Energy Strategy

Land Adjacent to 38-42 Hampton Road, Teddington

On behalf of Howarth Homes PLC

Revision A

Date: 5th March 2020

REVISION HISTORY

Revision	Issue Date	Description	Issued By	Checked By
A	05/03/2020	First Issue	RP	DS

Calculations contained within this report have been produced based on information supplied by the Client and the design team. Any alterations to the technical specification on which this report is based will invalidate its findings.

Energist London
4-12 Regent Street
London
SW1Y 4RG
Tel: 020 7129 8123

london@energistuk.co.uk
www.energistuk.co.uk

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1. EXECUTIVE SUMMARY

This Energy Strategy has been produced by Energist UK on behalf of Howarth Homes PLC ('the Applicant').

It will set out the design measures that have been implemented by the Applicant to achieve the required CO_2 reductions at the development site: Land Adjacent to 38-42 Hampton Road, Teddington ('the Development').

The Strategy is written in support of the full planning application being submitted to London Borough of Richmond Upon Thames.

The Strategy will demonstrate measures taken by the Applicant to comply with:

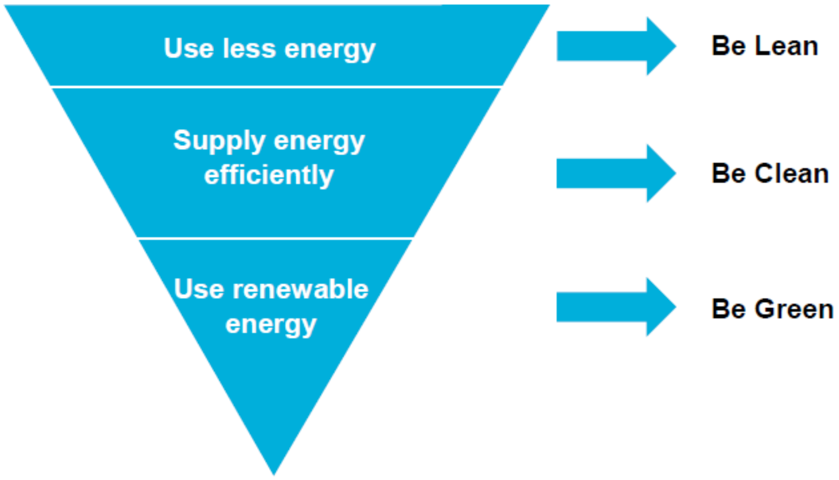
i) National Planning Policy Framework.

ii) The London Plan (Greater London Authority, 2016) planning policies 5.2 to 5.7 and 5.15 on climate change mitigation measures to:

- Achieve a minimum 35% on-site reduction in CO_2 emissions over Approved Document Part L (AD L) 2013 for all major, domestic and non-domestic development.
- Achieve the zero carbon homes standard in full on all major developments and, where this can not be achieved on site, a commitment to offset the shortfall in CO_2 emissions through a carbon offset payment.
- Evaluate the viability of decentralised energy in accordance with the following hierarchy: 1) connection to existing heating or cooling networks, 2) site-wide CHP network and 3) communal heating and cooling.
- Maximise opportunities for 20% on site low-carbon and renewable energy technologies where feasible.
- Design domestic development so that mains-water consumption meets a target of 105 litres or less per person per day (excluding an allowance of 5 litres or less per person per day for external water consumption).

iii) Energy Planning, Greater London Authority guidance on preparing energy assessments (March 2016).

Figure 1. The Energy Heirarchy.



The Strategy concludes that the following combination of measures, summarised here in Table 1, are included in the design of the Development:

Table 1. Measures incorporated to deliver the energy standard.

Be Lean	▪ Energy-efficient building fabric and insulation to all heat loss floors, walls and roofs. ▪ High-efficiency double-glazed windows throughout. ▪ Quality of build will be confirmed by achieving good air-tightness results throughout. ▪ Efficient-building services including high-efficiency heating systems. ▪ Low-energy lighting throughout the building.
Be Clean	▪ No measures have been proposed.
Be Green	▪ 10kWp of PV, approximately 70-80m^2, installed to a southerly orientation, at a 30 degree pitch, with little or no overshading.

The impact of these design measures and low-carbon and renewable energy solutions, in terms of how the Applicant delivers their commitment to the energy hierarchy, is illustrated in Figure 2.

Figure 2. How the Development delivers the energy hierarchy.

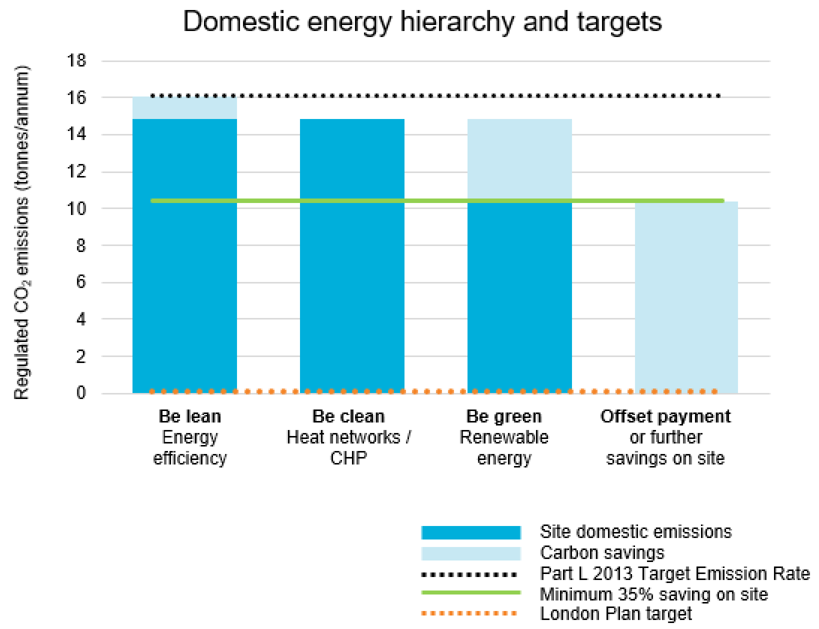


Table 2. CO_2 emissions after each stage of the energy hierarchy.

Carbon dioxide emissions for domestic buildings ($t.CO_2$ per annum)		
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	16.05	
After energy demand reduction	14.89	
After heat network / CHP	14.89	
After renewable energy	10.41	

Table 3. CO_2 savings after each stage of the energy hierarchy.

Regulated domestic carbon dioxide savings		
	t.CO_2 per annum	%
Savings from energy demand reduction	1.16	7.21
Savings from heat network / CHP	0.00	0.00
Savings from renewable energy	4.48	27.93
Cumulative on site savings	5.64	35.14
Annual savings from off-set payment	10.41	
	t.CO_2 over 30 years	
Cumulative savings for off-set payment	312.26	

Table 4. Carbon emissions and subsequent carbon offset payment calculation.

	CO_2 savings	
	t.CO_2 per annum	t.CO2 over 30 years
Carbon emissions to offset (Residential)	10.41	312.26
Carbon emissions to offset (Non-residential)	0.00	0.00
Savings from Allowable Solutions	0.00	0.00
Remaining carbon emissions to offset	10.41	312.26
	£ per annum	or £ lump sum
Carbon offset payment	988.82	29664.64

The Carbon Offset Payment has been calculated with reference to the *Greater London Authority's guidance on preparing energy assessments (March 2016)* and price of £95 per tonne of CO_2 emissions as required by the London Borough of Richmond upon Thames.

2. INTRODUCTION

2.1 Site Description

This Energy Strategy has been prepared for the residential development at Land adjacent to 38-42 Hampton Road, Teddington. This falls under the jurisdiction of London Borough of Richmond upon Thames.

The Development consists of fourteen residential units constructed within a new residential apartment block. The block is built over three floors and consists of two 1-bed wheelchair units, nine 1-bed two person units, and three 2-bed units.

The site lies between Hampton Road and Anlaby Road. It is approximately 0.16ha in size and comprises of open green space.

Map 1. Site location for Land Adjacent 38-42 Hampton Road, Teddington.

Source: Progress Planning, Proposed Block Plan, drawing number L1000, Rev P3, dated 10th January 2020.

2.2 Purpose of the Energy Strategy

The Strategy will demonstrate measures taken by the Applicant to comply with:

i) National Planning Policy Framework.

iv) The London Plan (Greater London Authority, 2016) planning policies 5.2 to 5.7 and 5.15 on climate change mitigation measures to:

- Achieve a minimum 35% on-site reduction in CO_2 emissions over Approved Document Part L (AD L) 2013 for all major, domestic and non-domestic development.
- Achieve the zero carbon homes standard in full on all major developments and, where this can not be achieved on site, a commitment to offset the shortfall in CO_2 emissions through a carbon offset payment.
- Evaluate the viability of decentralised energy in accordance with the following hierarchy: 1) connection to existing heating or cooling networks, 2) site-wide CHP network and 3) communal heating and cooling.
- Maximise opportunities for 20% on site low-carbon and renewable energy technologies where feasible.
- Design domestic development so that mains-water consumption meets a target of 105 litres or less per person per day (excluding an allowance of 5 litres or less per person per day for external water consumption).
- Energy Planning, Greater London Authority guidance on preparing energy assessments (March 2016).

The way in which the Applicant meets the energy standard and CO_2 reduction target at Land adjacent to 38-42 Hampton Road, Teddington will be explained in this Strategy as follows:

- **The Baseline:** The Development's baseline energy demand, the Target Emission Rate (TER): This will be calculated to establish the minimum on-site standard for compliance with AD L 2013. The baseline is calculated using a mains gas heating system.
- **Be Lean:** The Development's Dwelling Emission Rate (DER) will be calculated to explain how the Applicant's design specification has led to a reduced energy demand and an improved fabric-energy efficiency. The better the design of the building fabric in terms of, for example, insulation, air tightness and orientation to maximise solar gain, the less energy required to heat the dwelling and so the better the fabric energy efficiency.
- **Be Clean:** The potential to provide energy to the development in an efficient way, by either connecting to a District Heat Network (DHN) or installing on-site Combined Heat and Power (CHP), will be assessed and viability concluded.

- **Be Green:** Low-carbon and renewable energy technologies will be assessed for their suitability and viability in relation to the Development. Solutions will be put forward for the development and the resulting CO_2 emission savings presented.
- **Carbon Offset:** Where it is demonstrated that the energy target for the Development cannot be met onsite then any shortfall in CO_2 emissions reduction will be offset through a mechanism agreed in consultation with the Local Planning Authority.

2.3 Methods

Energist UK has used SAP 2012 methodology to calculate energy demand for three sample dwellings which adequately represent the different property types within the development. The data has been extrapolated to reflect more accurately the expected CO_2 emission rates and energy demand for all proposed dwellings included in the development application for this site.

3. BASELINE ENERGY DEMAND

3.1 Introduction

In order to measure the effectiveness of demand-reduction measures, it is first necessary to calculate the baseline energy demand and this has been done using SAP 2012 methodology. This can also be referred to as the Target Emission Rate (TER.) The baseline is calculated using a mains gas heating system.

The resulting AD L 2013 TER for Land adjacent 38-42 Hampton Road, Teddington, has been calculated using Part L model designs which have been applied to the Applicant's Development details. The TER, or baseline energy demand, represents the maximum CO_2 emissions that are permitted for the Development in order to comply with AD L 2013.

3.2 The Development Baseline

The resulting TER, representing the total maximum CO_2 emissions permitted for the Development has been calculated as 16,048 kg/CO_2 per annum. To ensure compliance with AD L 2013, CO_2 emissions should not exceed this figure.

4. BE LEAN – REDUCED ENERGY DEMAND

4.1 Introduction

The residential development at Land adjacent 38-42 Hampton Road, Teddington achieves a high quality, sustainable design by integrating the following design measures to reduce energy demand:

- Energy-efficient building fabric and insulation to all heat loss floors, walls and roofs.
- High-efficiency double-glazed windows throughout.
- Quality of build will be confirmed by achieving good air-tightness results throughout.
- Efficient-building services including high-efficiency heating systems.
- Low-energy lighting throughout the building.

4.2 The Development - Reduced Energy Demand

The Applicant's design specification and intended demand-reduction measures for the Development have been modelled using the same SAP 2012 methodology as before. This allows us to assess the effectiveness of Be Lean measures as a percentage reduction in CO_2 emissions over the Baseline.

The total calculated CO_2 emissions for Land adjacent 38-42 Hampton Road, Teddington is 14,890 Kg/CO_2 per annum, which is a reduction of 7.21% or 1,157Kg/CO_2 per annum over the Baseline. Refer to Appendix 3 for SAP Results and Table 3 for the Be Lean design specification.

Table 5. Be Lean design specification for Land adjacent 38-42 Hampton Road, Teddington.

Element	Be Lean Design Specification
Ground Floor U-Value (W/m².K)	0.13
External Wall U-Value (W/m².K)	0.18
Party Wall U-Value (W/m².K)	0 (fully filled and sealed)
Roof – insulated at ceiling U-Value (W/m².K)	0.13
Roof – insulated at slope U-Value (W/m².K)	0.13
Roof – Flat U-Value (W/m².K)	0.13
Glazing U-Value – including Frame (W/m².K)	1.2
Glazing g-Value	0.63
Door U-Value (W/m².K)	1
Design Air Permeability	5
Space Heating	Ideal logic combi ESP1 35
Heating Controls	Time and temperature zone controls
Domestic Hot Water	From main heating system
Ventilation	Natural ventilation
Low Energy Lighting	100% Low energy.
Thermal Bridging	ACDs (or equivalent)

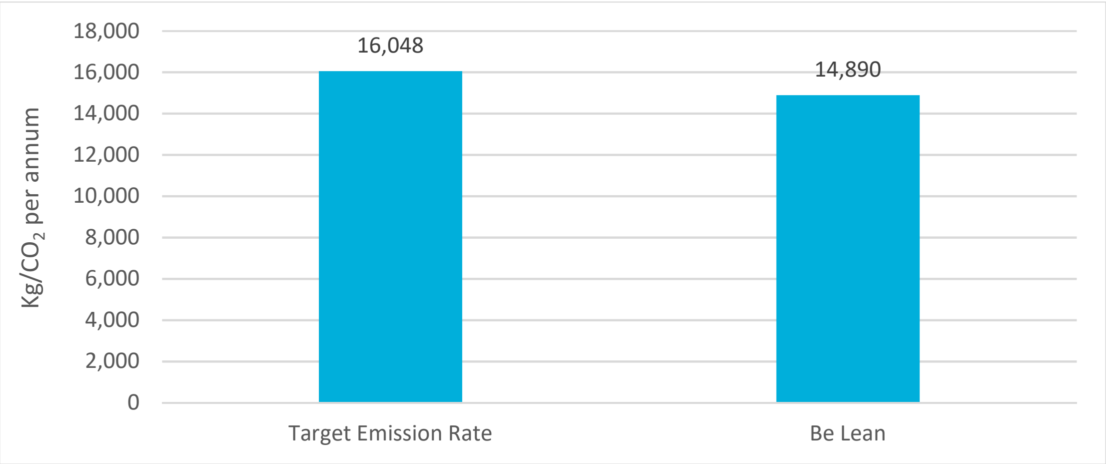
4.3 Conclusion

By incorporating sustainable design and energy-reduction design measures at Land adjacent to 38-42 Hampton Road, Teddington, the Applicant will reduce CO_2 emissions by 7.21% over the TER AD L 2013. This is illustrated in Table 4 and in Figure 3 below.

Table 6. CO_2 emissions and Be Lean demand-reduction measures.

	CO_2 emissions	
	Kg/CO_2 per annum	% reduction
Target Emission Rate: Compliant with AD L 2013	16,048	-
Be Lean: After demand-reduction measures	14,890	7.21%

Figure 3. TER and Be Lean CO_2-emissions summary.



5. BE CLEAN – SUPPLY ENERGY EFFICIENTLY

Steps have been taken by the Applicant to reduce the energy demand of the Development as far as is feasible.

The next step in the energy hierarchy is to consider how the remaining energy demand can be met and whether there is the potential for this to be done through the mechanism of establishing and/or linking up with existing or planned decentralised energy systems.

To ensure compliance with the Greater London Authority's energy hierarchy, the potential to supply energy efficiently to the Development at 38-42 Hampton Road, Teddington, and further reduce regulated CO_2 emissions through Be Clean measures, is evaluated.

5.1 Policy Drivers

The London Plan (2016) sets out The Mayor's expectations:

…For 25% of the heat and power used in London to be generated through the use of localised decentralised energy systems by 2025…

***…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:*

- *Connection to existing heating or cooling networks*
- *Site wide CHP network*
- *Communal heating and cooling*

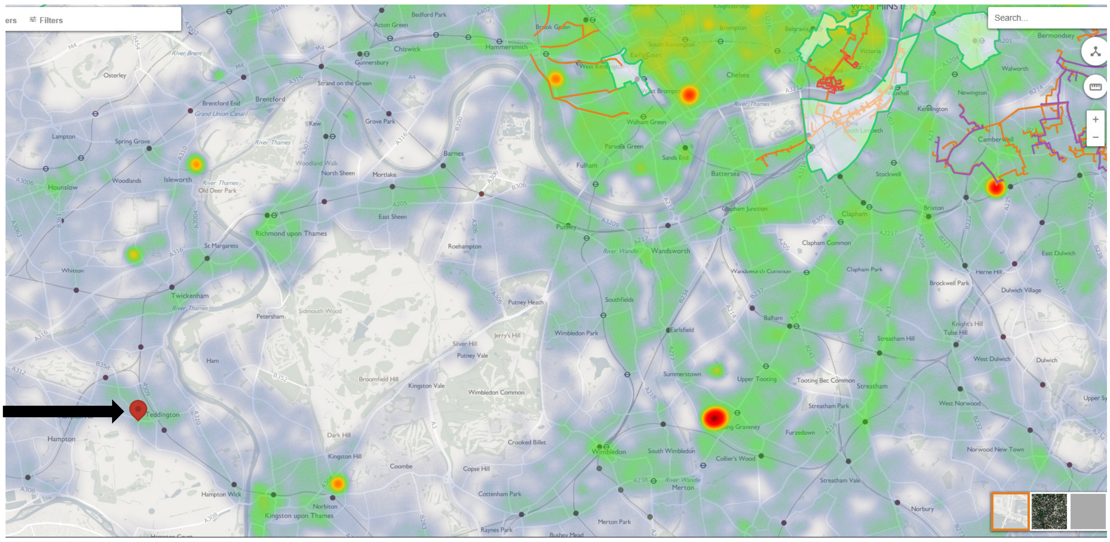
***C** Potential opportunities to meet the first priority in this hierarchy are outlined in the London Heat Map tool. Where future network opportunities are identified, proposals should be designed to connect to these networks.*

5.2 District Heat Network Viability

District Heat Networks (DHN), also referred to as either district energy systems or district heating schemes, produce steam, hot water or chilled water at a central energy centre. The steam or water is distributed in pre-insulated pipework, to individual buildings for space heating, domestic hot water and air conditioning. As a result, individual buildings served by a DHN do not require their own boilers or chillers (source: UK District Energy Association.)

The London Heat Map has been consulted to establish whether the Development lies within proximity of an existing DHN.

Map 2. Land Adjacent to 38-42 Hampton Road, Teddington within the context of the London Heat Map.



Key:

Heat Mapping Decentralised Energy Potential
Potential DHN
Existing DHN
Development Location

5.2.1 Application viability

Investigations in the surrounding area were undertaken in order to ascertain whether a heat network existed within the viscinity of the site, that could be connected into. The London heat map was consulted, and no networks found within an appropriate distance. The closest proposed network (not yet confirmed) was identified as the Hammersmith and Fulham network, over 8 miles away.

On review of the surrounding area, supported by the London Heat Map, the site is noted to be within an area of relatively low energy density, with the majority of nearby development consisting of low-rise housing and commercial space. Therefore, it is determined that there is an extremely low possibility of an area-wide network being deployed in this area in the future, as it would not be economically or sustainably viable to do so. It is therefore not considered sustainable to provide systems and infrastructure to facilitate connection to a future network.

Due to these considerations, connecting to a current, or future district heat network is not considered viable for this scheme.

5.3 Combined Heat and Power

Combined Heat and Power (CHP) is a relatively simple technology comprising of an engine (usually gas fired, but can be oil or biomass fired) which fires a generator producing on-site electricity. This process also generates heat as a by-product which can then be used to provide space heating and hot water. CHP systems can be small scale, used in single buildings, or large scale and used in a community or district heating network. As electricity is produced on site, distribution losses in comparison to the national grid are minimal and the heat by-product is captured instead of being wasted. As a result CHP provides an efficient, low carbon electricity and heat generation solution.

The following extracts from the GLA guidance on preparing energy assessments (March 2016) detail situations where CHP is unlikely to be a viable solution:

Small-medium residential development (eg. containing fewer than 500 apartments).

At this scale it is generally not economic to install CHP in residential led, mixed use developments (and where CHP is installed it tends to have lower electricial efficiencies). Due to the small landlord electrical demand, CHP installed to meet the base hear load would require the export of electricity to the grid. However, the administrative burden of managing CHP electricity sales at this small scale where energy service companies (ESCOs) are generally not active, and the low unit price available for small volumes of exported CHP electricity, means it is generally uneconomic for developers to pursue. This can lead to CHP being installed but not operated.

Non-domestic developments with a simultaneous demand for heat and power for less than 5,000 homes per annum.

Examples of such developments may include offices and schools.

5.3.1 Installation considerations

- The sizing of a CHP system is critical to its efficiency and operation. An oversized system will require a large buffer tank to absorb excess heat and will often have to turn off. This is not good for long term operation.
- Systems should therefore be undersized and meet base heating demand (usually hot water demand) to ensure continuous operation.
- Large scale CHP systems will require sufficient plant room to accommodate the engine and buffer vessel.
- Large systems suitable for developments of 500 or more units, although can be viable on smaller schemes.
- Systems perform well where there is a consistent demand for heat.
- Export of electricity can sometimes require an upgrade to a local substation.
- Flue design important.
- Design needs to be bespoke to the needs of the development.

5.3.2 Approximate upfront costs (TBC by supplier)

- Costs vary dependant on the size of the system. Small 24 kWt/1 kWe systems may start at £10,000 with larger systems costing substantially more.

5.3.3 Advantages

- There are significant CO_2 reductions for large-scale development (multiple apartment blocks) where there is a consistent requirement for heat.

5.3.4 Disadvantages

- Not financially viable on smaller developments.
- Plant room space required.
- Will not perform well where there is inconsistent demand for heat.
- Up-front and ongoing costs are higher than commercial gas boilers.

5.3.5 Application Viability

CHP is not considered suitable for the development. It is not expected that the simultaneous demand for heat and power will not exceed 5,000 hours per annum and so, in accordance with the London Plan and Mayor of London guidance, is considered too small, and the anticipated heat demand considered too low for CHP to be an economically viable option.

5.4 Conclusion

As the provision of onsite CHP is not considered viable for the Development, and as district heating networks are not currently available in this area, the Applicant should consider alternative options for providing heating in the building.

This will be covered in the following Be Green section.

There is no reduction to be shown via the Be Clean method.

6. BE GREEN – LOW-CARBON AND RENEWABLE ENERGY

6.1 Introduction

The Applicant adopts a fabric-first approach as the priority solution for this Development and steps have been taken to reduce energy demand through high-quality sustainable design. The planned integration of efficient building fabric and building services has been modelled and is predicted to lead to an enhancement over Part L of the Building Regulations 2013.

The next step in the energy hierarchy is referred to as Be Green. To ensure compliance with the Greater London Authority's energy hierarchy, opportunities to supply energy through low-carbon and renewable energy technologies will be assessed for their feasibility and solutions presented for the development at Land adjacent 38-42 Hampton Road, Teddington.

The selected solution will be put forward together with the resulting CO_2 emission savings.

Viability of the following low-carbon and renewable energy technologies have been considered:

- Wind
- Solar
- Aerothermal
- Geothermal
- Biomass

6.2 Policy Drivers

The London Plan (2016) sets out The Mayor's expectations in Policy 5.7 Renewable Energy:

B *Within the framework of the energy hierarchy, major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible…*

… *There is a presumption that all major development proposals will seek to reduce carbon dioxide emissions by at least 20 per cent through the use of on-site renewable energy generation wherever feasible. Development proposals should seek to utilise renewable energy technologies such as: biomass heating; cooling and electricity; renewable energy from waste; photovoltaics; solar water heating; wind and heat pumps…*

6.3 Wind	*The ability to generate electricity via a turbine or similar device which harnesses natural wind energy. This could be considered as an onsite solution to reducing carbon emissions (turbines included within the development), or offsite (investing financially into a nearby wind farm).*
Installation considerations	▪ Wind turbines come in a variety of sizes and shapes. Turbines of 1 Kw can be installed to single house and large-scale turbines of 1-2 MW can be installed on a development to generate electricity to multiple dwellings and other buildings. In both instances the electricity generated can be used on site or exported to the grid. Vertical- or horizontal-axis turbines are available. ▪ A roof-mounted 1 kW micro wind system costs up to £3,000. A 2.5 kW pole-mounted system costs between £9,900 and £19,000. A 6 kW pole-mounted system costs between £21,000 and £30,000 (taken from the Energy Saving Trust, TBC by supplier) ▪ Local average wind speed is a determining factor. A minimum average wind speed of 6 m/s is required. ▪ Noise considerations can be an issue dependent on density and build-up of the surrounding area. ▪ Buildings in the immediate area can disrupt wind speed and reduce performance of the system. ▪ Planning permission will be required along with suitable space to site the turbine, whether ground installed or roof mounted.
Advantages	▪ Generation of clean electricity which can be exported to the grid or used onsite. ▪ Can benefit from the Feed in Tariff, reducing payback costs.
Disadvantages	▪ Planning restrictions and local climate often limit installation opportunities. ▪ Annual maintenance required. ▪ High initial capital cost. It is usual for an investor to consider a series of turbines to make the investment financially sound.

Development feasibility

✗

- Installing a large turbine in an area such as this is not considered to be appropriate due to its appearance and physical impact on the built-up environment. Residents' and neighbours' concerns may include the look of the turbine, the hum of the generator and the possibility of stroboscopic shadowing from the blades on homes.
- Wind speed has been checked for the development scheme using the NOABL wind map: http://www.rensmart.com/Weather/BERR. The wind speed at ten metres for the development scheme is 4.6 metres per second (m/s) which is below the minimum of 5 m/s and threshold for technical viability.
- Typical payback times for a single turbine are expected to be greater than 15 years which means that the cost of installing and maintaining a single wind turbine is not considered a commercially-viable option.

6.4 Solar PV and Solar Thermal

The ability to generate energy (either electricity, hot water or a combination of the two) through harnessing natural solar energy. This could include the use of solar thermal panels, photovoltaic (PV) panels, or a combined solution. PV panels, similarly to turbines, can be considered both on and offsite.

Solar Photovoltaics convert solar radiation into electricity which can be used on site or exported to the national grid.

Solar Thermal generates domestic hot water from the sun's radiation. Glycol circulates within either flat plate or evacuated tube panels, absorbing heat from the sun, and transferring this energy to a water cylinder. A well designed solar thermal system will account for 50-60% of a dwelling's annual hot water demand. Sizing the system to meet a higher demand will lead to excess heat generation in the summer months, and overheating of the system.

Installation considerations	▪ Operate most efficiently on a south-facing sloping roof (between 30 and 45-degree pitch.) ▪ Shading must be minimal (one shaded panel can impact the output of the rest of the array.) ▪ Panels must not be laid horizontally on a flat roof as they will not self-clean. Panels will therefore need to be installed at an angle and with appropriate space between them, to avoid over-shading. ▪ Large arrays may require upgrades to substations if exporting electricity to the grid. ▪ Local planning requirements may restrict installation of panels on certain elevations. ▪ Installation must take into account pitch and fall of the roof, along with any additional plant on the roof to ensure there is sufficient room. ▪ The average domestic solar PV system is 4kWp and costs £5,000 - £8,000 (including VAT at 5 per cent) - (taken from the Energy Saving Trust, TBC by supplier.)
Advantages	▪ Relatively straightforward installation, connection to landlord's supply and metering. ▪ Linear improvement in performance as more panels are installed. ▪ Maintenance free. ▪ Installation costs are continually reducing. ▪ Can benefit from the Feed in Tariff to improve financial payback.
Disadvantages	▪ Not appropriate for high-rise developments, due to lack of roof space in relation to total floor area. ▪ With Solar Thermal, performance is limited by the hot water demand of the building – system oversizing will lead to overheating.
Development feasibility	▪ The suitability of Solar panels has been considered for this Development and are concluded as a technically-viable option. ▪ There are areas of roof space suitable for the positioning of unshaded Solar PV arrays.

✓	▪ The Development is not on land which is protected or listed, so it is considered that Solar panels would not have a negative impact on the local historical environment or the aesthetics of the area.
6.5 Aerothermal	*The transfer of latent heat in the atmosphere to a compressed refrigerant gas to warm the water in a heating system. This includes air to water heat pumps and air conditioning systems.* Air Source Heat Pumps (ASHPs) extract heat from the external air and condense this energy to heat a smaller space within a dwelling or non-domestic building. A pump circulates a refrigerant through a coil to absorb energy from the air. This refrigerant is then compressed to raise its temperature which can then be used for space heating and domestic hot water. They can feed either low-temperature radiators or underfloor heating and often have electric immersion heater back-up for the winter months.
Installation Considerations	▪ ASHPs operate effectively in buildings with a low energy demand, as they emit low levels of energy suitable for maintaining rather than dramatically increasing internal temperatures. It is therefore vital that the dwelling has a low heating demand to ensure the system can provide appropriate space-heating capability. ▪ Underfloor heating will give the best performance but oversized radiators can also be used. ▪ Immersion heater back-up required to ensure appropriate Domestic Hot Water (DHW) temperature in winter months. ▪ Noise from the external unit can limit areas for installation. ▪ £7,000-£11,000 per dwelling (taken from the Energy Saving Trust, TBC by supplier.)

Advantages	▪ Air source systems are a good alternative solution to providing heating and hot water to well-insulated, low heat loss dwellings. ▪ They require additional space when compared to a gas boiler. Space for an external unit is needed, as is space for the hot water cylinder and internal pump. ▪ Heat pumps are generally quiet to run, however if a collection of pumps were used, this could generate a noticeable hum while in operation. ▪ Running costs between heat pumps and modern gas boilers are comparable.
Disadvantages	▪ Residents need to be made aware of the most efficient way of using a heat pump; as the low flow rates used by such a system means that room temperature cannot be changed as reactively as a conventional gas or oil boiler system. ▪ Will not perform well in homes that are left unoccupied and unheated for a long period of time. ▪ Back-up immersion heating can drastically increase running costs. ▪ Noise and aesthetic considerations limit installation opportunities.
Development feasibility ✗	▪ ASHPs are not considered a technically-viable option for this development scheme. There are space constraints in terms of area available for installation on this scheme due to the nature and layout of the development.

6.6 Geothermal

The transfer of latent heat from the ground to a compressed refrigerant gas to warm the water in a heating system. This includes ground source heat pumps. Heat can be collected through the use of either horizontally laid or vertically installed coils.

	Ground Source Heat Pumps (GSHPs) operate on the same principle as an Air Source Heat Pump (ASHP) in that they extract heat from a source (in this instance the ground) and compress this energy to increase temperature for space heating and hot water. Pipework is installed into the ground, either through coils or in bore holes and piles, circulating a mix of water and antifreeze to extract energy from the ground, where the year-round temperature is relatively consistent (approx. 10℃ at 4 metres depth). This leads to a reliable source of heat for the building. Again, an electrically powered pump circulates the liquid and powers the compressor, however annual efficiencies for GSHPs tend to be higher than those of ASHPs.
Installation considerations	▪ Require appropriate ground conditions to sink piles/bore holes or excavate for coils (which also require a large area of land.) ▪ Decision between coils or piles can lead to significant extra cost. ▪ Need to consider whether low temperature output is fed through underfloor heating (most efficient) or oversized radiators. ▪ Similar to ASHPs, perform best in well-insulated buildings with a low heating demand. ▪ Electric immersion heater required for winter use. ▪ £11,000-£15,000 per dwelling dependent on the size of the system (taken from the Energy Saving Trust, TBC by supplier.)
Advantages	▪ Perform well in well-insulated buildings, with limited heating demand. ▪ More efficient than ASHPs.

Disadvantages	▪ The coils can be damaged by natural earthworks and by intensive gardening practices – occupants would need to be aware of the location of the coils for this system, and how to operate the system efficiently. Coils may also be damaged within the dwelling where the circuit is connected to the internal unit. ▪ Will not perform well in buildings that are left unoccupied and unheated for a long period of time. ▪ Back up immersion heating can drastically increase running costs. ▪ Large area of ground needed for coil installation.
Development feasibility ✗	▪ GSHPs are not considered a technically-viable option for this development scheme as there are physical constraints in terms of ground conditions and area available for installation. ▪ The capital installation cost would also be high which leads us to the conclusion that GSHPs would not be a commercially-viable option for this development scheme.

6.7 Biomass	*Providing a heating system fuelled by plant based materials such as wood, crops or food waste.* Biomass boilers generate heat for space heating and domestic hot water through the combustion of biofuels, such as woodchip, wood pellets or potentially biofuel or bio diesel. Biomass is considered to be virtually zero carbon. They can be used on an individual scale or for multiple dwellings as part of a district-heating network. A back-up heat source should be provided as consistent delivery of fuel is necessary for continued operation.
Installation considerations	▪ Biomass boilers are larger than conventional gas-fired boilers and also require what can be significant storage space for the fuel source. This needs to be considered at planning stage to ensure an appropriate plant room can be provided.

	▪ Flue required to expel exhaust gases – design needs to be in line with the requirements of the Building Regulations. ▪ Need to consider whether fuel deliveries will be reliable and consistent to the location of the site (especially relevant in rural areas) and whether the plant room can be easily accessed by the delivery vehicle. ▪ £9,000-£21,000 per dwelling dependent on size (taken from Energy Saving Trust, TBC by Supplier).
Advantages	▪ Considerable reduction in CO_2 emissions.
Disadvantages	▪ Limited reduction in running costs compared to A-rated gas boilers, but at a substantially higher up-front cost. ▪ Plant room space required for boiler and storage. ▪ Dependent on consistent delivery of fuel. ▪ Ongoing maintenance costs (need to be cleaned regularly to remove ash.)
Development Feasibility ✗	▪ Biomass is not considered a technically-viable option for the development scheme. The primary reason for this is down to the Development's location within the context of Inner City London and the negative environmental impact of high levels of NOx gases that are emitted from biomass boilers and the subsequent impact on local air quality. This is contrary to planning policies for air quality in London. ▪ There are also concerns regarding a sustainable supply of biomass to the site. ▪ The capital installation cost would be high, approximately three times that of a gas combi boiler, which leads us to the conclusion that biomass would not be a commercially-viable option for this development scheme.

6.8 Conclusion

The following low-carbon and renewable energy technologies, summarised here in Table 6, are considered potentially-viable options for the residential development scheme at Land adjacent 38-42 Hampton Road, Teddington.

Table 7: Summary of Feasibility for Land adjacent 38-42 Hampton Road, Teddington.

✓	▪ Solar thermal ▪ Solar PV
✗	▪ Wind ▪ Aerothermal ▪ Geothermal ▪ Biomass

The Applicant has opted to install a 10kWp PV array in order to meet the energy standard of 35% reduction in emissions on site. This is the equivalent of approximately 70-80m^2 of panels, installed at a southerly orientation, at a 30 degree pitch, with little or no overshading.

7. MAINS-WATER CONSUMPTION

7.1 Introduction

The water consumption of a dwelling has a significant impact on not only direct operational running costs (i.e. water consumption charges), but also indirectly through additional energy usage and the heating of water for domestic use. This is, in part, reflected in SAP 2012 methodology which assumes reduced energy consumption should a dwelling be compliant with Approved Document Part G 2013.

The standard of 110 litres of water per person per day can be met using the following specification as set out in Table 7 below. A water-efficiency calculation, demonstrating how the Applicant can achieve compliance, can be referred to in Appendix 4.

Table 8. Water calculations for new dwellings at Land adjacent 38-42 Hampton Road, Teddington.

Element	Performance
Kitchen Taps flow rate	5 Litres per minute
Other basin Taps flow rate	4 Litres per minute
WCs Flush Volume	6/3 Litres
Shower Flow rate	10 Litres per minute
Bath Volume	150 Litres
Dishwasher water consumption	1.25 litres per place setting
Washing-machine water consumption	8.17 litres per Kg

8. CONCLUSIONS AND RECOMMENDATIONS

The Applicant demonstrates their commitment to the energy and water-efficiency standards at Land adjacent 38-42 Hampton Road, Teddington as follows:

- The Development has been designed to achieve a total reduction in CO_2 emissions of 35.14% over the TER AD L 2013 through Be Lean and Be Green measures and successfully delivers the target of a 35% reduction in CO_2 over Approved Document Part L (AD L) 2013.
- The Applicant maximises every opportunity to reach the 20% renewables target and achieves a 27.93% reduction in CO_2 emissions through renewable and low-carbon energy technology installed onsite.
- The domestic elements of the Development will be designed to ensure that mains-water consumption will successfully deliver a target of 110 litres or less per person per day (including an allowance of 5 litres or less per person per day for external water consumption).
- The Development achieves the zero carbon homes standard by calculating a carbon offset payment for the remaining CO_2 emissions.

Table 9. Measures incorporated to deliver the energy standard.

Be Lean	▪ Energy-efficient building fabric and insulation to all heat loss floors, walls and roofs. ▪ High-efficiency double-glazed windows throughout. ▪ Quality of build will be confirmed by achieving good air-tightness results throughout. ▪ Efficient-building services including high-efficiency heating systems. ▪ Low-energy lighting throughout the building.
Be Clean	▪ No measures have been proposed.
Be Green	▪ 10kWp of PV, approximately 70-80m^2, installed to a southerly orientation, at a 30 degree pitch, with little or no overshading.

The way in which these design measures deliver the Applicant's commitment to the energy hierarchy is illustrated in Figure 5 and Table 9 overleaf.

Figure 5: How the Development delivers the energy hierarchy.

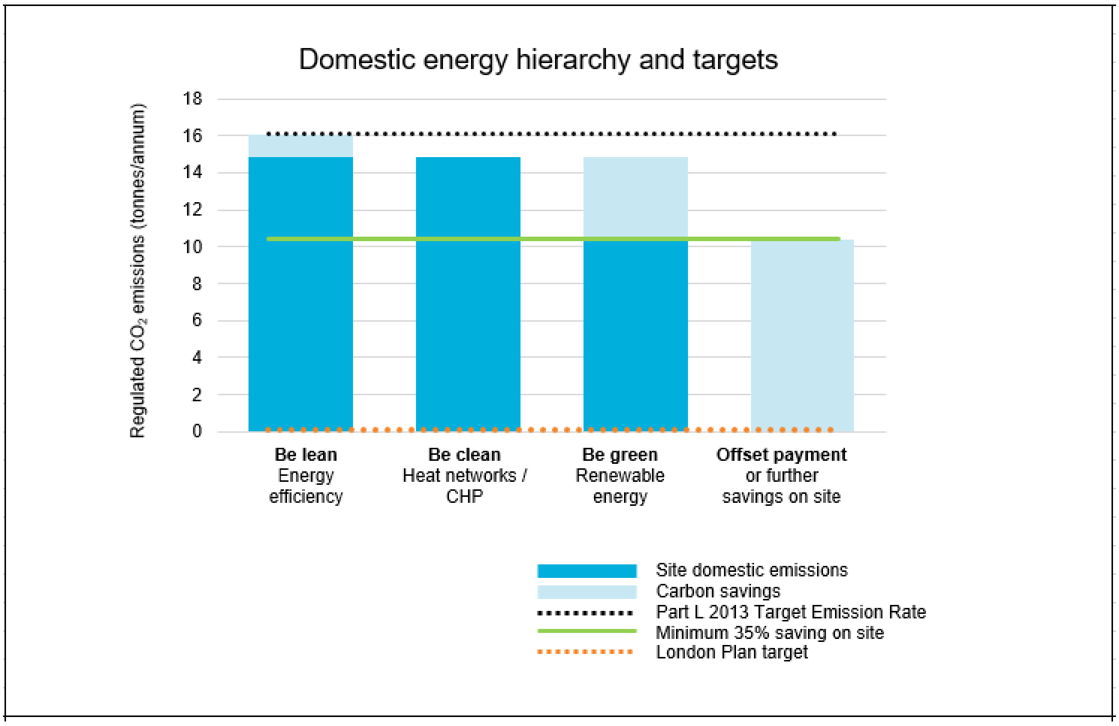


Table 10. CO_2 emissions after each stage of the energy hierarchy.

Carbon dioxide emissions for domestic buildings ($t.CO_2$ per annum)		
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	16.05	
After energy demand reduction	14.89	
After heat network / CHP	14.89	
After renewable energy	10.41	

Table 11. CO_2 savings after each stage of the energy hierarchy.

Regulated domestic carbon dioxide savings		
	t.CO_2 per annum	%
Savings from energy demand reduction	1.16	7.21
Savings from heat network / CHP	0.00	0.00
Savings from renewable energy	4.48	27.93
Cumulative on site savings	5.64	35.14
Annual savings from off-set payment	10.41	
	t.CO_2 over 30 years	
Cumulative savings for off-set payment	312.26	

Table 12. Carbon emissions and subsequent carbon offset payment calculation.

	CO_2 savings	
	t.CO_2 per annum	t.CO2 over 30 years
Carbon emissions to offset (Residential)	10.41	312.26
Carbon emissions to offset (Non-residential)	0.00	0.00
Savings from Allowable Solutions	0.00	0.00
Remaining carbon emissions to offset	10.41	312.26
	£ per annum	or £ lump sum
Carbon offset payment	988.82	29664.64

The Carbon Offset Payment has been calculated with reference to the *Greater London Authority's guidance on preparing energy assessments (March 2016)* and price of £95 per tonne of CO_2 emissions as required by the London Borough of Richmond upon Thames.

9. APPENDICES

APPENDIX 1: LIST OF ABBREVIATIONS

AD L 2013	Approved Document Part L of Buildings Regulations 2013
ASHP	Air Source Heat Pump
CHP	Combined Heat & Power
DER	Dwelling Emission Rate
DHN	District Heat Network
DHW	Domestic Hot Water
ESCO	Energy Services Company
GSHP	Ground Source Heat Pump
LPA	Local Planning Authority
PV	Photovoltaics
SAP	Standard Assessment Procedure
TER	Target Emission Rate

APPENDIX 2. PLANNING POLICY AND DESIGN GUIDANCE

The Climate Change Act (2008)

Passed in November 2008, the Climate Change Act mandated that the UK would reduce emissions of six key greenhouse gases, including Carbon Dioxide, by 80% by 2050.

As a consequence, the reduction of carbon dioxide emissions is at the forefront of National, Regional and Local Planning Policy, along with continuing step changes in performance introduced by the Building Regulations Approved Document L (2013).

Approved Document L (2013)

This development is subject to the requirements of Approved Document L (2013). AD L 2013 represented an approximate reduction of 6% in the Target Emission Rate (Kg/CO_2/sqm per annum) over the requirements of Approved Document L (2010) for residential development and an aggregate 9% reduction for non-residential development. AD L (2013) also sees the introduction of a Fabric Energy Efficiency Target, a measure of heating demand (kW hrs/sqm per annum) to ensure new-build dwellings with low-carbon heating systems still meet satisfactory energy-efficiency standards.

National Policy

The National Planning Policy Framework encourages Local Planning Authorities to “Have a positive strategy to promote energy from renewable and low-carbon sources” (NPPF paragraph 97), whilst “Ensuring that the adverse impacts are addressed satisfactorily, including cumulative landscape and visual impacts”. This suggests that although LPAs should encourage renewable technology, the merits of such should be assessed on a site-by-site basis.

The NPPF also requires that policy-making and planning obligations do not threaten the viability of a development, by maintaining competitive returns for developers and landowners alike. In this respect flexibility is encouraged by LPAs to ensure sustainability standards can be met without incurring unreasonable development costs.

The London Plan 2016

The following policies are applicable to this development from the London Plan:

Policy 5.1 Climate Change Mitigation

The Major seeks to achieve an overall reduction in London's carbon dioxide emissions of

60% (below 1990 levels) by 2025. It is expected that the GLA Group, London boroughs and other organisations will contribute to meeting the strategic reduction target, and the GLA will monitor progress towards its achievement annually.

Policy 5.2 Minimising Carbon Dioxide Emissions

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 Emissions Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.*

NB the date the planning application is submitted determines the applicable target

Residential buildings:

Year	Improvement on Building Regulations
2010 - 30th September 2013	25% over AD L 2010
1st October 2013 – 5th April 2014	40% over AD L 2010
6th April 2013 - 2016	35% over AD L 2013
2016 - 2036	Zero Carbon

Non-Domestic buildings:

Year	Improvement on Building Regulations
2010 - 30th September 2013	25% over AD L 2010
1st October 2013 – 5th April 2014	40% over AD L 2010
6th April 2013 - 2016	35% over AD L 2013
2016 - 2019	50% over AD L 2013
2016 - 2036	Zero Carbon

C *Major Development's 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

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.

Policy 5.4 Retrofitting

The environmental impact of existing urban areas should be reduced through policies and programmes that bring existing buildings up to the Mayor's standards on sustainable design and construction. In particular, programmes should reduce carbon dioxide emissions, improve the efficiency of resource use (such as water) and minimise the generation of pollution and waste from existing building stock.

Policy 5.5 Decentralised Energy Networks

A *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.*

B *Within LDFs boroughs should develop policies and proposals to identify and establish decentralised energy network opportunities. Boroughs may choose to develop this as a supplementary planning document and work jointly with neighbouring boroughs to realise wider decentralised energy network opportunities. As a minimum boroughs should:*

a) *identify and safeguard existing heating and cooling networks*
b) *identify opportunities for expanding existing networks and establishing new*

networks. Boroughs should use the London Heat Map tool and consider any new developments, planned major infrastructure works and energy supply opportunities which may arise

c) *develop energy master plans for specific decentralised energy opportunities which identify:*

- *Major heat loads (including anchor heat loads, with particular reference to sites such as universities, hospitals and social housing)*
- *Major heat supply plant*
- *Possible opportunities to utilise energy from waste*
- *Possible heating and cooling network routes*
- *Implementation options for delivering feasible projects, considering issues of procurement, funding and risk and the role of the public sector*

d) *Require developers to prioritise connection to existing or planned decentralised energy networks where feasible.*

Policy 5.6 Decentralised Energy in Development Proposals

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

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

D *All renewable energy systems should be located and designed to minimise any potential adverse impacts on biodiversity, the natural environment and historical assets.*

Policy 5.15 Water Use and Supplies

B *Development should minimise the use of mains water by:*

a) *Incorporating water saving measures and equipment*

b) *Designing residential development so that mains water consumption would meet a target of 105 litres or less per head per day (Excluding an allowance of 5 litres or less per head per day for external water consumption).*

Sustainable Design and Construction SPG (April 2014)

London Borough of Richmond upon Thames, Local Plan, July 2018

Policy LP 20

Climate Change Adaption

A. The Council will promote and encourage development to be fully resilient to the future impacts of climate change in order to minimise vulnerability of people and property.

B. New development, in their layout, design, construction, materials, landscaping and operation, should minimise the effects of overheating as well as minimise energy consumption 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 shading, reducing solar reflectance, 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).

C. Opportunities to adapt existing buildings, places and spaces to the likely effects of climate change should be maximised and will be supported.

Policy LP 22

Sustainable Design and Construction

A. Developments will be required to achieve the highest standards of sustainable design and construction to mitigate the likely effects of climate change. Applicants will be required to complete the following:

1. Development of 1 dwelling unit or more, or 100sqm or more of non-residential floor space (including extensions) will be required to complete the Sustainable Construction Checklist SPD. A completed Checklist has to be submitted as part of the planning application.
2. Development that results in a new residential dwelling, including conversions, change of use, and extensions that result in a new dwelling unit, will be required to incorporate water conservation measures to achieve maximum water consumption of 110 litres per person per day for homes (including an allowance of 5 litres or less per person per day for external water consumption).
3. New non-residential buildings over 100sqm will be required to meet BREEAM 'Excellent' standard.
4. Proposals for change of use to residential will be required to meet BREEAM Domestic Refurbishment 'Excellent' standard (where feasible).

Reducing Carbon Dioxide Emissions

B. Developers are required to incorporate measures to improve energy conservation and efficiency as well as contributions to renewable and low carbon energy generation. Proposed developments are required to meet the following minimum reductions in carbon dioxide emissions:

1. All new major residential developments (10 units or more) should achieve zero carbon standards in line with London Plan policy.
2. All other new residential buildings should achieve a 35% reduction.
3. All non-residential buildings over 100sqm should achieve a 35% reduction. From 2019 all major non-residential buildings should achieve zero carbon standards in line with London Plan policy.

Targets are expressed as a percentage improvement over the target emission rate (TER) based on Part L of the 2013 Building Regulations.

C. This should be achieved by following the Energy Hierarchy:

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

Decentralised Energy Networks

D. The Council requires developments to contribute towards the Mayor of London target of 25% of heat and power to be generated through localised decentralised energy (DE) systems by 2025. The following will be required:

1. All new development will be required to connect to existing DE networks where feasible. This also applies where a DE network is planned and expected to be operational within 5 years of the development being completed.
2. Development proposals of 50 units or more, or new non-residential development of 1000sqm or more, will need to provide an assessment of the provision of on-site decentralised energy (DE) networks and combined heat and power (CHP).

3. Where feasible, new development of 50 units or more, or new non-residential development of 1000sqm or more, as well as schemes for the Proposal Sites identified in this Plan, will need to provide on-site DE and CHP; this is particularly necessary within the clusters identified for DE opportunities in the borough-wide Heat Mapping Study. Where on-site provision is not feasible, provision should be made for future connection to a local DE network should one become available.

Applicants are required to consider the installation of low, or preferably ultra-low, NOx boilers to reduce the amount of NOx emitted in the borough.

Local opportunities to contribute towards decentralised energy supply from renewable and low-carbon technologies will be encouraged where appropriate.

Retrofitting

E. High standards of energy and water efficiency in existing developments will be supported wherever possible through retrofitting. Householder extensions and other development proposals that do not meet the thresholds set out in this policy are encouraged to complete and submit the Sustainable Construction Checklist SPD as far as possible, and opportunities for micro-generation of renewable energy will be supported in line with other policies in this Plan.

The Housing Standards Review and implications on Local Planning Policy

On March 25th 2015 the Government confirmed its policy to limit energy-efficiency targets that can be imposed on a development as a result of the Housing Standards Review. New developments should not be conditioned to achieve a reduction in Carbon Emissions exceeding a 19% improvement over the requirements of Approved Document L (2013) – the equivalent energy performance of a Code for Sustainable Homes Level 4 dwelling.

In addition the Government confirmed that the Code for Sustainable Homes is no longer an applicable standard for planning permissions granted on or after March 26th 2015. If a Local Planning Authority has an existing policy requirement for the CSH it may still condition the Ene 1 and Wat 1 requirements for CSH Level 4, but cannot require assessment against the remaining categories and full CSH Certification.

Sites with planning permission granted prior to March 25th 2015 can still be assessed and certified against the Code for Sustainable Homes, where there is a requirement to do so (known as legacy sites).

A CSH requirement can also apply where a previously approved Outline Planning Permission has been granted prior to March 25th 2015.

APPENDIX 3: SAP RESULTS.

Emissions - kg CO_2/m^2/year				
Dwelling Type	**Total Target Emissions**	**Be Lean**	**Be Clean**	**Be Green**
1B2P WC	2,736	2,529	2,529	1,890
1B2P	9,696	9,114	9,114	6,233
2B4P	3,615	3,247	3,247	2,286
Total Emissions	**16,048**	**14,890**	**14,890**	**10,409**

Be Lean, & Be Green SAP Reports to be sent separately.

APPENDIX 4: WATER-EFFICIENCY CALCULATIONS.

energist®

Water efficiency calculator for 38-42 Hampton Road, Teddington, London, TW11 0LR (HO.LA.TW11)

This calculation complies with the methodology used under 'The London Plan (2015)' for use in London.

Table A1: The water efficiency calculator

Installation type	Unit of measure	Capacity / Flow rate	Use factor	Fixed use litres/person/day	Litres per person per day
WC (single flush)	Flush volume (litres)	0.00	4.42	0	0.00
WC (dual flush)	Full flush volume (litres)	6.00	1.46	0	8.76
	Part flush volume (litres)	3.00	2.96	0	8.88
WCs (multiple fittings)	Average effective flushing volume (litres)	0.00	4.42	0	0.00
Taps (excluding kitchen / utility room taps)	Flow rate (litres per minute)	4.00	1.58	1.58	7.90
Bath (where shower also present)	Capacity to overflow (litres)	150.0	0.11	0	16.50
Shower (where bath also present)	Flow rate (litres per minute)	10.00	4.37	0	43.70
Bath only	Capacity to overflow (litres)	0.00	0.50	0	0.00
Shower only	Flow rate (litres per minute)	0.00	5.60	0	0.00
Kitchen / utility room sink taps	Flow rate (litres per minute)	5.00	0.44	10.36	12.56
Washing machine	Litres/kg of dry load	8.17	2.10	0	17.16
Dishwasher	Litres/place setting	1.25	3.60	0	4.50
Waste disposal unit	Litres/use	0.00	3.08	0	0.00
Water softener	Litres/person/day	0.00	1.00	0	0.00
				Total calculated use	119.96
		Contribution from greywater (litres/person/day) from Table 4.6			0.00
		Contribution from rainwater (litres/person/day) from Table 5.5			0.00
		Normalisation factor			0.91
		Total water consumption			109.16
		External water use			0.00

Total water consumption (litres/person/day)	109.16
Target	110.00

Assessed by Ruth Pike in the Energist Technical Team on 4/3/2020.

Revision A. Software version 5.1.0

Head Office: College Farm, Tetbury Road, Cirencester, GL7 6PY | t: 08458 386 387 | e: info@energistuk.co.uk
London Office: 4 Regent Street, London, SW1Y 4RG | t: 020 7129 8123 | e: london@energistuk.co.uk