



ROLTON GROUP
ENGINEERING THE FUTURE™

ENERGY STATEMENT

FOR

THE ORACLE, READING - BUILD TO RENT SCHEME

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1.0 EXECUTIVE SUMMARY

This report has been produced by the Rolton Group to outline the high-level energy strategy for the proposed development for the Oracle Centre in Reading and is intended to assess the means of achieving the requirements set out in the national and local planning policies particularly relating to the site.

This energy strategy has been developed in line with the widely recognised Energy Hierarchy model, which utilises a three-stage approach in order to reduce the site’s carbon emissions. The strategy focuses on the “Be Lean, “Be Clean” and “Be Green” methodology to minimise the energy consumption of the development. A fabric first approach, adoption of energy efficient equipment, passive and active design measures and renewable technologies are considered for the scheme to achieve both carbon and energy reduction.

Based on the current model there is a reduction in both energy and carbon emission for of 6% and 8% for YHP1 for YHP2 respectively - relative to the notional building.

When comparing the proposed system to a conventional boiler system there is 224% difference in carbon emissions and 225% difference in energy rate for YHP1.YHP2 has a 142% for carbon emissions and 146% for energy rate.

This will equate to an energy Opex savings of approximately £83k per annum relative to the notional building.

2.0 INTRODUCTION

The Oracle, Reading is a large indoor shopping/leisure mall situated near the River Kennet. The property is currently owned and developed by a joint venture between Hammerson and Abu Dhabi Investment Authority. The property was acquired in 1997 and is approximately 22 acres in size. The site currently contains approximately 90 retail stores, mixture of 22 restaurants, cafes and bars as well as a 11-screen cinema. There is parking on site with an estimated total capacity of 2,300 spaces.

The current proposal is for a demolition of the buildings which currently house VUE cinema and Debenhams. The new build will contain a mixture of residential and retail. The proposal will include the lower levels for retail and upper levels for residential apartments. Debenhams which has been given to connotation Yield Hall Place 1 (YHP1) shall be constructed with a total of 19 floors which contain 11 studio apartments, 119 one-bedroom apartments, 64 two-bedroom apartments and 4 three-bedroom apartments. VUE which has been given the connotation Yield Hall Place 2(YHP2) side will be constructed with a total of 16 floors which contain 20 studio apartments, 119 one-bedroom apartments, 98 two-bedroom apartments and 10 three-bedroom apartments.

The philosophy of the project is to reduce as much carbon as possible for an environmentally friendly operation. The current proposal for MEP operation includes a number of heat pumps which will operate via an ambient loop system. A ground source system is ideal for this site as the river Kennet runs relatively close by and renewable energy can be harnessed to provide heating/cooling for the site. Gas will be avoided where possible and energy efficient technologies will be utilised across the build.

The initial energy assessments for the development use a mixture of energy modelling methodologies to define the baseline energy consumption and carbon dioxide emissions benchmarks used within this strategy. The required information for each building has been derived through approved software (Tas) as well as information gathered from energy strategies used on previous similar projects.

During the modelling of the building type we have used the hierarchical methodology of “Be Lean, “Be Clean” and “Be Green” to reduce energy for the development as outlined below: -

“Be Lean” energy efficiency measures will include passive and active solutions such as: optimised U-Values, low air permeability, low energy lighting, heat recovery ventilation, natural ventilation strategies, limitation of overheating, etc.

“Be Clean” stage of the energy hierarchy reviews and considers air source heat pump technologies, or other such technologies.

With respect to the “Be Green” element a number of renewable energy technologies have been considered and these have been assessed on their suitability for the development and the varying building types. Those technologies deemed as most feasible for the development have been reviewed in more detail and proposed for the various building types. The general overall strategy is that Air source heat pumps would offer the greatest contribution to the reduction of carbon and energy emissions, whilst minimising the environmental impact.

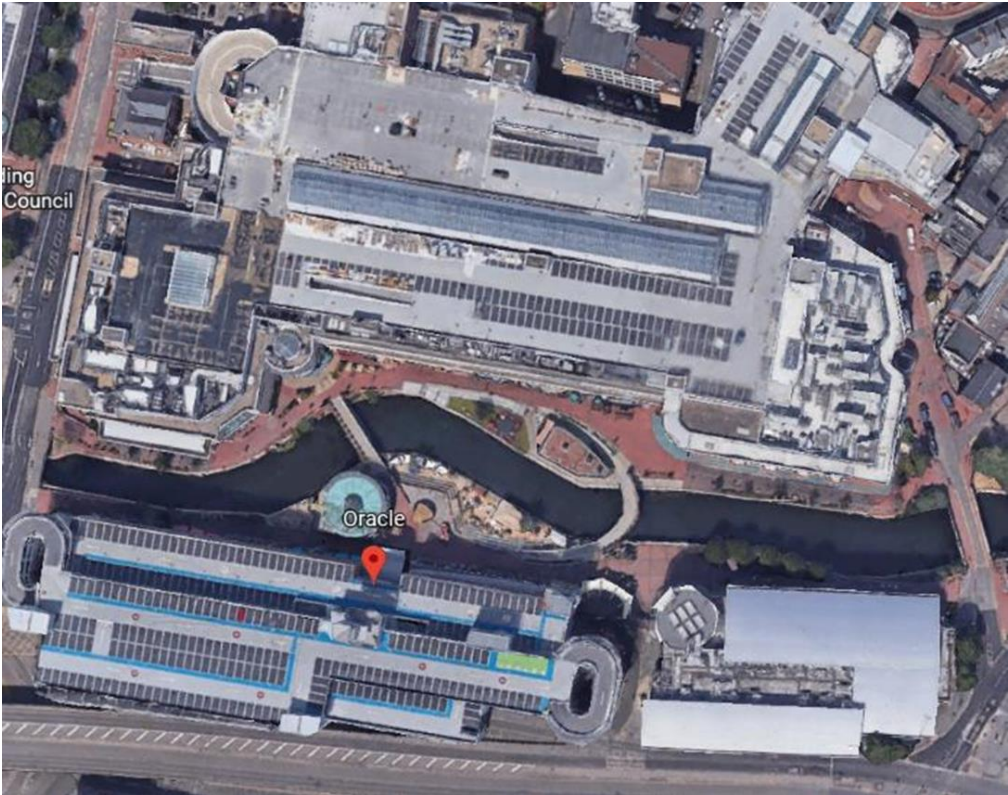


Figure 1 – Site Overview

Budget	Carbon budget level	Reduction below 1990 levels	Met?
1st carbon budget (2008 to 2012)	3,018 MtCO ₂ e	25%	Yes
2nd carbon budget (2013 to 2017)	2,782 MtCO ₂ e	31%	Yes
3rd carbon budget (2018 to 2022)	2,544 MtCO ₂ e	37% by 2020	On track
4th carbon budget (2023 to 2027)	1,950 MtCO ₂ e	51% by 2025	Off track
5th carbon budget (2028 to 2032)	1,725 MtCO ₂ e	57% by 2030	Off track
6th carbon budget (2033 to 2037)	985 MtCO ₂ e	78% by 2035	Off track
Net Zero Target		At least 100% by 2050	

Figure 2 - UK Govt. Carbon Reduction Target

2.1 NATIONAL POLICY

Due to the current climate there is a significant push for renewable projects to be utilised. The UK government plans to reduce their carbon emissions by at least 100% when compared to the 1990 levels by 2050. For this reason, the 'Climate Change Act' was implemented to promote renewable and low carbon technologies to allow the country to achieve this goal. System efficiencies play a key part in this goal as there is a reduced carbon implication for high efficiency systems.

2.2 LOCAL POLICY & PLANNING CRITERIA

In February 2019, Reading Borough Council declared a Climate Emergency and set out on a journey to achieve a carbon neutral borough by 2030.

The Carbon Plan 2020-25 will work towards four headline targets as follows - by 2025 we will:

- Reduce the organisation's carbon emissions by 85%, against a 2008/9 baseline
- Generate equivalent to 50% of our energy from renewable sources by 2025
- Reduce our use of fossil fuels by 50%, against a 2008/09 baseline
- Achieve a 5% p.a. reduction in water use against a 2019/20 baseline.

By achieving these targets Reading Borough Council will be on track to meet its challenging ambition of becoming a net zero carbon organisation by 2030.

The SPD is intended to guide developers and decision-makers on the implementation of key sustainability policies set out in the Reading Local Plan namely CC2-CC5 and H5.

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:

All major non-residential developments or conversions to residential are required to meet the most up-to-date BREEAM 'Excellent' standards, where possible;

- All minor non-residential developments or conversions to residential are required to meet the most up-to-date BREEAM 'Very Good' standard as a minimum;
- All non-residential development or conversions to residential should incorporate water conservation measures so that predicted per capita consumption does not exceed the appropriate levels set out in the applicable BREAM standard. Both residential and non-residential development should include recycling greywater and rainwater harvesting where systems are energy and cost effective.

CC3: ADAPTION TO CLIMATE CHANGE

All developments will demonstrate how they have been designed to incorporate measures to adapt to climate change. The following measures shall be incorporated into development:

Wherever possible, new buildings shall be orientated to maximise the opportunities for both natural heating and ventilation and reducing exposure to wind and other elements;

- Proposals involving both new and existing buildings shall demonstrate how they have been designed to maximise resistance and resilience to climate change for example by including measures such as solar shading, thermal mass, heating and ventilation of the building and appropriately coloured materials in areas exposed to direct sunlight, green and brown roofs, green walls, etc;
- Use of trees and other planting, where appropriate as part of a landscape scheme, to provide shading of amenity areas, buildings and streets and to help to connect habitat, designed with native plants that are carefully selected, managed and adaptable to meet the predicted changed climatic conditions; and
- All development shall minimise the impact of surface water runoff from the development in the design of the drainage system, and where possible incorporate mitigation and resilience measures for any increases in river flooding levels as a result of climate change

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.

Any development of more than 20 dwellings and/ or non-residential development of over 1,000 sq m shall consider the inclusion of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable, feasible or viable for this form of energy provision.

Where there is existing decentralised energy provision present within the vicinity of an application site, further developments of 10 dwellings or more or non-residential development of 1,000 sq m or more will be expected to link into the existing decentralised energy network or demonstrate why this is not feasible.

H4: BUILD TO RENT SCHEMES

Planning permission will be granted for developments of self-contained, private rented homes which:

- 1) Are secured in single ownership providing solely for the rental market for a minimum 20-year term with provision for clawback of affordable housing contributions should the covenant not be met; and;
- 2) Provide tenancies for private renters for a minimum of three years with a six-month break clause in the tenant's favour and structured and limited in-tenancy rent increases agreed in advance; and;
- 3) Provide a high standard of professional on-site management and control of the accommodation; and;
- 4) Provide a commitment to high-quality rental arrangements, through meeting Reading Borough Council's voluntary Rent with Confidence Standards or equivalent measures; and;
- 5) Provide for a mix of unit sizes in accordance with Policy H2 or CR6; and;
- 6) Meet the standards of design set out in Policy H5; and;
- 7) Provide 30% on-site affordable housing, either in accordance with Policy H3 and any relevant Supplementary Planning Document; or in the form of Affordable Private Rent Housing as defined and set out in a relevant Supplementary Planning Document.

We can see from the tables that in terms of efficiencies, there is no competition when a ground/water source heat pump is involved and these do not produce any carbon emissions directly. The initial capital cost is greater but there is reduction in running cost when means the system will pay itself back in general energy savings. A significant factor is the building construction make up and insulation levels within the building which has to do with heat losses and heat gains. As this is a new build and the BREEAM target is excellent, if heat losses and heat gains within the building can be reduced this will reduce the energy required to both heat and cool the building resulting in reduced carbon footprint in line with aspirations of both Part L2a and BREEAM.

	OPTION 1	OPTION 2
	POLICY COMPLIANT SPECIFICATION	GOOD PRACTICE SPECIFICATION
Element	U value [W/m²K]	U value [W/m²K]
External Wall	0.18	0.10
Roof	0.13	0.10
Floor	0.11	0.08
Doors	1.40	1.00
Windows	1.40	1.30
Air Test	5m³/h.m² at 50Pa	3m³/h.m² at 50Pa

Table 1 - U Value Comparison

From the table above, we are aiming to achieve U values which are inline with the good practice specification. These values exceed part L and will be much more difficult to achieve. The closer we get to these U values, the more efficient the installed heating system will perform. As the total system operates more efficiently, there will be an energy saving attached to it.

H5: STANDARDS FOR NEW HOUSING

New build housing should be built to the following standards, unless it can be clearly demonstrated that this would render a development unviable:

- a) All new build housing outside the Central Area as defined on the Proposals Map will comply with the nationally-described space standard.
- b) All new build housing will be built to the higher water efficiency standard under
- c) Regulation 36(3) of the Building Regulations
- d) All major new-build residential development should be designed to achieve zero carbon homes.
- e) All other new build housing will achieve at a minimum a 19% improvement in the dwelling emission rate over the target emission rate, as defined in the 2013 Building Regulations.
- f) All new build housing will be accessible and adaptable in line with M412) of the
- g) Building Regulations, unless it is built in line with M4(3) (see below).
- h) On developments of 20 or more new build dwellings, at least 5% of dwellings will be wheelchair user dwellings in line with M4(3) of the Building Regulations. Any market homes provided to meet this requirement will be 'wheelchair adaptable' as defined in part M, whilst homes where the Council is responsible for allocating or nominating an individual may be 'wheelchair accessible'

2.3 ENERGY EFFICIENCY AND USE OF RESOURCE

To ensure that a building is designed in the most energy and cost-efficient manner a specific energy hierarchy should be followed.

The hierarchy is as follows:

- Use less energy (be lean).
- Supply energy efficiently (be clean).
- Use renewable energy (be green).

Consequently, before considering Low Zero Carbon (LZC) technologies, the design strategy should be to reduce building energy consumption through use of energy efficiency measures.

The new building elements will be required to work harder/more efficiently before the associated Mechanical & Electrical (MEP) building services are designed to provide for comfort needs of occupants. This includes use of natural ventilation, solar shading and thermal mass in preference to mechanical systems and the optimisation of lighting control and energy efficient luminaires.

A number of energy efficiency measures are included within the proposals. These include designing in —passive systems and maximising building fabric insulation performance. The identified measures will be subject to review and refinement as the client brief and detailed design for the development. (Refer to the passive proposal Report for additional information 210388-RGL-ZZ-XX-RP-U-95-0003)

Measures included are described below (unless noted otherwise refer to the Planning Application drawings for details):

- U-values – Minimising heat loss conducted through the building envelope by providing high levels of insulation and high-performance glazing in excess of performance requirements of Part L of the Building Regulations.
- Air leakage – ensuring that the building is built tight to achieve the requirements of latest Part L2 for air leakage testing.
- Shading – south facing glazed façades will be shaded to optimise solar heat gain during winter months and minimize summertime heat gain to the building whilst allowing for the best use of natural daylight to reduce lighting usage.
- Thermal mass – provision of exposed thermal mass in the building interior to assist maintaining a steady thermal environment, i.e., reduce peak heat gains in summer and fill the troughs of peak heat loss in winter.
- Daylighting and natural ventilation – North facing facades optimise daylight penetration compared with winter heat loss through glazing. The building floor plate and façade design make maximum use of daylight penetration and natural ventilation strategies.
- Casual gains – using heat recovery systems within installed mechanical ventilation systems to reclaim heat energy from processes, people and equipment within the building and re-directing this energy to parts of the building requiring heat energy, e.g., heating or hot water systems.
- The selection of Active Building Services Systems – to provide acceptable levels of comfort for the building occupants, active building services systems will be a fundamental part of the energy usage within the development. The following mechanical systems are proposed to be as energy efficient as possible:
 - Mechanical ventilation: The energy performance of the installed mechanical ventilation system will be designed in line with Best Practice. A target of energy consumption from the non-domestic building services compliance guide for new buildings shall be used.
 - Heat recovery: where mechanical ventilation systems are used, due to the densely populated spaces, large quantities of air will be exhausted which contain considerable useful heat or coolth energy. Where contents of exhausted air permits, air to air heat recovery devices shall be incorporated into the mechanical ventilation systems to reclaim heat back to the incoming fresh air supply or to provide pre-heat of the hot water system.

- Air conditioning: full air conditioning (humidity control/air filtration) will not be provided to the development. Mechanical comfort cooling systems, however, will be provided where passive measures cannot achieve satisfactory internal temperatures for occupants or associated processes within the building. The mechanical refrigeration plant will be considered in the light of their Coefficient of Performance (COP) and specification of refrigerant gas. These comfort cooling systems shall also utilise waste heat reclaim to provide heating to the hot water systems and/or over door heaters.
- The following electrical systems are proposed to be as energy efficient as possible:
 - Daylight-linked artificial lighting: a daylighting and occupancy linked lighting control system shall be provided. The automatic dimming of artificial light in response to useful daylight levels and room usage/occupancy shall maintain optimum visual comfort.
 - Artificial lighting: the most efficient lighting systems will be targeted including modern high efficacy LED fittings. In addition, this system will provide for the monitoring of the presence, or absence of people and control the lighting accordingly.
 - Low energy appliances & luminaires – new equipment will be specified to be low energy/Energy Star compliant. LED's luminaires shall be used throughout.
 - Motors: All motors fitted to pumps and fans shall have variable speed drive controls, to ensure at partial load conditions the motor speeds are reduced to match load and thereby reduce associated energy consumption and CO₂ emissions.

Energy meters will be provided throughout the development to enable at least 90% of energy consumption for each fuel/energy type to be assigned to its end use category.

2.4 LOW CARBON TECHNOLOGIES

2.4.1 BIOMASS

Biomass covers a range of organic fuels used as combustible materials for boiler plant to produce heat and/or electrical power. There are two types: direct combustion and biogas. Direct combustion uses the burning of the fuel (usually wood chips or pellets) to generate heat for the boilers. Biogas is produced either through gasification or anaerobic digestion of the materials which is subsequently burnt as a fuel.

Biomass can be used to fuel both heating and Combined Heat and Power (CHP) systems. If technically viable for this site, a biomass heating system would deliver significant CO₂ savings.

Important considerations when determining the suitability of biomass are the availability of fuel sources, the space available for fuel storage and the route by which fuel deliveries would be made.

Due to the size of the building and the required load, the size of the biomass boiler would be extensive. If a suitable location was selected, there would be a need for a dedicated section for fuel storage and delivery. As the site is located in a heavily congested location, this will cause significant issues in the long run.

The combustion of wood-based material generates unfavourable emissions that can adversely affect local air quality. To overcome this issue would require the construction of a tall chimney or flue dilution system. Local Clean Air requirements also impact upon the viability of this as a renewable energy source.

Having considered the following factors, biomass systems have not been pursued as a viable LZC technology:

- Limited localised sources of biomass fuel supply.
- Limited plantroom space (or external storage) to accommodate the biomass fuel supplies.
- The residential nature of adjacent properties.
- NO_x emissions associated with biomass systems.
- Increased capital cost of flues and flue treatment systems.
- Biomass Fuel Delivery access routes.

2.4.2 WIND POWER

Wind power can be harnessed using a catchment device connected to a turbine that will either feed an electrical load directly or charge a battery. When well located, wind turbines can present significant carbon savings.

Wind power is generally much more effective in high, rural locations and as such wind turbine based renewable energy systems are generally not practicable or cost effective for installation in urban locations.

Turbines need to be much taller than other buildings around them, to ensure they are properly installed within a reasonable strength & constant speed ambient air flow, unaffected by eddies created from adjacent buildings/structures. The movement of air across rotating turbine blades also generates noise, which is not ideal for the project given the urban/residential nature of adjacent properties.

Having considered the following factors, wind turbines have not been pursued as a viable LZC technology:

- Availability of suitable areas for installation of large/tall wind turbines.
- Height of turbines required.
- Planning implications due to likely scale of turbines.
- Planning implications of associated noise outputs from turbines.
- Relatively high capital cost of turbines compared to their CO₂ emission reduction.

2.4.3 AIR SOURCE HEAT PUMP (ASHP)

ASHP technology extracts their heating/cooling energy from the surrounding ambient air. In a temperate climate such as the UK, this allows them to provide electrical heating/cooling with a typical average COP of around 3.0–4.5 dependant on the time of year.

They are ideally suited to highly efficient modern buildings with low heating requirements alongside cooling demands during summer months.

As an alternative to ground source systems, air source systems enjoy similar heating efficiencies, but is significantly cheaper when compared its ground source alternative and does not require as much space. A further advantage of utilising both air and Ground Source heat pump (GSHP) is their ability to be reversed and used to provide cooling services.

This application to provide both heating and cooling is particularly suited to this development. Due to the nature of ASHP, they are commonly installed outdoors to have the relevant exposure to the environment. If this is not possible, there are ways to provide the required exposure via mechanical ventilation, but this can prove tricky depending on the restrictions within the development. As there are no suitable outdoor locations for this heat pump and advanced design nature of providing the exposure via mechanical ventilation, it would prove difficult to utilise ASHP to its full potential within this development.

This low energy design strategy will further reduce the buildings CO₂ emissions.

Having considered the following factors, air source heat pumps should not be adopted as a viable LZC technology:

- Limited outdoor locations for the external condensing unit.
- Complexity of install for indoor installation as no allocated areas available for outdoor units to be installed.

2.4.4 GROUND SOURCE HEAT PUMP (GSHP) OPEN LOOP

Water is drawn by an aquifer from deep within the ground to provide heating / cooling as necessary. Ground conditions may mean it is uneconomic to drill boreholes to an adequate depth to reach a suitable source of ground water. The ground water temperature is relatively constant at between 6 and 10°C throughout the year. Through reversible heat pumps, the energy in this water can be concentrated efficiently to provide heating or cooling supplies. In a temperate climate such as the UK, this allows them to provide electrical heating/cooling with a typical average COP / SEER of around 3.0–4.0 dependant on the time of year.

Typically, an open loop system comprises two boreholes, a “warm well” and a “cold well”. When cooling is required, water is drawn from the cold well to pass through the heat pump/heat exchanger, heat is extracted from the building and discharged into the ground source water through heat transfer. The warmed ground source water is then returned to the ground via the warm well aquifer.

If heating is instead required in the building, the system will run in reverse; water is drawn from the warm well, heat is extracted from the ground source water, i.e., the water is cooled, & heat supplied into the building through the heat pump. The cooled ground source water is then returned to the ground via the cold well aquifer.

The following factors are key to the successful selection of an open loop system:

- Timescales to ascertain the suitability of the local geology for open loop GSHP.
- Approval period from the Environment Agency to obtain an extraction licence.
- Cost of drilling the boreholes.

Licence Approval is required from the Environment Agency (EA) to extract water from aquifers. Further investigation and ground conditions testing are also required to confirm the suitability of open loop GSHP for the development. The costs of these investigations are estimated at £50-100,000 and have associated timescales of around 6 months.

Having considered the following factors, open loop GSHP have not been pursued as a viable LZC technology:

- Programme implications to obtain EA approval.
- At risk investigative costs.
- Programme implications to remove the risk of ground conditions.
- Maintenance
- Water extraction permits

2.4.5 GROUND SOURCE HEAT PUMP CLOSED LOOP

As suggested by their name, closed loop systems do not draw water from the aquifer below the ground. They instead consist of a loop of pipework that passes through the ground providing heat exchange between the flow water and the aquifer. They can either be vertical or horizontal loops of pipework.

Horizontal loops take up significantly larger horizontal area when compared to the vertical loop but do not require the as deep as their vertical counterpart. This is perfect for developments with large amounts of free land.

Vertical loops are more expensive to install due to the increased bore hole depth required; however, they provide a more stable temperature of ground source water due to the increased depth at which they operate and hence an improved system efficacy.

Due to the site location ground source heat pump technology will be perfect for this development as there is sufficient internal plant room sizes as well the distance between the nearby river will prove useful to provide the load as well as reduce the cost in terms of distance excavated.

Having considered the following factors, closed loop ground source heat pumps have been pursued as a viable LZC technology:

- Available internal plant room sizes
- Stable temperatures to provide the required load
- Distance between river and site

2.4.6 FUEL CELLS

Fuel cells provide heat and electrical power from electrochemical reactions. Within the built environment, this is a relatively immature/new technology. Cells generally consist of an anode, a cathode and an electrolyte. The cell is supplied with oxygen to the cathode and hydrogen, which is available from a number of sources (coal, natural gas, biogas and other fuels containing hydrogen) to the anode. Ions flow through the electrolyte from the anode to cathode generating an electric current.

One single fuel cell produces only around 1V of electricity and so a number are usually arranged into a stack of over 100 cells.

Fuel cells are currently quite expensive in comparison to some other renewable technologies. This leaves them as an uneconomical option compared to a number of other possible LZC solutions.

Having considered the following factors, fuel cells have not been pursued as a viable LZC technology:

- Limited application of the technology in similar projects.
- Limited plantroom space to accommodate the fuel cells.
- Increased capital cost of the fuel cells.
- Risks associated with an unproven technology.

2.4.7 PHOTOVOLTAIC (PV) SYSTEM

PV utilise solar power and convert it directly into Direct Current (DC) electricity. The panels themselves consist of a thin piece of semiconducting material (usually silicon). Certain wavelengths of light striking the panel ionises some of the silicon atoms, giving some positive and some negative charge. These are then attracted to each other and when recombining produces the output DC power.

PV are competitively priced and a well-established and proven renewable energy technology.

PV technology require roof space which is not available on this site. If relevant roof spacing was available, it proves to be useful to install PV technology to offset grid electricity and its associated carbon.

Having considered the following factors, PV panels have not been adopted as a viable LZC technology:

- No allocated roof space for plant installation

2.4.8 SOLAR THERMAL HOT WATER

Solar thermal hot water panels utilise heat from the sun to produce Hot Water Service (HWS). Solar infra-red heat striking the panels heats up a liquid inside the panels which in turn is passed through a coil to heat up water within a separate cylinder. This cylinder is also supplied with heat from another source to provide heat on particularly overcast or cool days.

Solar hot water panels are relatively inexpensive and are a well-established and proven renewable energy technology.

Having considered the following factors, solar thermal hot water has not been pursued as a viable LZC technology:

- Restricted access of suitable roof areas for installation.

2.4.9 COMBINED HEAT AND POWER

CHP boilers simultaneously generate both usable heat and power from the same source. The mechanical power of an engine is used to generate electricity and the heat emitted from the engine (waste heat in a conventional engine) is used for space heating or hot water. CHP can be powered by either gas or biomass.

A CHP unit requires a continuous heating or hot water load all year round (run time of 4500 – 5000 hours) to operate most efficiently. Hence CHP is most viable when serving a building that has a significant year-round heating and electrical demand.

Most buildings have a minimal summertime heat demand to provide heat to generate hot water. However as noted previously, summertime heat output from a CHP unit can be adventitiously used to provide heat to an absorption chiller. This provides low carbon cooling, displacing the need for traditional carbon intensive electrically powered chiller & air-conditioning units.

Having considered the following factors, CHP has not been pursued as a viable LZC technology:

- No demand for constant year-round heat generation from the CHP plant.
- System would not run for 5000-5500 hours per annum to be efficient.
- Capital cost higher than for technologies providing comparable levels of carbon reduction.

2.5 FURTHER CONSIDERATIONS

2.5.1 ENERGY EXPORT

Import and export of energy via district heating and / or power systems were considered, however with no suitable energy consumers or generators within the local vicinity, these were deemed not applicable for the development.

Should suitable networks become available in the future, systems would be able to be adapted to accommodate alternative heat / power sources.

The proposed ambient loop system is very similar to district heating but operates at a much lower heat loss due to the temperatures involved within the system.

2.5.2 ENERGY STORAGE

Energy storage was considered; however, this technology would only be suitable when energy on site is being generated at a scale such to produce a significant excess. This is unlikely to be the case in this site. Additional plant space would also be required and additional capital expenditure could not be justified.

2.6 MODEL AND SIMULATION

A thermal model was produced for both YHP1 and YHP2. These models are capable of producing estimated energy consumption and carbon emission production via simulation. The simulation software used was TAS, which is capable of simulating conditions close to real world scenarios.

Within the software a notional building shall be available to provide comparison to the actual building(s) standards. This will have pre-set parameters of the software and will used to determine how the proposed building is rated compared to the notional building.

The software utilises parameters which can be altered such as the designed u values and specific performance values of components of the building to allow for a more customisable approach. As the software is quite advanced the location data was also considered i.e., weather profiles and average temperatures of the specific region.

We can see from the table below that there is a significant improvement when compared to the part L requirements for 2013.

ELEMENT	2013 PART L REQUIREMENTS	PROPOSE VALUES	% DIFFERENCE
Roof	0.18	0.10	57.14
External Wall	0.26	0.10	88.89
Floors	0.25	0.08	103.03
Windows	2.2	1.3	51.43
Air	10	3	230%

Table 2- Comparison With 2013 Part L Values

3.0 ENERGY CONSUMPTION & CO2 EMISSION RATE

The tables below highlight models CO₂ emission and primary energy rate of the modelled building. The target rates have also been included to allow for a baseline comparison.

Utilising the modelled data highlighted in tables 3 and 4 we can determine the amount of carbon offsetting that is required and a high-level cost can be produced:

Combined target CO2 emission: 6.74 kgCO₂/m².annum
 6.74kgCO₂/m².annum*48,197m² (Architect stated total area) = 324,847.78 kgCO₂/annum= 324.84778 tonnesCO₂/annum
 324.84778 tonnesCO₂/annum *£1800= £584,726.004

Currently at RIBA stage 2 there is approximately an 6% reduction in both BER and BPER when compared to their target values.

Target CO ₂ emission rate (TER), kgCO ₂ /m ² .annum	3.04
Building CO ₂ emission rate (BER), kgCO ₂ /m ² .annum	2.86
Target primary energy rate (TPER), kWh/m ² .annum	33.27
Building primary energy rate (BPER), kWh/m ² .annum	31.34

Table 3 – YHP1 Model Results

Currently at RIBA stage 2 there is approximately an 8% reduction in both BER and BPER when compared to their target values.

Target CO ₂ emission rate (TER), kgCO ₂ /m ² .annum	3.7
Building CO ₂ emission rate (BER), kgCO ₂ /m ² .annum	3.05
Target primary energy rate (TPER), kWh/m ² .annum	40.19
Building primary energy rate (BPER), kWh/m ² .annum	33.08

Table 4 – YHP2 Model Results

3.1 REGULATED AND UNREGULATED ENERGY

The section highlights the regulated and unregulated energy for the project. The regulated energy values were obtained using the dynamic model simulation while the unregulated energy values were obtained via a high level TM54 calculation. The calculation below will only provide an estimation as due to the nature of RIBA stage 2 there is not enough information to produce and accurate regulated and unregulated energy value.

LOCATION	MODELLED KWH/M ²	NOTIONAL KWH/M ²
YHP1 Total	21.32	22.59
YHP2 Total	22.38	27.18

Table 5 – Regulated Energy Model Data

LOCATION	UNREGULATED ENERGY (KWH)
Co-working	69.962
retail	14.173
leisure	12.171
cinema	83.229
restaurant	269.225
Typical flat	35.058
External Lighting	3317
Lifts and escalator	251.930

Table 6 -Unregulated Energy Calculation

3.2 SAVINGS AND COST IMPLICATION

As the philosophy of the building is to maximise efficiency the building is working off a fabric first approach. This is where as much savings are gathered from the fabric i.e., insulation. As table 1 highlights the building shall try to achieve to U values which are far more stringent than the current part L guidelines. This will allow for heat loss to reduced as much as possible which will in turn reduce carbon emissions and energy generation.

The cost per kWh of electricity on average is approximately £0.34. if we compare the values from Table 3 & 4 we can see there is a difference of 1.93kWh/m² and 7.11kWh/m² respectively. There will be £0.66/m² and £2.42/m² cost saving when compared to target rates.

Implementation of solar panels would reduce the carbon emissions significantly as well as increase the energy savings as the proposed system utilises a significant proportion of electricity. This is currently not feasible as there has been no allocated roof space for installation.

To highlight further savings table 6 below shows the identical building if a standard boiler system was utilised instead of a high efficiency renewable system. we can see that there is 224% difference in carbon emissions and 225% difference in energy rate for YHP1. For YHP2 there is a 142% for carbon emissions and 146% for energy rate.

LOCATION & DESCRIPTION	DATA
YHP1 Building CO ₂ emission rate (BER), kgCO ₂ /m ² .annum	6,42
YHP2 Building CO ₂ emission rate (BER), kgCO ₂ /m ² .annum	4.33
YHP1 Building primary energy rate (BPER), kWh/m ² .annum	70.74
YHP2 Building primary energy rate (BPER), kWh/m ² .annum	48.14

Table 7 – Regulated Energy Model Data

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The Development: **THE ORACLE, READING - BUILD TO RENT SCHEME**

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