Hydrock

BoKlok, Hoodlands

Sustainable Energy Statement

For BoKlok UK

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CONTENTS

Tables

Figures

Executive Summary

Hydrock Consultants has been appointed by BoKlok UK to provide planning stage advisory services in relation to the design and construction of the proposed BoKlok development at Hoodlands Farm along Hambrook Lane, Harry Stoke.

This document forms part of the detailed planning application for the site and will inform the South Gloucestershire Council Planning Department of the proposed energy strategy for the site.

At this early stage, while it is difficult to estimate the potential reduction in CO_2 emissions and energy demand, because the scheme is prefabricated the design is more advanced than a typical development at planning stage, we therefore have greater clarity on the expected energy use, carbon emission and embodied carbon. There are a number of energy solutions for the BoKlok product, however, we anticipate the energy solution will be ASHPs, providing space heating and hot water to all houses.

This system will provide a **20.2% reduction** in energy demand through renewables against a typical gas boiler system without the need for photovoltaics. The document below explains how policy compliance is met, in particular PSP Policy 6.

Additionally, Section 4 outlines the sustainability measures for the site including; Sustainable Design & Construction, Ecology, Flooding & Drainage, Waste management, Transport, Pollution and Broadband connectivity. The embodied carbon analysis equates to a total embodied carbon of 230.15kgCO_2e/m^2, a reduction of over 55% against RICS.

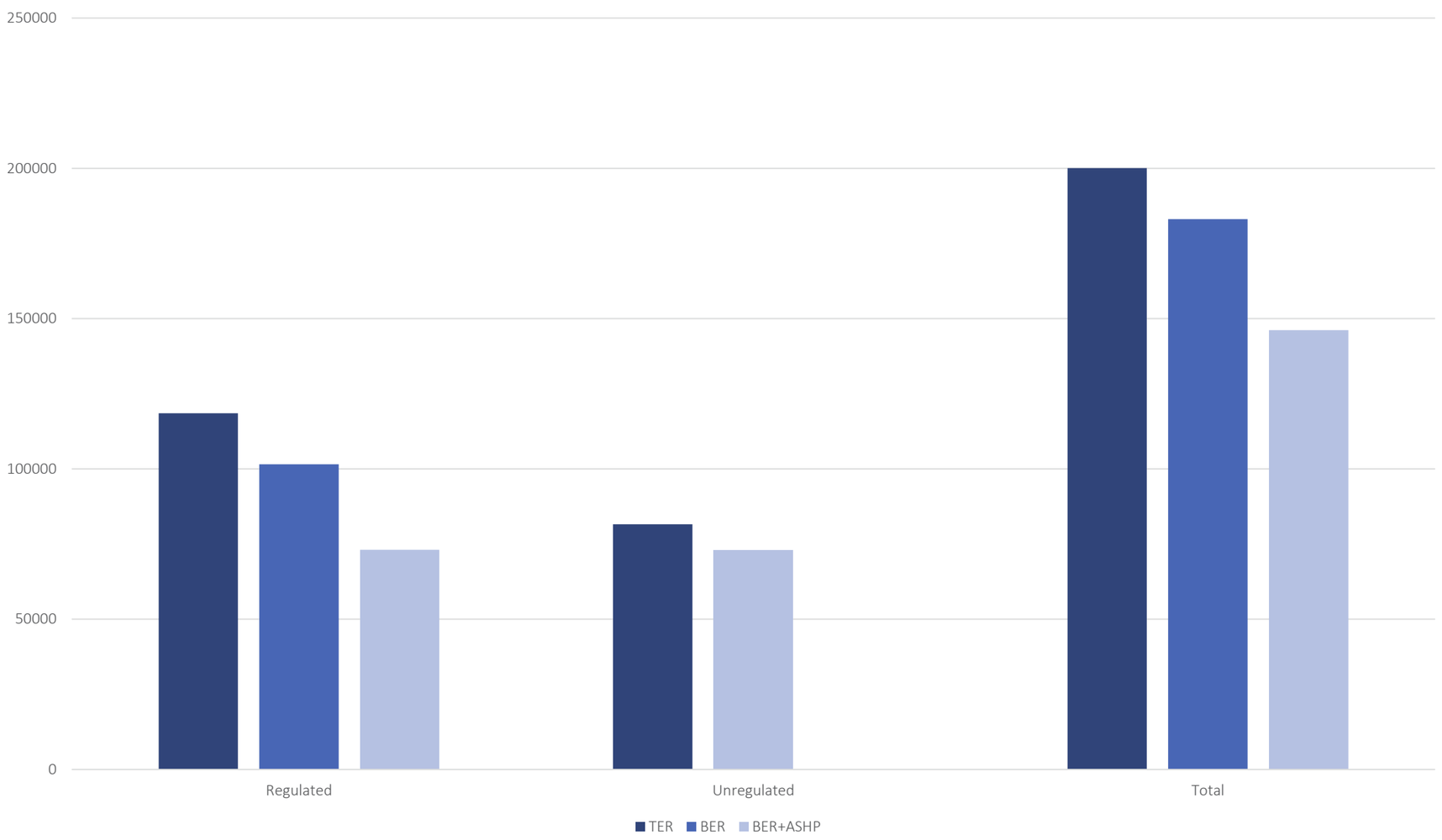


Figure 1: Estimated Target Energy Demand, Building Energy Demand, Building Energy Demand with the inclusion ASHP for the entire development (Regulated and Unregulated)

Introduction

BoKlok, Hoodlands

Hydrock Consultants has been appointed by BoKlok UK to provide planning stage advisory services in relation to the design and construction of the proposed BoKlok development at Hoodlands Farm along Hambrook Lane, Hambrook.

This document forms part of the detailed planning application for the site and will inform the South Gloucestershire Council Planning Department of the proposed energy strategy for the site.

1.1 Purpose of Report

The purpose of this document is to inform the design team, and the South Gloucestershire Council, of the energy strategy for the project and how it relates to the local Planning requirements.

This document summarises an initial options appraisal that has been carried out for the development in terms of energy. This includes looking at the inclusion of renewable energy systems as well as passive and active design measures.

Throughout this report carbon emissions are split into two categories:

- Regulated: Emissions associated with heating, cooling, hot water, lighting and any other fixed building services equipment (those that are covered under Building Regulations Part L1A and L2A); and
- Unregulated: Emissions that are associated with small power and plug-in items and any other process or plant equipment (these are not covered by Building Regulations Part L1A and L2A).

1.2 Site and Location

The development is currently grassland with 1 dwelling and associated buildings, situated between Hambrook Lane, M32, M4 and Stoke Giffard Bypass, as well as GWR railway line to the north.

The site location is shown in Figure 2.

1.3 Description of Development

Full planning permission for the erection of 50 new high-quality modular dwellings including Affordable Housing, consisting of 17 no. 2-bedroom houses, 2 no. 2-bedroom mobility unit houses & 31 no. 3-bedroom houses, with associated car and cycle parking, open space, landscaping.

Figure 2: CGI view of proposed BoKlok Hoodlands site

Planning Policy

2. NATIONAL

2.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF) acts as guidance for local planning authorities and decision makers, both in drawing up plans and making decisions about planning applications.

The NPPF sets out the Government's planning policies for England and how these are expected to be applied through local authorities. It sets out the Government's requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so.

The NPPF also 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.

2.2 Building Regulations Part L

The development will need to meet the standards set by Building Regulations Approved Document Part L1A and L2A, Conservation of Fuel and Power in New Dwelling and New Buildings other than Dwellings respectively (2013).

These standards include a minimum level for Regulated carbon emissions defined by the Target Emission Rate (TER) which relate to a 'Notional Building', automatically generated as part of the Standard Assessment Procedure (SAP) and Simplified Building Energy Model (SBEM) toolkits for residential and non-residential respectively. In addition, there are minimum levels of fabric efficiency set by the Target Fabric Energy Efficiency rating (TFEE) under the SAP methodology.

The resulting Dwelling Emission Rate (DER), L1A or Building Emission Rate (BER), L2A, must be less than the relevant TER in order to comply. A benchmark Energy Performance Certificate (EPC), rated A (most efficient) through G (least efficient) will also be calculated as part of this assessment via comparison of each building assessed to a 'Reference Building', also automatically generated as part of the SAP and SBEM toolkits. Domestic EPCs are required whenever a property is built, sold or rented, while non-domestic EPCs are required on the sale, rent or construction of buildings other than dwellings with a floor area greater than 50m^2 from 6 April 2008, that contain fixed services that condition the interior environment.

2.3 SAP 2012 vs SAP10

An emissions assessment has been undertaken for the gas and electric options.

Using current Building Regulations SAP 2012 CO_2 emission factors, the following would be derived (this takes into account conversion efficiencies, distribution losses etc. as previously described):

Option	SAP 2012 ($kgCO_2$/kWh)	$kgCO_2$/kWh Heat Delivered	$kgCO_2$/ dwelling/ year
Gas Heating	0.216	0.264	1,100
Elec Heating	0.519	0.519	2,100

Table 1: Emissions per unit of heat delivered (SAP 2012)

The emission factors contained within current Building Regulations are known to be significantly out of date.

Proposed revised fuel emission factors have recently been published by UK Government under SAP 10. The revised document is due for adoption in late 2021. Emissions will undergo a significant change for electricity - from 0.519 $kgCO_2$/kWh to 0.233 $kgCO_2$/kWh, which is only slightly higher than mains gas at 0.210 $kgCO_2$/kWh.

This change has resulted from the increased use of renewable energy feeding electricity to the national grid.

The change would have the following impact on predicted emissions for each option:

Option	SAP 10 ($kgCO_2$/kWh)	$kgCO_2$/k Wh Heat Delivered	$kgCO_2$/ dwelling/ year
Gas Heating	0.210	0.256	1,050
Elec Heating	0.233	0.233	1,030

Table 2: Emissions per unit of heat delivered (SAP 10)

Indirect CO_2 emissions are predicted to be approximately equivalent to the gas heating option (slightly saving).

Due to the SAP 10 software not yet being released, all current calculations within this document have been undertaken in SAP 2012.

3. LOCAL

3.1 South Gloucestershire

The following policies of the South Gloucestershire Council Local Plan are of relevance.

3.1.1 Policy CS1 - High Quality Design

Development will only be permitted where the highest possible standards of design and site planning are achieved. Information submitted with an application should be proportionate to the scale, significance and impact of the proposal.

3.1.2 Policy CS2 - Green Infrastructure

The Council and its partners will ensure that existing and new Green Infrastructure (GI) is planned, delivered and managed as an integral part of creating sustainable communities and enhancing quality of life.

3.1.3 Policy CS3 - Renewable and Low Carbon Energy Generation

Proposals for the generation of energy from renewable or low carbon sources, provided that the installation would not cause significant demonstrable harm to residential amenity, individually or cumulatively, will be supported.

3.1.4 Policy CS4 - Renewable or Low Carbon District Heat Networks

Major development proposals should, where practical and viable:

1. Include renewable or low carbon heating or CHP generation and distribution infrastructure on-site and demonstrate how opportunities to accommodate an energy and or district heating solution have been maximised, taking into account density, mix of uses, layout and phasing; or
2. Connect to or provide a renewable or low carbon heat distribution network; or
3. Provide evidence that heat distribution has been fully explored and is unfeasible.

3.2 SGC Local Policies, Sites and Places DPD

For major greenfield residential development proposals, PSP Policy 6 has an additional requirement for proposals to reduce residual CO_2 emissions by at least 20% via the use of renewable and/or low carbon energy generation sources on or near the site.

4. SUMMARY

New development will be required to demonstrate as part of an Energy Statement submitted with the planning application, how the above issues have been addressed.

This document seeks to provide response to these objectives.

Sustainability

5.1 Sustainability Design and Construction

Passive design measures, including daylight access, natural ventilation and risk of overheating, and active design measures including building services and renewables are covered under the energy strategy sections of this report.

5.1.1 Design & Access

The site will be designed to allow safe and easy access for all potential users, including pedestrians and cyclists. 87 resident's car parking bays have been included on site, with an additional 10 visitors parking bays.

5.1.2 Material Selection

The BRE 'Green Guide to Specification' is proposed to be used when selecting the construction materials, to encourage the use of materials which have been produced with minimal impact to the environment in line with good-practice methodology. The Guide promotes the use of sustainable materials with low embodied energy, minimal ecotoxicity and long-life span.

Additionally, the materials selected will be responsibly sourced and where practicable meet the following guidelines:

- ISO14001;
- BES6001;
- PEFC / FSC;
- Chain of Custody.

5.1.3 Security

The development should be designed in a manner which minimises the risk of crime. The site should be designed securely and seek to ensure a safe working environment and ensure that the building is safe and accessible.

5.2 Ecology

5.2.1 Biodiversity

A Preliminary Ecological Assessment of the site identified the site as comprising of buildings, hardstanding, fences, walls, a non-native species-poor hedgerow and introduced shrub of negligible ecological importance; and poor semi-improved grassland, native species-rich hedgerows, native species-poor hedgerows and scattered trees of local ecological importance.

Ecological surveys of the main house and the annex confirm that no bats roost on site at present and there are likely no great crested newts on site. Reptile surveys indicate small population of slow worm is present at the site, precautionary methods will be employed during habitat clearance in order to avoid harm.

5.3 Flooding & Drainage

5.3.1 Flood Risk

A site-specific Flood Risk Assessment (FRA) and Drainage Strategy was prepared by Structa for new development at Hoodlands Farm, along Hambrook Lane, Hambrook.

It is deemed that the risk of flooding from rivers, seas, groundwater, sewers and reservoirs is considered to be low. The application site is located within Flood Zone 1, although additional flood checking is to be carried out to determine the climate change flood extents of flood zones 2 and 3.

Sustainable Drainage Systems have been incorporated into the surface water drainage network for the discharge of surface water on site which will minimise flood risk and improve water quality. The foul drainage from the proposed development will be collected by a foul drainage network and discharged into the Local Sewer network.

5.4 Water (Supply)

To reduce the consumption of potable water, efficient sanitary ware and water-saving features will be specified.

This will include limiting flow rates and reducing flush levels of sanitary ware fittings. The development aims to reduce water usage and improvement in water efficiency over a notional baseline established by the BRE in line with best practice guidelines.

At present, and where applicable, this will include:

- Low and dual flush WCs - Dual flush cisterns with low effective flush volume will be specified;
- Taps – Wash hand basins and sinks will be water efficient.
- Showers – Aerated or low flow showerheads will be included to help reduce water consumption; and
- Kitchen appliances – Low water consuming equipment to be considered.

All external planting will rely on manual watering, or precipitation only.

5.5 Waste

The new development aims to minimise waste throughout construction and also to reduce waste throughout operations by providing appropriate facilities, in accordance with good-practice principles. Throughout construction, the appointed contractor will make effort to minimise waste and, where possible, divert waste from landfill through reuse or recycling.

Waste will be minimised throughout the demolition and construction phase through the implementation of the waste hierarchy. The principles of the waste hierarchy are shown below.

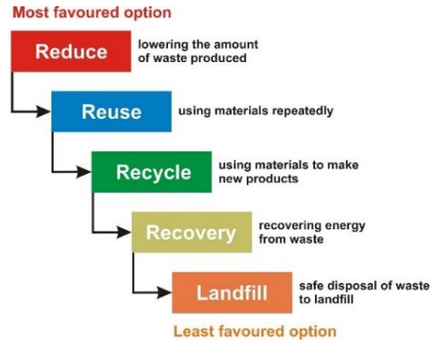


Figure 3: Waste Hierarchy.

5.6 Transport

A Transport Statement has been prepared by Jubb. The proposals have been assessed in relation to the site's accessibility in sustainable travel terms as well as the sites potential net highway impact on the existing highway network in addition to the future accessibility credentials and likely highway impact being taken into consideration.

The site is well-located to access a range of facilities, services and employment opportunities, and is in a position to link into existing walking routes, cycle routes and excellent public transport services. As a result, there is the opportunity to travel to and from the site by sustainable modes of transport.

It is proposed that vehicular access to the site initially be provided by way of Hoodlands, with the existing track upgraded. Pedestrian access to the site would be provided by way of a footway along the western side of the proposed vehicular access. Once the connections through the neighbouring Crest development are constructed to the boundary of the site and come 'online', vehicular access would be provided by way of the Crest development and the initial access by way of Hoodlands would be 'downgraded' to provide a 'green corridor' accommodating active travel.

There will be multiple points of access for pedestrians and cyclists, including the 'green

corridor' along Hoodlands as well as through the Crest development.

For further information refer to Transport Statement prepared by Jubb. An outline Framework Travel Plan will be prepared to support the planning application stage, to agree these key initiatives with SGCC.

5.7 Pollution

Pollution can harm both the natural environment and the human environment and consequently can negatively influence the wellbeing of wildlife and humans.

Best practice pollution prevention measures will be implemented throughout construction to reduce the potential negative impacts on water, and air, to minimise disturbance to the surrounding areas. In addition, the design of the buildings have been undertaken in a way which negates or reduces the impact of pollution.

5.7.1 Air

Hydrock have prepared an Air Quality Assessment (AQA) in support of the proposed residential development (the Development) located at Hoodlands Farm, North of Hambrook Lane, Harry Stoke, Bristol (the Site).

Defra background concentrations and local air quality monitoring have been used to establish baseline air quality conditions in the area, pollutant concentrations are well below the National Air Quality Objectives (NAQOs).

A qualitative construction dust risk assessment has been undertaken in line with the Institute of Air Quality Management (IAQM) guidance. It has been shown that the construction phases of the Development could give rise to emissions that are Medium Risk for dust soiling and a Low Risk for human health impacts. However, by adopting the appropriate mitigation measures in the AQA, there should be no significant residual effects.

The potential exposure of future occupants at the Site to poor air quality has been qualitatively assessed taking into consideration the local highway network and the railway to the north of the Site. The risk of exposure to NAQO exceedances due to emissions from both the local highway and the railway has been shown to be low. Therefore, it is concluded the Site is suitable, in terms of air quality, for the proposed residential use.

By following screening criteria provided in IAQM guidance, it is likely that any potential effects of the Development on air quality would be not significant. The cumulative impact of the Development is also considered from a review of the East of Harry Stoke Outline Application Environmental Statement, which concluded no significant impacts would occur. Therefore, no mitigation should be required in terms of air quality.

However, the transport consultants for the scheme, JUBB, are preparing a Framework Travel Plan for the scheme. The sustainable travel measures within this Framework Travel Plan that support or incentivise the use of sustainable transport will be beneficial in terms of air quality. Also, it is proposed that 100% of parking spaces be provided with passive provision for Electric Vehicle (EV) charging points and 23 parking space be provided with active EV charging points. This would have the effect of incentivising and enabling the use of EVs which are beneficial to air quality.

From the evidence in the AQA, and by following the guidance provided therein, the Development should comply with all relevant air quality policy. As such, air quality should not pose any significant obstacles to the planning process at the site.

5.7.2 Land

Any existing land contamination will be remediated prior to the commencement of construction activities on site.

Further intrusive ground investigations will be required prior to the commencement of any development. The testing and remediation have been carried out and these tests will be taken into account during the construction to ensure:

- There will no unacceptable environmental risks to future residents of the site and that they and the ground water environment will be protected from pollution; and
- There will be no foreseeable criminal, civil or other liability as a result of contamination in, at or under the site and/or the migration of contamination from the site.

5.7.3 Water (Foul)

All areas of the development will connect to the public foul sewer network.

5.7.4 Noise

RBA Acoustics have been appointed by BoKlok to assess acoustic compliance of the proposed site layout with the requirements of South Gloucestershire County Council (SGCC) and, following liaison with the EHO, have subsequently responded to specific feedback and additional queries relating to acoustics.

Due to the pre-fabricated nature of BoKlok developments, the scheme is compliant with the required British Standard criteria through the use of standard Boklok specification units.

Measured noise levels were used for the assessment of the glazing requirements to ensure suitable internal noise levels are capable of being achieved at the proposed development, with reference t BS 8233 and WHO.

5.7.5 Light

Light pollution can result from any adverse effect of artificial lighting and includes the following:

- Glare – the uncomfortable brightness of a light source when viewed against a dark sky;
- 'Light trespass' – the spread of light spillage the boundary of the property on which a light is located; and
- 'Sky glow' – the orange glow seen around urban areas caused by a scattering of artificial light by dust particles and water droplets in the sky.

All external lighting for the site will be designed in line with current British Standards and ILP Guidelines.

5.8 Broadband Connectivity

A review of broadband connectivity options has been carried out for the site to determine providers and expected bandwidths. High speed broadband is; standard broadband up to 11Mb and fibre optic up to 100Mb. Suppliers serving the area include Vodafone, Plusnet, BT and NOW Broadband.

6. EMBODIED CARBON

Embodied carbon refers to the carbon footprint of a material, it considers the quantity of greenhouse gases (GHGs) that are released during the manufacture, transport and construction of a building as well as its life cycle and decommissioning at the end of its life. Typically, this figure is represented as one kilogram of carbon dioxide ('equivalent' to normalize other GHGs emitted) per meter squared of building area; $kgCO_2e/m^2$.

This allows for direct comparison between different materials, construction processes, buildings and services solutions and further more to benchmark a buildings (or sites) carbon footprint throughout its life cycle. A lower carbon footprint during manufacturing and construction will be much easier to offset with ever improving efficiency of renewable technologies and de-carbonisation of the grid in the future.

6.1 Traditional New Build

The Royal Institute of Chartered Surveyors (RICS) provide information on existing and new builds. A typical low-rise apartment scheme can have a range of embodied carbon from 540 to over 1100 $kgCO_2e/m^2$.

Comparing other residential schemes that we have worked on with the information provided by RICS is a good indicator and average for the industry. These figures can vary by a large factor once construction processes, use and end of life elements are taken into account. We have given an example of a recent scheme in the following section.

6.2 Current Design Schemes

For comparison an internal study of a recent project revealed that for a traditional two-storey two bed build results in 591 $kgCO_2e/m^2$. Once carbon saving measures had been implemented this figure dropped to 516 $kgCO_2e/m^2$.

6.3 BoKlok – Proposed Apartments

The embodied carbon analysis for the BoKlok development has allowed for the following processes; main build, waste, transportation and an additional 5% for site based abnormals to give a comparable score to the schemes listed above. The figures equate to a total embodied carbon of 230.15 $kgCO_2e/m^2$. The current design proposals do not currently include any allowance for solar panels. So, by comparison to the RICS Low Case (LC) we are proposing a reduction of over 55%. This gain has largely come from the pre-fabrication of the BoKlok product which is assembled off-site based on a standardised set of constructions, which utilise low embodied carbon materials and reduce the amount of waste from the construction process.

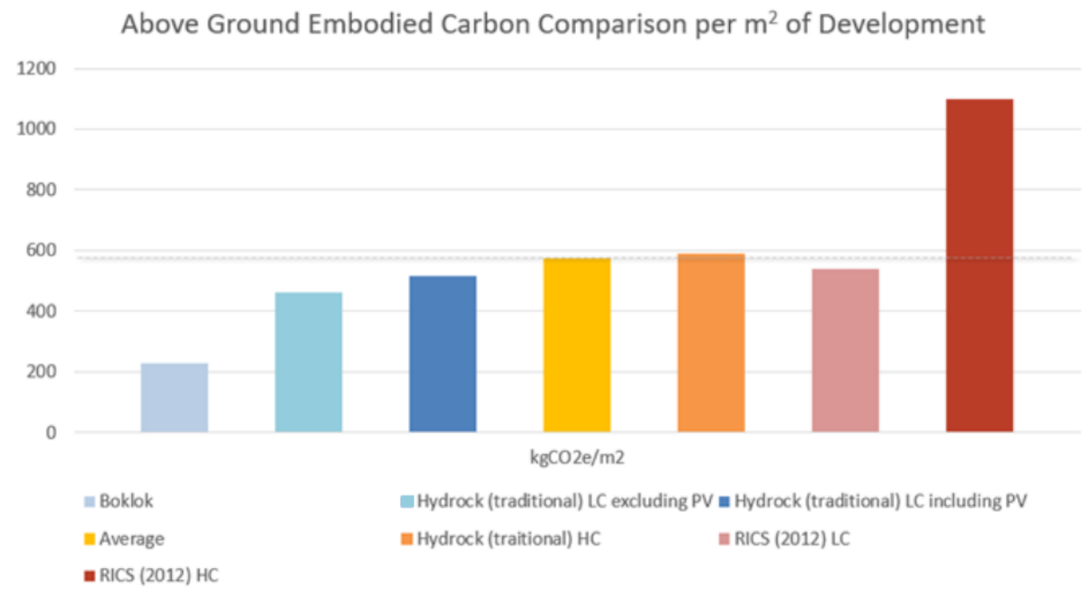


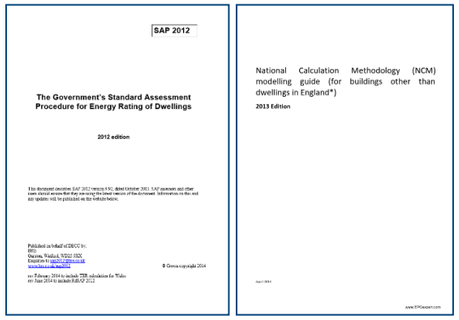
Figure 4: Embodied Carbon Comparison per m²

BoKlok LC	Lowest figure provided by BoKlok
BoKlok HC	Highest figure provided by BoKlok
Hydrock Traditional LC Ex PV	Lowest carbon development without PV
Hydrock Traditional LC	Hydrock analysis of traditional build with improvements
Hydrock Traditional HC	Hydrock analysis of traditional build without improvements
RICS (2012) LC	Weighted above ground only RICS (low range)
RICS (2012) HC	Weighted above ground only RICS (high range)

Energy and Carbon Emissions

This section of the report establishes the baseline energy consumption and associated CO_2 emissions for the scheme. The baseline carbon dioxide emissions refers to a Building Regulations 2013 Part L compliant development.

Under Part L, residential areas of the development are to be assessed under the Standard Assessment Procedure (SAP).


SAP 2012

The Government's Standard Assessment Procedure for Energy Rating of Dwellings

2012 edition

National Calculation Methodology (NCM) modelling guide (for buildings other than dwellings in England*)

2013 Edition

7.1 Standard Assessment Procedure (SAP) Energy Modelling

The dwellings on site have been assessed under Part L 2013 using the Government's Standard Assessment Procedure (SAP). The CO_2 reduction requirements have been assessed on an aggregate approach across the site, taking into account the orientation, number, size and type of dwelling.

7.2 Internal gains

Weather data is based on the UK average climatic data provided by SAP for the dwellings.

Solar gains are calculated automatically by the modelling software and are based on the orientation of the building, the transmission coefficients of the glazing and the solar angles. SAP also takes into account shading devices.

Gains from lighting, appliances, cooking and from the occupants are estimated from the floor area.

7.3 Building fabric

All fabric attributes for the baseline case are as per the Part L1A notional building. The table below show the baseline U-values for a Part L1A baseline development.

The air permeability (air leakage index) lies between 3 and 5 $m^3/hr/m^2$ at 50 Pa depending on the building typology.

Building Element	Part L1A 2013 Notional Building U-value
Roof	0.13 W/m²k
Wall	0.18 W/m²k
Floor	0.13 W/m²k
Glazing	1.40 W/m²k

Table 3: Part L1A Notional Building U-values

7.4 Building services

All efficiencies for the baseline case match the notional buildings.

7.5 Unregulated Energy Demand

Unregulated emissions relate to any energy consuming activities that are not covered under Building Regulations Parts L1A.

This usually consists of small power (plug-in) devices or any other plant process or equipment.

For BoKlok houses, this will include:

- Small power – Televisions, computers, laptops and other electrical equipment.
- Kitchen equipment – Cookers, fridges, freezers and dishwashers etc.

Table 4: Typical dwelling TER figures

Apartment	Area (m²)	TER ($kgCO_2/m^2/yr$)	TER (kCO_2/yr)	UnReg ($kgCO_2/yr$)
House - 2B4P Mid-terrace	82	25.90	2,120	1,580
House - 2B4P End-terrace	82	27.89	2,285	1,515
House - 2B4P Mobility Unit House	93	27.63	2,580	1,655
House - 3B4P End-terrace	89	27.15	2,415	1,660

7.6 Total Baseline Energy Demand

The baseline CO_2 emissions for the entire development has been approximately calculated.

The total baseline regulated energy demand is approximately **118,490 $kgCO_2/yr$**.

The total unregulated baseline regulated energy demand is approximately **81,565 kgCO2/yr**.

8. ENERGY EFFICIENCY MEASURES FOR DWELLINGS

8.1 Introduction

This section looks at measures to reduce emissions from the new residential element of the development against the notional building baseline. Energy demand reduction provides the greatest opportunity for minimising a building's potential CO_2 emissions.

Design strategies typically include building form and fabric measures (passive design) and energy efficient building services (active design). Focusing on form and fabric in particular at an early stage in the build process is often the most cost-effective way to reduce energy consumption and CO_2 emissions.

8.2 Passive Design

Passive design options are those which utilise building form, massing and glazing ratios to exploit the natural surroundings of the site to help reduce energy demand.

The energy requirements of a residential development can be significantly reduced when the siting and location is appropriate, aiding passive solar gain and natural daylight.

The aim is to have an efficient building fabric, including low thermal transmittance building elements, to reduce heat loss from the building, see Figure 4 for diagram.

Building Element	Proposed Building Fabric
Roof	0.11 W/m²k
Wall	0.19 W/m²k
Floor	0.10 W/m²k
Glazing	1.0 W/m²k

Table 5: Proposed building fabric - Residential

The air permeability (air leakage index) is 3.9 and 5.0 $m^3/m^2/hr$ at 50 Pa, for apartments and houses respectively.

Natural ventilation should be utilised where possible with extract ventilation in wet areas, such as kitchens and bathrooms. To enable efficient natural ventilation dwellings should be designed with dual aspect living spaces, where applicable, to allow cross-ventilation through windows and openings in the façade.

Access to natural daylight can be maximised throughout the site at masterplan level through efficient spacing and orientation of buildings. Buildings have been orientated to minimise overshadowing and to allow daylight to penetrate the dwellings, where possible.

Potential for overheating can be assessed against the CIBSE TM59 (2017) criteria.

8.3 Active Design

Active design relates to energy efficiency measures that can be included within the building services specification to reduce energy consumption. All services will be designed to meet at least the minimum recommended performance requirements contained in the UK Government Domestic Services Compliance Guide.

For residential houses, an individual ASHP system will provide heating and hot water. Hot water delivery should include high levels of insulation and low heat loss storage vessels, where required, coupled with efficient fittings to minimise water consumption and energy consumption.

All dwellings should be provided with energy efficient light fittings (in the form of pendants or downlights) including LEDs.

Living spaces could all be naturally ventilated, depending on the provision of suitable window openings. Natural ventilation should be assessed according to the external acoustic environment and levels of local air pollution, in addition to its propensity to alleviate risk of overheating in summer.

Low solar gain coefficient (G-value) glazing may be required for south facing rooms to aid the passive cooling strategy. Although MVHR is particularly attractive in winter, where heat recovery is utilised, it is not used on BokLok schemes.

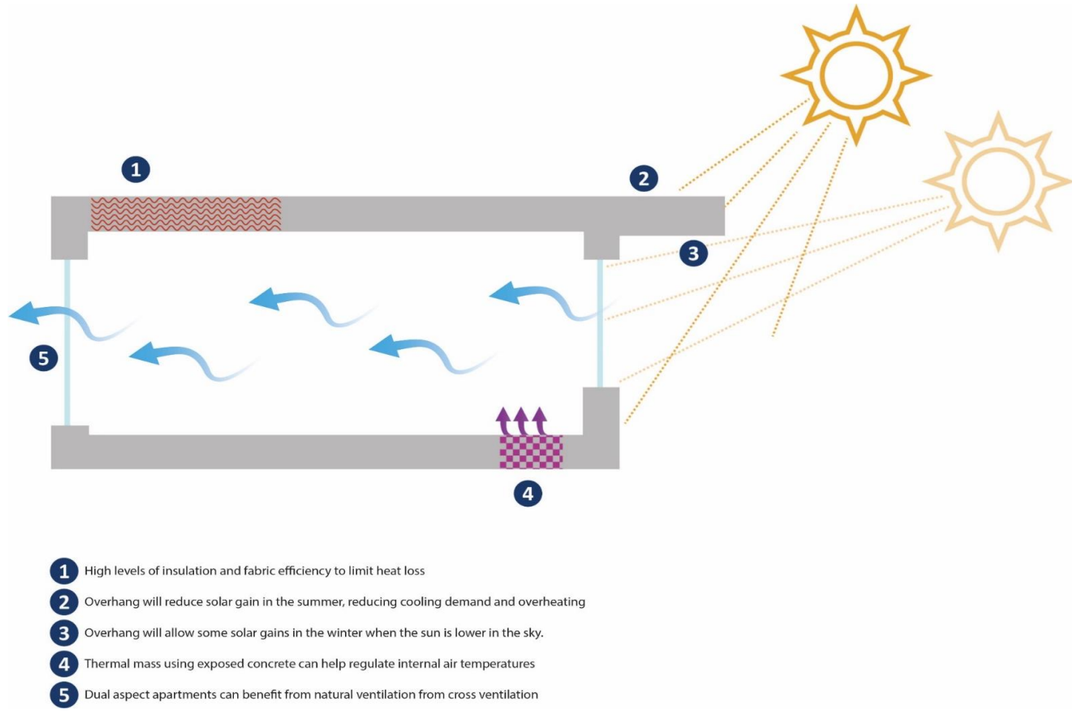


Figure 5: Passive design options

Residual Carbon Emissions and Renewable Energy

9.1 Introduction

In order to achieve the on-site energy reduction requirement, set out by the South Gloucestershire Council, the development will need to utilise energy from renewable or low carbon sources to offset the residual energy and unregulated energy use by 20%.

9.2 Renewable Energy Options

A number of site wide energy generation technologies could be given initial consideration:

- Solar Thermal Hot Water;
- Wind turbines;
- Photovoltaics;
- Combined Heat and Power; and
- Air Source Heat Pumps (ASHP).

9.2.1 Solar Thermal Hot Water

Solar water heating systems use the energy from the sun to heat water. The systems use heat collectors, generally mounted on the roof in which a fluid is heated by the sun. This fluid is used to heat up water that is stored in either separate hot water storage vessel or a twin coil hot water storage inside the building. The anticipated life span of a SHW system is 30 years.

SHW can work well in conjunction with other renewable technologies, but is unlikely to work well with future potential connection to district heating as both will be sized to provide the base load heating and hot water.

Solar thermal could be explored for BoKlok, but thermal storage and the suitability for the tenants will need to be considered. Specifically, for the Hoodlands site, the feasibility of connecting a solar thermal system to individual dwelling would be unviable.

9.2.2 Wind Turbines

Wind turbines work by converting the kinetic energy in wind into mechanical energy that is then converted to electricity. They are available in a range of sizes and designs and can either be free standing, mounted on a building or integrated into a building structure.

Roof-mounted turbines could be explored for BoKlok, although consideration for potential noise and aesthetic impact. Specifically, as the Hoodlands site is situated within a rural area, and the impacts will affect residential developments, the use of wind turbines will be expected to be refused.

9.2.3 Solar Photovoltaics

PV panels work by converting the energy from sunlight into usable electricity via photovoltaic cells placed on the roof of buildings. These can be integrated into the roof itself or tradition “bolt-on” panels.

These can vary in efficiency with the most efficient panel having an efficiency of 21%, while most perform at around 15-18%.

PV panels have a low visual impact, have limited effects on the environment, and can be combined with battery storage if desired. They can also work well in conjunction with future district heating systems.

Battery storage is the technology of charging medium-scale battery storage from PVs. This could be utilised to provide the peak electricity usage of a household, as it will consume all generated energy during off-peak times (mid-day).

Solar PV, either with or without the addition of battery storage, could be explored for BoKlok, as it is a very reliable and sustainable technology.

Although, there will need to be consideration into whether the energy generated by PV will be beneficial to the tenants, as the site will likely be not used during peak sunlight hours.

9.2.4 Combined Heat and Power

Combined Heat and Power Units are essentially small electricity power stations. They generate electricity and are more efficient than power stations because the heat generated as a by-product of electricity generation is used to provide hot water to buildings.

To be considered as a renewable energy, CHP must be powered by a biomass system. A biomass system uses woodchips, pellets, or other natural products to burn in a large boiler system. However, this system is unsustainable for BoKlok developments.

9.2.5 Air Source Heat Pump

ASHPs work by using refrigerant at low temperatures to extract the heat from external air. The refrigerant is then compressed to increase its temperature, the high temperature is then passed onto the water serving heating and hot water circuits in the dwelling.

ASHPs use a small amount of electricity to run the compressor but do not need a heat source installed as the heat is taken from the surrounding air.

For BoKlok, ASHPs are proposed for the development as the lead heating source with backup boilers to be provided for the coldest months and provide resilience in the heating system.

9.3 Residual Energy Demand

The residual carbon emissions refer to the site wide CO_2 emissions rate, after the implementation of energy efficiency measures.

The baseline energy demand for the site is approximately **199,305 kWh/yr**. After Energy Efficiency Measures (fabric improvements), the energy demand is approximately **182,105 kWh/yr**.

A final site energy demand (Reg and Unreg), after Energy Efficiency Measures and renewable technologies, is **145,500 kWh/yr** (20.1% reduction).

Energy Summary

10.1 Overview

This report has provided a detailed assessment of the reduction of energy demand for the BoKlok development at Hoodlands Farm.

The purpose of this report is to inform South Gloucestershire Council, of an energy assessment for the BoKlok development.

After analysis of anticipating CO_2 emissions under Building Regulations Part L, and having undergone a lean design process to reduce the demand for energy, it is proposed that the development will utilise a ASHP per house, providing **20.2% reduction** on BER.

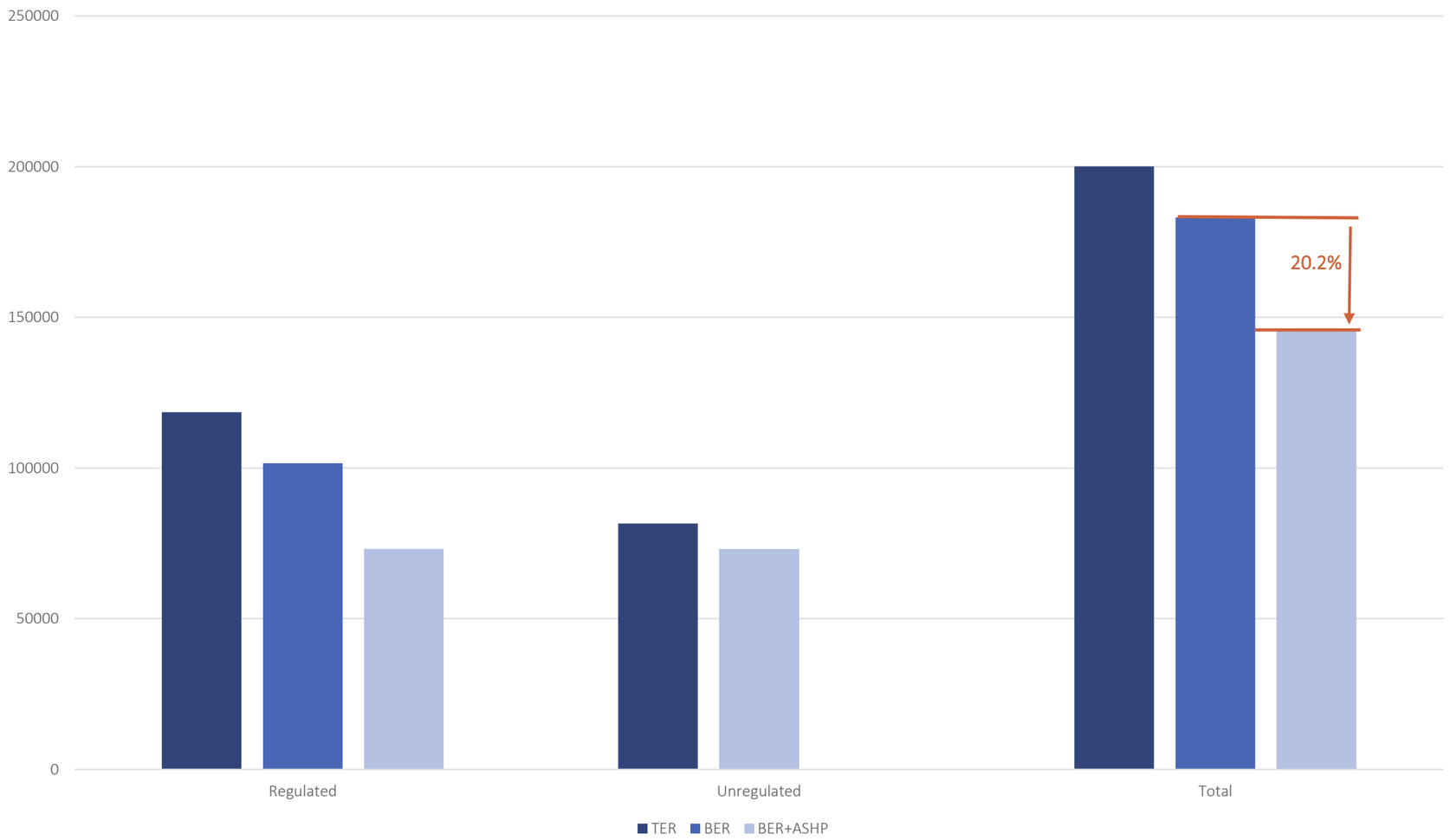


Figure 6: Estimated Target Energy Demand, Building Energy Demand, Building Energy Demand with the inclusion ASHP for the entire development (Regulated and Unregulated)