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ENERGY STRATEGY REPORT

FIRST URBAN GROUP

THE RAILWAY, LONDON, NW6 2LU

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Client:	Project Site Address:
First Urban (WH) Limited	The Railway 100 West End Lane London NW6 2LU

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1.0 INTRODUCTION

This report details the energy strategy for the proposed development at The Railway, London NW6 2LU. The development involves the refurbishment of the existing property as follows:-

1. Retention of pub, with re-configured back of house facilities
2. Provision of new managers ancillary accommodation to lower ground floor
3. Conversion of existing first floor area into 2 No. office spaces
4. Conversion of existing 2^{nd} & 3^{rd} floor into 6 No. residential units.
5. Creation of new office/residential entrance lobby.

The various national, regional and local planning policies are considered and an energy strategy is formed to meet their requirements for sustainable design.

Various options for serving the building, including the use of renewable energy technologies, are considered. The proposed strategy has been modelled for all dwellings within the development using approved software, the resulting predicted carbon emissions are displayed in table 6.

In addition to meeting the policies listed this report shall be used as evidence in meeting the energy section of the BREEAM domestic refurbishment assessment for the development.

2.0 POLICY REVIEW

2.1 Summary of Planning Policy Context

This section summarises national, regional and local policies that aim to enforce sustainable building design and reduce energy consumption and carbon dioxide emissions.

The section includes relevant exerts from each policy and explains why they have been enforced.

2.2 National Legislation

2.2.1 The Building Regulations

The most relevant Building Regulations relating to sustainable and energy efficient developments are as follows:
- Part F (Ventilation) – regulates the control and effectiveness of ventilation schemes.
- Part L (Conservation of Fuel and Power) – regulates the energy performance and carbon emissions of new and existing buildings. In this instance Part L1A shall apply.

These documents were updated in 2010 in order to comply with the Energy Performance of Buildings Directive.

2.3 Regional Energy Policy

The London Plan: Spatial Development Strategy for Greater London.
The London Plan was originally introduced in 2004 however the plan has been updated with new versions released in 2008 and July 2011.

The London Plan aims to ensure London becomes an "exemplary, sustainable world city", it includes a climate change policy that's aim is to create "A city that becomes a world leader in improving the environment locally and globally, taking the lead in tackling climate change, reducing pollution, developing a low carbon economy, consuming fewer resources and using them more effectively." This energy strategy report addresses the following policies from the London Plan.

Policy 5.2 - Minimising carbon dioxide emissions

Planning decisions
A) Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:

1) Be lean: use less energy
2) Be clean: supply energy efficiently
3) Be green: use renewable energy

B) The Mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.

Residential buildings:
Year Improvement on 2010 Building Regulations
2010 – 2013 25 per cent (Code for Sustainable Homes level 4)
2013 – 2016 40 per cent
2016 – 2031 Zero carbon

C) Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy.

D) As a minimum, energy assessments should include the following details:

a) calculation of the energy demand and carbon dioxide emissions covered by the Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including plant or equipment, that are not covered by the Building Regulations at each stage of the energy hierarchy
b) proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services
c) proposals to further reduce carbon dioxide emissions through the use of decentralised energy where feasible, such as district heating and cooling and combined heat and power (CHP)
d) proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies.

E) The carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

Policy 5.3 - Sustainable design and construction Strategic

A) The highest standards of sustainable design and construction should be achieved in London to improve the environmental performance of new developments and to adapt to the effects of climate change over their lifetime.

Planning decisions
B) Development proposals should demonstrate that sustainable design standards are integral to the proposal, including its construction and operation, and ensure that they are considered at the beginning of the design process.

C) Major development proposals should meet the minimum standards outlined in the Mayor's supplementary planning guidance and this should be clearly demonstrated within a design and access statement. The standards include measures to achieve other policies in this Plan and the following sustainable design principles:

a) minimising carbon dioxide emissions across the site, including the building and services (such as heating and cooling systems)
b) avoiding internal overheating and contributing to the urban heat island effect
c) efficient use of natural resources (including water), including making the most of natural systems both within and around buildings
d) minimising pollution (including noise, air and urban run-off)
e) minimising the generation of waste and maximising reuse or recycling
f) avoiding impacts from natural hazards (including flooding)
g) ensuring developments are comfortable and secure for users, including avoiding the creation of adverse local climatic conditions
h) securing sustainable procurement of materials, using local supplies where feasible, and
i) promoting and protecting biodiversity and green infrastructure.

Policy 5.5 - Decentralised energy networks

Strategic
The Mayor expects 25 per cent of the heat and power used in London to be generated through the use of localised decentralised energy systems by 2025. In order to achieve this target the Mayor prioritises the development of decentralised heating and cooling networks at the development and area wide levels, including larger scale heat transmission networks.

Policy 5.6 Decentralised energy in development proposals

Planning decisions
A) Development proposals should evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine opportunities to extend the system beyond the site boundary to adjacent sites.

B) Major development proposals should select energy systems in accordance with the following hierarchy:

1) Connection to existing heating or cooling networks
2) Site wide CHP network
3) Communal heating and cooling.

C) Potential opportunities to meet the first priority in this hierarchy are outlined in the London Heat Map tool. Where future network opportunities are identified, proposals should be designed to connect to these networks.

Policy 5.7 - Renewable energy

Strategic

A) The Mayor seeks to increase the proportion of energy generated from renewable sources, and expects that the projections for installed renewable energy capacity outlined in the Climate Change Mitigation and Energy strategy and in supplementary planning guidance will be achieved in London.

Planning decisions

B) Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.

Policy 5.9 – Overheating and Cooling

Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy:

1) Minimise internal heat generation through energy efficient design,
2) Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls,
3) Manage the heat within the building through exposed internal thermal mass and high ceilings,
4) Passive ventilation,
5) Mechanical ventilation,
6) Active cooling systems (ensuring they are the lowest carbon options).

Local Policies

The Railway is located within the London Borough of Camden (North London) and is subject to the planning guidelines of this Borough. Camden have produced planning guidance documents (CPG). They provided guidance on new development in West Hampstead. The document CPG 3 dated September 2013, Sustainability detail that the following policies are applicable;

1. Sustainability Assessment
2. Energy Efficiency
3. Renewable Energy
4. Air Quality
5. Water

Sustainability

Camden planning guidance 3.3 states "All new developments are to be designed to minimise carbon dioxide emissions by being as energy efficient as is feasible and viable."

Energy Efficiency

Camden planning guidance 3.4 states Development involving a change of use or a conversion of 5 or more dwellings or 500sq m of any floorspace, will be expected to achieve 60% of the un-weighted credits in the Energy category in their EcoHomes or BREEAM assessment, whichever is applicable.."

Renewable Energy

Camden planning guidance 6.2 states "*developments will be expected to achieve a 20% reduction in carbon dioxide emissions from on-site renewable energy generation unless it can be demonstrated that such provision is not feasible.."*

3.0 METHODOLOGY

The thermal modelling software IES Virtual Environment was used to create a three dimensional model of the proposed development.

The thermal model geometry, illustrated in Appendix A, was used to perform the following stages of SAP energy assessment in line with the Greater London Authority (GLA) process:-

1) "***be lean***" – initially focussing on passive methods, to reduce projected energy including improved thermal performance through improved U-values, reduced air leakage and optimisation of useful solar gains through adjusting building orientation.

   Reducing energy usage through the implementation of energy efficient building services such as low energy lighting, gas condensing boilers, low loss hot water storage vessels, adaptive heating and hot water controls, and heat recovery ventilation systems.

2) "***be clean***" – an assessment of the viability and effectiveness of the use of decentralised energy generation i.e. micro CHP.

3) "***be green***" – feasibility into and effectiveness of various different renewable energy technologies including Solar thermal panels, Photovoltaic Panels Small Scale, Wind Turbines Ground Source Heat Pumps, Air Source Heat Pumps and Exhaust Air Source Heat Pumps

The effect that these various measures have on the projected carbon emissions of a single typical dwelling within the development is provided in results tables within each section.

With each iteration of the design, the thermal model provides a building emission rate (BER) that is then compared against a Target Emission Rate (TER). Calculating the difference between the two carbon emission rates provides a method of assessing compliance with the policy documents listed above.

4.0 PASSIVE ENERGY EFFICIENCY MEASURES (BE LEAN)

The key to producing a sustainable and low carbon development is to firstly minimise the thermal loads associated with the heating/cooling the building through passive measures.

The first stage of energy efficiency measures is to improve the thermal envelope of the building, it is proposed to improve the existing thermal envelop above the minimum requirements of the building regulations part L2B.

The second stage is to improve the efficiency of mechanical and electrical services. The following design data was incorporated to reduce the projected carbon emissions:-

Lighting

The lighting for the dwellings is proposed to be 100% low energy LED luminaires. This is a 25% improvement on the building regulations limiting amount of energy efficient lighting.

Lighting to all other areas is proposed to be 100% low energy fluorescent luminaires with high frequency control gear.

The calculations do not take into account lighting control, so further savings in energy and carbon emissions may be made via passive infra-red sensors and controls etc.

Ventilation

All of the dwellings are proposed to have a balanced whole house mechanical ventilation system with heat recovery. To ensure the results were comparable a Nuaire Ltd unit was modelled in each dwelling with all heating systems, the ductwork was specified as rigid and insulated and the number of wet rooms was specified for each individual dwelling. The Nuaire unit was selected as it has very efficient fan motors, with a Specific Fan power of just 0.69W/l/s and up to 90% efficient heat recovery. Respectively these are 54% and 20% better than the 2010 building regulations limiting standards of 1.5W/l/s and 70%.

Heating

Heating to the pup & dwellings is proposed to be high efficiency gas fired condensing boilers. The gas boilers used within the calculations were specified as a 90% efficient gas fired condensing boiler with automatic ignition. The main dining area will be provided with a high efficiency air source heat pump.

Within the office areas air source heat pumps have been used to improve the energy performance of the heating installation to these spaces

Domestic Hot Water

Within the pub it is proposed to provide a dedicated condensing gas fired water heater shall be installed to provide hot water to the kitchen & the toilets.

Domestic hot water in the new residential units is locally generated by the condensing combination boiler

The table below illustrates the carbon emission improvement for the building based on the proposed installation and minimum required building regulations part L2B requirements.

Results Table 1 – Energy efficiency measures (be lean)

	Part L2B Min Requirements	Proposed Development	% improvement
Carbon emissions for building	54.2kgC02/m2	40.80 kgC02/m2	24.7%

6.0 DECENTRALISED ENERGY PRODUCTION (BE CLEAN)

Combined Heat and Power is a plant which consumes fuel to produce electricity and useful heat. In most cases the fuel used is natural gas and the plant is a type of sterling heat engine. The unit supplies heat to the heating system through a heat exchanger as from a conventional boiler. The electricity generated is fed into the electrical supply system, thus reducing the need for purchased electricity.

Heat and electricity from CHP plant are produced with typically 50% savings in emissions of the greenhouse gas carbon dioxide, and 30% savings in consumption of primary energy (a measure of energy which includes the fuel consumed by power stations) compared to conventional boiler plant and electricity supplies.

In order to maximise the longevity of the plant longer running hours are preferred to reduce short cycling. This also enables the most CHP plant to operate at its maximum efficiency which in turn can enable payback for the plant within its economic life. Therefore CHP plant is perhaps slightly better suited to buildings that have a constant base load that enables the plant to operate for longer periods.

The base thermal load of a domestic building, such as The Railway, is not normally constant with peaks of heating and domestic hot water loads in the morning and evening and generally very little in between.

Therefore due to the lack of thermal base load and the management and maintenance requirements of implementing a centralised community heating system with mini-CHP such a system is deemed unfeasible. In addition to this the plant space requirements for a centralised system of this size are exorbitantly large and would necessitate a significant reduction in the floor plan of one of the dwellings.

7.0 RENEWABLE ENERGY TECHNOLOGIES (BE GREEN)

In a mechanically ventilated building CO2 emissions are predominantly caused by the generation of heat both for hot water and heating, and in the form of electricity for fans, lighting and equipment. It is now possible to significantly reduce these emissions and in some cases eliminate them by implementing low and zero carbon technologies.

Several low and zero carbon (LZC) energy sources are considered for use in the dwellings in order to provide a sustainable and energy efficient development.

The following thermal and electrical renewable energy sources were considered;
- Solar Thermal Panels
- Photovoltaic Panels
- Small Scale Wind Turbines
- Ground Source Heat Pumps
- Air Source Heat Pumps
- Exhaust Air Source Heat Pumps
- Biomass Boilers

The following text provides descriptions of the above renewable energy technologies and assesses their suitability for integration into the proposed development at the Railway.

Solar Thermal Panels – Solar thermal and, especially, active Solar Domestic Hot Water (SDHW) heating is a well-established renewable energy system in many countries outside the UK. It can be one of the most cost-effective renewable energy systems available.

The main component in a solar water heating system is the collector. The two basic types of solar hot water collectors are flat plate collectors and evacuated tube collectors. Evacuated collectors will absorb approximately 20% more energy per annum than flat plate collectors however their initial capital cost is greater and therefore sometimes they are not as economically viable.

Whilst hot water demand constitutes a high proportion of the annual energy use, as an existing building heating demand remains high even with enhanced thermal envelope. We have included an evaluation of the benefit in our thermal modelling results in table 2 below.

Photovoltaic Panels – A solar PV system is an energy system which directly converts energy harnessed from the sun into electricity. This electricity is used throughout a building in the same way as conventional electricity imported from the grid.

Silicon material is at the core of most solar PV technology. Once light hits the silicon, electricity is generated and fed through a cable to be collected at an inverter. The inverter converts the Direct Current (DC) to Alternating Current (AC) before feeding it into the building's main electrical circuit. The electricity generated by the system works hand in hand with the existing electrical supply sharing the same circuitry and wiring.

The introduction of the feed in tariffs incentive make photovoltaic systems far more likely to be economically viable with paybacks in region 10 to 14 years for a typical appropriately selected installation.

Small Scale Wind Turbines – Turbines can vary in size and power output from very small ones that can supply energy for battery charging systems (boats, caravans etc) to large ones grouped on wind farms that supply electricity directly to the national grid.

The output from a wind turbine is highly sensitive to wind speed. It is essential that turbines should be sited away from obstructions, with a clear exposure or fetch for the prevailing wind. Wind speed also increases with height so it is best to have the turbine high up, and most small turbines have towers much higher relative to their diameter than large ones.

According to the *DTI Windspeed Database* the proposed site has an average wind speed at 10m above ground level of 5.0m/s. The wind speed increases to 5.9m/s at a height of 25m agl. When the site wind speed is cross referenced with a turbine power curve shown below it is clear that the turbine would only produce a small amount of its rated output.

The wind speed/power characteristics of a 15kW wind turbine with a rotor diameter of 9m has a peak power output of 15kW with a wind speed of 12m/s and a hub height of 15m. Whilst this would be a larger than any wind turbine proposed for The Railway it does indicate that at the sites average wind speed this turbine would only produce a small amount of its rated output.

We therefore do not consider that the wind turbine option is viable to pursue on this project.

Ground Source Heat Pumps – A GSHP system consists of a ground heat exchanger, a water-to-water heat pump, and a heat distribution system. Until recently open-loop GSHP systems using groundwater were the most widely used type. Where a suitable source of groundwater is available this can be very cost effective because water can be delivered and returned using relatively inexpensive wells that require little ground area. However, the disadvantages are that water availability is limited, fouling and corrosion may be a problem depending on water quality and most importantly environmental regulations covering the use of groundwater are becoming increasingly restrictive.

Heat Pump systems operate at higher efficiencies as the difference in temperature between the source and the system served reduces. e.g. In this case, the temperature of the ground and the heating system. Hence if the heating system can operate with lower temperature hot water the efficiency of the heat pump is improved.

Hence ground source heat pumps are ideally suited to LTHW under floor heating systems as such heating systems utilise low water temperatures in the region of 40ºC.
In new construction where building heat losses are very low, it is now possible to utilise convector type heaters with low water temperatures to achieve the required heat outputs.

In order to produce domestic hot water with a ground source heat pump a much higher flow temperature of 65-70ºC is required. This is commonly achieved with the heat pump operating for limited periods of time at a higher temperature, and / or back up with direct electric heating elements.

Borehole collectors are normally only economically viable if piling for the buildings foundations is necessary. The alternative is to bury pipes in a trench collector. In this case a large area of land is needed to accommodate the pipe coils.

In this case the property is existing with no significant external space to accommodate sufficient linear trench length for buried ground source heat extraction. Therefore we consider that a ground source heat pump solution is not the best option to pursue for this project.

Air Source Heat Pumps – An air source heat pump uses outside air as a heat source or heat sink. An ASHP system consists of an external condensing unit, an air-to-water heat exchanger and a heat distribution system to absorb heat externally and release it internally to provide heating and hot water. ASHPs draw heat from the ambient air source and can extract heat from the air even when the outside temperature is below 0°C.

Heat Pump systems operate at higher efficiencies as the difference in temperature between the source and the system served reduces. E.g., In this case, the temperature of the air and the heating system. If the heating system can operate with lower temperature hot water the efficiency of the heat pump is improved.

Hence, as with ground source heat pumps, air source heat pumps are ideally suited to LTHW under floor heating systems as they utilise low water temperatures, in the region of 40ºC.

As with GSHP's, in order to produce domestic hot water the heat pump will be required to operate for limited periods of time at a higher temperature, and / or have back up with direct electric heating elements.

The installation of air source heat pumps would place a greater strain and dependency on the national electricity grid. This coupled with the detrimental aesthetic impact of placing outside air cooled condensing units, approximately 1345H x 900W x 320D, on the roof or external façade to serve the dwellings has made this option unsuitable. Placing these units on the roof of the development would also reduce the space available for solar energy technologies.

Biomass Boilers
Biomass boilers provide a thermal output which is commonly used to generate heating and hot water service in domestic, commercial and industrial buildings. They consume biomass fuel which is considered near carbon neutral. Biomass is generally in the form of wood chip or wood pellets. Wood pellets are more expensive than wood chips but have a significantly higher calorific value and lead to less maintenance of the boiler being required. They can be used with district heating networks or as individual boilers on a house by house basis.

Thermal modelling has indicated that a biomass boiler installation serving 50% of the heating load would reduce the projected carbon emission by around 39%. Unfortunately in this development the tight site constraints, which would increase risks to health and safety during deliveries, and restrictions imposed by London's clean air act make their implementation unsuitable. Additionally, the carbon dioxide emissions and air pollution emitted by biomass delivery vehicles goes against the WCC and London Plan policy's for reducing local air pollution. The maintenance costs for a site of this size would also be disproportionately high in comparison to alternative technologies.

Results of Renewable Energy Technology Assessment

Results table 2 below indicates the percentage reduction in CO2 emissions available from the various renewable energy technologies when modelled on the typical dwelling with both "be lean" and "be clean" measures considered.

Renewable Technology	% additional improvement	% cumulative improvement
Wind Turbine	Considered impractical	
Solar thermal panels, 3m²*	0.7%	24.9%
Solar thermal panels, 6m²*	1.4%	25.6%
Solar thermal panels, 9m²*	1.9%	26.1%
Biomass boiler doing 50% of heating load	Considered impractical	
Photovoltaic Array 40m²	3.5%	28.2%

Table 2 – Renewable energy technologies

Renewable energy conclusions

There is insufficient roof space for an installation of either solar thermal or solar PV panels that would reduce in CO2 emissions adequately to meet the current planning policy.

Photovoltaic panels are the preferred option as they require minimal maintenance which reduces the risks of working at heights, can reduce carbon emissions further, have less potential for wasting solar energy due to the grid feed in system and reduce the developments dependence on the national grid.

8.0 CONCLUSIONS

CARBON REDUCTION

Alternative renewable energy technologies such as biomass boilers and wind turbines have been discounted due to site constraints. Biomass boilers were deemed unfeasible due to the residential nature of the area and the restrictions imposed by London's Clean Air Act. Wind turbines were considered impractical due to the urban landscape acting to reduce wind velocities and the detrimental aesthetic impact they would have. Solar thermal panels were discounted as Photovoltaic panels can provide a greater reduction in CO2 emissions for the area of roof space available.

The proposed scheme shall however incorporate the following energy efficiency measures in compliance with London Plans Hierarchy for sustainable development:

> **Be Lean** - The building fabric U-values shall be improved. Energy efficient fixed services shall be installed throughout including LED lighting, highly insulated hot water storage vessels with insulated connecting pipework and intelligent heating and hot water controls. The latest in whole house heat recovery systems, with high efficiency fans, will be utilised to reduce heating loads
>
> **Be Clean –** Decentralised energy systems are not considered suitable for this development
>
> **Be Green -** The introduction of photovoltaic arrays serving the development shall displace the use of grid supplied electricity and shall feed into the grid network when no load is present.

Carbon Emissions Savings Summary

	Part L2B Min Requirements	Proposed Development	% improvement
Be Lean	54.2kgC02/m2	40.80 kgC02/m2	24.7%
Be Clean	Considered impractical for this development		
Be Green	54.2kgC02/m2	39.5 kg/C02/m2	28.2%

OVERHEATING AND COOLING

In order to minimise the risk of overheating, provide a comfortable, habitable living environment and to address the requirements of the London Plan Policy 5.9 the following measures are proposed:

1) Internal heat generation from mechanical and electrical plant shall be minimised by the installation of high performance thermal insulation to hot water service pipework and cylinders, the installation of 100% high efficiency LED lighting, the installation of A grade energy efficient appliances.
2) Internal walls and partitions shall be constructed from dense plaster board to add exposed thermal mass to the building.

3) Large full height opening windows/doors shall be installed to provide rapid purge ventilation of the dwellings. In cases where single sided ventilation is not possible due to the depth of the spaces cross ventilation between 2 different building facades shall be possible.
4) Highly efficient mechanical whole house heat recovery ventilation shall be provided in each dwelling as part of the controlled heating/ventilation strategy. The heat recovery units shall have a summer bypass which shall enable them to be used during the summer months for both trickle ventilation, during the day and night time cooling. The ventilation unit shall also help to maintain security in the building by continuing to dissipate any excessive heat build-up when the building is unoccupied and ground floor windows, in particular, cannot be opened. The system shall also aid in reducing day time space temperatures in the summer by providing night time cooling of the internal building fabric.

Appendix A

THERMAL MODELLING

Following consideration of the various planning policy documents above a thermal model of the building was created to assess the effectiveness of various sustainable building designs in minimising energy usage and projected carbon emissions of the building.

Model Geometry

Model geometry has been taken from Cornish Architects plans and sections and constructed using IES Virtual Environments modelling builder with the thermal modelling software IES Virtual Environment used to perform the energy and carbon emissions assessment.

The following images indicate the geometry used for modelling purposes