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engineering change

Northampton – M1 Junction 15

Sustainability Statement for Planning

Contents

1.0 Introduction

This Statement has been produced on behalf of Roxhill (Junction 15) Ltd to support an application for a Strategic Rail Freight Interchange on land adjacent to Junction 15 of the M1 at Northampton.

This report has been compiled having regard to the requirements of the National Policy Statement for National Networks, in particular paragraph 5.16 which requires proposals to ensure that their carbon footprint in not unnecessarily high. The Statement also has regard to the National Planning Policy Framework, Section 10 and the requirements of Policy S10 of the West Northamptonshire Joint Core Strategy.

The planned new development having regard to the illustrative Masterplan, totals some 468,324m^2 Gross Internal Area (GIA) of floor space arranged across 7 industrial units and a freight terminal office, as shown below in Figure 1.

Having regard to the Policy requirement to minimise carbon footprint, this Statement sets out an energy strategy for the approach to the built development on the scheme. The Statement considers both energy efficiency through building design and reduction in carbon impact through the use of Low and Zero Carbon (LZC) technologies. The overarching aim of the scheme is to:

- Achieve a BREEAM ‘Very Good’ rating under the New Construction 2018 criteria.
- Incorporate energy efficiency measures to reduce the inherent energy demand and associated carbon dioxide (CO_2) emissions of the development.

To this end, the proposed design shall promote reduced CO_2 emissions from delivered energy consumption by minimising operational energy demand through passive and best-practice measures.

LZC technologies will also be incorporated into the design, as deemed appropriate, as part of an integrated services strategy as opposed to a ‘bolt-on’ approach.

This report has been compiled to address the specific requirements of Policy S10 of the West Northamptonshire Joint Core Strategy in terms of demonstrating an exemplar sustainability strategy for the proposed development.

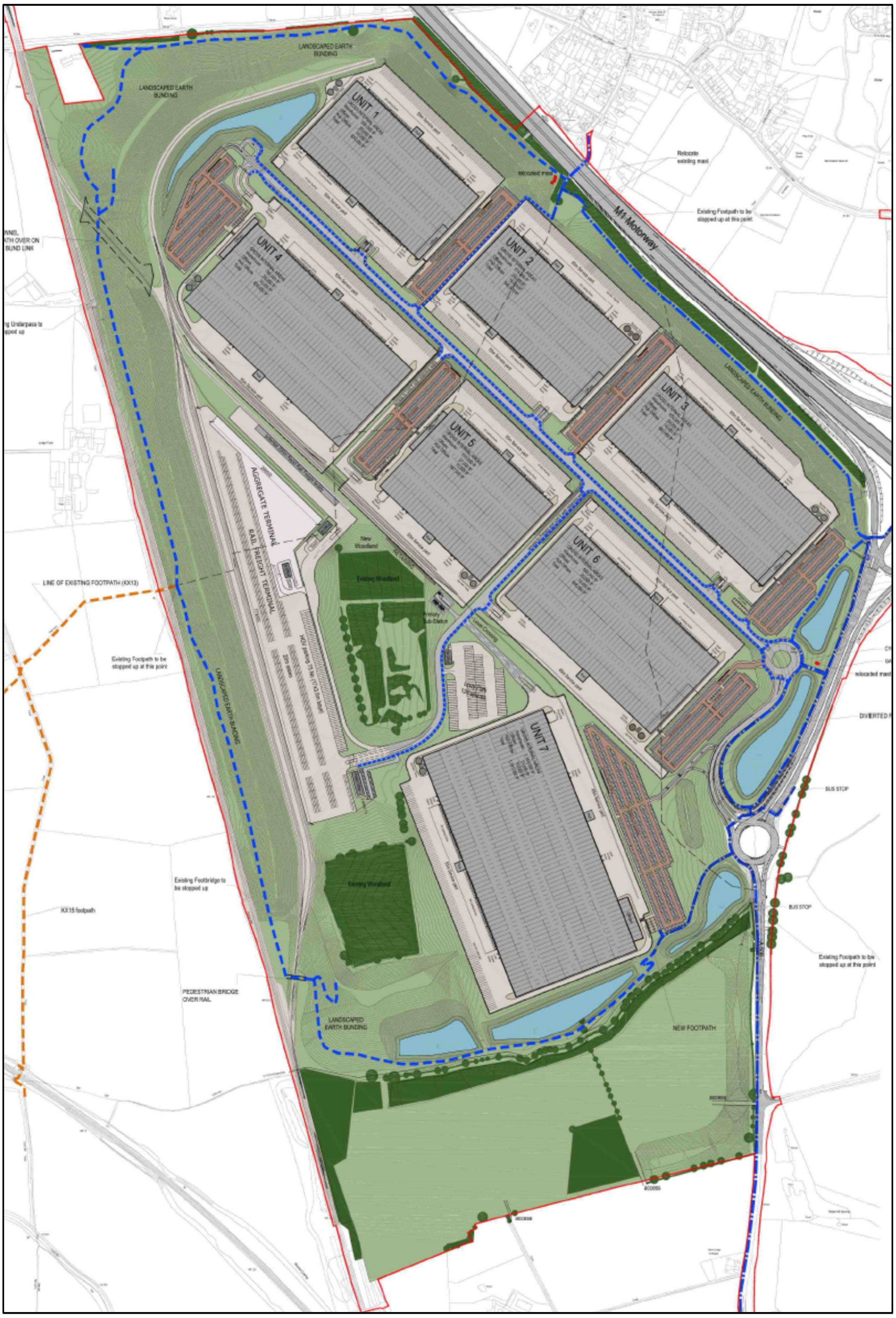


Figure 1. Proposed Site Layout

2.0 Energy Benchmarking

2.1 Estimated Energy Demands and CO_2 Emissions

In order to benchmark the proposed new development, estimated energy demands and CO_2 emissions data have been calculated. These estimated energy consumptions are indicative only at this stage. They will, however, be used as a guideline to assess the percentage of the building's total energy consumption and CO_2 emissions that could be reduced or offset by applying best practice energy efficiency measures and/or LZC technology solutions.

For the purposes of BREEAM, it is prudent for this report to reflect the benchmark data derived from approved Dynamic Simulation Model (DSM) software which uses government and industry agreed National Calculation Method (NCM) room templates containing standard operating conditions. This is due to the fact that BRE Global will only accept results from the approved models when verifying the percentage reduction in CO_2 emissions from the building for credits Ene 1 and Ene 4 (BREEAM 2018).

To assist with the formulation of an energy strategy, the estimated **regulated** energy consumption and CO_2 emissions for the development have been derived from approved DSM software (IES):

The total predicted regulated notional energy consumption is: **9,703,673kWhr per year**

The total predicted regulated notional CO_2 emissions are: **4,261,748kgCO_2 per year**

Note 1. CO_2 emission factors of 0.216 for Gas and 0.519 for Electricity have been used to calculate the above and are taken from Building Regulations Approved Documents.

3.0 Energy Efficiency

In order to deliver environmentally responsible building stock, an exemplar approach is being proposed based on low energy design principles. In summary, this approach involves energy demand minimisation through effective building form and orientation, good envelope design and proficient use of services; such that the buildings themselves are being used as the primary environmental modifier.

Long term energy benefits are best realised by reducing the inherent energy demand of the building in the first instance. These benefits are described and quantified as follows:

3.1 Building Design – Energy Efficiency

The general construction design standards to be adopted must exceed the requirements of the current (2013 Edition) Part L Building Regulations which stipulate an improvement on the CO_2 emissions of an aggregated 9% against 2010 standards.

The building envelope will be designed to ensure that the fabric and form of the office and warehouse spaces encompass the low energy sustainability principles necessary to target a BREEAM 'Very Good' rating.

The following table (Table 1) describes the proposed minimum building envelope thermal performance criteria.

Element	Part L 2013 Building Regulations U-Value (W/m^2K)	Target U-Value (W/m^2K)	Notes
General Glazing (including frame)	U = 2.20	U = 1.50	Glass to achieve a total light transmission of 0.38 (g = 0.42)
Roof Lights (including frame)	U = 2.20	U = 1.30	Glass to achieve a total light transmission of 0.58 (g = 0.55)
External Walls	U = 0.35	U = 0.35	
Roof	U = 0.25	U = 0.25	
Ground Floor	U = 0.25	U = 0.25	
Thermal Bridging ψ Value	-	0.01W/mK	

Table 1. Summary of Building Envelope Thermal Performance Criteria

In accordance with the requirements of a low energy building, the air tightness characteristics will be addressed. With robust design, the target proposed for the buildings is $2.5m^3/m^2/hr$ @ 50Pa. This compares to the current Part L Building Regulations standard of $10m^3/m^2/hr$ @ 50Pa and hence represents an improvement of 75%.

High levels of natural daylight will be provided, wherever possible, through effective window design and 12% roof lights to the warehouse areas. The glazing specifications for the new buildings will be optimised to ensure that the glazed elements provide excellent thermal performance combined with optimum solar reflectance to minimise summer solar heat gains along with high daylight transmittance factors to maximise daylight factors. Encouraging the correct quality and quantity of daylight to penetrate the buildings is key to reducing the amount of light required from artificial sources and hence energy requirements.

It is imperative that the lighting design philosophy provides the correct quality of lighting with minimum energy input and hence reduce internal heat gains. In the buildings, energy efficient lighting will be deployed throughout and lighting schemes will be appropriately zoned to allow control of luminaires via switches/absence detection and daylight sensors. Output performance or Light Output Ratios (LORs) will exceed 80%.

To complement the significant improvements in envelope design and lighting provision, the building services heating and ventilation systems being proposed will also drastically reduce the inherent energy consumption of the site.

The provision of an effective control and metering philosophy is fundamental to the efficient operation of the building's environmental services. The following provides an overview of the plant efficiency and control measures that are proposed:

- Low NO_x high efficiency condensing gas boilers.
- Low temperature flow and return hot water heating to maximise heat generating efficiency and minimise distribution losses.
- High efficiency hybrid heat recovery ventilation with automatic control strategy to the office spaces.
- Zoning of mechanical ventilation systems.
- Modular open architecture controls systems and associated network.
- High efficiency low energy motors to be used to drive mechanical ventilation systems.
- Variable speed pumps and fans to be used to promote lower operating costs and help match energy usage with the operating profile and occupancy of the building.
- Sub-metering to be provided such that approximately 90% of the input energy from each utility service may be accounted for at end use. The Building Management System (BMS) will be interfaced to provide automatic monitoring and targeting of all sub-meters to promote energy management and deliver lower consumption.

4.0 Appraisal of Renewable and Low Carbon Technology Energy Options

The technical feasibility and economic viability of installing each LZC technology at the Northampton M1 Junction 15 development have been assessed in order to discount any unsuitable options at an early stage. A summary of the feasibility process is tabulated below and an overview of each viable technology is given subsequently.

Technology	Brief Description	Benefits	Issues/Limitations	Feasible for site
Solar Photovoltaic	Solar photovoltaic panels convert solar radiation into electrical energy through semiconductor cells. They are not to be confused with solar panels which use the sun's energy to heat water (or air) for water and space heating.	Low maintenance/no moving parts Easily integrated into building design Income generated from Feed-in Tariff (FIT)	Any overshadowing reduces panel performance Panels ideally inclined at 30º to the horizontal facing a southerly direction	Yes
Solar Thermal	Solar thermal energy can be used to contribute towards space heating and hot water requirements. The two commonest forms of collector are panel and evacuated tube.	Low maintenance Little/no ongoing costs Income generated from Renewable Heat Incentive (RHI) scheme	Must be sized for the building hot water requirements Panels ideally inclined at 30º to the horizontal facing a southerly direction	Yes
Ground Source Heat Pump (GSHP)	GSHP systems tap into the earth's considerable energy store to provide both heating and cooling to buildings. A number of installation methods are possible including horizontal trench, vertical boreholes, piled foundations (energy piles) or plates/pipe work submerged in a large body of water. The design, installation and operation of GSHPs is well established.	Minimal maintenance Unobtrusive technology Flexible installation options to meet available site footprint Income generated from Renewable Heat Incentive (RHI) scheme	Large area required for horizontal pipes Full ground survey required to determine geology More beneficial to the development if cooling is required Integration with piled foundations must be done at an early stage	No, prohibitively expensive installation costs
Air Source Heat Pump	Electric or gas driven air source heat pumps extract thermal energy from the surrounding air and transfer it to the working fluid (air or water).	Efficient use of fuel Relatively low capital costs Income generated from Renewable Heat Incentive (RHI) scheme	Specialist maintenance More beneficial to the development if cooling is required Requires defrost cycle in extreme conditions Some additional plant space required	Yes

Technology	Brief Description	Benefits	Issues/Limitations	Feasible for site
Wind Turbine *(Stand-alone column mounted)*	Wind generation equipment operates on the basis of wind turning a propeller, which is used to drive an alternator to generate electricity. Small scale (1kW – 15kW) wind turbines can be pole or roof mounted.	Low maintenance/ongoing costs Minimum wind speed available *(www.bwea.com)* Excess electricity can be exported to the grid Income generated from Feed-in Tariff (FIT)	Planning issues Aesthetic impact and background noise Space limitations on site Wind survey to be undertaken to verify 'local' viability	No, not suitable on this site
Wind Turbine *(Roof Mounted)*	As above	Low maintenance/ongoing costs Minimum wind speed available *(www.bwea.com)* Excess electricity can be exported to the grid Income generated from Feed-in Tariff (FIT)	Planning issues Aesthetic impact and background noise Structural/vibration impact on building to be assessed Proximity of other buildings raises issues with downstream turbulence Wind survey to be undertaken to verify 'local' viability	No, not suitable on this site
Gas Fired Combined Heat and Power	A Combined Heat and Power (CHP) installation is effectively a mini on-site power plant providing both electrical power and useful heat. CHP is strictly an energy efficiency measure rather than a renewable energy technology.	Potential high CO_2 saving available Efficient use of fuel Excess electricity can be exported to the grid Benefits from being part of an energy centre/district heating scheme	Maintenance intensive Sufficient base thermal and electrical demand required Some additional plant space required	No, limited domestic hot water requirements
Bio-fuel Fired Combined Heat and Power	As above.	Potential high CO_2 saving available Efficient use of fuel Excess electricity can be exported back to the grid Benefits from being part of an energy centre/district heating scheme Income generated from Renewable Obligation Certificates (ROCs) and	Maintenance intensive Sufficient base thermal and electrical demand required Significant plant space required Biomass fuelled systems are at early stages of commercialisation Large area needed for fuel delivery and storage	No, not suitable on this site

Technology	Brief Description	Benefits	Issues/Limitations	Feasible for site
		Renewable Heat Incentive (RHI) scheme	Reliable biomass fuel supply chain required	
Bio-Renewable Energy Sources *(Automated feed – wood-fuel boiler plant)*	Modern wood-fuel boilers are highly efficient, clean and almost carbon neutral (the tree growing process effectively absorbs the CO_2 that is emitted during combustion). Automated systems require mechanical fuel handling and a large storage silo.	Stable long term running costs Potential good CO_2 saving Income generated from Renewable Heat Incentive (RHI) scheme	Large area needed for fuel delivery and storage Reliable fuel supply chain required Regular maintenance required Significant plant space required	No, not suitable on this site
Fuel Cells and Fuel Cell Combined Heat and Power	Fuel cells convert the energy of a controlled chemical reaction, typically involving hydrogen and oxygen, into electricity, heat and water vapour. Fuel cell stacks operate in the temperature range 65°C – 800°C providing co-generation opportunities in the form of Combined Heat and Power (CHP) solutions.	Zero CO_2 emissions if fired on pure hydrogen and low CO_2 emissions if fired on other hydrocarbon fuels Virtually silent operation since no moving parts High electrical efficiency Excess electricity can be exported back to the grid Benefits from being part of an energy centre/district heating scheme	Expensive Pure hydrogen fuel supply and distribution infrastructure limited in the UK Sufficient base thermal and electrical demand required Some additional plant space required Reforming process, used to extract hydrogen from alternative fuels, requires energy; lowering overall system efficiency	No, expensive, emerging technology

Table 2. Summary of Renewable and Low Carbon Technology Energy Options

4.1 Solar Photovoltaic (PV) Panels

Solar photovoltaic panels convert solar radiation into electrical energy through semiconductor cells. They are not to be confused with solar panels which use the sun's energy to heat water (or air) for water and space heating.

Figure 2. East Midlands Distribution Centre – 6.1MW$_p$ Solar PV Installation

Photovoltaic panels are available in a number of forms including mono-crystalline, polycrystalline, amorphous silicon (thin film) or hybrid panels. Polycrystalline products offer the best combination of performance and cost at present. They are fixed or integrated into a building's un-shaded south facing façade or pitched roof. Distribution centre roofs provide an ideal location for the installation of PV panels, as shown above.

It is essential that the panels remain un-shaded, as even a small shadow can significantly reduce output. This is not an issue on warehouse projects due to the uncluttered nature of the roof. The individual modules are connected to an inverter to convert their direct current (DC) into alternating current (AC) which is usable in buildings.

Although rooftops provide an ideal site for fixing PV panels, there are a number of alternative solutions whereby PV panels can be incorporated into the actual building fabric of the development.

Figure 3. Building Integrated Solar Photovoltaic Installation

Solar glazing uses a combination of solar PV and glass, where the PV cells are laminated between two panes of specialised glazing (see above). The resulting glass laminate serves the dual function of creating energy and shade at the same time, reducing the risk of overheating.

Solar glazing can be used wherever conventional glass would be specified, especially in atria. Bespoke designs allow for varying light penetration by changing the spacing between individual cells. Typically, a combination of 50% PV and 50% translucent glazing is used.

Photovoltaic technology may be feasibly incorporated into the building design with little/no maintenance or on-going costs. Installations are scaleable in terms of active area; size being restricted only by available façade and/or roof space.

A particular advantage of solar PV is that running costs are very low (requires no fossil fuel for operation) and, since there are no moving parts, very little maintenance is required.

It should be noted that the installation and connection of embedded generation equipment to the mains electrical utility grid (National Grid), including solar PV panels rated at more than 16A per phase, is subject to technical approval by the District Network Operator (DNO). This takes the form of a G59/2-1 agreement. The G59 is the regulation surrounding the connection of any form of generator device to run 'in parallel' or 'synchronised' with the grid.

The DNO are required (under the Connection and Use of System Code) to make a request for a Statement of Works (SoW) to National Grid Electricity Transmission plc (NGET) in relation to the potential impact of connection of embedded generation on the National Electricity Transmission System (NETS). As such, there is no guarantee that approval for the connection of embedded generation equipment will be granted.

4.1.1 Smart Grid – Solar PV, Battery Storage and Electric Vehicle (EV) Charging

The UK electricity infrastructure is gradually moving from a traditional top down power flow model with predictable loads, to a more complex nodal model characterised by intermittent distributed generation (PV/wind) and irregular loads (electric vehicles/heat pumps), often located at the very extremities of the network.

The current infrastructure is showing signs of strain due to the increase in complexity and technical challenges associated with balancing supply and demand across the power transmission and distribution system, whilst maintaining power quality.

Given the size and nature of the development, opportunities exist to maximise the site's overall efficiency by adopting a 'smart grid' approach. This is where the intermittent generation of energy from renewable sources (in this case solar PV) is paired with an energy storage and management system before being re-distributed at times of high energy demand and/or to provide e.g. dedicated electric vehicle charging.

This arrangement requires the installation of a large scale on-site battery array. At present, lithium-ion based Battery Energy Storage Systems (BESS) are commercially available from e.g. Tesla, and can be located above or below ground.

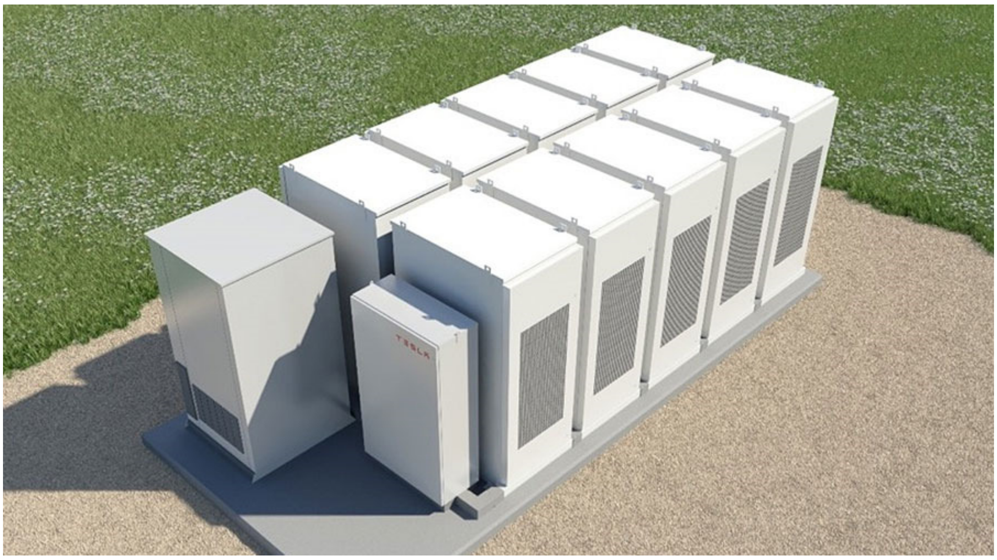


Figure 4. Battery Energy Storage System (BESS)

The BESS can be used to balance the site energy requirements through mechanisms known as renewable firming, load shifting and peak shaving, thereby modulating the use of grid electricity and, in turn, reducing costs. In addition, external grid services, procured through an aggregator from the National Grid in the form of Demand Side Response (DSR) participation, can be exploited to generate revenue.

With the current scheme, it would be prudent to consider using the BESS to provide electric vehicle (EV) charging infrastructure, as this can place a heavy burden on the power demands of the site during business hours. The exact number of EV charging stations is not known at this point, but with fast AC chargers rated at 7kW or above, the total load across the site could be significant and would have to be carefully managed. The most efficient way of recharging an EV is to use power generated locally and this is where the BESS paired with solar PV comes into play.

Figure 5. EV Battery Charging Stations

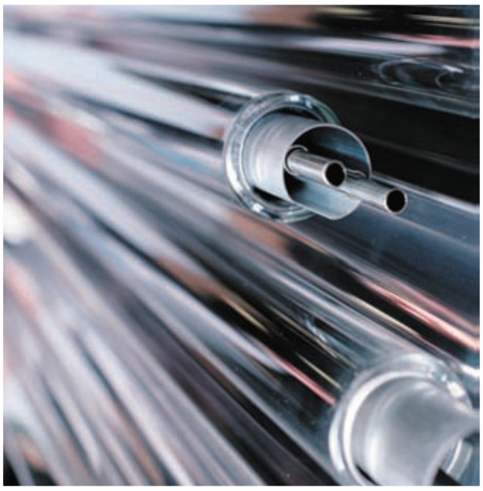
With the establishment of a rail network to serve the development, on-site transportation will form a major role in the delivery and uplift of goods to and from each unit. The use of electric transportation is a viable proposition with the use of e.g. open trailer configurations to facilitate palletised deliveries and uplifts using forklift trucks. The transportation and goods handling vehicles could be charged using their own dedicated charging network.

4.2 Solar Thermal

Solar thermal energy can be used to contribute towards space heating and hot water requirements. In the UK, most applications focus on hot water installation as the solar availability during the space heating season is limited.

Figure 6. CPW Solar Thermal Evacuated Tube Systems: William Brookes School (above left) and Police Federation Headquarters (above right)

The use of solar water heating installations is widespread throughout Europe. The systems use a heat collector, generally located at roof level on support frames, orientated in a southerly direction to maximise solar heat absorption.



A working fluid is used to heat water that is stored in either a separate hot water cylinder or more commonly a twin coil hot water cylinder with the second coil providing top-up heating from a conventional boiler.

The two commonest forms of collector are panel and evacuated tube.

The panel type collectors are generally more robust and reliable while manufacturers claim that the evacuated tube versions offer better winter all-round performance.

Figure 7. Evacuated Tube Type Collectors

The design of the flat plate panels is relatively straightforward; consisting of water tubes arranged behind solar glass and an absorber plate. The absorber plate absorbs the sun's rays and transfers energy to the water flowing through the tubes. In contrast, the evacuated tube type collectors are more complicated consisting of double wall glass tubes with a space in the centre containing a heat pipe and a liquid.

Coatings on the inner glass ensure that around 93% of the absorbed heat is retained within the system and the vacuum prevents loss of heat through conduction and convection. The circular design helps maximise the potential to collect solar energy all year round when the sun is at different angles.

The heat pipes are connected to a manifold containing circulating water. The liquid in the heat pipe is evaporated by the suns energy and rises to a heat exchanger within the manifold where it condenses and gives up its latent heat energy to the water. This heated water is then pumped to a coil in the hot water cylinder sized to meet the demand of the installation. Evacuated tube systems deliver higher temperature water than flat plate types, with little decrease in efficiency, making them more effective with thermal storage solutions.

As a general rule, the evacuated tube collectors can deliver around 700kWhr/m^2/yr when in optimum orientation (inclined at 30º to the horizontal facing a southerly direction). This compares to around 580kWhr/m^2/yr for the flat plate collectors under similar conditions.

Solar thermal installations can be designed to fit the available roof space and/or building façade. Each evacuated tube is approximately 2m in length with an external diameter of 58mm. They weigh around 2kg each and can be spaced from 10mm to 500mm apart in an array. A typical panel array, 2.1m x 1.0m, will provide around 1.33m^2 of absorber area and weigh approximately 45kg. Bespoke mounting frames can be fashioned to provide the ideal inclination of 30º to the horizontal facing a southerly direction. Access to the roof mounted solar collectors will be necessary for occasional cleaning of the active tubes.

For the current development, any solar thermal system should be sized to meet the domestic hot water demands of the building to prevent the risk of overheating during the summer months.

Solar thermal systems generally come with a 10-year warranty. Very little maintenance is required and a check by a professional installer of pumps, valves and anti-freeze mixture every 3 – 5 years is usually sufficient.

4.3 Air Source Heat Pumps

Electric driven air source heat pumps extract thermal energy from the surrounding air and transfer it to the working fluid (air or water). Like GSHPs they can provide both heating and cooling to buildings and have an associated Coefficient of Performance (COP). This is typically around 3 to 4 for heat pumps driven by compressors powered by electric motors and incorporating Variable Refrigerant Flow (VRF) technology. With VRF technology, there is an opportunity to heat and cool separate spaces and recover the heat between them.

Figure 8. Air Source Heat Pumps

Care should be taken when mounting the units to avoid any acoustic problems associated with operating the fans. The outdoor units normally operate with sound levels typically in the range 55 - 60dB(A).

A downside of electric driven air source heat pumps is that they require a defrost cycle in extreme conditions which impacts on the system efficiency. Heating capacity also falls off as the ambient temperature drops below 5ºC but still maintains 80% capacity at -5ºC.

Stiebel Eltron offer a small footprint (1.7m width x 2.0m depth x 1.5m height) air-to-water unit, rated at 30kW (ambient air temperature of +2ºC and a flow temperature of +35ºC to the heating system – ideally under floor). Units are either roof or ground mounted and coupled to a thermal buffer store with additional back-up electric immersion heaters in the cylinder, to make up any shortfall. Alternative heat pump solutions can be supplied for internal installation within a plant room.

Air source heat pump systems are scaleable to meet the specific demands of the development, but for this study, assume that the office areas are being targeted.

5.0 BREEAM Assessment

A BREEAM 2018 pre-assessment of the new development has been undertaken by a qualified BREEAM Accredited Professional (AP) against the New Construction criteria at Design and Procurement stage. The Northampton M1 Junction 15 Unit 4 has been used as an example and currently achieves a score of 55.39% which translates into an overall BREEAM rating of ‘Very Good’. The table below shows a breakdown of the BREEAM score:

BREEAM® UK — BREEAM New Construction 2018 — bre

Pre-assessment: Northampton M1 Junction 15 Unit 4 (17403)

BREEAM Rating

	Credits available	Credits achieved	% Credits achieved	Weighting	Category score
Man	18.0	13.0	72.22%	11.00%	7.94%
Hea	10.0	4.0	40.00%	8.00%	3.20%
Ene	21.0	11.0	52.38%	14.00%	7.33%
Tra	12.0	5.0	41.67%	11.50%	4.79%
Wat	8.0	6.0	75.00%	7.00%	5.25%
Mat	14.0	5.0	35.71%	17.50%	6.25%
Wst	9.0	6.0	66.67%	7.00%	4.66%
LE	13.0	8.0	61.54%	15.00%	9.23%
Pol	11.0	7.0	63.64%	9.00%	5.72%
Inn	10.0	1.0	10.00%	10.00%	1.00%
Total	126.0	66.0	52.38%	-	55.39%
Rating	-	-	-	-	Very Good

Performance by environmental category

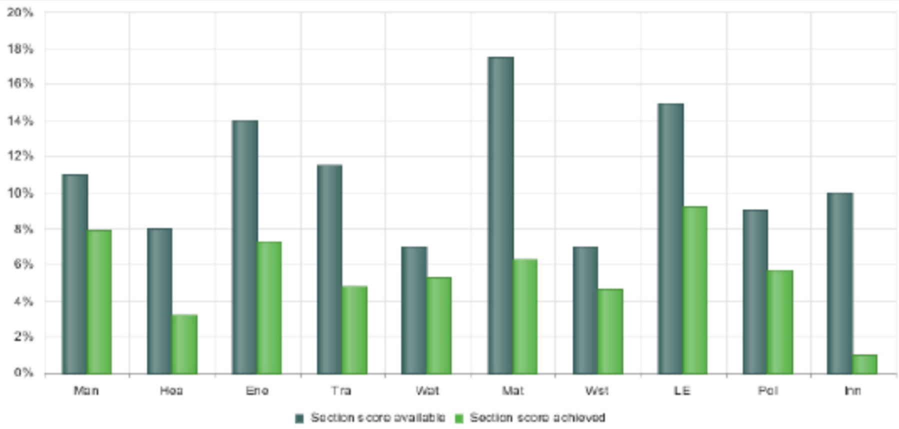


Table 3. Summary of BREEAM 2018 Assessment

6.0 Summary and Conclusions

This Statement sets out an energy strategy for the built environment at Northampton Gateway SRFI. Having regard to the Policy requirements to minimise the carbon footprint, the statement considers both energy efficiency through building design and reduction in carbon impact through the use of LZC technologies.

In order to deliver environmentally responsible building stock, an exemplar approach is being proposed based on low energy design principles. In summary, this approach involves energy demand minimisation through effective building form and orientation to promote high levels of daylight, good envelope design and proficient use of building services such that the buildings themselves are being used as the primary environmental modifier.

It is worthy of note, that long term energy benefits are best realised by reducing the inherent energy demand of the buildings in the first instance. This is the approach adopted by the Design Team.

To further quantify the positive impact of the proposed sustainability measures, a BREEAM 2018 Design and Procurement pre-assessment has been undertaken by a qualified BREEAM Accredited Professional (AP) against the New Construction criteria. The scheme currently achieves a score of 55.39% which translates into an overall BREEAM rating of 'Very Good'.

Having reviewed the feasibility of installing each LZC technology solution, the following is proposed for inclusion on the scheme, at this stage, in order to provide a proportion of the regulated energy requirements of the development and to help reduce CO_2 emissions across the estate:

- **1,500kW Air Source Heat Pump installation**
- **80m^2 Solar Thermal Evacuated Tube installation**
- **5,000m^2 Solar Photovoltaic Panel installation**

- **Overall regulated CO_2 emissions reduction compared to a notional development c. 8.8%**

Other LZC technology solutions have been discounted on the grounds that they are not technically feasible or economically viable for the development, as described in Table 2 of this report.

Given the size and nature of the development, opportunities exist to maximise the site's overall efficiency by adopting a 'smart grid' approach. In this case, that could involve the use of a battery energy storage system (BESS) paired to the solar PV array to help balance the supply and demand of the development. The BESS could be used to provide electric vehicle (EV) charging infrastructure for use by employees via EV charging stations and an additional dedicated network for on-site electric transportation vehicles.