat loss parameter

Element	Gross m ²	Openings m ²	NetArea m ²	U-value W/m ² K	A x U W/K	K-value kJ/m ² K	A x K kJ/K
Window (Uw = 1.40)			28.3900	1.3258	37.6383		(27)
Front door			1.9500	2.2000	4.2900		(26)
Heat Loss Floor 1			76.6800	0.1200	9.2016		(28a)
External Wall 1	72.4900	28.3900	44.1000	0.2000	8.8200		(29a)
Sheltered wall 1	48.7900		48.7900	0.1500	7.3185		(29a)
Party wall	6.8900	1.9500	4.9400	0.1500	0.7410		(29a)
Total net area of external elements Aum(A, m ²)			204.8500				(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	68.0094		(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m ² K							250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							15.3731 (36)
Total fabric heat loss						(33) + (36) =	83.3825 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m	27.5334	27.2042	26.8751	25.2293	24.9001	23.2543	23.2543	22.9252	23.9127	24.9001	25.5584	26.2167 (38)
Heat transfer coeff	110.9158	110.5867	110.2575	108.6117	108.2826	106.6368	106.6368	106.3077	107.2951	108.2826	108.9409	109.5992 (39)
Average = Sum(39)m / 12 =												108.5294 (39)
HLP	1.4465	1.4422	1.4379	1.4164	1.4121	1.3907	1.3907	1.3864	1.3993	1.4121	1.4207	1.4293 (40)
HLP (average)												1.4154 (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												2.3968 (42)
Average daily hot water use (litres/day)												91.1252 (43)
Daily hot water use	100.2377	96.5927	92.9477	89.3027	85.6577	82.0127	82.0127	85.6577	89.3027	92.9477	96.5927	100.2377 (44)
Energy conte	148.6496	130.0099	134.1586	116.9627	112.2285	96.8446	99.7408	102.9789	104.2088	121.4453	132.5670	143.9592 (45)
Energy content (annual)										Total = Sum(45)m =		1433.7538 (45)
Distribution loss (46)m = 0.15 x (45)m	22.2974	19.5015	20.1238	17.5444	16.8343	14.5267	13.4611	15.4468	15.6313	18.2168	19.8851	21.5939 (46)

Water storage loss:												
Store volume												180.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):												1.8500 (48)
Temperature factor from Table 2b												0.6000 (49)
Enter (49) or (54) in (55)												1.1100 (55)
Total storage loss												
	34.4100	31.0800	34.4100	33.3000	34.4100	33.3000	34.4100	34.4100	33.3000	34.4100	33.3000	34.4100 (56)
If cylinder contains dedicated solar storage												
	34.4100	31.0800	34.4100	33.3000	34.4100	33.3000	34.4100	34.4100	33.3000	34.4100	33.3000	34.4100 (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												
	206.3220	182.1011	191.8310	172.7747	169.9009	152.6566	147.4132	160.6513	160.0208	179.1177	188.3790	201.6316 (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												
	206.3220	182.1011	191.8310	172.7747	169.9009	152.6566	147.4132	160.6513	160.0208	179.1177	188.3790	201.6316 (64)
								Total per year (kWh/year) = Sum (64)m =				2112.7998 (64)
Heat gains from water heating, kWh/month												
	95.5639	84.9012	90.7456	83.5397	83.4539	76.8504	75.9767	80.3784	79.2990	86.5185	88.7281	94.0044 (65)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9937	0.9879	0.9704	0.9134	0.7830	0.5840	0.4154	0.4846	0.7749	0.9520	0.9884	0.9950 (94)
Useful gains	508.1373	588.4321	682.5487	770.7454	750.4221	565.5592	381.2372	396.0248	541.4195	549.9368	498.4063	482.0791 (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	1557.7800	1512.2017	1377.3860	1157.9684	897.4426	595.8330	386.5885	406.0912	640.7412	964.4187	1278.8291	1547.6533 (97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.8330	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000 (97a)
Space heating kWh	780.9341	620.7732	516.9590	278.8005	109.3832	0.0000	0.0000	0.0000	0.0000	308.3745	561.9044	792.7872 (98)
Space heating												3969.9162 (98)
Space heating per m2												51.7725 (99)
										(98) / (4) =		

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 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	1.1000 (306)
Space heating:	
Annual space heating requirement	3969.9162 (98)
Space heat from Heat pump = (98) x 1.00 x 1.00 x 1.10	4366.9078 (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	2112.7998 (64)
Water heat from Heat pump = (64) x 1.00 x 1.00 x 1.10	2324.0797 (310a)
Electricity used for heat distribution	66.9099 (313)
Annual totals kWh/year	
Electricity for pumps and fans:	
(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.6250)	
mechanical ventilation fans (SFP = 0.6250)	219.2569 (330a)
Total electricity for the above, kWh/year	219.2569 (331)
Electricity for lighting (calculated in Appendix L)	334.3494 (332)
Total delivered energy for all uses	7244.5938 (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	2230.3292	0.5190	1157.5408 (367)
Electrical energy for heat distribution	66.9099	0.5190	34.7262 (372)
Total CO2 associated with community systems (negative value allowed since DFEE <= TFEE)			1192.2671 (373)
Space and water heating			1192.2671 (376)
Pumps and fans	219.2569	0.5190	113.7943 (378)
Energy for lighting	334.3494	0.5190	173.5273 (379)
Total CO2, kg/year			1479.5887 (383)
Dwelling Carbon Dioxide Emission Rate (DER)			19.3000 (384)

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

DER		19.3000 ZC1
Total Floor Area	TFA	76.6800
Assumed number of occupants	N	2.3968
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190
CO2 emissions from appliances, equation (L14)		16.4112 ZC2
CO2 emissions from cooking, equation (L16)		2.3021 ZC3
Total CO2 emissions		38.0133 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		38.0133 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 (m ²)	Storey height (m)	Volume (m ³)
Ground floor	76.6800 (1b)	x 3.7500 (2b)	= 287.5500 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	76.6800		(4)
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	= 287.5500 (5)

2. Ventilation rate

	main heating	secondary heating	other	total	m ³ 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				3 * 10 =	30.0000 (7a)
Number of passive vents				0 * 10 =	0.0000 (7b)
Number of flueless gas fires				0 * 40 =	0.0000 (7c)
Infiltration due to chimneys, flues and fans	= (6a)+(6b)+(7a)+(7b)+(7c) =				30.0000 / (5) = 0.1043 (8)
Pressure test					Yes
Measured/design AP50					5.0000
Infiltration rate					0.3543 (18)
Number of sides sheltered					1 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =				0.9250 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =				0.3278 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000 (22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750 (22a)
Adj infilt rate												
Effective ac	0.4179	0.4097	0.4015	0.3605	0.3523	0.3114	0.3114	0.3032	0.3278	0.3523	0.3687	0.3851 (22b)
Effective ac	0.5873	0.5839	0.5806	0.5650	0.5621	0.5485	0.5485	0.5460	0.5537	0.5621	0.5680	0.5742 (25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K					
TER Opaque door			1.9500	1.0000	1.9500			(26)				
TER Opening Type (Uw = 1.40)			17.2400	1.3258	22.8561			(27)				
Heat Loss Floor 1			76.6800	0.1300	9.9684			(28a)				
External Wall 1	72.4900	17.2400	55.2500	0.1800	9.9450			(29a)				
Sheltered wall 1	48.7900		48.7900	0.1800	8.7822			(29a)				
Party wall	6.8900	1.9500	4.9400	0.1800	0.8892			(29a)				
Total net area of external elements Aum(A, m2)			204.8500					(31)				
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		54.3909			(33)				
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K								250.0000 (35)				
Thermal bridges (Sum(L x Psi) calculated using Appendix K)								11.9699 (36)				
Total fabric heat loss						(33) + (36) =		66.3608 (37)				
Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)												
(38)m	55.7312	55.4095	55.0941	53.6129	53.3357	52.0456	52.0456	51.8067	52.5425	53.3357	53.8964	54.4825 (38)
Heat transfer coeff	122.0920	121.7702	121.4549	119.9736	119.6965	118.4064	118.4064	118.1674	118.9033	119.6965	120.2571	120.8433 (39)
Average = Sum(39)m / 12 =												119.9723 (39)
HLP	1.5922	1.5880	1.5839	1.5646	1.5610	1.5442	1.5442	1.5410	1.5506	1.5610	1.5683	1.5759 (40)
HLP (average)												1.5646 (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												2.3968 (42)
Average daily hot water use (litres/day)												91.1252 (43)
Daily hot water use	100.2377	96.5927	92.9477	89.3027	85.6577	82.0127	82.0127	85.6577	89.3027	92.9477	96.5927	100.2377 (44)
Energy conte	148.6496	130.0099	134.1586	116.9627	112.2285	96.8446	89.7408	102.9789	104.2088	121.4453	132.5670	143.9592 (45)
Energy content (annual)										Total = Sum(45)m =		1433.7538 (45)
Distribution loss (46)m = 0.15 x (45)m												
22.2974	19.5015	20.1238	17.5444	16.8343	14.5267	13.4611	15.4468	15.6313	18.2168	19.8851	21.5939 (46)	
Water storage loss:												
Store volume												180.0000 (47)
a) If manufacturer declared loss factor is known (kWh/day):												1.5520 (48)
Temperature factor from Table 2b												0.5400 (49)

Enter (49) or (54) in (55)												0.8381 (55)
Total storage loss	25.9803	23.4661	25.9803	25.1422	25.9803	25.1422	25.9803	25.9803	25.1422	25.9803	25.1422	25.9803 (56)
If cylinder contains dedicated solar storage	25.9803	23.4661	25.9803	25.1422	25.9803	25.1422	25.9803	25.9803	25.1422	25.9803	25.1422	25.9803 (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	197.8923	174.4871	183.4012	164.6169	161.4711	144.4988	138.9835	152.2215	151.8630	170.6879	180.2212	193.2019 (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	197.8923	174.4871	183.4012	164.6169	161.4711	144.4988	138.9835	152.2215	151.8630	170.6879	180.2212	193.2019 (64)
	Total per year (kWh/year) = Sum(64)m = 2013.5465 (64)											
Heat gains from water heating, kWh/month	88.8201	78.8101	84.0019	77.0134	76.7101	70.3242	69.2330	73.6346	72.7728	79.7747	82.2019	87.2606 (65)

Metabolic gains (Table 5), Watts												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(66)m	119.8425	119.8425	119.8425	119.8425	119.8425	119.8425	119.8425	119.8425	119.8425	119.8425	119.8425	119.8425 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	18.9297	16.8132	13.6734	10.3517	7.7380	6.5327	7.0589	9.1754	12.3152	15.6369	18.2506	19.4559 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	212.3622	214.5659	209.0127	197.1908	182.2676	168.2420	158.8720	156.6684	162.2215	174.0435	188.9666	202.9922 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.9842	34.9842	34.9842	34.9842	34.9842	34.9842	34.9842	34.9842	34.9842	34.9842	34.9842	34.9842 (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)	-95.8740	-95.8740	-95.8740	-95.8740	-95.8740	-95.8740	-95.8740	-95.8740	-95.8740	-95.8740	-95.8740	-95.8740 (71)
Water heating gains (Table 5)	119.3819	117.2769	112.9057	106.9631	103.1050	97.6725	93.0550	98.9713	101.0733	107.2240	114.1693	117.2857 (72)
Total internal gains	412.6266	410.6088	397.5446	376.4583	355.0633	334.4000	320.9387	326.7677	337.5627	358.8572	383.3392	401.6865 (73)

[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					11.8500	10.6334	0.6300	0.7000			0.7700	38.5090 (74)
West					5.3900	19.6403	0.6300	0.7000			0.7700	32.3525 (80)
Solar gains	70.8615	136.8810	229.2788	352.8741	456.8765	480.3717	451.9998	370.5166	271.5731	162.6994	87.8456	58.7081 (83)
Total gains	483.4881	547.4897	626.8234	729.3324	811.9398	814.7717	772.9384	697.2844	609.1358	521.5566	471.1848	460.3946 (84)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
tau	43.6147	43.7299	43.8434	44.3848	44.4875	44.9722	44.9722	45.0632	44.7843	44.4875	44.2801	44.0653
alpha	3.9076	3.9153	3.9229	3.9590	3.9658	3.9981	3.9981	4.0042	3.9856	3.9658	3.9520	3.9377
util living area	0.9972	0.9951	0.9887	0.9663	0.9022	0.7699	0.6213	0.6906	0.8984	0.9813	0.9952	0.9978 (86)
MIT	19.2354	19.3942	19.7045	20.1494	20.5662	20.8509	20.9534	20.9291	20.6882	20.1647	19.6313	19.2146 (87)
Th 2	19.6190	19.6221	19.6251	19.6394	19.6421	19.6545	19.6545	19.6569	19.6497	19.6421	19.6367	19.6310 (88)
util rest of house	0.9962	0.9933	0.9843	0.9515	0.8563	0.6623	0.4557	0.5278	0.8301	0.9706	0.9930	0.9969 (89)
MIT 2	17.3137	17.5473	18.0006	18.6479	19.2158	19.5560	19.6387	19.6287	19.3918	18.6806	17.9036	17.2909 (90)
Living area fraction										fLA = Living area / (4) =		0.3770 (91)
MIT	18.0382	18.2436	18.6430	19.2140	19.7249	20.0442	20.1344	20.1190	19.8806	19.2401	18.5550	18.0162 (92)
Temperature adjustment												0.0000
adjusted MIT	18.0382	18.2436	18.6430	19.2140	19.7249	20.0442	20.1344	20.1190	19.8806	19.2401	18.5550	18.0162 (93)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation	0.9945	0.9906	0.9797	0.9454	0.8596	0.6973	0.5190	0.5895	0.8446	0.9660	0.9905	0.9955 (94)
Useful gains	480.8172	542.3346	614.0723	689.5045	697.9789	568.1377	401.1775	411.0527	514.4699	503.8468	466.6949	458.3019 (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	1677.3243	1624.8566	1474.8309	1237.4044	960.5571	644.6285	418.4949	439.4591	687.3294	1034.1950	1377.5416	1669.5891 (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	890.2013	727.4548	640.4044	394.4879	195.3582	0.0000	0.0000	0.0000	0.0000	394.5791	655.8096	901.1977 (98)
Space heating												4799.4931 (98)
Space heating per m2												62.5912 (99)
										(98) / (4) =		67.5912 (99)

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													5133.1477 (211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	890.2013	727.4548	640.4044	394.4879	195.3582	0.0000	0.0000	0.0000	0.0000	394.5791	655.8096	901.1977	(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)	952.0870	778.0265	684.9245	421.9122	208.9393	0.0000	0.0000	0.0000	0.0000	422.0097	701.4007	963.8478	(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	197.8923	174.4871	183.4012	164.6169	161.4711	144.4988	138.9835	152.2215	151.8630	170.6879	180.2212	193.2019	(64)
Efficiency of water heater (217)m	88.3456	88.2118	87.8768	87.0629	85.3230	79.8000	79.8000	79.8000	79.8000	86.9784	87.9576	88.4073	(216)
Fuel for water heating, kWh/month	223.9979	197.8047	208.7027	189.0781	189.2470	181.0762	174.1647	190.7538	190.3045	196.2418	204.8955	218.5361	(219)
Water heating fuel used												2364.8031	(219)
Annual totals kWh/year													
Space heating fuel - main system												5133.1477	(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)												334.3051	(232)
Total delivered energy for all uses												7907.2558	(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	5133.1477	0.2160	1108.7599 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating (other fuel)	2364.8031	0.2160	510.7975 (264)
Space and water heating			1619.5574 (265)
Pumps and fans	75.0000	0.5190	38.9250 (267)
Energy for lighting	334.3051	0.5190	173.5044 (268)
Total CO2, kg/m2/year			1831.9867 (272)
Emissions per m2 for space and water heating			21.1210 (272a)
Fuel factor (electricity)			1.5500
Emissions per m2 for lighting			2.2627 (272b)
Emissions per m2 for pumps and fans			0.5076 (272c)
Target Carbon Dioxide Emission Rate (TER) = (21.1210 * 1.55) + 2.2627 + 0.5076, rounded to 2 d.p.			35.5100 (273)

Appendix D: BRUKL output

Project name

Caversham - Retail only Part L**As built****Date:** Wed Mar 09 20:34:00 2022**Administrative information****Building Details****Address:** Address 1, City, Postcode**Certification tool****Calculation engine:** Apache**Calculation engine version:** 7.0.13**Interface to calculation engine:** IES Virtual Environment**Interface to calculation engine version:** 7.0.13**BRUKL compliance check version:** v5.6.b.0**Certifier details****Name:** Name**Telephone number:** Phone**Address:** Street Address, City, Postcode**Criterion 1: The calculated CO₂ emission rate for the building must not exceed the target**

CO ₂ emission rate from the notional building, kgCO ₂ /m ² .annum	30.7
Target CO ₂ emission rate (TER), kgCO ₂ /m ² .annum	30.7
Building CO ₂ emission rate (BER), kgCO ₂ /m ² .annum	27.6
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	U _a -Limit	U _a -Calc	U _i -Calc	Surface where the maximum value occurs*
Wall**	0.35	0.15	0.15	00000000:Surf[6]
Floor	0.25	0.18	0.18	00000000:Surf[0]
Roof	0.25	0.12	0.12	00000000:Surf[1]
Windows***, roof windows, and rooflights	2.2	1.52	1.6	00000000:Surf[2]
Personnel doors	2.2	1.78	2.2	00000000:Surf[50]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building
U _a -Limit = Limiting area-weighted average U-values [W/(m ² K)] U _a -Calc = Calculated area-weighted average U-values [W/(m ² K)] U _i -Calc = Calculated maximum individual element U-values [W/(m ² K)] * There might be more than one surface where the maximum U-value occurs. ** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows. *** Display windows and similar glazing are excluded from the U-value check. N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.				

Air Permeability	Worst acceptable standard	This building
m ³ /(h.m ²) at 50 Pa	10	3

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	0.9 to 0.95

1- DX

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.5	4.1	0	0	0.85
Standard value	2.5*	2.6	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					

"No HWS in project, or hot water is provided by HVAC system"

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]										HR efficiency	
	ID of system type	A	B	C	D	E	F	G	H	I		
	Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
00-Retail		-	-	-	1.6	-	-	-	-	-	-	N/A

General lighting and display lighting

General lighting and display lighting		Luminous efficacy [lm/W]			
Zone name		Luminaire	Lamp	Display lamp	General lighting [W]
Standard value		60	60	22	
00-Retail		-	100	70	3206

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
00-Retail	NO (-72.2%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m ²]	348.7	348.7
External area [m ²]	702.3	702.3
Weather	LON	LON
Infiltration [m ³ /hm ² @ 50Pa]	3	3
Average conductance [W/K]	240.22	354.51
Average U-value [W/m ² K]	0.34	0.5
Alpha value* [%]	10	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area Building Type

100	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	2.39	4.11
Cooling	4.9	9.37
Auxiliary	7.51	3.06
Lighting	37.24	42.99
Hot water	1.7	1.86
Equipment*	20.26	20.26
TOTAL **	53.73	61.39

* Energy used by equipment does not count towards the total for consumption or calculating emissions.

** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO₂ Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m ²]	123.75	165.61
Primary energy* [kWh/m ²]	163.31	180.23
Total emissions [kg/m ²]	27.6	30.7

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance										
System Type	Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER	
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	36.1	87.6	2.4	4.9	7.5	4.19	4.97	4.5	7
	Notional	37.8	127.8	4.1	9.4	3.1	2.56	3.79	----	----

Key to terms	
Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	U _{i-Typ}	U _{i-Min}	Surface where the minimum value occurs*
Wall	0.23	0.15	00000000:Surf[6]
Floor	0.2	0.18	00000000:Surf[0]
Roof	0.15	0.12	00000000:Surf[1]
Windows, roof windows, and rooflights	1.5	1.4	00000000:Surf[3]
Personnel doors	1.5	1.6	00000000:Surf[17]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building
U _{i-Typ} = Typical individual element U-values [W/(m²K)]		U _{i-Min} = Minimum individual element U-values [W/(m²K)]	
* There might be more than one surface where the minimum U-value occurs.			

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	3



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