

Gas Holder Site, Reading

Energy Statement

April 2019





Executive Summary

Danescroft (Kenavon Drive Project Management) LLP has instructed Briary Energy to create this document, which examines the feasibility of suitable LZC (Low to Zero Carbon) sources, high-efficiency alternative systems, and low carbon energy efficiency measures.

The proposed Gas Holder Site, Reading development will comprise of 130 dwellings. The developer will meet the Building Regulations reduction in emissions across all dwellings relative to a 2013 Part L1A Building Regulations baseline, and will be achieved solely through the use of improved energy efficiency measures such as improved thermal fabric efficiency, air tightness and effective heating controls.

A combination of energy demand reduction measures and solar photovoltaic panels will deliver minimum total Carbon savings of 20.24% , and energy demand reduction would be 14.98%. This represents over 20% improvement over a Part L 2013 compliant development with at least a 14% Energy demand reduction using a fabric first and a solar Pv solution.

This strategy presents the proposed approach to meeting planning obligations relating to sustainability. The strategy calculates the total CO2 arising from the dwellings and demonstrates that a 20% reduction in CO2 emissions can be achieved through a combination of improved fabric measures and PV technology or a CHP communal scheme.

The energy consumption figures for the development are based on benchmark figures for each building type from CIBSE for non-domestic buildings or based on SAP 2012 for domestic buildings, and include regulated and non-regulated emissions.



National Planning Policy Framework (NPPF) – 2019

On 19 February 2019 the Government published the National Planning Policy Framework (NPPF), which sets out the Government's planning policies for England and how these are expected to be applied. At the heart of the NPPF is a presumption in favour of planning for climate change:

Achieving a sustainable development

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

Planning for climate change

150. New development should be planned for in ways that:

- a) avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and
- b) can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards.

151. To help increase the use and supply of renewable and low carbon energy and heat, plans should:

- a) provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);
- b) consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and
- c) identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for collocating potential heat customers and suppliers.

152. Local planning authorities should support community-led initiatives for renewable and low carbon energy, including developments outside areas identified in local plans or other strategic policies that are being taken forward through neighbourhood planning.

Paragraph 154 sets out what is expected from local authorities when considering strategies to mitigate and adapt to climate change:

154. When determining planning applications for renewable and low carbon development, local planning authorities should:

- a) not require applicants to demonstrate the overall need for renewable or low carbon energy, and recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and
- b) approve the application if its impacts are (or can be made) acceptable*. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.

LPA Policy section

Current Policy - Reading Core Strategy January 2008

Policy CS1: Sustainable Construction and Design

Proposals for new development, including the construction of new buildings and the redevelopment and refurbishment of existing building stock, will be acceptable where the design of buildings and site layouts use energy, water, minerals, materials and other natural resources appropriately, efficiently and with care and take account of the effects of climate change.

To meet these requirements –

- On larger developments of more than 10 dwellings ensure that 50% of the provision meets the most up to date Eco-Homes and BREEAM 'Excellent' standards;
- All new developments maximise the use of energy efficiency and energy conservation measures in their design, layout and orientation to reduce overall energy demand;
- All developments of more than 10 dwellings incorporate on-site generation of energy from renewable sources and energy efficient design measures (including the use of CHP where appropriate) to off-set at least 20% of predicted carbon dioxide emissions from the estimated energy usage of the completed and occupied development.
- All developments reduce mains water use and demonstrate that water conservation measures are incorporated so that predicted per capita consumption does not exceed the appropriate levels set out in the Code for Sustainable Homes or BREEAM Standards.

Emerging Policy - Draft Local Plan (likely to be adopted Spring 2019)

Policy CC2: Sustainable Design and Construction

Proposals for new development, including the construction of new buildings and the redevelopment and refurbishment of existing building stock, will be acceptable where the design of buildings and site layouts use energy, water, minerals, materials and other natural resources appropriately, efficiently and with care and take account of the effects of climate change.

To meet these requirements –

- Both residential and non-residential development should include recycling greywater and rainwater harvesting where systems are energy and cost effective.

Policy CC4: Decentralised Energy

In meeting the sustainability requirements of this plan, developments of the sizes set out below shall demonstrate how consideration has been given to securing energy for the development from a decentralised energy source, including CHP.

Any development of more than 20 dwellings shall consider the inclusion of a CHP plant, or biomass-fuelled heating scheme, or other form of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable or feasible for this form of energy provision.

Where there is existing decentralised energy provision, including a CHP plant or district energy network present within the vicinity of an application site, further developments of over 10 dwellings will be expected to link into the existing decentralised energy network or demonstrate why this is not feasible."

Energy Standards

The March 2015 ministerial statement additionally stated:

"For the specific issue of energy performance, local authorities will continue to be able to set and apply policies in their Local Plans which require compliance with energy performance standards that exceed the energy requirements of Building Regulations until commencement of amendments to the Planning and Energy Act 2008... Until the amendment is commenced, we would expect local planning authorities to take the government's intention into account in applying existing policies and not set conditions with requirements above a Code Level 4 equivalent".

Changes to National Policy

Significant changes to both Building Regulations standards and national policy have occurred, since 2010.

Reductions in CO2 emissions from new development have been mandated through changes to Part L England and Wales. Updates in 2010 and 2013 required CO2 reductions from residential development cumulatively equating to approximately 30% better than Part L 2006, when the minimum standards for CO2 emissions were first introduced.

Further changes to national policy impact on the application of local planning policy, as expressed by the guiding principle within the National Planning Policy Framework¹ published in March 2012 which states that local policy should, "when setting any local requirement for a building's sustainability, do so in a way consistent with the Government's zero carbon buildings policy."

With respect to 'zero carbon', the implementation timescale and meaning of 'zero carbon' buildings has been under review and consultation in recent years. 'Zero carbon homes' was originally planned for introduction in 2016, with non-residential development to follow in 2019, however a policy announcement presented by HM Treasury as part of the July 2015 productivity plan "Fixing the Foundations"² advised that the government is not intending to proceed with zero carbon policy at this time, commenting that energy efficiency standards introduced through the 2013 amendment to Part L 'need time to become established' and will therefore persist until further notice.

Proposed LPA Policy Response

Policy CS1: Sustainable Construction and Design (2008) states that all developments of more than 10 dwellings are to incorporate on-site generation of energy from renewable sources and energy efficient design measures (including the use of CHP where appropriate) to off-set at least 20% of predicted carbon dioxide emissions from the estimated energy usage of the completed and occupied development.

Based on Part L 2013, this statement has demonstrated that through applying the energy hierarchy approach, the preferred solution is Photovoltaics to the South and South west facing roofs.

A combination of energy demand reduction measures and solar photovoltaic panels will deliver minimum total Carbon savings of 20.24% , and energy demand reduction would be 14.57%. This represents over 19% improvement over a Part L 2013 compliant development with at least a 14% Energy demand reduction using a fabric first and a solar Pv solution.

Energy hierarchy through design

The Gas Holder Site, Reading development will be developed with the aim to reduce annual energy consumption, whilst providing energy in the most environmentally friendly way to reduce the annual CO₂ footprints.

This outline strategy has been developed using established methodology (as recommended by CIBSE and the London Plan). It has three priorities, seeking to reduce energy use through the cleanest possible solutions. Reducing the demand for energy in the first place, means our priority is always to use a fabric first approach: -

Be Lean - Reducing energy needs through improved design and construction.

Be Clean - Supply energy efficiently through the use of decentralised energy where feasible.

Be Green - Further reduce CO₂ emissions through the use of on-site renewable sources, where practical.

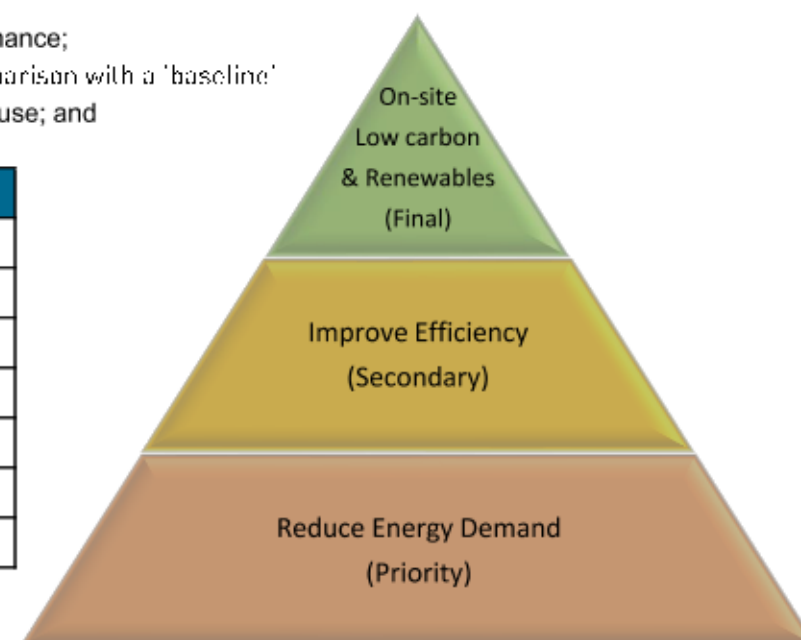
As this hierarchy demonstrates, designing out energy use is weighted more highly than the generation of low- carbon or renewable energy to offset unnecessary demand. Applied to the development of new housing, this approach is referred to as 'fabric first' and concentrates finance and efforts on improving U-values, reducing thermal bridging, improving airtightness, installing energy efficient ventilation and heating services.

This approach has been widely supported by industry and government for some time, with previous reports from Zero Carbon Hub[1] and Energy Saving Trust[2] having both stressed the importance of prioritising energy demand as a key factor in delivering resilient, low energy homes.

Further to the above methodology, we have also looked at other steps towards achieving a low carbon solution, including:

- The incorporation of passive design solutions by considering the dwellings orientation and layout solutions;
- The incorporation of energy efficiency measures through the design of services and improved fabric performance;
- Calculation of the predicted design energy consumption rates and associated annual CO₂ emissions in comparison with a 'baseline' building (using Part L Regulations compliance standards) to include both regulated and un-regulated energy use; and
- Assessment of the viability of incorporating low and zero carbon energy sources.

Benefits of the Fabric First Approach	Fabric Energy Efficiency Measures	Boil on renewable energy technologies
Energy/CO ₂ /fuel bill savings applied to all dwellings	✓	0
Savings built-in for life of dwelling	✓	0
Highly cost-effective	✓	0
Increases thermal comfort	✓	0
Potential to promote energy conservation	✓	✓
Minimal ongoing maintenance / replacement costs	✓	0
Minimal disruption to retrofit post occupation	✓	0



[1] Zero Carbon Hub, Zero Carbon Strategies for tomorrow's new homes, Feb 2013

[2] Energy Saving Trust, Fabric first: Focus on fabric and services improvements to increase energy performance in new homes, 2010

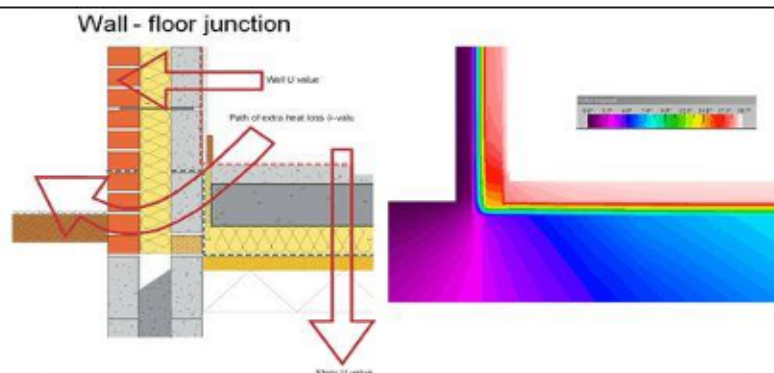
Be Lean - Energy efficient design measures

Enhancing the thermal performance of the building is usually cheaper than providing renewable energy, with more reliable CO₂ savings for the long-term lifecycle of the building. Without the cost of replacing mechanical or electrical components on a continual basis. Adding renewable technology will then maximise on these carbon reductions reducing the quantity required.

This development will achieve compliance with Approved Document L1A of the Building Regulations (2013) without relying upon the contribution of renewable energy.

Element	Building Regulations	Proposed
Ground Floor	0.25 W/m ² k	0.15 W/m ² k
External Wall	0.30 W/m ² k	0.26 W/m ² k
Dormer	0.20 W/m ² k	0.1 W/m ² k
Flat Roof	0.20 W/m ² k	0.18 W/m ² k
Windows	2.00 W/m ² k	1.4 W/m ² k
Doors	2.00 W/m ² k	1.09 W/m ² k
Air Perm	10.00 W/m ² k	5.01 W/m ² k
Thermal Bridges	0.15 ≤ Y	Calculated Constructive Details

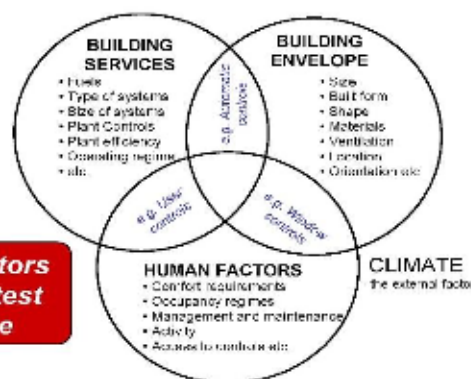
Improving the thermal bridge constructive details can have a great impact on the heat loss of the development, in some cases using enhanced details can make as much as a 27% improvement on fabric alone.



Additional improvements to thermal performance can be achieved by ensuring good practice airtightness targets are achieved. Simple measures like sealing around services (eg water, gas and cables), using proprietary seals and collars, ensuring blockwork is sealed and parging layer/plaster finish is applied to external walls before erecting studwork for internal partitions.

Be Clean - Energy efficient mechanical & electrical systems

FACTORS THAT INFLUENCE ENERGY CONSUMPTION



**Human factors
have greatest
influence**

Having reduced energy demand through the fabric first approach, we now look to specify mechanical and electrical systems with efficiencies that far surpass the requirements of the Domestic and Non-domestic Building Services Compliance Guide (2013): -



The following energy efficient systems are proposed, this covers the clean mechanical and electrical systems. HVAC (heating, ventilation, air conditioning), hot water, lighting and efficient controls. Some renewable factors may be considered and included at this stage, i.e: heat recovery, air source heat pumps, ground source heat pumps...

Element	Compliance	Proposed
Low energy lighting (efficacy $\geq 45\text{lm/W}$)	75%	100%
Ideal logic Code Combi 38 ESP1 and System S18	88%	89.6%
Shower Save (WWHRS)	N/A	N/A
Hot water 250L cylinder	$\leq 2.56 \text{ kW/day}$	1.85 kWh/day
Heating controls	Programmer, TRV's & room stats	Time & Temp Zone controls
Advanced controls	N/A	delayed start
Greenwood unity CV2GIP	0.3 I/W/s (SFP)	0.2 I/W/s (SFP)

Be Green – Decentralised and Low to Zero Carbon sources

Feasibility is based on location, cost, payback for both initial payment and ongoing maintenance and suitability. The following pages, show each Low to Zero Carbon energy solution that has been considered. Further feasibility has been calculated and demonstrated for each, with a list below of all the technologies considered with in depth information about each technology, regardless of whether it is proposed or not: -

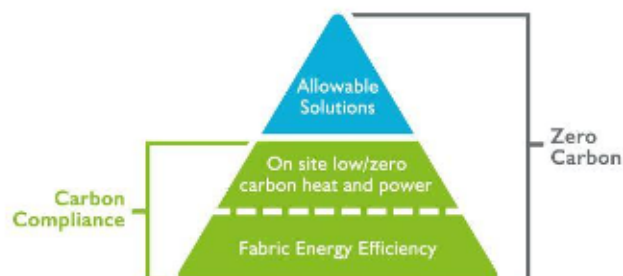
Zero carbon technologies

- Solar Hot Water;
- Solar Photovoltaic;
- Perovskite Photovoltaic;
- Wind Turbines; and
- Small Scale Hydro Power.

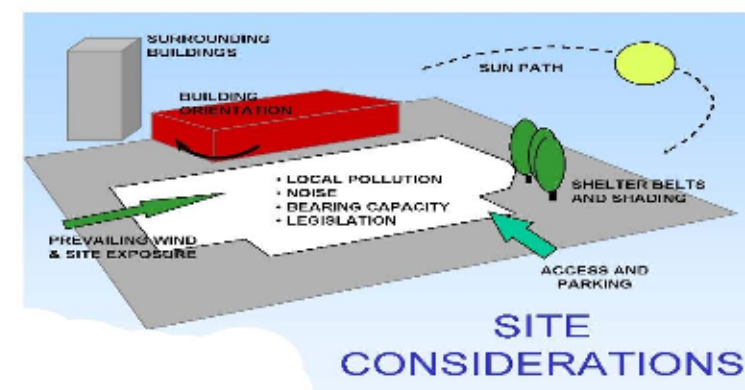
Low carbon technologies

- Biomass;
- District Heating and Combined Heat and Power (CHP);
- Heat pumps: Ground Source Heat Pumps, Geothermal Heating Systems, Air Source Heat Pump;
- Flue Gas Heat Recovery Systems (FGHRS); and
- Showersave / Waste Water Heat Recovery System (WWHRS).

In order to satisfy the local planning requirements, a more detailed assessment of each of the following solutions will be explored later on in this statement. Each energy efficiency measure has been looked at more fully, to give a greater understanding of which solutions could be implemented at the development to make energy and CO₂ savings beyond current building regulations.



Considered technologies	
Solar hot water	No
Solar Photovoltaic	Yes
Wind Turbines	No
ASHP	No
GSHP	No
Flue Gas Heat Recovery	No
Waste Water Heat Recovery	No
Fabric Approach	Yes



CHP District Heating (considered)

As part of planning, any major development proposals should evaluate energy systems in accordance with the following hierarchy: -

- Connection to existing heating and cooling networks;
- Site wide combined heat and power (CHP) network;
- Communal heating and cooling.

Over several years, building service engineers, Max Fordham have studied the benefits and drawbacks of providing heat to buildings via hot water heat networks supplied from community scale heat sources, in particular combined heat and power (CHP).

Government scenario planning includes predictions that by 2050 heat networks may supply about 20% of the UK's building heat demand [D. o. E. & C. Change, "National Energy Efficiency Data-Framework (NEED) report: Summary of analysis 2013 Part 1," DECC, 2013.]. It is clear that government policy is vigorously pursuing gas fired CHP with heat networks, but to what effect?

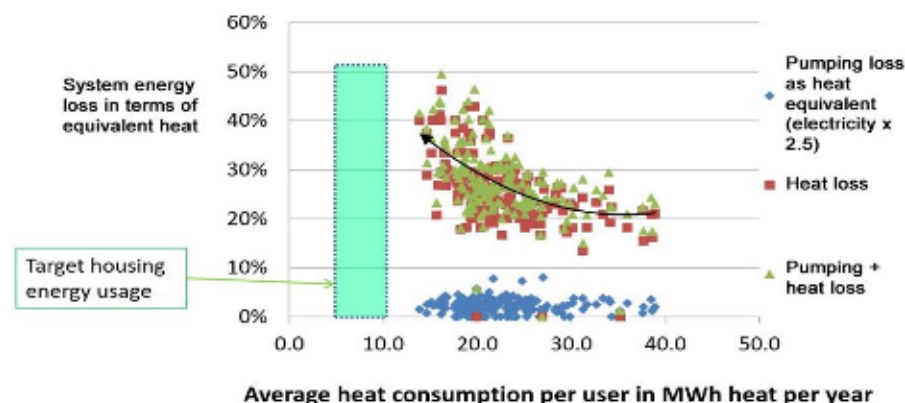
The issues are varied, complex and include: consideration of the heat sources that may be in use in the future; the future strategy for national electricity generation; the difference between "as predicted" and "as measured"; the relationship to the intensity of heat demand; and the costs to the end users.

The most important aspect that Max Fordham concluded is that the heat network system heat losses are very large. They are much larger than the assumed values used in regulatory and system planning calculation methods (such as SAP).

An unfortunate feature of this (district heating) debate is that good quality data from a wide range of UK installations is not available or not publishable due to its commercially sensitive nature. Clearly this situation is not helping the UK develop a low carbon heat strategy.

However, data from the Danish District Heating Association shows that from analysis of about 100 installations the heat losses in the municipal distribution pipes ranged from 15% to 45% of the heat supplied. This is only the loss up to the building site boundaries. There will be additional losses inside the buildings too. The current UK average domestic heat demand is 14MWhr/dwelling/yr [D. o. E. & C. Change, "National Energy Efficiency Data-Framework (NEED) Summary consumption statistics," DECC, 2011.]. At this scale the Danish data shows that a heat loss of around 35%. If the heat demand from buildings is reduced to less than 10 MWhr/yr (which is desirable) then the heat losses might represent 50% of the heat supplied.

Danish data of heat and pumping losses in district heating systems. Source: Birger Lauersen, International chef / Manager International Affairs, Dansk Fjernvarme / Danish District Heating Association



District Heating - (continued)

The development will be future proofed to connect to any existing district heating system, but a communal CHP system has been considered, but these points must be taken into account:

- the site is mainly residential, with units dispersed over 3 blocks. This will mean that a large distribution network would be required, and it is anticipated that distribution losses would be potentially high.
- the site will be constructed in phases, so a temporary heating system would need to be installed to serve initial phase, and the carbon reductions would not be realisable until the majority of the development had been constructed, and the district heating network came online.
- the home owners would be tied to the same supplier, removing choice - this is becoming an issue across the country

High system heat losses (and pumping demands) mean that in many cases, gas fired CHP with heat networks will not reduce, but increase carbon emissions. This is particularly true when compared to using individual gas boilers and electricity from the current national grid. It is clear that heat networks need to be reassessed (by the UK Government) taking into account the true extent of heat losses and/or the mitigation measures required to reduce them. If this is done, we may well see quite a change in national and local policies for heat networks, with or without CHP.

Our preference has always been a much more vigorous pursuit of heat demand reduction, principally by insulating and draught proofing existing buildings.

From our observations of district heating systems we believe that the very high losses can be reduced with improved components, improved design and improved care during installation. However, it is highly unlikely that the system losses could be reduced to the levels that have informed current government policy, anytime soon.

The economic case for generating electricity with CHP is based on allocation of government tax incentives on plant, and avoidance of the levies on the retail cost of electricity by using gas that does not have these additional costs, rather than saving energy or CO2 emissions. A CHP community heating system on this development would be more costly to install and uses more energy than a conventional system.

On the basis that it costs considerably more to install and run and actually uses more energy, we have ruled out the use of this technology for this development, but will future proof the system on order that it could be connected into a community heating scheme.

Low to Zero Carbon Technology Reductions

A detailed assessment, which will include the practical implications of installing each technology and quantity to achieve the required mandatory improvement in DER over 2013 Building Regulations, will be discussed in more detail later in this report, should any of these technologies be considered economically viable for the Gas Holder Site, Reading development.

Potentially viable energy strategies considered	Number of Dwellings Applied to	Energy Saved %	Carbon Saved %	Capita Cost per m ²	Cost Per kg/CO ₂ saved over 15 years	Cost per Kw Saved over a 15 year period	Proposed?
Solar hot water	130	11.1%	9.7%	£30.12	£1.83	£0.30	No
Solar Photovoltaic	130	8.8%	15.5%	£20.48	£0.03	£0.01	Yes
Wind Turbines	0	0%	0%	£43.38	£0.00	£0.00	No
ASHP	0	0%	0%	£54.22	£0.00	£0.00	No
GSHP	0	0%	0%	£54.22	£0.00	£0.00	No
CHP Communal system	130	44.4%	38.9%	£57.35	£0.90	£0.20	No
Flue Gas Heat Recovery	0	0%	0%	£3.61	£0.00	£0.00	No
Waste Water Heat Recovery	0	0%	0%	£5.42	£0.00	£0.00	No
Fabric Approach	130	6.2%	5.4%	N/A	£0.00	£0.00	Yes

Technologies Not Considered

Fuel Cells: These are not yet fully commercially available.

Hydro: Small scale hydro would be inappropriate for integration into the proposed development due to the geographical location of the proposed site.

CHP, Biomass and Biogas District heating schemes have been discounted under the District Heating Scheme section

Solar Hot Water

Proposed for this development?

No

Solar water heating systems use heat from the sun to work alongside conventional primary water heaters. The technology is well developed with a large choice of equipment to suit many applications.

For domestic hot water there are three main components Solar panels or collectors- are fitted to the roof. They collect heat from the sun's radiation. There are 2 main types of collector:

- Flat plate systems- which are comprised of an absorber plate with a transparent cover to collect the sun's heat, or
- Evacuated tube systems- which are comprised of a row of glass tubes that each contains an absorber plate feeding into a manifold which transports the heated fluid.



A heat transfer system- uses the collected heat to heat water;

Hot water cylinder- stores the hot water that is heated during the day and supplies it for use later.

All savings are approximate and are based on the hot water heating requirements of a 3 bed semi detached home.

Solar water heating can be used in the home or for larger applications, such as swimming pools. For a domestic system you will need 3-4 square metres of southeast to southwest facing roof receiving direct sunlight for the main part of the day, a space to locate an additional water cylinder if required.

Solar water heating systems tend to require little maintenance Installation and maintenance costs. The typical installation cost for a domestic system is £3,000- £5,000. Evacuated tube systems are more advanced in design than flat plate, and so tend to be more expensive. Solar water heating systems generally come with a 5-10 year warranty and require little maintenance. A yearly check by the householder and a more detailed check by a professional installer every 3-5 years should be sufficient.

Gas Holder Site, Reading Solar Thermal Calculation

Number of plots with panels	130
Size of Panel	4.5 m ²
Number of Panels per plot	1
Total m ²	585 m ²
Average kWh/m ²	294
Energy produced by panels	171752
Energy% Saved From Panels	11.1%
CO ₂ % Saved From Panels	9.7%

Not Proposed for this development because...

Solar Thermal panels on this development will only produce a saving of 9.73% carbon emissions and a 11.10% energy demand reduction, which is not the most efficient technology available for this development: -

- *Solar Thermal relies on energy from the sun, therefore producing hot water only during daylight hours;
- *Poor servicing and badly programmed controls can make this technology operate less efficiently than a standard boiler;
- *Hot water storage has a heat loss linked to it, which can contribute to summer over heating and reduced efficiency;
- *This is not a 'fit and forget' technology, it requires regular servicing, replacement parts, optimizing of controls and more.
- *This is not suitable for poorly orientated dwellings.

Photovoltaic Collectors (PV)

Solar PV (photovoltaic) creates electricity to run appliances and lighting from natural daylight (direct sunlight is not required) to generate electricity.

How it works

Photovoltaic systems use cells to convert solar radiation into electricity. The PV cell consists of one or two layers of a semi conducting material, usually silicon. When light shines on the cell it creates an electric field across the layers, causing electricity to flow. The greater the intensity of the light, the greater the flow of electricity. PV systems generate no greenhouse gases, saving approximately 325kg of carbon dioxide emissions per year- adding up to about 8 tonnes over a system's lifetime- for each kilowatt peak (kWp - PV cells are referred to in terms of the amount of energy they generate in full sun light).

PV arrays now come in a variety of shapes and colours, ranging from grey 'solar tiles' that look like roof tiles, to panels and transparent cells that you can use on conservatories and glass to provide shading as well as generating electricity. As well as enabling you to generate free electricity they can provide an interesting alternative to conventional roof tiles!



PV systems for a building with a roof or wall that faces within 90 degrees of south, as long as no other buildings or large trees overshadow it.

If the roof surface is in shadow for parts of the day, the output of the system decreases. Solar panels are not light and the roof must be strong enough to take their weight, especially if the panel is placed on top of existing tiles. Solar PV installations should always be carried out by a trained and experienced installer. The area of PV required to generate 1kw hour peak varies but generally 6-8m² for M6n crystalline or 102 for polycrystalline modules of PV will produce 1Kw peak of electricity.

In order to meet energy demand improvements using Solar Photovoltaics, this site would require 63kWp to be shared amongst 130 dwellings. Carbon emissions could be reduced by 15.52% compared with Part L 2013 Target Emission Rate, and energy demand reduced by a further 8.77%.

Cost and maintenance

Prices for PV systems vary, depending on the size of the system to be installed, type of PV cell used and the nature of the actual building on which the PV is mounted. The size of the system is dictated by the amount of electricity required. For the average domestic system, costs can be around £1250-£2000 per kWp installed (energy saving trust 2017), with most domestic systems usually between 1.5 and 2 kWp. Solar tiles cost more than conventional panels, and panels that are integrated into a roof are more expensive than those that sit on top. Grid connected systems require very little maintenance, generally limited to ensuring that the panels are kept relatively clean and that shade from trees has not become a problem.

The wiring and components of the system should however be checked regularly by a qualified technician. Stand-alone systems, i.e. those not connected to the grid, need maintenance on other system components, such as batteries.

Photovoltaic Collectors (PV) Calculations

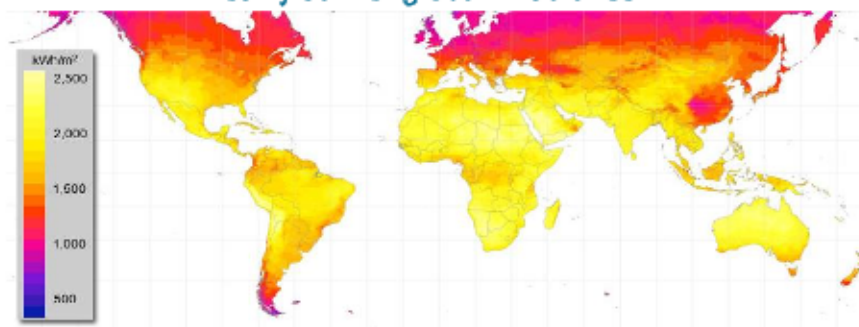
In calculating the feasibility of Solar PV, we will use a global formula $E = A \times r \times H \times PR$ to calculate the energy generated by the proposed PV to be placed on the development.

Losses details (depend of site, technology, and sizing of the system)

Inverter losses	4%
Temperature losses	3%
DC cables losses	1%
AC cables losses	1%
Shadings	0%
Losses weak irradiation	1%
Losses due to dust, snow	1%
Other Losses	0%

	Total site kWp	PR = Perf Ratio	H = Annual Irradiation	r=panel yield(%)	A=Panel Area(m ²)	E=Energy (kWh)
South	36.0	0.89	1054	20%	180	33,770.16
SE/SW	27.0	0.89	997	20%	135	23,957.91
East/West	0.0	0.89	854	20%	0	0.00
NE/NW	0.0	0.89	686	20%	0	0.00
North	0.0	0.89	640	20%	0	0.00
	63.0				Total Energy kWh	57,728.07

Yearly sum of global irradiance



The panels will be applied to some of the detached south, south east and south west dwellings

Amount of PV Panels to meet 63kWp Requirement

240w Panels
263 Panels Required
250w Panels
252 Panels Required
260w Panels
242 Panels Required



Proposed for this development because...

In order to achieve a 19% carbon emissions improvement (over part L) Gas Holder Site, Reading, 63kWp of Solar PV is our preferred choice, now that we have reduced the energy demand and improved the efficiency of this development. Here are some of the reasons why Solar PV is the most viable option: -

- *Clean green energy, during electricity generation with PV panels there are no harmful greenhouse gas emissions;
- *PV panels have no mechanically moving parts, with good quality panels lasting up to 25 years and some inverters lasting as long as 10 years;
- *Solar energy is energy supplied by nature, it is therefore free and as abundant as the sun; and
- *There are direct cost savings to the dwelling occupier, less electricity to buy and often FIT, tax credits and other incentives.

Micro wind turbine

Proposed for this development?

No



Wind turbines use the wind's lift forces to rotate aerodynamic blades that turn a rotor which creates electricity. In the UK we have 40% of Europe's total wind energy. But it's still largely untapped and only 0.5% of our electricity requirements are currently generated by wind power. How does it work? Most small wind turbines generate direct current (DC) electricity. Systems that are not connected to the national grid require battery storage and an inverter to convert DC electricity to AC (alternating current- mains electricity). Wind systems can also be connected to the national electricity grid. A special inverter and controller convert DC electricity to AC at a quality and standard acceptable to the grid. No battery storage is required. Any unused or excess electricity may be able to be exported to the grid and sold to the local electricity supply company.

There are two types of wind turbines: -

- Mast mounted- which are free standing and located near the building(s) that will be using the electricity.
- Roof mounted- which can be installed on house roofs and other buildings.

Potential Benefits

Wind power is a clean, renewable source of energy which produces no carbon dioxide emissions or waste products.

In the UK we have 40% of Europe's total wind energy. Individual turbines vary in size and power output from a few hundred watts to two or three megawatts (as a guide, a typical domestic system would be 1- 6 kilowatts). Uses range from very small turbines supplying energy for battery charging systems (e.g. on boats or in homes), to turbines on wind farms supplying electricity to the grid.

Not Proposed for this development because...

The Government wind speed database predicts local wind speeds at Gas Holder Site, Reading to be 4.7 m/s at 10m above ground level, 5.4 m/s at 25m above ground level and 5.9 m/s at 45m above ground level. This is below the level generally required for commercial investment in large wind turbines and in addition the land take, potential for noise and signal interference make a large wind turbine unsuitable for this development.

*Horizontal axis micro-wind turbines only reduce carbon emissions by a small amount. In high winds they need to be static due to fundamental design issues.

*Health and safety is also a factor, with high speed moving parts mechanical failure can be catastrophic to human life, birds and wildlife.

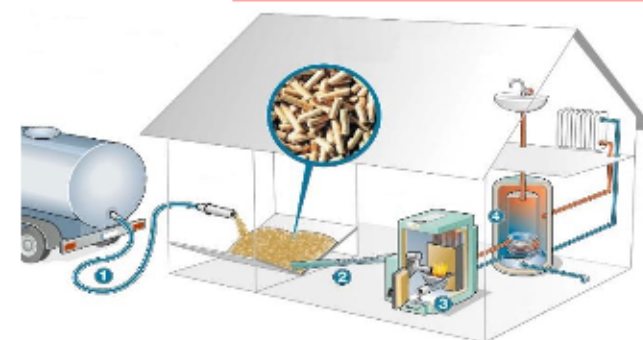
*Flicker means that the turbine needs to be at least 400 mtrs from the nearest dwelling and computer controlled to take into account the position of the sun.

Bio Mass

Biomass is produced from organic materials, either directly from plants or indirectly from industrial, commercial, domestic or agricultural products. It is often called 'bio energy' or 'bio fuels'. It doesn't include fossil fuels, which have taken millions of years to be created.

Biomass fall into two main categories: -

- Woody biomass includes forest products, untreated wood products, energy crops and short rotation coppice (SRC), which are quick-growing trees like willow.
- Non-woody biomass includes animal waste, industrial and biodegradable municipal products from food processing and high energy crops. Examples are rape, sugar cane, maize.



Proposed for this development?

No

Planning

If the building is listed or in an area of outstanding natural beauty (AONB), then you will need to check with your Local Authority Planning Department before a flue is fitted.

Costs and savings

Stand alone room heaters generally cost £2,000 to £4,000 installed. Savings will depend on how much they are used and which fuel you are replacing. A biomass stove which provides a detached home with 10% of annual space heating requirements could save around 840kg of carbon dioxide when installed in an electrically heated home. Due to the higher cost of biomass pellets compared with other traditional heating fuels, and the relatively low efficiency of the stove compared to a central heating system it will cost more to run. The cost for boilers varies depending on the system choice; a typical 15kW (average size required for a three-bedroom semi detached house) pellet boiler would cost around £5,000- £14,000 installed, including the cost of the flue and commissioning. A manual log feed system of the same size would be slightly cheaper. A wood pellet boiler could save you around £750 a year in energy bills and around 6 tonnes of CO₂ per year when installed in an electrically heated home.

Not Proposed for this development because...

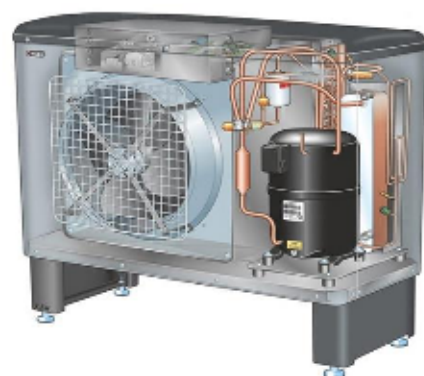
Biomass boilers, wood burning stoves and CHP engines all create a large amount of pollution and carbon emissions. Although it is considered that Biomass is a carbon neutral technology, thanks to the CO₂ being absorbed by growing new trees. It is not viable at Gas Holder Site, Reading development.

- *With pollution levels in London consistently increasing, particulate levels in burning biomass mean is not a clean technology;
- *Wood is a major source of biomass energy. Producing biomass fuel on a large scale can lead to deforestation;
- *Delivering the fuel can lead to more traffic causing more pollution and more delays, supply needs to be within a 40 mile radius;
- *By developing crops to produce fuel for biomass energy, we are utilizing land that may have been used for food sources.

Heat Pumps (ASHP & GSHP)

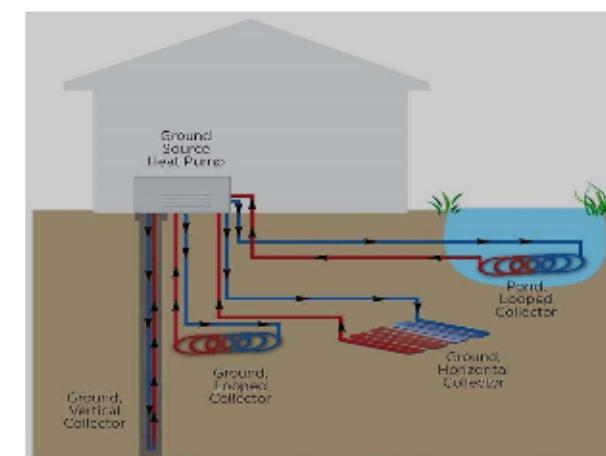
There are two types of heat pumps, ground source and air source. Heat pumps work in a very similar way to fridges and air conditioners and absorb heat from the ground or from the air. Ground or air source heat pumps are mainly designed to work with under floor heating systems because of the lower design temperatures of under floor systems. Efficiencies of ground source heat pumps are between 350%-550% and air source between 250%-450%. Heat pumps are a viable alternative to electric, LPG and oil fuel boilers, but are not considered as an alternative to natural gas.

Generally speaking, the ground source heat pump is considered the best for use in cold weather. This is because the ground has a natural supply of warmth. Typically, the piping is buried far enough down that the frost and cold weather will not be able to reach it, and so it is prevented from freezing by the natural warmth that surrounds it. This also means it does not lose efficiency at any point in the year. This is in contrast to the air source heat pump, which is installed outside.



Commercial buildings and some dwellings can benefit from variable refrigerant flow systems (VRF), which are large-scale ductless HVAC systems that can perform at a high capacity. VRF systems can either be heat pump or heat recovery systems, which provides simultaneous heating and cooling. These systems function in a similar way to ASHP, when designed correctly they can produce far greater efficiencies, in some circumstances outperforming GSHP.

A VRF HVAC system can heat and cool different zones or rooms within a building simultaneously. If the appropriate VRF system is selected, building occupants have the ability to customize the temperature settings to their personal preferences. These systems are advantageous in buildings with plenty of glass on several orientations, helping to reduce the risk of over heating and producing adequate heat whilst maintaining a lower energy demand.



Not Proposed for this development because...

GSHP - the area of land required for individual systems means GSHP systems are not viable on this development and bore holes would need extensive survey work in relation to the sewers and Underground networks.

ASHP -while they are viable, there is a reduction on CO₂ but an increase in energy demand as they are powered by electricity. There is a question of efficiency in areas where the temperature in winter regularly drops below -1.5°C. The CoP can drop below that of a gas boiler increasing running costs significantly. Meeting hot water demand solely from ASHP is an issue as they are a low temperature system, topping the heat up using the immersion element can create a high energy demand.

*Lower heat supply compared to oil and gas boilers, so larger radiators would be needed but they perform better with underfloor heating or warm air heating and work more efficiently when coupled with larger radiators

*A highly insulated development is required to take advantage of maximum energy demand reductions;

*Heat pumps need to run constantly during the winter, with similar noise to an air conditioning unit and a constant energy demand;

*The cost of installing an air source heat pump is usually between £3,000-£11,000.

Combined Heat & Power (CHP)

Proposed for this development?

No

Combined heat and power (CHP) and Micro combined heat and power (Micro CHP) CHP (combined heat and power) the earlier ones where basically diesel engines converted to run on oil or gas, electricity been the primary output and heat been the secondary.

They have been around for many years, but mainly used in larger buildings like hotels and large blocks of flats etc. For CHP systems to be economically viable they need to run for at least 4,000 hours per year. They are more suitable for leisure centres with swimming pools and hospitals that have a high, year round heat demand or in mixed use developments with suitable heat demands However, new housing or office developments may be able to make use of existing CHP schemes nearby.



The benefits of CHP when compared to importing electricity and using boilers to generate heat include;

Savings on total energy costs for the user

Improved efficiency of fuel use

Reduced emissions

Independence & security of power supply

Exemption from the Climate Change Levy for energy costs.

The UK Government is committed to increasing the country's CHP capacity and it forms a key element of it's strategy to reduce the country greenhouse gas emissions. It is widely predicted that further legislation and incentives will be introduced in the near future to encourage the use of CHP.

The cost benefits achieved by CHP unit are a function of;

- * Electricity savings; power produced that would otherwise have been imported from the grid.
- * Heat savings; heat generated that would otherwise have been using on site gas fired boilers

Not Proposed for this development because...

Please see the section on district Heating systems

Flue Gas Heat Recovery Systems (FGHRS)

Proposed for this development?

No

In reality the FGHRs provides a good reduction in CO₂ emissions compared to some technologies that are classified and listed as LZC technologies yet do not provide a reduction in CO₂ emissions when compared to a Natural Gas energy model.



Flue Gas Heat Recovery Systems takes advantage of the heat within the waste flue gasses resulting from the combustion of gas in the boiler. This recovered heat is used to preheat the cold water entering the boiler, thereby lowering the amount of energy needed to warm the water up to the required temperature.

It can be applied to mains gas, LPG or oil condensing boilers.

The flue gas heat recovery system requires very little maintenance, with no need for mains electricity. These systems should be planned in early as there are additional space requirements for the FGHRs. Some boilers have the system built in, and in others it takes the form of a "top box". It is important that the specific boiler and FGHRs are compatible so check this with the manufacturer or seek further advice

Systems can be either a "wet" or "dry" version

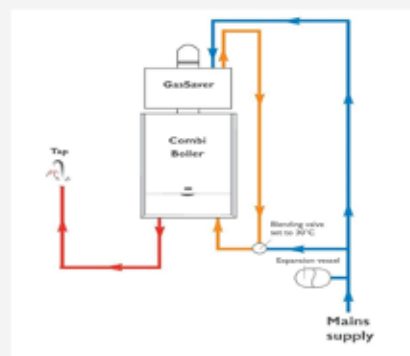


Image © Zenox

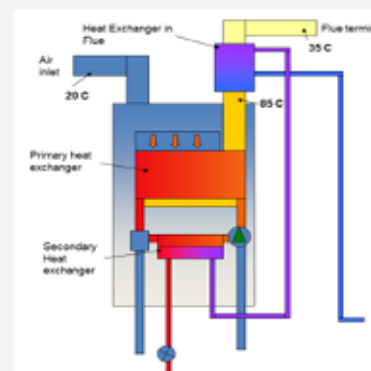


Image © Ideal Boilers

Land use

FGHRS requires no specific land use requirements.

Planning

FGHRS require no additional planning requirements.

Not Proposed for this development because...

Flue Gas Heat Recovery Systems are not the most efficient carbon reducing technology for Gas Holder Site, Reading development. They are better suited to small dwellings with no more than five occupants and two bathrooms, although there are some devices that are capable of providing hot water or central heating to larger dwellings and even non-domestic buildings. These types are less efficient and can often require continual servicing and calibration. By including FGHRs at Gas Holder Site, Reading development, there would only be a % carbon emissions improvement with a small % energy demand reduction.

Waste Water Heat Recovery Systems(WWHRS)

Proposed for this development?

No

Shower Save (Figures 1 & 2) Waste Water Heat Recovery Systems (WWHRS) is a Dutch technology, where in The Netherlands, they are fitted to 20% of new dwellings. Although generically classified as a WWHRS, the Shower-Save device is primarily applicable to heat recovery from warm shower waste water.

The most common configuration known as Recoh-vert (Figure 1), is applicable to upstairs showers, whilst the Recoh-tray (Figure 2) can be used in apartments, bungalows or other single storey properties. The principle of heat recovery is the same in both cases: -

- Warm shower water passes through the 'grey' water side of a copper counter-flow heat exchanger
- Mains pressure water simultaneously passes through the fresh water side of the heat exchanger, where it is pre-heated before passing into both the 'cold' inlet of the mixer shower and the 'cold' inlet to the hot water cylinder, combi boiler or other water heater.
- The use of pre-heated water (orange line in Figures 1 and 2) reduces the total volume of hot water required per shower, whilst also pre-heating the cold feed to the hot water heater which increases potential flow rates for combi or shortens the re-heat time of cylinders. The energy saving applies to whichever fuel is used for water heating, which is therefore not limited solely to gas boilers. Whilst technically applicable to instantaneous electric showers, these ARE NOT currently modelled by SAP, so it is not possible to apply in Appendix Q either. WWHRS does not save energy from baths, in which hot water use is in advance of grey water disposal, but it is applicable to the shower over a bath.



System A set ups are now feasible for apartment projects, yielding efficiencies as high as 65.2% when installed effectively, using a shared soil stack for every apartment above 1st floor height. The solution being the to use an in-line tray system for the ground floor apartment.

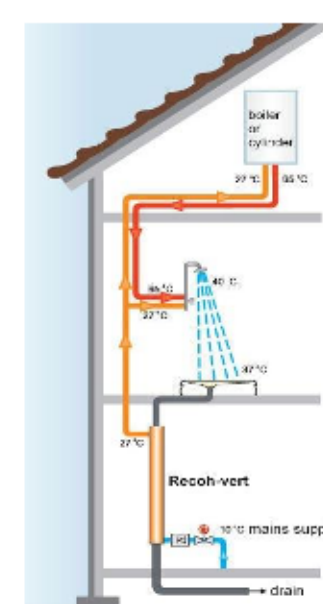


Figure 1

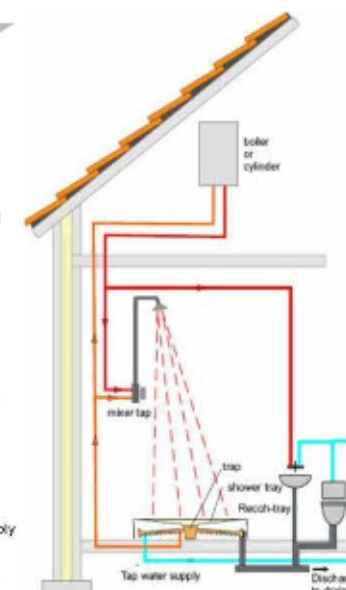


Figure 2

Not Proposed for this development because...

It is not viable due to construction constraints to install WWHRS to this development, for the following reasons: -

- *Although WWHR can be installed on ground floor-single floor dwellings, the devices are less efficient;
- *multiple shower locations may require multiple WWHRS devices;

Baseline Energy Calculations

A baseline total energy demand has been established for the proposed development. Reductions in demand due to energy conservation measures are considered and form the basis of the renewable energy strategy which follows.

Floor plans for the Gas Holder Site, Reading development have been used in conjunction with an outline accommodation schedule and building specifications to prepare initial preliminary SAP Calculations. SAP calculations have been carried out to Part L1A 2013.

Total Energy Demand is used in the final analysis to determine the contribution which renewable energy technology makes to total energy requirements for the development once energy conservation measures have been considered.

Energy savings are measured in terms AC757 of a reduction in CO₂ emissions and kWh, which are calculated from their association with a particular fuel source. CO₂ conversion factors have been taken from the approved DEFRA Carbon Factors 2017 DECC conversion (cF)1: -

Activity	Fuel	Unit	Energy – Gross CV
Electricity Generated	Electricity	kWh	0.35156 kgCO ₂ e
Gaseous Fuels	Natural Gas	kWh	0.18416 kgCO ₂ e
Biomass	Wood Pellets	kWh	0.01270 kgCO ₂ e



Baseline Energy Calculations (continued)

Predicted Carbon Emissions: Part L1A (2013) TER, Before Fabric Improvements

	Space Heating Demand	Hot Water Demand	Energy From Pumps and Fans	Energy from Lighting		Totals
Part L1A Plots (kWh/a)	337,806	304,037	9,750	47,465		699,059
CO ₂ Associated with total Energy Demand (kg/a)	62,210	55,992	3,428	16,687		138,317

Predicted Carbon Emissions: Part L1A (2013) DER, with improved fabric, controls and heating system

	Space Heating Demand	Hot Water Demand	Energy From Pumps and Fans	Energy from Lighting		Totals
Plots (kWh/a)	366,440	234,502	9,750	47,465		658,157
CO ₂ Associated with total Energy Demand (kg/a)	67,484	43,186	3,428	16,687		130,784

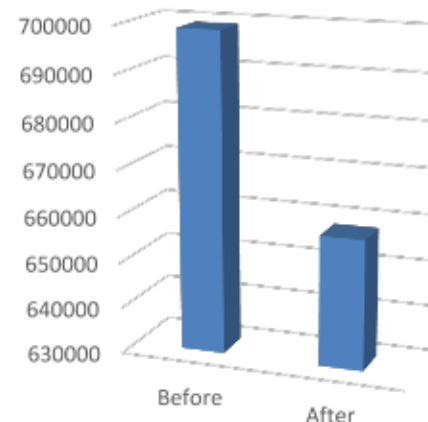
Fabric First Results

When compared against Part L1A 2013 Building Regulations: -

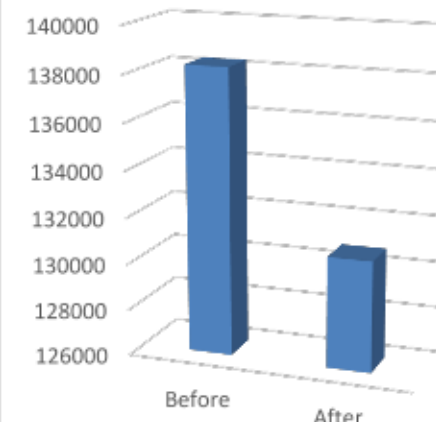
Total CO₂ demand for the residential units at the Gas Holder Site, Reading is calculated to be 130784 kg per annum. This represents a saving of 5.4% over the Part L1A 2013 compliant figure of 138317 kg per annum

Total energy demand for the residential units at the Gas Holder Site, Reading is calculated to be 658157 kWh per annum. This represents a saving of 5.9% over the Part L1A 2013 compliant figure of 699059 kWh per annum

Energy kWh



Carbon CO₂



Energy and Carbon Reduction Summary

Analysis based on a provisional SAP assessment of the house types proposed demonstrates that Part L compliant emissions equate to a site-wide calculated 138,317kgCO₂/year.

In order to achieve the proposed 20% reduction, demand reduction measures would therefore need to deliver a demand reduction of 27,663kgCO₂/year.

The dwellings are to be constructed to meet the requirements of Part L 2013, which requires CO₂ emissions to be reduced by approximately 30% beyond Part L 2006 standards.

From this baseline, further energy demand reduction has been prioritised, as part of the widely supported 'fabric first' approach. The benefits to the resident of this approach have been discussed in detail, which include an improvement in thermal comfort, lower energy bills, reducing the risk of fuel poverty and minimal maintenance requirements. These benefits are realised alongside the crucial aspect of the long-term reduction in energy demand that is built into the lifetime of the dwellings.

Through a combination of the fabric specification proposed, detailing to avoid thermal bridging, reducing air leakage and employing passive and active design measures, the dwellings will secure energy demand reduction equating to a saving in CO₂ emissions of 7,533 kgCO₂/year. In order to meet the CO₂ reductions of 20% beyond Part L 2013 standards, a further 20,130 kgCO₂/year will therefore need to be offset from renewable or low carbon energy technologies across the site.

A full assessment of appropriate technologies has been undertaken, concluding that solar photovoltaic (PV) systems are likely to be most suitable for this development. The calculations undertaken demonstrate that an overall annual energy generation of 57,728kWh would be sufficient to deliver the required CO₂ savings (20,295 kgCO₂/year)

Water Conservation

Performance target: 105 Litres per person per day - Code level 4

Water consumption in the UK has risen by 70% over the last 30 years. Trying to meet the increasing demand by creating new sources of water supply is both expensive and damaging to the environment. The efforts should be focused on reducing the demand for water and managing existing resources. Good water management can contribute to reducing the overall level of water consumption maintaining a vital resource and having environmental as well as cost benefits in the life cycle of the building. Water efficient devices will be fully evaluated, and installed, wherever possible.

The specification of such devices will be considered at design stage and each will be subject to an evaluation based on technical performance, cost and market appeal, in order to comply with the water use regulations. The following devices will be incorporated within each dwelling: water efficient taps, water efficient toilets, low output showers, flow restrictors to manage water pressures to achieve optimum levels and water meters to all homes with guidance on water consumption and savings.

Installation type			Unit of measure		Capacity/ flow rate		Use factor		Fixed use		Litres/ person/day	
WC (dual flush)			Full flush volume		4.00		1.46		0.00		5.84	
			Part flush volume		2.00		2.96		0.00		5.92	
Taps (excluding kitchen/utility room taps)			Flow rate (l/min)		5.00		1.58		1.58		9.48	
Bath (where shower also present)			Capacity to overflow		200.00		0.11		0.00		22.00	
Shower (where bath also present)			Flow rate (l/min)		8.00		4.37		0.00		34.96	
Bath only			Capacity to overflow		N/A		0.50		0.00		0.00	
Shower only			Flow rate (l/min)		N/A		5.60		0.00		0.00	
Kitchen/utility room sink taps			Flow rate (l/min)		8.00		0.44		10.36		13.88	
Washing machine			Litres/kg dry load		5.62		2.10		0.00		11.80	
Dishwasher			Litres/place setting		1.25		3.60		0.00		4.50	
Waste disposal unit			Litres/use		N/A		3.08		0.00		0.00	
Water softener			Litres/person/day		N/A		0.00		0.00		0.00	
Greywater Contribution		N/A	Rainwater Contribution		N/A	Normalisation factor		0.91	Total calculated use			108.38
Normalised total water consumption			98.63		External water use		5.00		Total Water Consumption			103.63
The calculation methodology is to be used to assess compliance against the water performance targets in Regulation 36. It is not a design tool for water supply and drainage systems. It is also not capable of calculating the actual potable water consumption of a new dwelling. Behaviour and changing behaviour can also have an effect on the amount of									Part G 17.K Compliance?			Yes
									Performance Target Met			YES

The calculation methodology uses the water consumption figures provided from manufacturers' product details. Where details have not been provided, figures have been used to achieve compliance. These must be met in order to satisfy the Part G Calculation .

Management

A suitable designed Home User Guide will be produced and made available to all new occupants. It will provide information on the energy efficient design of the dwellings, how to operate the services and equipment in the home and also provide important information about the remainder of the site and its surroundings.

Household Waste

All dwellings will be provided with external space for household waste, compliant with British Standard BS5906, i.e: 100ltrs volume for a single bedroom dwelling, with a further 70ltrs for each additional bedroom. Additional space for 1sq m store and sacks, blue box, compost bin to meet local recycling initiatives.

Air Quality

The quality of the air in modern homes is perhaps not something many people think about, but the reality is that if this is not managed appropriately it can impact on health. The incidence of asthma and other breathing complaints is on the increase and it is widely accepted that the indoor environment can exacerbate and bring on such problems in many people whether or not they have suffered in the past.

Pollution

To reduce the amount of greenhouse gas emissions associated with the development, all insulation used in the building fabric and services shall have a Global Warming Potential (GWP) of less than 5. By selecting suitable insulation products, the development is helping to minimise future effects of global Climate Change. The proposed gas fired CHP or communal heating systems will have a NOx rating of under 40mg/kWh.

Site Location & Public Transport

The transport of people between buildings is the second largest source of CO₂ emissions in the UK after energy use in buildings, and remains the main source of many local pollutants. Energy use and emissions from transport are growing at 4% per year, and at the same time, the effects of climate change are becoming more severe; there will be greater pressure to control CO₂ emissions from transport.

In addition to energy use and CO₂ emissions, in areas of high transport usage there is likely to be an increase in congestion, noise and airborne pollution, which have an adverse impact on the health and quality of life of the local inhabitants. The proposed buildings location and design will aim to minimise the use of private cars and the associated impacts. A travel plan will be generated to cover all aspects of travel to avoid using cars. Electric vehicle charging points will be included where possible.

There will be a requirement to consider improvements to the footpaths and create cycle routes improving existing routes connecting to public transport.

Safety and security

Safety & security is a primary factor when designing a new home these days. This development has been designed to ensure that suitable security measures have been considered, including security lighting fitted with PIR (Photo Infra Red) sensors, suitable locks on all windows and external doors, and the bike store is fitted with suitable security measures.

Construction considerations

A NEBOSH accredited health and safety manager will ensure all measures are adhered to and followed. Including reducing sound and dust pollution during the construction phase, allocating appropriate parking and traffic control for the construction teams and all heavy machinery. Ensuring adequate temporary works design and coordination is applied in accordance with the HSE.

Lighting and natural light

High quality lighting design is an important and desirable feature that supports how you feel and use your home. Providing adequate access to and control of lighting within your home is a basic function that contributes to our comfort and health.

Careful consideration will be made to ensure that background lighting levels will meet the requirements as set out in CIBSE Internal Lighting Guide & SLL Lighting Guide with the following targets set as shown in Table 5.0.

All internal and external lighting will be supplied by energy efficient fittings with LED lamps which will offer luminous efficacy greater than 45 lumens per circuit Watt and greater than 60 lumens per circuit Watt for the non-domestic unit.

The dwellings have been designed to maximise the level of daylight into the Kitchens, and Living Rooms which will help to achieve the required average daylight factors (ADF's) and will have a view of sky.

ROOM TYPE	LUX LEVEL
Entrance Lobby	150
Kitchen	500
Living Space	200
Bathroom	200
Bedrooms	150

Table 5.0 – CIBSE Internal Lighting Guide - recommended lighting levels

Materials

Building and construction activities worldwide consume 3 billion tons of raw materials each year, which account for approximately 50% of total global consumption. Using green/sustainable building materials and products promotes conservation of dwindling non-renewable resources. In addition, integrating sustainable building materials into building projects can help reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these source materials. The aim for the proposed development will be for its overall environmental impact to be minimised through the specification of sustainable materials and components. Materials with low overall environmental impact will be selected for the key building elements in the proposed scheme, targeting A/A+ ratings where possible, from the BRE 'Green Guide to Specification'. The Green Guide rates the environmental impact of different materials and components over their lifecycle, taking into account factors like toxicity, ozone depletion, extraction, ease of recycling, waste disposal etc.

Materials will be selected where possible from responsible suppliers, who can provide environmental certificates for the manufacturing processes of their products (including the supply chain processes), i.e. ISO14001, BES6001 or equivalent certificates.

Recycled materials will be specified where possible and it will be ensured that for all new raw materials being used, as much as much as possible can be recycled at the end of the buildings' life.

Specifying materials with a high-recycled content is a method of saving processing or manufacturing energy. The recycled content of a material can be described as either post-consumer or post-industrial to indicate at what point in the life cycle a material is reclaimed.

Some typical building materials that can contain a high percentage of recycled material include reinforcing and framing steel, concrete masonry units, gypsum wallboard, acoustic ceiling panels and their suspension system.