CITY AIRPORT DEVELOPMENT PROGRAMME (CADP)

CADP: ENERGY & LOW CARBON STRATEGY

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Document history

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Table of contents

Chapter	Pages
Executive Summary	**4**
1. Introduction	**6**
Project Summary	6
Policy Context	7
Baseline CO_2 emissions	11
Calculation Methodology	12
2. Technology Review	**15**
Introduction	15
District Heating Systems	15
Photovoltaics	16
Combined Heat and Power (CHP) and Combined Cooling Heat and Power (CCHP) Systems	17
Biomass Boiler Systems	20
Dock Water Source Heat Pump	21
Wind Generated Power	25
Solar Thermal Energy	27
CHP from Renewables	27
3. Proposed Energy and Low Carbon Strategy	**29**

Executive Summary

This report summarises the Energy and Low Carbon Strategy for the building elements of the proposed City Airport Development Programme (CADP) ("the Project"). The project includes the extension of infrastructure and passenger facilities at the Airport, including modifications and extensions to the existing Terminal, the creation of 7 new and 4 reconfigured aircraft parking stands, a parallel taxilane and ancillary infrastructure (proposed within Planning Application CADP1), and a Hotel (proposed within Planning Application CADP2). The building elements of the Project addressed by this Strategy comprise the Western and Eastern Extension of the existing Terminal together with its reconfiguration, the construction of a Coaching Facility (to transfer passengers between aircraft and the Terminal), a Hotel and a Taxi and Car Rental Facilities building.

The Project buildings will be designed to comply with Building Regulations Part L2A for the new build elements (comprising the Western and Eastern Extensions, Coaching Gate, Hotel and Taxi and Car Rental Facilities Building) and Part L2B for the refurbishment elements (being the existing Terminal).

An early-stage thermal model of the Project buildings has been set up using Integrated Environmental Solutions (IES) software (Simplified Building Energy Module, SBEM, equivalent) to illustrate anticipated CO_2 emissions and compliance with Part L of the Building Regulations, including the Greater London Authority's (GLA) requirement for a 25% improvement over Part L 2010.

Various options for meeting Part L of the Building Regulations and planning policy requirements (which include London Borough of Newham (LBN) Core Strategy Policies SC1, SC2 and INF4, as well as the GLA London Plan 2011) have been considered and informed by discussions with the LBN and the GLA.

The proposed Energy and Low Carbon Strategy is based on the GLA's energy hierarchy of reducing CO_2 emissions via a 'be lean, be clean and be green' priority approach:

- Design measures proposed to be lean include:
  - Energy efficient systems to meet planning policy and Part L, SBEM CO_2 emissions requirements;
  - Efficient thermal envelope to reduce heat losses ;
  - Solar shading to reduce heat gains;
  - Use of natural daylighting where possible to reduce lighting energy requirements;
  - High efficiency lighting;
  - High efficiency plant and equipment; and
  - Low energy systems e.g. using heat reclaim where appropriate.

- Design measures proposed to be clean include:
  - Provisions (e.g. valved connections) for connectivity to a future district heating system. This connection can be made in the future should a proximate district heating system become available in the area, the timescale of which is uncertain at present but could be in the next five to ten years;
  - Small scale localised CCHP (Combined Cooling, Heat and Power) systems to suit base load profiles. Capacities proposed are: 35 kWt for the Western Terminal Extension and Coaching Gate, 230kWt for the Eastern Terminal Extension and presently calculated size of 330kWt for the Hotel. The CCHP plant will be located in two Energy Centres (east and west) due to proposed phasing and proximity; and

- Design measures proposed to be green include:
  - Photovoltaic (PV) arrays on the roofs of the Terminal buildings, Taxi and Car Rental Facilities building and the roofing of the canopied walkway;
  - A closed loop dock source heat exchange (DSHE) system. Depending on the detail of the DSHE system, the capacities for the CCHP systems may vary since some of the loads could be offset.

Using the design measures above, the Project will be capable of meeting and exceeding current Part L and London Plan 2011 requirements which seek a 25% CO2 reduction relative to a 2010 benchmark.

The strategy also acknowledges that Part L of the Building Regulations and London Plan policy may seek a higher target from October 2013, of a 40% reduction in CO_2 emissions compared to 2010. In this respect space has been safeguarded for further PV arrays which, together with further optimisation measures as the design develops (as energy efficiencies of the latest products and systems improve further e.g. lighting), would ensure that the scheme can respond to and meet this more challenging target.

Figure 1 shows that by considering the energy efficiency measures (be lean), the CCHP system (be clean) and the photovoltaics and potential DSHE system (be green), how the current 25% CO_2 reduction target can be achieved.

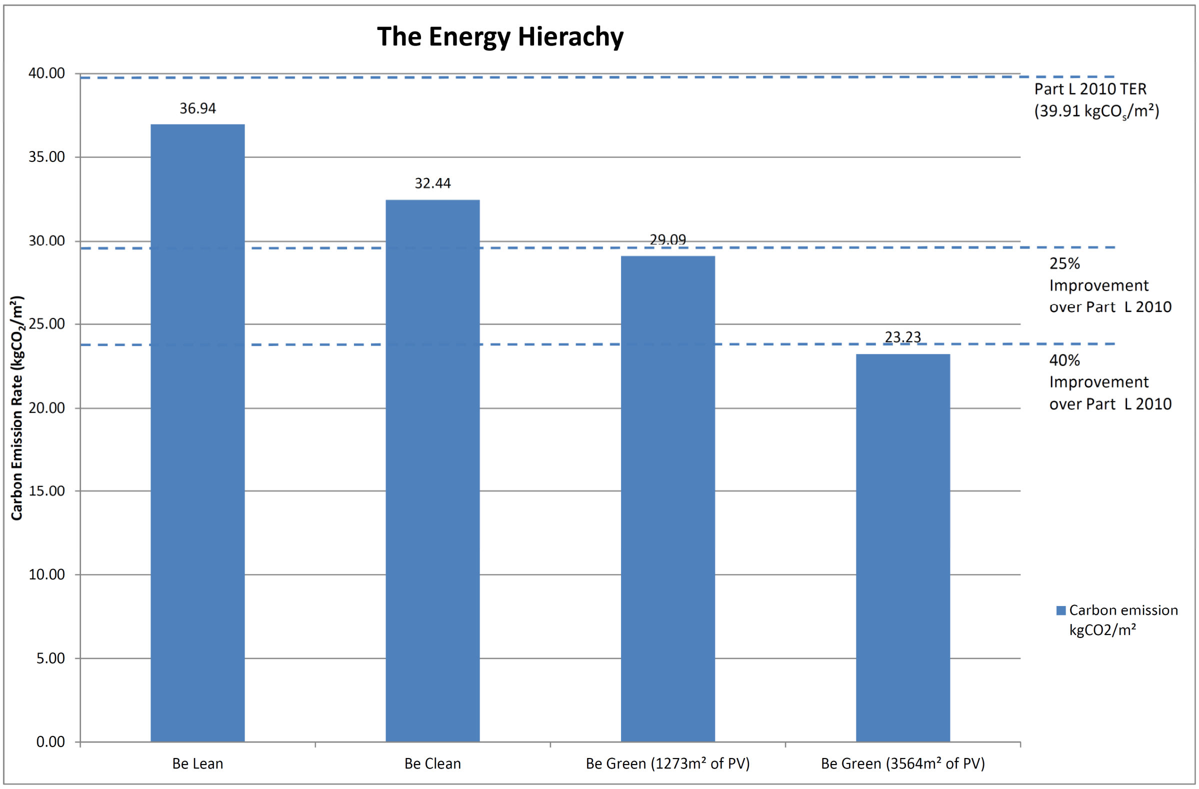

Figure 1: Carbon Emissions Reductions from Be Lean, Be Clean, Be Green measures

The energy measures proposed contribute towards achieving a BREEAM ‘very good’ rating, as explained in detail in the Sustainability Statement that accompanies the CADP application.

1. Introduction

1.1 This report describes the proposed Energy and Low Carbon Strategy for the Project and how it responds to national and local planning policy. Energy use in buildings is a major contributor to global CO_2 emissions and global warming. Designing energy efficient buildings and incorporating low and zero carbon energy generation is a vital part of ensuring the Project is sustainable.

1.2 This report describes how the proposed Energy and Low Carbon Strategy for the Project has been developed, in accordance with the GLA's energy hierarchy:

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

Project Summary

1.3 The proposed description of development is as follows:

Planning Application 1 (CADP1)
"Planning Application CADP 1: Works to demolish existing buildings and structures and provide additional infrastructure and passenger facilities at London City Airport without changes to the number of permitted flights or opening hours previously permitted pursuant to planning permission 07/01510/VAR. Detailed planning permission is being sought for

(a) Demolition of existing buildings and structures;
(b) Works to provide 4 no. upgraded aircraft stands and 7 new aircraft parking stands;
(c) The extension and modification of the existing airfield to include the creation of a taxilane running parallel to the eastern part of the runway and connecting with the existing holding point;
(d) The creation of a vehicle access point over King George V Dock for emergency vehicle access;
(e) Laying out of replacement landside Forecourt area to include vehicle circulation, pick up and drop off areas and hard and soft landscaping;
(f) The Eastern Extension to the existing Terminal building (including alteration works to the existing Terminal) to provide reconfigured and additional passenger facilities and circulation areas, landside and airside offices, immigration areas, security areas, landside and airside retail and catering areas, baggage handling facilities, storage and ancillary accommodation;
(g) The construction of a 3 storey passenger Pier to the east of the existing Terminal to serve the proposed passenger parking stands;
(h) Erection of a Noise Barrier at the eastern end of the proposed Pier
(i) Erection of a temporary Noise Barrier along part of the southern boundary of the Application Site to the north of Woodman Street;
(j) Western Extension and alterations to the existing Terminal to provide reconfigured additional passenger facilities and circulation areas, security areas, landside and airside offices, landside retail and catering areas and ancillary storage and accommodation;
(k) Western Energy Centre, storage, ancillary accommodation and landscaping to the west of the existing Terminal;
(l) Temporary Facilitation Works including the erection of a Noise Barrier to the south of 3 aircraft stands, a Coaching Facility and the extension to the outbound baggage area;
(m) Works to upgrade Hartmann Road;
(n) Landside passenger and staff parking, car hire parking and associated facilities, taxi feeder park and ancillary and related work;
(o) Eastern Energy Centre;
(p) Dock Source Heat Exchange System and Fish Refugia within King George V Dock; and
(q) Ancillary and related work.

Planning Application 2 (CADP2)

Planning Application CADP 2: Erection of a Hotel with up to 260 bedrooms, ancillary flexible A1-A4 floorspace at ground floor, meeting/conference facilities together with associated amenity space, landscaping, plant and ancillary works.

1.4 The building elements of the Project addressed by this Strategy comprise the Western and Eastern Extension of the existing Terminal together with its reconfiguration, the construction of a Coaching Facility (to transfer passengers between aircraft and the Terminal), a Hotel and a Taxi and Car Rental Facilities building. Other buildings or structures within the Project such as the Eastern Ancillary Buildings are not served by the proposed centralised low carbon energy systems due to either their distance from the proposed Energy Centres or the greater suitability of standard electrical systems, for example, for the Taxi and Car Rental Facilities building. Photovoltaics are, however, proposed on the roofs of the Taxi and Car Rental Facilities building and forecourt canopied walkway to reduce the carbon emissions.

Site Description

1.5 The proposed CADP is located at the Airport, which lies in east London in the London Borough of Newham. The Airport is notable in that is adjacent to and includes decks built on the King George V (KGV) Dock, part of a complex of water bodies created on the north side of the Thames in a period between 1855 and 1921. Built to serve the huge trading power of the British Empire, the Royal Docks as they are collectively known, were the last docks to be built in London, and subsequently (due to their relatively modern design) the last to close, in 1981.

1.6 A full description of the Application Site and its surroundings is provided in the Planning Statement and Environmental Statement that accompany the CADP planning submission. From an energy and low carbon perspective, it is particularly relevant to note that the existing Airport lies directly above and adjacent to the KGV Dock, with the open expanse of the Queen Victoria Dock to the north. These are very substantial interconnected water bodies, offering good opportunities for harnessing heat exchange technologies.

1.7 The surrounding urban area, including a range of relatively high buildings and the partly elevated Docklands Light Railway (DLR), tightly hems in the Application Site on the south side, which both limits the potential for development in that direction and acts as a heavy constraint on the potential for exploiting wind energy technologies in the CADP Energy and Low Carbon Strategy.

Policy Context

1.8 The proposed Energy and Low Carbon Strategy for the proposed CADP has been developed in response to a number of increasingly stringent national and local policies adopted with the aim of reducing carbon dioxide (CO_2) emissions associated with the Project. The main energy policies relevant to the Project are summarised below.

National Policy

1.9 Under the Climate Change Act 2008, the Government put in place legally binding carbon reduction targets of 35% by 2020 and 80% by 2050 compared to 1990 levels. The construction and operation of UK buildings accounts for approximately 60% of national carbon dioxide emissions. Therefore, planning legislation seeks to mitigate the impacts of (in particular) new construction to minimise these emissions, and assist in meeting the over-arching national target.

1.10 The National Planning Policy Framework (NPPF) was published in March 2012. It replaces the majority of national planning policy statements and guidance. The document formalises a presumption in favour of sustainable development, and places an emphasis on plan-led and local decision making.

1.11 Specific reference and guidance on energy is covered under section 10 "Meeting the Challenge of Climate Change, Flooding and Coastal Change" and paragraphs 93-98 encourage local planning authorities to support the move to low carbon energy and to encourage an increase in the use and supply of renewable and low carbon energy.

The London Plan

1.12 The London Plan is the overall strategic plan for London. It sets out a fully integrated economic, environmental, transport and social framework for the development of the capital to 2031. It forms part of the development plan for Greater London. London boroughs' local plans need to be in general conformity with the London Plan, and its policies guide decisions on planning applications by councils and the Mayor.

1.13 The latest version of the London Plan was adopted on the 22nd of July 2011 and replaces the London Plan (consolidated with alterations since 2004) which was published in February 2008.

1.14 The following energy related policies are relevant to the Project:

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:

a) Be lean: use less energy
b) Be clean: supply energy efficiently
c) 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.

	Non-domestic buildings
Year	Year Improvement on 2010 Building Regulations*
2010-2013	25 percent
2013-2016	40 percent
2016-2019	As per building regulations
2019-2031	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 (see paragraph 5.22) 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

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.

Policy 5.6: Decentralised Energy Networks

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:

a) Connection to existing heating or cooling networks
b) Site wide CHP network
c) 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 5.8 Innovative Energy Technologies

Strategic

A: The Mayor supports and encourages the more widespread use of innovative energy technologies to reduce use of fossil fuels and carbon dioxide emissions. In particular the Mayor will seek to work with boroughs and other partners in this respect, for example by stimulating:

a) the uptake of electric and hydrogen fuel cell vehicles
b) hydrogen supply and distribution infrastructure
c) the uptake of advanced conversion technologies such as anaerobic digestion, gasification and pyrolysis for the treatment of waste.

Policy 5.9 Overheating and cooling

Strategic

A: The Mayor seeks to reduce the impact of the urban heat island effect in London and encourages the design of places and spaces to avoid overheating and excessive heat generation, and to reduce overheating due to the impacts of climate change and the urban heat island effect on an area wide basis.

Planning decisions

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

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

C: Major development proposals should demonstrate how the design, materials, construction and operation of the development would minimise overheating and also meet its cooling needs. New development in London should also be designed to avoid the need for energy intensive air conditioning systems as much as possible. Further details and guidance regarding overheating and cooling are outlined in the London Climate Change Adaptation Strategy.

Local Planning Policy

1.15 The LBN adopted its Core Strategy in January 2012. Environmental and Sustainability standards are implemented under the following Core Strategy policies.

Policy SC1: Climate Change

Development will respond to a changing climate through mitigation and adaptation measures, which include the following relating to energy:

a) Major developments (non-residential) will be required to be assessed against the Building Research Establishment Environmental Assessment Method (BREEAM). It will be expected that developments achieve 'very good' as minimum (or the equivalent level of any subsequently adopted national standard on sustainable design and construction); and
b) Maximising the efficient use of energy through passive solar design and meeting the requirements of Policy SC2.

Policy SC2: Energy

Carbon emissions from new and existing development will be reduced by the following measures:

a) Requiring that all new non-residential development is built in line with the London Plan and Building Regulations to reach zero carbon by 2019 (or any subsequently adopted national standard on energy and low carbon design);
b) Connections to, or provision for connection to, decentralised heat networks (See Policy INF4);
c) Incorporating on-site renewable energy generation in line with the requirements of the London Plan, and other innovative technologies to reduce carbon emissions.

Policy INF4: Local Heat and Power Networks

Applications for major development in the vicinity of an existing or a planned district heating network or other heat distribution network, should provide for connection to that network. If that connection is not feasible at the time the development is implemented, then the development should ensure that a future connection can be made.

1.16 LBN has issued a Draft District Heat Network Local Development Order (LDO) in May 2012 to promote decentralised energy in Newham. The intention is to create an extended district heating network. Section 1.4 states that "This is a long term project and the route would be built in shorter sections over the next 5-10 years and in response to available demand for consumer connections. The roll-out of the heat network within LBN is expected to start from the Royal Docks, and the introduction of the LDO is part of new streamlined planning processes for the Royal Docks Enterprise Zone, assisting in its growth as a leader in the new low carbon economy.

Baseline CO_2 emissions

1.17 In order to quantify the impact of the Project in terms of CO_2 emission reductions, the baseline CO_2 emissions have been calculated in line with the requirements of the London Plan. Baseline emissions are based on meeting Building Regulations 2010, and are defined by the "notional building". This is a virtual model of a building with the same geometry as the proposed building, but with certain defined parameters. The model is made using recognised software (in this case from Integrated Environmental Solutions, IES) that operates an approved calculation method to assess the building's annual "regulated" energy use and associated emissions. "Regulated" energy use is that by fixed building services, such as heating, hot water and lighting.

1.18 The buildings are required to be designed to comply with Part L2A for the new build elements and Part L2B for the refurbishment elements.

Calculation Methodology

1.19 To assess the proposed buildings improvement over Part L, and to understand the requirements for use of renewable energy, the Project has been modelled using Integrated Environmental Solutions (IES) 2012 software (which uses the SBEM calculation methodology) against the requirements of the Building Regulations Part L 2010.

1.20 A baseline case early-stage thermal model was set up using the building services parameters summarised in the next paragraph. The impact of each low carbon option was then compared against this baseline model in order to calculate the % improvement over Part L, in line with the calculation methodology set out in "Energy Planning: GLA Guidance on preparing energy assessments – 2011".

1.21 Below are the building services parameters that were used in the baseline case model, to which the low carbon options were compared:

Heating 92% efficiency gas fired boiler

Cooling and Ventilation Western Terminal Extension: European Seasonal Energy Efficiency Ratio (ESEER) 5.3 air cooled chillers, all air VAV ventilation; constant volume with variable fresh air for transient corridors, natural ventilation for plant areas, and mechanical extract ventilation for WCs

Eastern Terminal Extension: Seasonal Energy Efficiency Ratio: (SEER) 4.14 air cooled chillers, displacement type ventilation in areas where floor to ceiling heights are sufficient for such a system; constant volume with variable fresh air for transient corridors and other areas, natural ventilation for storage area and mechanical extract ventilation for WCs

Taxi and Car Rental Facilities building: Seasonal Energy Efficiency Ratio: (SEER) 6.5 variable refrigerant flow air source heat pump (cooling/heating) system; heat recovery ventilation system

Lighting Airport opening hours with 50% dimming from 10am to 2pm set to 55 Lum/w for the area with glazing

Domestic Hot Water Western and Eastern Terminal Extensions: using the same system as heating with storage and secondary circulation

Taxi and Car Rental Facilities building: Using local water heaters

Auxiliary Power Variable speed pumps with sensor + Fan power 1.4 Watts/litre/second

Thermal Performance of Baseline Case Model – Building Fabric

The thermal performance of the new building envelope in the base case model is designed to comply with Part L of the Building Regulations. All thermal models use the same U-values and air permeability values as the baseline case model (see table that follows). The buildings are assumed to be appropriately insulated and air-tight in order to minimise heat loss.

Building Element	U-Value (W/m².K)
External Wall	0.15
Curtain Walling	1.44 (G-value = 0.33
Glazing	1.70 (G-value = 0.33)
Ground Floor Slab	0.18
Roof	0.19
Roof Lights	1.70

Air Leakage Rate 3.0 m³/h/m² of envelope area at 50 Pa

1.22 Figures 2a, 2b, 2c and 2d show screenshots of the early stage thermal models.

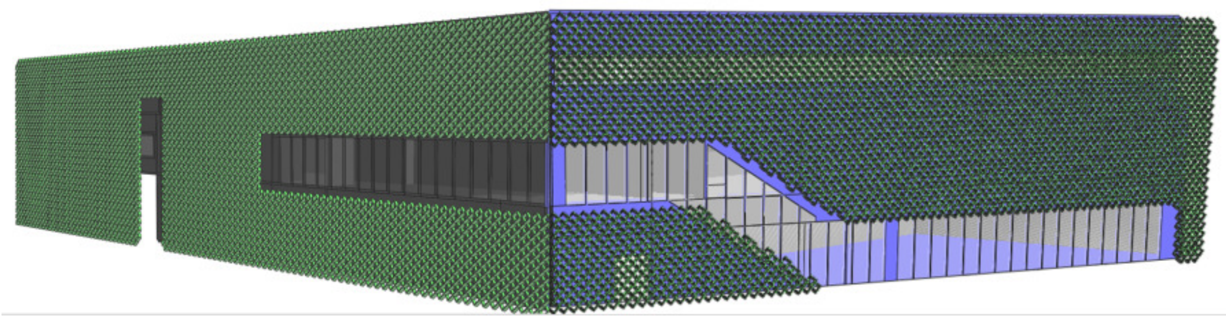

Figure 2a: Screenshot of the IES Base Case thermal model showing the Western Terminal Extension

Figure 2b: Screenshot of the IES Base Case model showing the Eastern Terminal Extension

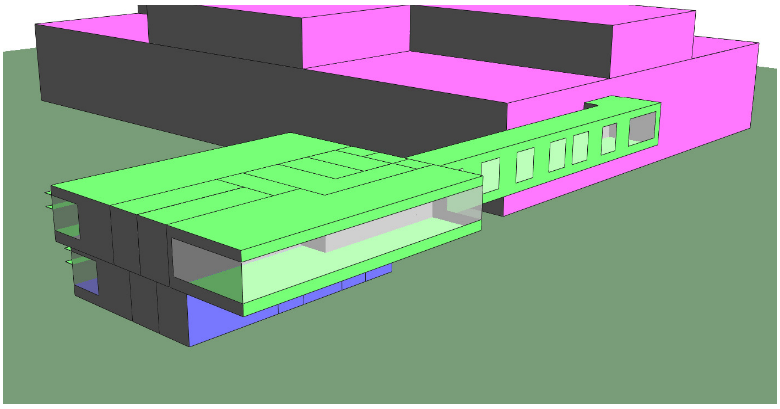

Figure 2c: Screenshot of the IES Base Case model showing the Coaching Gate

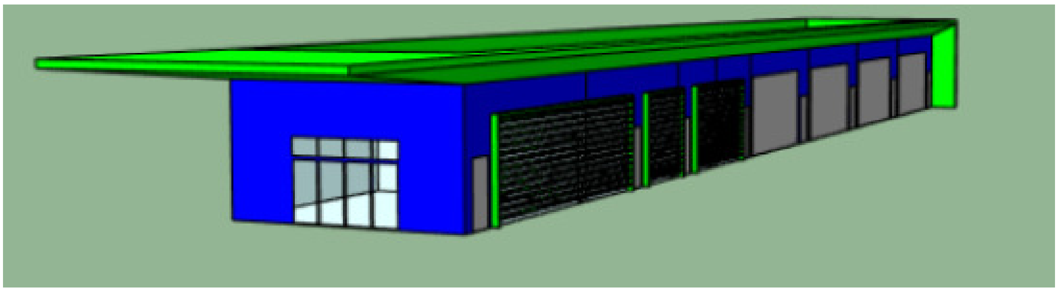

***Figure 2d: Screenshot of the IES Base Case model showing the* Taxi and Car Rental Facilities building**

2. Technology Review

Introduction

2.1 In order to ensure that the appropriate and best-suited technologies are selected for the Project, a review of low carbon energy technologies and their potential utilisation has been carried out. The review has been undertaken to ensure that on technical, functional, economic and environmental grounds, the most appropriate systems are investigated and selected

2.2 The design aims to improve the energy use, both in heating and in electrical consumption, so the target of at least 25% improvement over Part L2a 2010 is achieved in line with the current GLA planning requirements.

2.3 The Strategy also addresses the forthcoming changes to the GLA requirements for a 40% improvement over Part L2a 2010 from October 2013 as outlined in paragraph 1.13.

District Heating Systems

2.4 As a District Heating (DH) system is unlikely to be ready within the timescales of the Project, the design will incorporate provisions for future connectivity to the DH system via valved and capped-off pipework connections and space for future heat exchangers in the Energy Centres. When a district network is installed in future, then a connection to the system can be made, if shown to be viable. Below is Figure 3 taken from the London Heat Map (http://www.londonheatmap.org.uk/), the solid lines indicating the proposed district heating network. The dashed red line shown on Figure 4 indicates a possible extension route to connect to the Airport Energy Centres.

Map LDO1 – Extent of District Heat Network Local Development Order

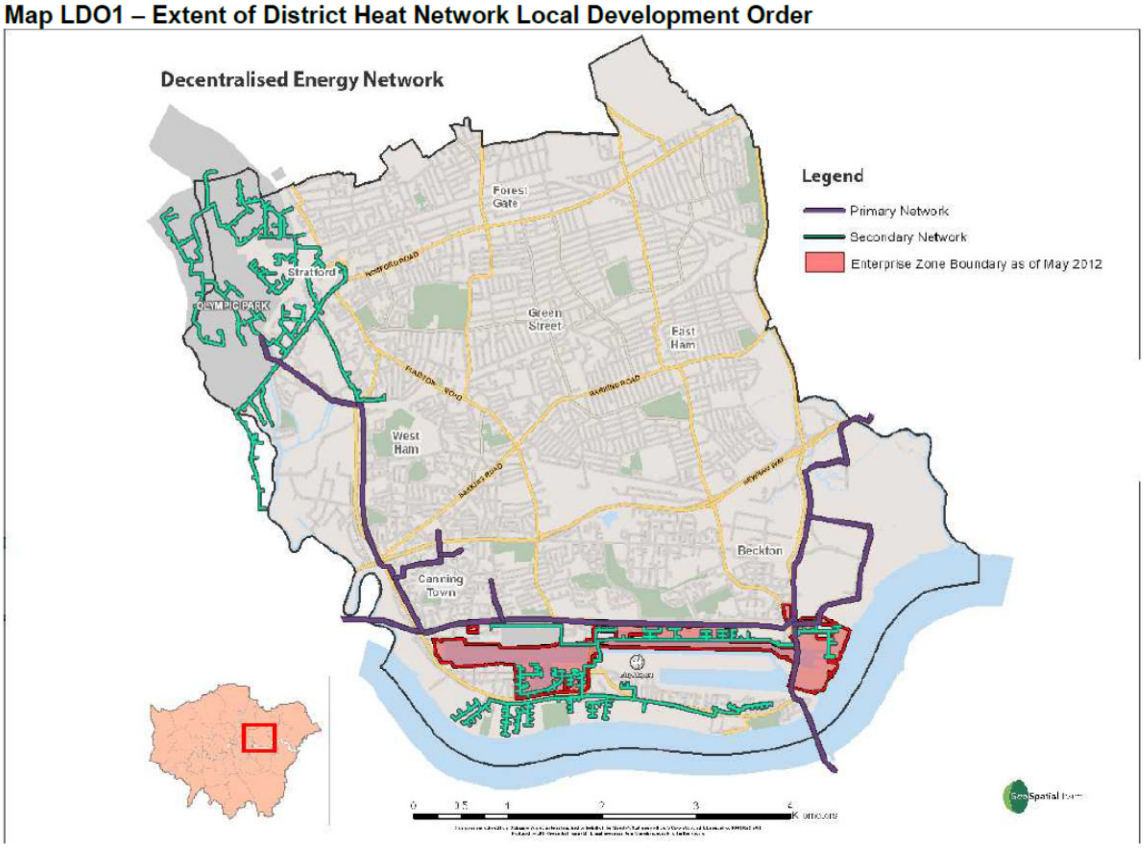

Figure 3: LBN Proposed District Heating Network LDO

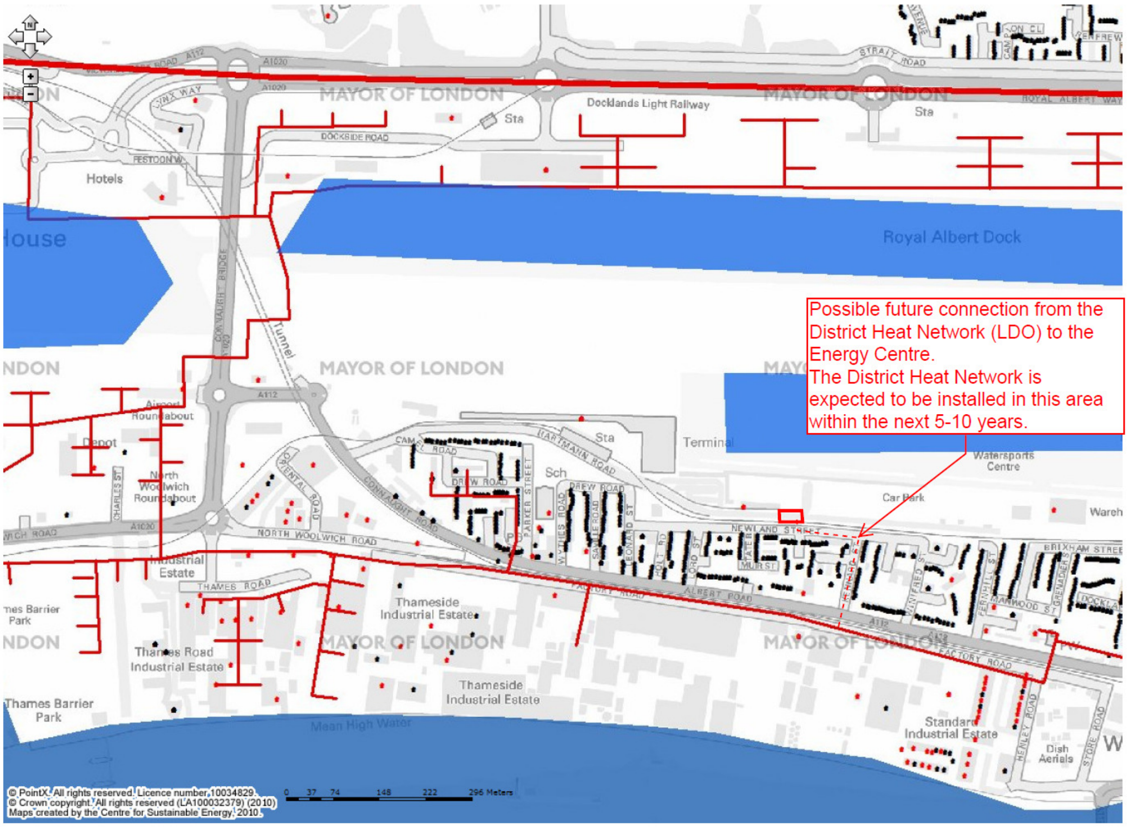

Figure 4: Potential future connectivity route from LBN Proposed District Heating Network

Photovoltaics

2.5 Photovoltaic (PV) systems convert energy from the sun into electricity through semi-conductor cells. Systems consist of semi-conductor cells connected together and mounted into modules. Modules are connected to an inverter to turn their direct current (DC) output into alternating current (AC) electricity for use in buildings. Excess electricity can be sold to the National Grid when the generated power exceeds the local need. PV systems require only daylight, not sunlight, to generate electricity (although more electricity is produced with more sunlight), so energy can still be produced in overcast or cloudy conditions.

2.6 Ideally PV cells should be positioned so that they face between south-east and south-west, at an elevation of about 10° (minimum angle for self cleaning) to 40°. The optimum for the Airport would be orientated due south and angled at between 10 to 31 degrees from the horizontal. However, flat roofs receive 90% of the energy of an optimum system. The roofs of the new buildings offer good mounting locations for PVs. In addition to this, PVs are particularly suited to buildings that use electricity during the day, as in the case of the Project.

2.7 The size of a PV system is expressed by its kilowatt peak (kWp) potential, which is an indication of how much electricity the system could generate at peak or optimum conditions. As a rule of thumb a typical 1kWp system in the UK could be expected to produce between 700-750 kWh/yr of electricity, although some technologies will generate considerably more. A high performance system in London might be expected to produce a maximum of 850kWh/yr.

2.8 The cost of installing a PV system is specific to its size and location. The price of PV modules is reducing as demand rises and they are becoming more mass produced. It is likely that by the time of construction, the cost of PV modules will have reduced and electricity prices will have risen, thus increasing their economic advantages.

2.9 PVs do provide a significant contribution to carbon emission reduction and are proposed as part of the energy and low carbon strategy towards meeting the required CO_2 improvements over Building Regulations Part L2A 2010.

2.10 Roof areas have been assessed to identify where PVs could be mounted, taking into account space allowance for plant, equipment, maintenance and access. (This is based on information from a mainstream PV supplier, which recommends generally leaving 1.5m clear from all edges and then reducing the remaining areas by 30% to allow space for equipment and maintenance). The assessment indicates that:

- Sufficient roof area is available for the required 370m² to 630m² PV area (for the 25% to 40% carbon reduction targets) on the Western Terminal Extension;
- For the Eastern Terminal Extension, the PV area that can be accommodated is 2400m² which can accommodate all of the 800 m² (for the 25% target) and the majority of the 2600 m² (for the 40% target), with remaining PVs to be located on the existing buildings plus some optimisation measures as the Eastern Terminal Extension design is refined further in the lead-in to implementation and energy efficiencies of the latest products continue to improve, which would reduce PV area requirements further. (Reducing the roof level circulation space percentage slightly compared to the supplier's indication would allow further PV area to be accommodated.)
- Sufficient roof area is available for the required 103m² to 134m² PV area (for the 25% to 40% carbon reduction targets) on the Taxi and Car Rental Facilities building.

Combined Heat and Power (CHP) and Combined Cooling Heat and Power (CCHP) Systems

2.11 Combined Heat and Power (CHP) is a more sustainable form of energy generation than grid supplied electricity or natural gas supplied and used separately (see Figure 5 below). It has therefore been accepted that CHP is a method of contributing to any development's sustainability. The system usually comprises a gas fired internal combustion engine to generate electricity with practical use made of the heat which is an inevitable by-product. The overall efficiency of such systems can be in excess of 80%. Economic viability requires high annual running hours and a close match between the electrical and thermal load profiles. As more heat is generated than electricity, it is the norm to match the heat output to the heat load, which sets the electrical output. If it is done the other way i.e. matching electrical generation to load then the result is surplus heat that will need to be rejected as is the case at power stations.

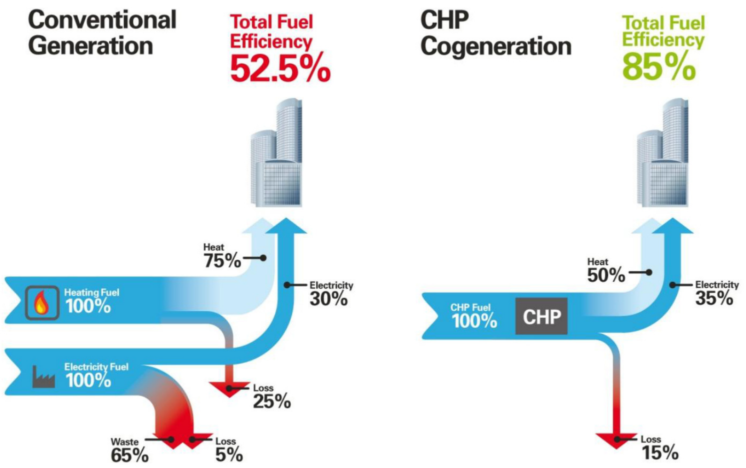

Figure 5: Conventional Generation vs CHP Generation

2.12 By using natural gas to generate electricity in CHP systems, the cost differential compared to conventional generation systems offers financial savings, which are best realised if plant is running in excess of 5,000 hours per year. This could be achieved by sizing the plant to satisfy a development's domestic hot water demand, which is usually an all year requirement. An example would be a mini CHP linked to a thermal store, the mini CHP running constantly to provide domestic hot water.

2.13 Larger CHP for buildings that do not have an all season heat demand are not normally viable. However, it is possible to use heat to generate cooling via absorption chillers, but these are generally inefficient and require substantial heat rejection via adiabatic coolers or cooling towers. Energy centres that use heat from generators to heat and cool a building or group of buildings is known as tri-generation or Combined Cooling, Heat and Power (CCHP). It generally requires substantial investment.

2.14 Fired on natural gas, CHP/CCHP are carbon displacement technologies, meaning that while they still produce carbon emissions to generate electricity this is far less than that from the production of electricity at the power station and gas consumption of a boiler. CHP works on a heat to power ratio of around 1.5:1, converting approximately 35% of fuel input into electricity, compared to around 30% for conventional generation.

2.15 For the purposes of this review, early stage CHP and CCHP feasibility assessments were conducted which concluded the following:

CHP feasibility assessment:

- For the Western and Eastern Terminal Extensions and Coaching Gate:
    - A mini CHP system is a possible option to provide heat for the hot water system linked to a storage vessel, and in winter potentially also contributing to night set-back heating.
    - A larger CHP plant to provide space heating is much less viable as there is insufficient heat load in summer and therefore the CHP would be under-utilised.
- For the Hotel, the use of a CHP system is likely to be viable due to the continuous hot water demand throughout the year.
- For the Taxi and Car Rental Facilities building, the use of a CHP system is not viable due to the small thermal loads in the building which are not continuous throughout the year.

2.16 It is to be noted that use of CHP systems can conflict with potential use of other renewable systems that generate heat (e.g. solar thermal and biomass), and in such instances the most appropriate system or combination can be selected.

CCHP feasibility assessment:

- For the Western and Eastern Terminal Extensions and Coaching Gate:
    - A small scale localised CCHP unit providing cooling, heating and power was investigated. A CCHP unit has an additional absorption chiller and dry air cooler, and is therefore a more expensive investment than CHP (typically twice the capital cost). As the proposed Terminal Extensions do not have a steady heating demand throughout the year, a CCHP unit could use excess heat to drive a hot water absorption chiller. The thermal model shows that the cooling demand is greater than the heating demand and this would make CCHP a more viable option than a CHP. The CCHP unit also offers better carbon savings than a CHP unit, and hence it is being proposed for the Project.
- For the Hotel, the use of a CCHP system is likely to be viable due to the continuous hot water and heating / cooling demand throughout the year.
- For the Taxi and Car Rental Facilities building, the use of a CCHP system is not viable due to the small thermal loads in the building which are not continuous throughout the year.

The early stage CCHP feasibility study for these areas concluded the following:

- For the Western Terminal Extension and Coaching Gate, a small CCHP system (e.g. 30-35kWt) is proposed to meet the base load heating/cooling demand;
- For the Eastern Terminal Extension, a 230kWt localised CCHP system is proposed to meet the base load heating/cooling demand;
- For the hotel, the presently calculated size is 330kWt;
- It is not feasible to connect the Taxi and Car Rental Facilities building to the CCHP system in the Energy Centres due to the long distance between the buildings, the

relatively small thermal loads of this building, and since the use of alternative energy systems such as air source heat pumps (rather than CHP or CCHP) are better suited to the building loads and location.

2.17 It is to be noted that for this early stage assessment, the Part L standard templates have been used for sizing against the base heating and hot water load. A detailed assessment will be carried out during the detailed design stage using actual loads to confirm the precise CHP / CCHP sizes. Also, the CCHP capacities put forward above may be adjusted for optimum combination with the other technologies, such as a dock source heat exchange system.

2.18 In summary:

- For the Western and Eastern Terminal Extensions and Coaching Gate the CCHP systems offer more carbon reductions than the CHP systems and as such these are proposed as the preferred approach;
- For the Hotel, either a CHP or CCHP is likely to be viable and could be considered for use to meet the base loads, subject to further detailed evaluation when the Hotel design progresses. However, since the CCHP systems offer more carbon reductions than the CHP systems, these are proposed as the preferred approach; and
- It is not economically viable to connect the Eastern Ancillary Buildings to the CCHP plant in the Energy Centres due to the distance between them and the relatively small energy loads. These ancillary buildings will be fed independently from localised energy efficient plant.

2.19 Due to the location of the new build projects to the west and to the east of the existing Terminal building and their phasing, two Energy Centres are proposed, a smaller one to the west and a larger one to the east. These will house the CCHP plant and equipment proposed to meet part of the site energy requirements associated with the Project. The CCHP plant in both cases would act as the lead boiler / chiller to meet part of the base load, with the lag gas boilers and air source chillers (which will be located in the main buildings) to meet the remainder of the loads.

2.20 Insulated heating and cooling pipework would run between the appropriate Energy Centre and the proposed Western and Eastern Terminal Extensions and Hotel. A new gas feed would be provided to the CCHP system.

2.21 As the CCHP alone would not provide the full 25% (to 40%) CO_2 reduction over Part L2a 2010, additional low carbon technologies (e.g. PVs as already discussed) are also proposed to achieve the reduction as described in paragraph 2.10.

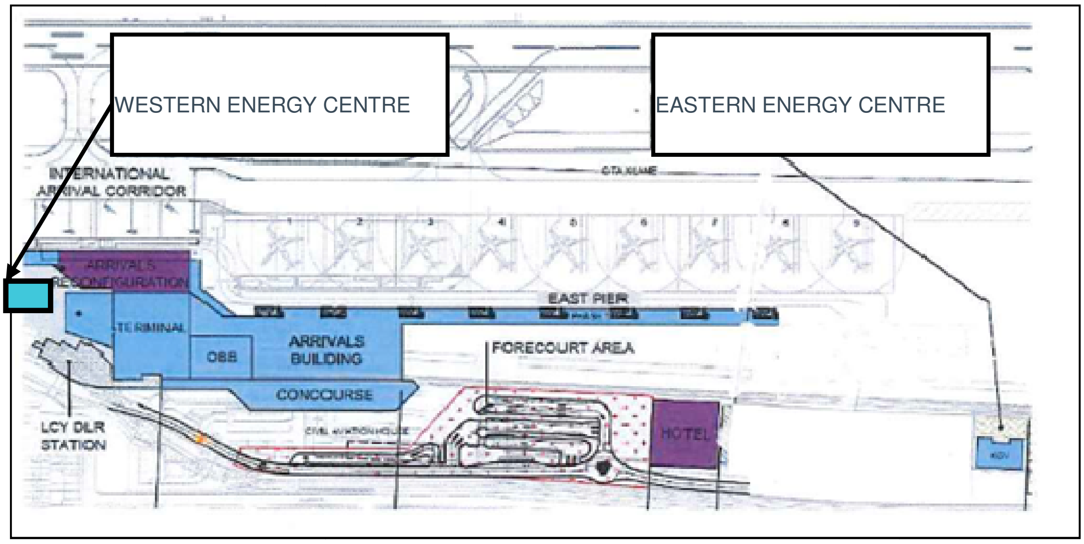

Figure 6: Locations of the Eastern and Western Energy Centres housing the CCHP plant.

Biomass Boiler Systems

General

2.22 Biomass boilers are those which burn sustainable organic fuel. The most common biomass fuels in the UK are wood chip and wood pellets. Both these fuels are grown sustainably for utilisation in biomass heating systems.

2.23 The use of biomass is generally classed as a ‘low carbon intensity’ fuel because the carbon dioxide released during the generation of energy is balanced by that absorbed by the trees during their growth. However, it is not neutral as account must be made for any other energy inputs that occur in the production and transportation of the fuel.

2.24 When assessing a biomass system, it is important not only to consider the technology itself, but also to assess the practicality of installing such a technology. Biomass heating is one of the few renewable technologies that require the regular delivery of fuel for input in to the system. While other technologies such as CHP require fuel inputs, this is often natural gas. However, in order to sustain a biomass boiler, regular deliveries of wood chips or pellets need to be received, transported to boiler and stored on site, requiring the site to be accessible. Biomass technology can yield good savings in carbon emissions, but the practicalities must also be considered, as discussed in the following paragraphs.

Overview and assessment

2.25 A biomass boiler using wood-pellets for fuel could make a contribution towards the 25% improvement over Part L2a 2010 due to the good carbon emission savings that can be made over conventional technologies. However, this technology has to be assessed considering the following:

- The emissions from the biomass boiler would be subject to the restrictions imposed by “The Clean Air Act”. The emissions also need to meet the Air Quality Strategy (Policy 8), set out by the London Plan to ensure low carbon energy sources do not contribute to worsening local air quality conditions. The emission limits vary in each London borough and are set in the Air Quality Management Plan by LBN.
- Discussions at a meeting with LBN on 7th November 2012 indicate that biomass systems are not favoured by LBN due to the emissions issues.
- As a guide, the chimney would need to be 2 metres higher than surrounding buildings within a radius of 5 times the flue height. However, local environmental health considerations would need to take into account the overall emissions in the general area, e.g. from buildings, factories, warehouses etc. The Local Environmental Health Officer (EHO) for the borough would need to be involved in the assessment.
- Availability and delivery of biomass fuel to the area.
- A biomass boiler would need to be sized to meet average base heating demand linked to a thermal store for morning boost. Biomass boilers cannot be switched on and off like a gas boiler, they need time to start up and to shut down, hence the need for a thermal store to dissipate heat when demand ceases.
- Site constraints. The amount of fuel required to supply the boiler and the size of biomass store to be provided, taking account of acceptable site constraints and frequency of delivery of fuel. Wood pellets have a higher calorific value than wood chips, and hence require less storage space for a given energy output.
- Type of fuel: Wood pellets are a cleaner biomass fuel than wood chips and require less ash removal and maintenance, but wood chips are cheaper. Wood pellets can be blown a short distance (up to 10m) to a storage vessel from the delivery vehicle and the fuel store structure can be above ground; wood chips need to be tipped into place and therefore require a suitable below-ground fuel store arrangement. Other sources of biomass can be considered provided there is a reliable supply chain, such as waste.

Important considerations/restrictions regarding use of biomass boilers:

- A waiver would need to be obtained for the "clean air act". Factors which contribute towards securing this waiver are use of certain biomass boilers which have certified exemptions, and height of the chimney.
- Local authority requirements to ensure the technology does not have detrimental effects on local air quality.
- Possible emissions from a biomass system.
- If the emissions do not comply with the local authority's air quality management plan, then further measures would be required e.g. the boiler flue would need to be fitted with ammonia scrubbers. This helps to reduce the NOX and PM levels, but will reduce the overall system efficiency.

2.26 Considering all the above, and the outcome of discussions with LBN (which addressed biomass and CHP/CCHP systems and identified CHP/CCHP as their clear preference), biomass systems have been discounted as part of the energy and low carbon strategy for the Project.

Dock Water Source Heat Pump

2.27 Using the dock water as a heat sink both for cooling in summer and heating in winter is a clear potential opportunity, given the particular location of the site and the size of the adjacent water body. The majority of heat pump systems installed in the UK are either air or ground source. Water source, however, has a higher heat transfer rate, and can achieve a higher coefficient of performance (CoP) than ground or air source systems. They are considered a sustainable technology due to the energy they can extract from the external environment, in this case the dock water. A typical water source heat pump can achieve a coefficient of performance of 5. This means for every 1kW of electrical input energy, the system can provide 5kW of cooling energy (with 4kW provided from the external environment).There are two types, a closed and open loop system.

2.28 An open loop system would involve extracting filtered water from the dock and passing it through an additional heat exchanger. Connected to the heat exchanger would be a reversible heat pump capable of extracting cooling in summer and heating in winter. The additional heat exchanger has to be corrosion resistant and requires regular cleaning and maintenance. An open loop system requires two licences from the Environment Agency (EA), an Abstraction Licence and an Environmental Permit, the former for taking water from the environment, the latter for discharging the water back.

2.29 A closed loop system has the heat exchanger, similar to ground source flexible pipework system, laid in the dock water at several metres above the base, so as not to disturb the less oxygenated water at low level. A closed loop would avoid the need for filtration of water. It also does not typically require either an Abstraction Licence or an Environmental Permit from the EA, since it does not draw water from or discharge water to the dock.

2.30 As a closed loop system can affect the water environment, through the slight localised change in water temperature and possible effect on the local ecology of the dock; this matter is covered in the Environmental Statement accompanying the CADP application. This concludes that the effects are unlikely to be significant.

Meetings with Royal Docks Management Authority (RODMA) and the Environment Agency (EA)

2.31 Meetings were held with RODMA and the EA in December 2012, January 2013 and May 2013 to discuss the proposals and to identify any concerns they may have. Following receipt of detailed information, the EA has confirmed that it is in full support of the principle of the dock source heat exchange system. RODMA also acknowledges the potential environmental benefits of the system and discussions over the practicalities are on-going.

Proposed dock source heat exchange (DSHE) system

2.32 The proposed dock source heat exchange system would serve a proportion of the heating and cooling demand of the proposed Eastern Terminal Extension and also potentially the Western Terminal Extension.

2.33 The anticipated cooling load of each gate room within the Eastern Terminal Extension and transient space stand module is approximately 70kW. In cooling mode, the DHSE system is likely to have a flow temperature of 30℃ and a return of 25℃. Therefore the surrounding water directly adjacent to the flexible pipework could be raised by a maximum of 5℃. Though the dock water temperature may increase slightly local to the pipework, the volume of the dock water is large compared to the volume of the closed loop system, and so the overall temperature increase in the body of dock water is likely to be minimal. In heating mode the flow temperature will be 6℃ with a return of 11℃, with a slight cooling effect to the surrounding water.

2.34 It is estimated that each system loop, one per gateroom, would require a 25x25m surface area of dock water for the closed loop to be located in. The location is proposed to be above the dock bed and in the open dock area, rather than under the deck, for ease of installation, maintenance and security.

2.35 Figure 7 shows the proposed locations of the DSHE installations. As shown on Figures 8 and 9, the heat exchanger pipework will be installed on a frame with stilts. The stilts will be designed to give at least 2-3m clearance from the bottom, to avoid disturbing any contaminants that may be present at the bottom of the dock

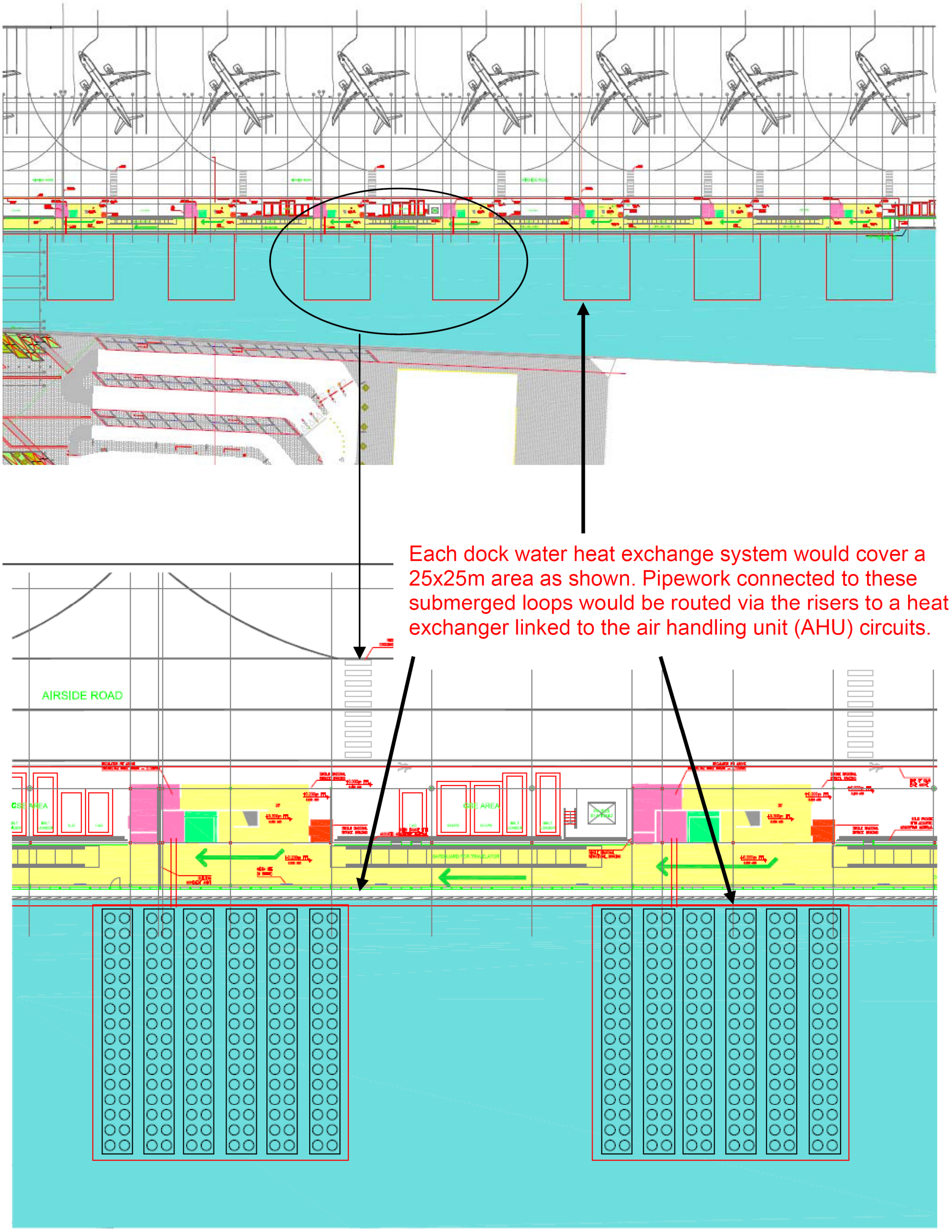

Figure 7: Proposed location of dock source water heat exchange pipework adjacent to typical Eastern Extension gaterooms.

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2.36 The heat exchanger is proposed to be located between 3m to 6m below the dock water surface. This is to ensure there is enough coverage to keep sunlight levels low enough to deter algae growth, but not to a depth that could potentially disturb the contaminants on the dock bed through thermal buoyancy within the water. A deflector plate is also proposed beneath the heat exchanger to minimise disturbance of the deeper water levels.

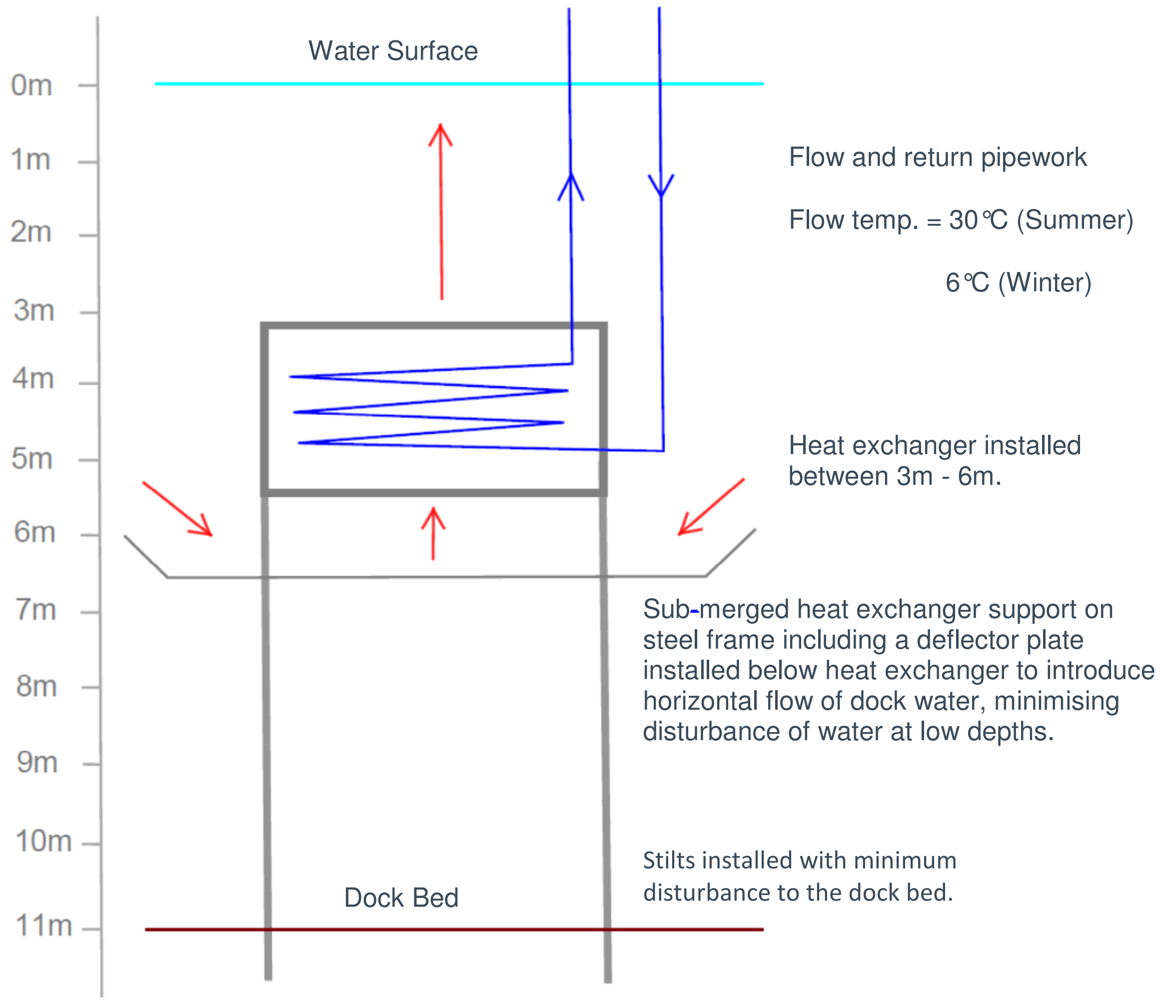


Figure 8: Diagram showing indicative submerged depth of heat exchanger.

Figure 9: Laying 'flexible' pipework for a closed loop water source heat pump

2.37 Figure 9 shows how the pipework based heat exchanger could be lowered into the dock on a framing system.

Wind Generated Power

2.38 Wind turbines can either be stand-alone units or be building-mounted and can be horizontal or vertical axis. The chosen design for any given application is normally determined by the available space on the site.

2.39 Horizontal axis wind turbines are susceptible to a reduction in performance due to wind turbulence and therefore are not generally suited to an urban environment.

2.40 Vertical axis turbines are less susceptible to turbulence and are more likely to be viable in urban locations provided wind speed is greater than 5.5m/s. They would need to be spaced by a minimum distance of 15m between turbines and the distance to surrounding buildings should be at least 110% of the height of the obstruction. Although vertical wind turbines are only half as efficient as horizontal types, in some instances the local turbulence effects may result in them being more viable.

2.41 The average wind speed for the area is around 4 - 4.5 m/s. This is less than the recommended minimum for vertical wind turbines to operate effectively. This type of wind technology has therefore been discounted.

2.42 With regard to horizontal wind turbines, an assessment has been carried out, looking at the local topography, in particular local buildings heights. It is recommended that horizontal wind turbines are located at a distance away of around 10 times a building height, in order to avoid effects from surrounding buildings.

2.43 The following page shows two maps (figures 10a and 10b) indicating the building height disturbance radii and cones relative to the tallest buildings locally. These are to the south and therefore impede the prevailing wind.

2.44 As can be seen from the circular zones (approximately 10x building height) and cones (effect of buildings on prevailing winds) indicated, the site is generally affected by turbulence, thus making the use of horizontal wind turbines unfeasible.

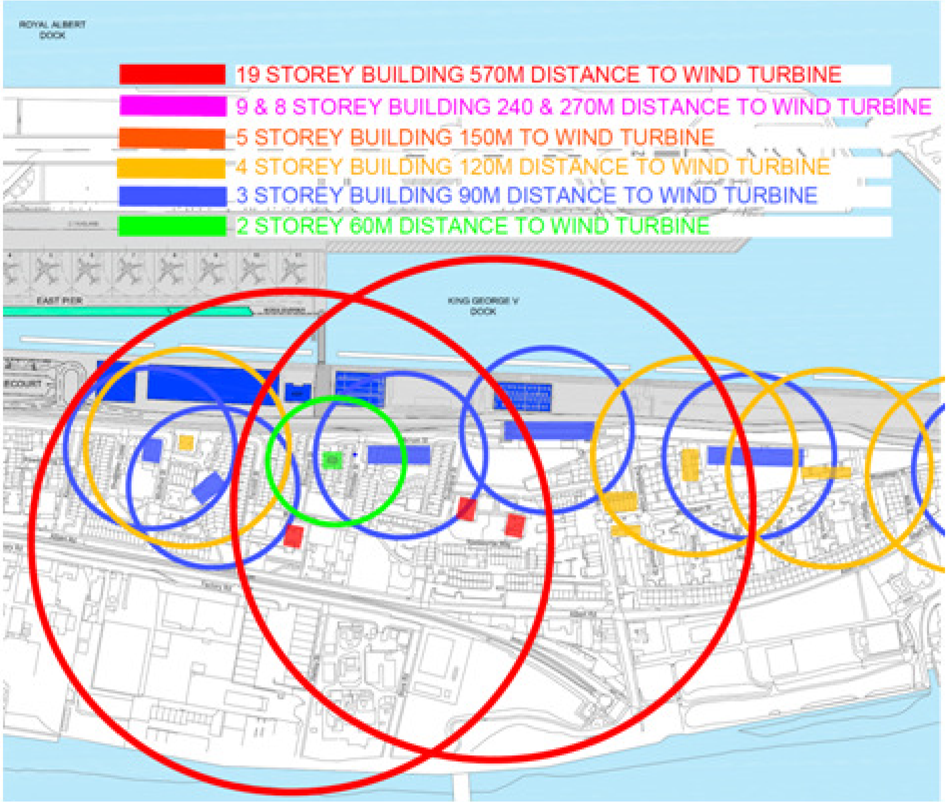


Figure 10a: Wind interference from adjacent tall buildings

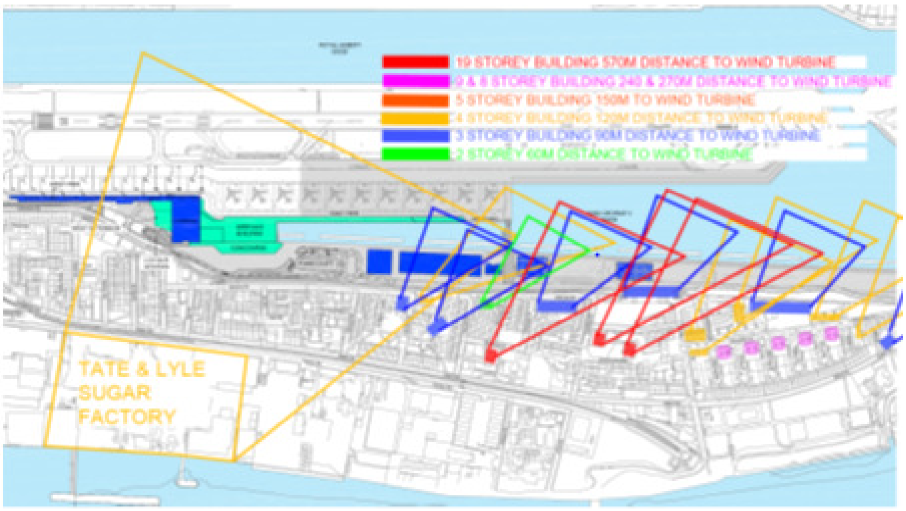


Figure 10b: Wind interference from adjacent tall buildings

Solar Thermal Energy

2.45 Solar thermal systems use the energy from the sun to heat water for general hot water needs. The systems use a heat collector, generally mounted on the roof in which a fluid is heated by the sun. This fluid is used to heat up water that is stored in either a separate hot water cylinder or a twin coil hot water cylinder inside the building. The systems work very successfully in all parts of the UK, and can contribute to the generation of hot water even in diffused light conditions.

2.46 There are two types of collectors commonly used in the UK. Flat plate collectors and evacuated tube collectors. The former is the cheaper option, but the latter has better overall performance. Each collector is best positioned in a predominantly South facing direction with between 10º and 60º of elevation.

2.47 A typical commercial thermal hot water system can provide the equivalent of 582kWh/yr/m² and would be capable of supplying a proportion of the domestic hot water requirements at the Airport. This would directly offset some of the gas demand for the domestic hot water heating system and, as such, could achieve an annual saving in the region of 11,640kWh from a system comprising of 20m² of collector plates.

2.48 If a solar thermal system was used, it could be located on the roof area of new buildings. However, it would only be part of the energy strategy if CHP or CCHP is not used for domestic water heating. Since CCHP systems are proposed, solar thermal systems are discounted as they would duplicate part of the heating function of the primary sustainable energy system.

CHP from Renewables

2.49 Gas fired CHP has been assessed within the CHP section of this report. However, CHP can also be fired by a number of renewable fuel sources. However, this is not proposed as part of the energy strategy for the reasons noted in the biomass section and those below.

Biomass

2.50 Whilst Biomass CHP is a proven technology at power station scale, it is not yet market ready at the scale required for the Project. Unlike natural gas CHP, biomass CHP systems require space for a solid fuel store on site. Furthermore, depending on the process specified, plant space may also be required to gasify wood chip prior to combustion in the CHP engine. Depending on the moisture content of the fuel supply and the requirements of the manufacturer, space may also be required for driers to reduce the moisture content of the fuel. Drying can be done offsite but this will increase the cost of the fuel supply.

2.51 This technology has not been taken forward as it is not considered market ready due to the small number of suppliers, substantially higher capital costs and the potentially high operating costs including major replacement of key components.

Biodiesel

2.52 Biodiesel is a more proven technology than biomass CHP and although it also requires space for fuel storage, the space implications are reduced compared to the use of solid biomass. Typical CO_2 emission reductions are around 25% rising to around 30% if the biodiesel is produced from recycled vegetable oil.

2.53 Although less space intensive than solid biomass CHP, biodiesel CHP still requires fuel storage on site. There is at present considerable debate about the sustainability of using bio-fuels within buildings. One concern is that creating demand for bio-fuels such as palm oil will create conflict with other land uses, for example for food production or protection of existing forest cover. A further issue is that a limited supply of bio-fuels may be better utilised in transport systems where there are fewer low carbon alternatives to the use of fossil fuels.

2.54 Bio-Diesel CHP has not been considered further due to concerns regarding the ongoing sustainability of the use of bio-fuels for building energy supply and the limited availability and potentially high cost of securing a sustainable bio-diesel supply.

Fuel Cell

2.55 Fuel Cells can be run on natural gas to produce both heat and power, through an electro-chemical process.

2.56 Fuel Cells produce a relatively high proportion of electricity to heat compared with gas reciprocating CHP engines, which typically means they offer the potential for higher carbon savings. While there is limited availability of Fuel Cells in the UK, Fuel Cell Energy, a US based company provide a 300KW fuel cell through a UK distributor.

2.57 While fuel cells could potentially provide significant carbon savings, there are substantial commercial barriers for their use in the UK at the present time. Therefore, this technology has not been taken forward as it is not considered market ready due to the small number of suppliers, substantially higher capital costs and the potentially high operating costs including major replacement of key components.

3. Proposed Energy and Low Carbon Strategy

3.1 The potential systems outlined in Section 2 were evaluated for the Project to determine the most appropriate technologies to use to deliver the required carbon savings. The evaluations considered the advantages and disadvantages of each system, design considerations, contributions to CO_2 savings, indicative payback periods and the relevant selection criteria. The early stage evaluation results are included in Appendices 1A, 1B, 1C and 1D for information. Further evaluation and development of the potentially viable technologies were then considered in Section 2 to determine potential capacities that could be used. Thermal modelling was carried out to assess the carbon impact, and this has led to the conclusions and overall strategy that follows in this section.

3.2 District heating would be the most economically viable option, requiring less investment, less plant space and offering good carbon savings, and is consistent with policies in the London Plan. However since the district heating system is only likely to be installed in sections over the next 5 to 10 years, and the Project is likely to be complete before then, provisions for future connectivity will be provided in the form of valved and capped-off connections and space for future heat exchangers. As and when available in the future, this will be a key element of the Airport's longer term energy and low carbon strategy.

3.3 Therefore, following the feasibility assessment discussed above, the Energy and Low Carbon Strategy set out below is proposed, based on the GLA energy hierarchy of reducing CO_2 emissions via a 'be lean, be clean and be green' priority approach:

- Design measures proposed to be lean include:
  - Passive measures such as:
    - Efficient thermal envelope to reduce heat losses;
    - Solar shading to reduce heat gains; and
    - Use of natural daylighting where possible to reduce lighting energy requirements.
  - Energy efficient systems to meet GLA and Part L, SBEM CO_2 emissions requirements;
  - High efficiency lighting;
  - High efficiency plant and equipment; and
  - Low energy systems e.g. using heat reclaim where possible with appropriate controls.

- Design measures proposed to be clean include:
  - Provisions (e.g. valved connections) for connectivity to a future district heating system. This connection can be made in the future when a district heating system becomes available in the area, the timescale of which is uncertain at present but likely to be in the next five to ten years; and
  - Small scale localised CCHP (Combined Cooling, Heat and Power) systems to suit base load profiles. Capacities proposed are: 35kWt for the proposed Western Terminal Extension & Coaching Gate, 230kWt for the proposed Eastern Terminal Extension, and presently calculated size of 330kWt for the proposed Hotel. The CCHP plant will be located in two Energy Centres (east and west) due to proposed phasing and proximity.

- Design measures proposed to be green include:
  - Photovoltaic (PV) arrays on the roofs of the Terminal buildings, Taxi and Car Rental Facilities building and the roofing of the canopied walkway; and
  - A closed loop dock source heat exchange (DSHE) system. Depending on the detail of the DSHE system, the capacities for the CCHP systems may vary since some of the loads could be offset.

3.4 Using the design measures set out above, the design is able to meet and better the Part L and London Plan 2011 requirements of a 25% CO_2 reduction relative to a 2010 benchmark.

3.5 The strategy also acknowledges that Part L of the Building Regulations and London Plan policy may seek a higher target from October 2013, of a 40% reduction in CO_2 emissions compared to 2010. In this respect space has been safeguarded for further PV arrays which together with further optimisation measures as the design develops (as energy efficiencies of the latest products and systems improve further e.g. lighting), would ensure that the scheme can respond to and meet this more challenging target.

3.6 The following graphs, figures 11a, 11b, 11c and 11d, have been produced using the early stage thermal model results and the GLA guidance on preparing energy assessments to show the effect of the energy strategy. They show that by adopting the energy efficiency measures (be lean), the CCHP system (be clean) and the photovoltaics and DSHE system (be green), the buildings are able to surpass Part L 2010 and current GLA requirements to achieve 25% (GLA 2011) improvements over part L 2010. The graphs also show the forthcoming 40% target for information, which can be achieved by using additional PVs on the roofs of the new and existing buildings and further efficiency and optimisation measures.

3.7 The energy measures proposed contribute towards achieving a BREEAM ‘very good’ rating for the airport terminal buildings, as explained in detail in the Sustainability Statement also accompanying the application.

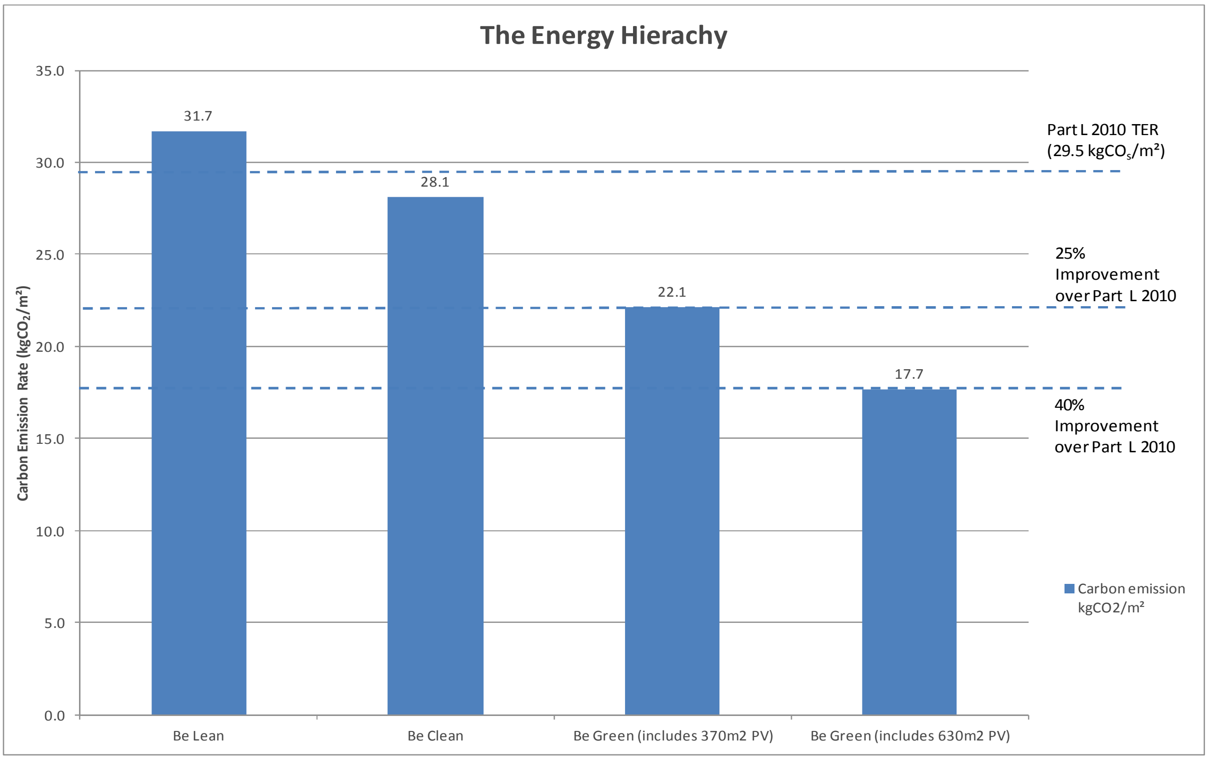


Figure 11a: Western Terminal Extension

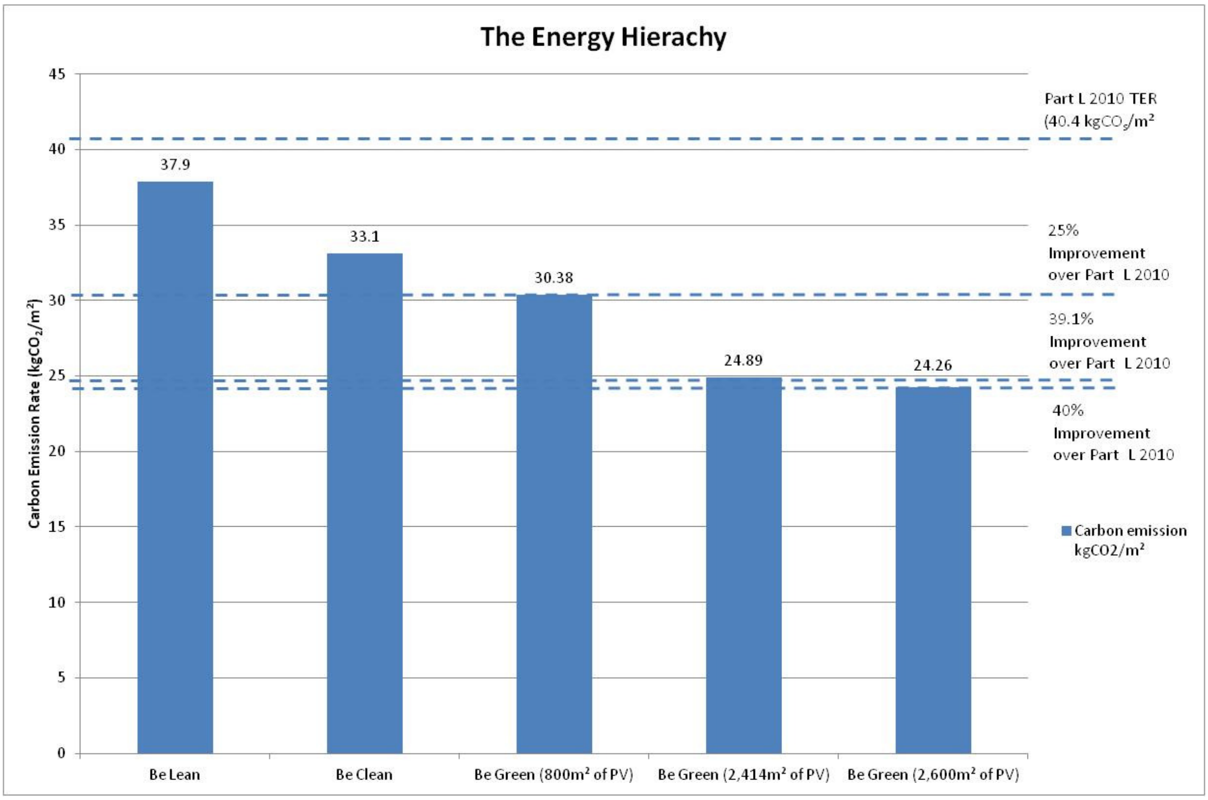


Figure 11b: Eastern Terminal Extension

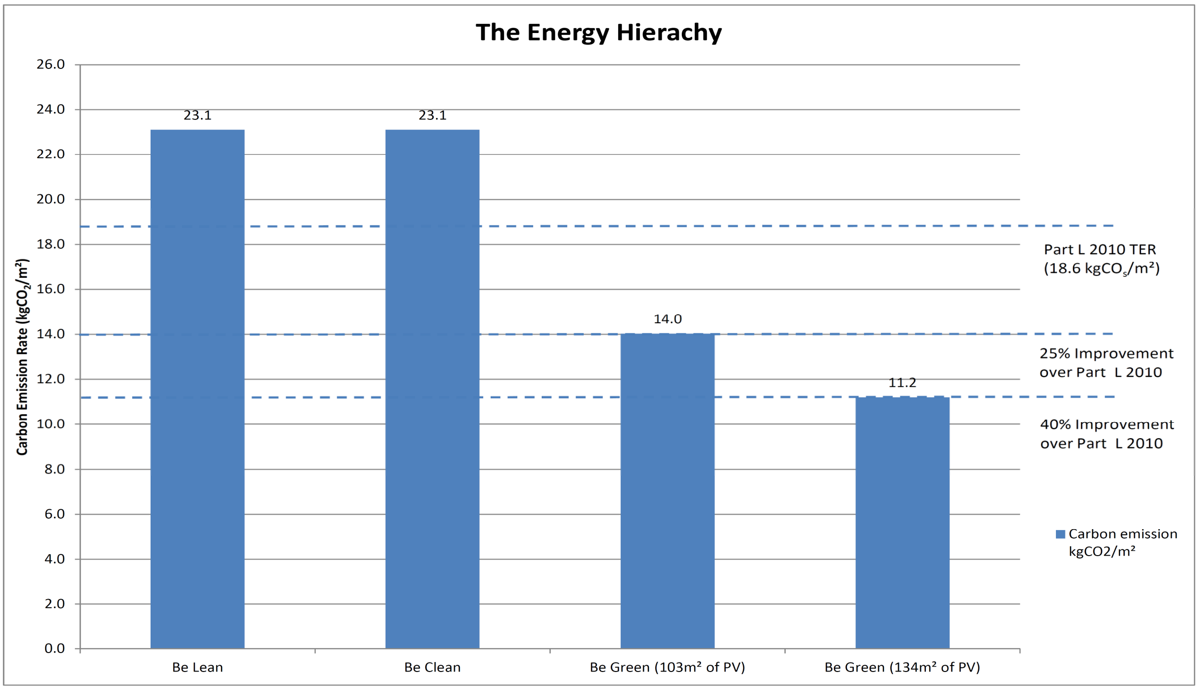


Figure 11c: Taxi and Car Rental Facilities building

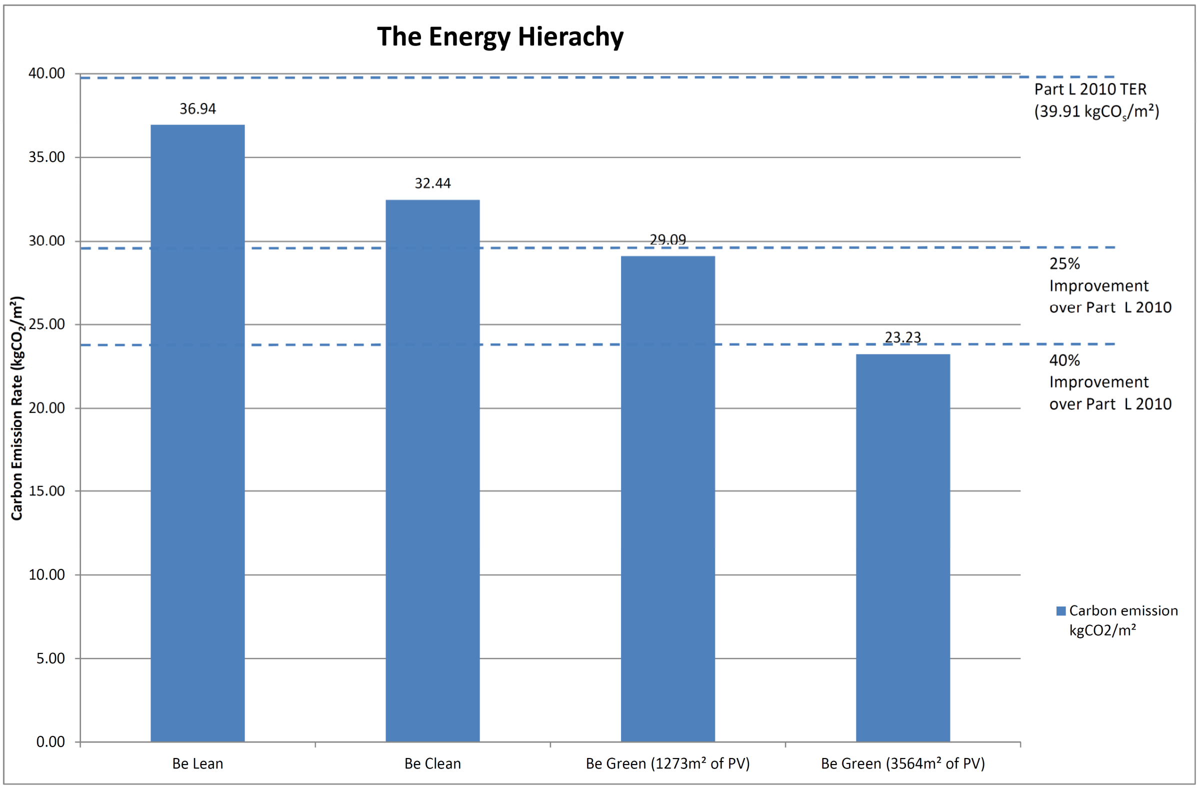


Figure 11d: Overall Terminal Extensions (including Coaching Gate)

Appendix 1A: Initial Evaluation of low Carbon Technologies

Technology	Shortlisted for further consideration?	Reason	Consideration	Equipment required	Other Requirements	Emissions Data (where appropriate)
Biomass Heating	No	It is considered unlikely that the emissions will be acceptable with regard to meeting the local authority's air quality management plan.	Air quality issues with boiler flue emissions and meeting air quality management plans Meeting with LBN in early Nov 2012 indicate that use of biomass is not favoured due to emissions. Additional space required for storage of fuel. Storage size will determine frequency of deliveries. This could be as often as every two weeks. Type of fuel e.g. wood pellets or wood chips. Wood pellets more viable than wood chips, as storage space required is smaller and the fuel has a higher calorific value per kg. Security of supply - concern over long term fuel supplies. Lag gas fired boiler/s will be required, as the Biomass boiler will be sized to deal with the building's base load, as its more efficient to operate a biomass boiler with a steady and continuous load.	Biomass boiler, biomass store, conveyor system, insulated heating pipework between biomass boiler plantroom and terminal plantroom.	Would need to include a 5m tall pellet boiler silo. Flue height is required to be 2m above tallest plant, therefore 7m. If there are any buildings within 5 times the flue height, i.e. 5 x 7 = 35m radius, then the flue will need to be a minimum of 2m above this.	
Dock Water Source Heat Pump	Yes – closed loop heat exchange system	Reduces demand on the central heating and cooling systems. (Using individual systems to serve the pier gateroom Air Handling Units.	Geological and ecological constraints could affect this. Approval required from docks authorities and other stakeholders. Environmental Agency (EA) considerations: - For open water loop heat pump systems, two licenses and a flood risk assessment would be required. - For a closed loop heat pump system, an ecology assessment may be required. - Refer to Dock Source Heat Pump section for further information. The closed loop heat exchange system proposals were discussed with the EA and they have confirmed their support of a dock source heat exchange system.	Due to marine environment, some parts of system e.g. frames requires the use of cupronickel or stainless steel material. An open loop system would require an additional heat exchanger to prevent fouling.	25 x 25m area of dock water required per AHU stand heat exchange system.	
CCHP (Tri-generation)	Yes	Can provide both heating and cooling, and reduce carbon emissions compared to a traditional boiler and chiller system.	Needs to match load profiles. CCHP found to be more viable than CHP for the proposed West and East Terminal Extensions based on load profiles. With tri-generation, the excess heat can be used by the absorption chiller to provide cooling. CCHP also feasible for the hotel as an alternative to CHP. CCHP would only cover the base loads for heating, approximately 25% of the peak load. The remainder would be covered by a gas fired lag boiler and air cooled chillers.	Gas fired spark ignition (4-stroke engine), synchronous generator, heat recovery system, control system, associated pipework, dry air cooler & a hot water-fired absorption chiller.	Flue will be required to be at least 1.5m higher than the surrounding building.	The air quality consultant has advised that the emissions data from the supplier for the proposed small scale CCHP systems are unlikely to lead to objections by the local authority.
CHP	Possibly as an alternative to CCHP, if load profiles are suitable (e.g. hotel)	Needs to match load profiles	For the proposed West and East Terminal Extensions the intermittent heating profile does not give a suitable base load for a heating only CHP system; (CCHP offers more benefit.) For the hotel, CHP could be considered for use due to adequate domestic hot water loads throughout the year.	-	-	-

Technology	Shortlisted for further consideration?	Reason	Consideration	Equipment required	Other Requirements	Emissions Data (where appropriate)
Horizontal Wind Turbine	No	Due to the heights of building to the south, turbulence will significantly reduce overall efficiency of the turbines	Surrounding buildings, wind speed, prevailing wind direction.	-	-	-
Vertical Wind Turbine	No	Not viable since the average wind speed is less than the required 5m/s	Need wind speed >5m/s	Vertical turbines, pole mountings, electrical connectivity	Require 50m spacing between each turbine.	n/a
Solar Water Heating	Possibly, if no CHP / CCHP system	Would only be viable if there are no CHP/CCHP heating provisions	Viability would be affected by C/CHP. A suitable area will need to be coordinated with the PV installation. A low cost way of integrating renewable energy	Solar thermal panels, pumps, storage vessel & pipework.	Space required on roofs. Space subject to assessment of demand & suitability.	n/a
Mini CHP or CHP	Possibly depending on load profiles and annual running hours.	High efficiency of system in generating power and heat. However economic viability at site and suitable size of installation needs further investigation.	Unit needs to run in excess of 5000 hrs/year for financial viability. This will restrict size of system that could be viable, and hence contribution to the 25% over Part L. Sizing of system important to overall efficiency and viability of future projects. Mini-CHP not yet commonly used. Needs continuous heat rejection throughout the year.	CHP unit/s, plantroom, potential gas upgrades, electrical connectivity, excess heat rejection. Possibly 30-35 kW mini-CHP dependent on load profiles.		It has been advised by the air quality consultant that the emissions data from the supplier are unlikely to lead to objections by the local authority.
Photovoltaic PVs	Yes, as will mostly likely be required to supplement one of the other low carbon options	Long payback but with increasing energy prices may pay back within life.	Can make significant carbon savings. Almost certainly required to meet the 25% improvements required over Part L.	PV panels, electrical connectivity	Significant areas required facing south at a 30-40° angle.	n/a
District Heating	Provision for future connectivity	District heating system unlikely to be available for the next 5-10 years	Offers good carbon savings Low plant space requirements Make provision for potential future connectivity	Valves and safeguarded space for future heat exchangers in the energy centres		
Biomass CHP	No	It is considered unlikely that the emissions will be acceptable given the local authority's air quality management plan.	Increased storage. Fuel consumption significant. Technology not well established for small scale installation.	-		

Appendix 1B: Initial Low Carbon Energy & Renewable Systems Optioneering: Eastern Terminal Extension

Based on early stage IES model :

Options Tested vs base case V01:	V01 Energy Efficient Measures with Gas Boilers (Base Case)	V02 Use Biomass Boiler as part of heating system to meet base load	V03 Use CHP system for part load	V04 Use Biomass CHP system for part load	V07 Use mini-CHP system for part load	V05 Use CCHP system for part load	V06 Use Biomass CCHP system for part load
Pro's	• No specialised equipment so more easily maintainable	• Biomass reduces extent of PVs required	• Considered in GLA energy hierarchy as an efficient energy supply option	• Biomass reduces extent of PVs required • CHP considered in GLA energy hierarchy as an efficient energy supply option	• CHP considered in GLA energy hierarchy as an efficient energy supply option	• C/CHP considered in GLA energy hierarchy as an efficient energy supply option	• Reduces extent of PVs required • C/CHP can supply energy efficiently (subject to load profiles) • C/CHP considered in GLA energy hierarchy as an efficient supply option • Additional plant space required
Con's		• Biomass deliveries & storage issues • more plant space requirements • Emissions Issues • Needs further discussion with LBN & GLA (LBN advised CHP/CCHP preferred to biomass)	• Does not suit load profiles for project • Potential Emissions issues • Needs further discussion with LBN&GLA	• Does not suit load profiles for project • Biomass deliveries & storage issues • Additional plant space required • Emissions Issues • Needs further discussion with LBN & GLA (LBN advised CHP/CCHP preferred to biomass)	• Potential Emissions issues • Needs further discussion with LBN & GLA • Could be sized to meet domestic hot water load for project • Additional plant & plant space requirements	• Potential Emissions Issues (size dependant) • Needs further discussion with LBN&GLA • Additional plant & plant space required • Subject to further viability assessments. Load profiles would only suit a small CCHP system if viable	• Biomass deliveries & storage issues • Additional plant & plant space required • Emissions Issues • Needs further discussion with LBN & GLA • Subject to further viability assessments. Load profiles would only suit a small CCHP system if viable
% CO2 savings vs base Case	0.0	24.8	4.7	36.3	1.9	7.6	41.0
% CO2 savings vs 2010 Target							
Indicative preliminary payback of technology (excluding PV element)		20-50 years depending on relative fuel price	medium/large CHP not viable for loads	medium/large CHP not viable for loads	20-50 years depending on capacity, run time & draw off	25 years	50+ years
Comparative % PV area required relative to base case	100	66	87	33	95	78	19
Relative % capital cost (incl PVs) vs base case	100	102.5	100	92.5	97.5	100	70
Consider / Discount		Discount due to biomass emissions, deliveries, storage, additional maintenance, larger energy centre etc	Discount. Medium/large CHP not viable due to load profiles	Discount Medium/large biomass CHP not viable due to load profiles. Also due to biomass emissions, deliveries, storage, additional maintenance, larger energy centre etc	Can consider further, subject to further evaluation, though capacity limited due to hot water profiles.	Consider further, subject to further evaluation	Discount due to biomass emissions, deliveries, storage, additional maintenance, larger energy centre etc
Green : Consider further Amber : Investigate further as an option Red : Unviable/unlikely							

Options Tested vs base case V01:	V08 Impact of Shading vs V01	V09 Use Dock Source Heat Pump for part cooling / heating load	V11.1 Use Future District Heating for space heating load (emission factor of 0.025 for DH plant)	V12.1 Use Solar Thermal for domestic water heating load	V13 30kW wind turbine 5 turbines, 6kW each, tower height 11.8m. Total power output 30kW	V14 • CCHP • 2600m² PV • Solar shading • Energy efficient measures • Dock source heat pump
Pro's	• Shading recommended to South & East facing facades to reduce solar gains and associated cooling requirements	• LBN seem to have expressed an interest in this technology	• DH considered in GLA energy hierarchy as an efficient energy supply option	• Can provide some energy savings (if no other renewable heat sources used)	• Can provide energy savings in favourable conditions	• Favourable combination of design options that provides a design that can meet the GLA 40% improvement target. (*Use of 2,414m2 PV provides 39% improvement) • Applied options include inovative use of local dock water.
Con's	• Cleaning / maintainability issues	• Ecological Impacts due to water temperature increase • Need to discuss further with relevant authorities incl EA, EA fisheries, RODMA etc	• Unlikely to be available in the timescale of our project	• Potential glare issues • Maintainability	• Windspeed reduction & inefficiencies due to T&L building • Potential radio & communication interference issues • Maintainability	
% CO2 savings vs base Case	8.9	2.5	19.5	0.8	0.6	54.1
% CO2 savings vs 2010 Target						40%
Indicative preliminary payback of technology (excluding PV element)	Required design measure for cooling cost savings	20 years	2-10 yrs depending on system factor	10-20 years	15-20 years	
Comparative % PV area required relative to base case	75	99	73	98	98	
Relative % capital cost (incl PVs) vs base case	67.5	100	70	100	110	
Consider / Discount	Consider - reduces cooling energy and cost - reduces PV requirement	Needs further discussion with EA.	Consider further though unlikely to be available in project timescale. Provide connectivity for future DH system.	Consider further if no other heat source (eg no mini-CHP)	Discount due to windspeed interference from T&L and other surrounding buildings	Consider further. (Design is subject to further evaluation and development during detailed design stage.)
Green : Consider further Amber : Investigate further as an option Red : Unviable/unlikely			Provision for future connectivity			V14 represents the design options that that have been investigated in the current design. (*Use of 2,414m2 PV instead of 2600m2 PV provides 39% improvement)

Carbon emission kgCO₂/m²	BER	2010 Target	GLA target
V01	52.9	45.8	34.4
V02	39.8	36.8	27.6
V03	50.4	45.8	34.4
V04	33.7	36.8	27.6
V07	51.9	45.8	34.4
V05	48.9	45.8	34.4
V06	31.2	36.8	27.6
V08	48.2	45.8	34.4
V09	51.6	44.4	33.3
V11.1 (GLA column: 25% reduction based on 2010 TER)	42.6	38.7	29.0
V12.1 (GLA column: 25% reduction based on 2010 TER)	52.5	45.8	34.4
V13 (GLA column: 25% reduction based on 2010 TER)	52.6	45.8	34.4
V14 (GLA target (40%))	24.26	41.4	24.8

*Variants V01 to V14 indicate system variation options that were evaluated for carbon dioxide savings. Column V14 indicates the system selection that can achieve a 39-40% carbon improvement.

Appendix 1C: Initial Low Carbon Energy & Renewable Systems Optioneering: Western Terminal Extension

Based on early stage IES model :

Options Tested vs base case V01:	V01 Energy Efficient Measures with Gas Boilers (Base Case)	V02 Impact of Shading vs V01	V03 Use mini-CHP system for part load + shading	V04 Use CCHP system for part load + shading	V05 Use water cooled chillers (dock water heat rejection) + shading	V06 Use Future District Heating for space heating load (emission factor of 0.025 for DH plant) + shading	V07 CCHP system for part load + 630m^2 PV + shading
Pro's	• No specialised equipment so more easily maintainable	• Shading recommended to South & West facing facades to reduce solar gains and associated cooling requirements	• CHP considered in GLA energy hierarchy as an efficient energy supply option	• C/CHP considered in GLA energy hierarchy as an efficient energy supply option	• LBN seem to have expressed an interest in this technology	• DH considered in GLA energy hierarchy as an efficient energy supply option	• C/CHP considered in GLA energy hierarchy as an efficient energy supply option
Con's		• Cleaning / maintainability issues	• Potential Emissions issues • Needs further discussion with LBN & GLA • Could be sized to meet domestic hot water load for project • Additional plant & plant space requirements	• Potential emissions issues • Needs further discussion with LBN&GLA • Additional plant & plant space required • Subject to further viability assessments. Load profiles would only suit a small CCHP system if viable	• Ecological Impacts • Need to be agreed with relevant authorities incl EA, RODMA etc	• Unlikely to be available in the timescale of our project	• Potential emissions issues • Needs further discussion with LBN&GLA • Additional plant & plant space required • Subject to further viability assessments. Load profiles would only suit a small CCHP system if viable
% CO2 savings vs base Case	0.0	2.0	4.7	5.1	2.2	5.1	30.3
% CO2 savings vs 2010 Target	13.9	15.6	18.0	18.3	15.8	18.3	40.0
Indicative preliminary payback of technology (excluding PV element)		Required design measure for cooling cost savings	20-50 years depending on capacity, run time & draw off	25 years	20 years	2-10 yrs depending on system factor	25 years
Comparative % PV area required relative to base case	100	85	63	60	83	60	
Consider / Discount		Consider - reduces cooling energy and cost - reduces PV requirement	Can consider further, subject to further evaluation, though capacity limited due to hot water profiles.	Consider further, subject to further evaluation	Needs further discussion with EA & evaluation.	Consider further though unlikely to be available in project timescale. Provide connectivity for future DH system.	Consider further, subject to further evaluation
Green : Consider further Amber : Investigate further as an option Red : Unviable/unlikely						Provision for future connectivity	V07 represents the desing options that have been carried through within the current design.

	V01			V02			V03			V04			V05			V06			V07		
Carbon emission kgCO$_2$/m^2	BER	2010 Target	GLA target (25%)	BER	2010 Target	GLA target (25%)	BER	2010 Target	GLA target (25%)	BER	2010 Target	GLA target (25%)	BER	2010 Target	GLA target (25%)	BER	2010 Target	GLA target (25%)	BER	2010 Target	GLA target (40%)
	25.4	29.5	22.1	24.9	29.5	22.1	24.2	29.5	22.1	24.1	29.5	22.1	24.8	29.5	22.1	24.1	29.5	22.1	17.7	29.5	17.7

*Variants V01 to V07 indicate system variation options that were evaluated for carbon dioxide savings. Column V07 indicates the system selection that can achieve a 40% carbon improvement.

Appendix 1D: Initial Low Carbon Energy & Renewable Systems Optioneering: Taxi & Car Rental Facilities Building

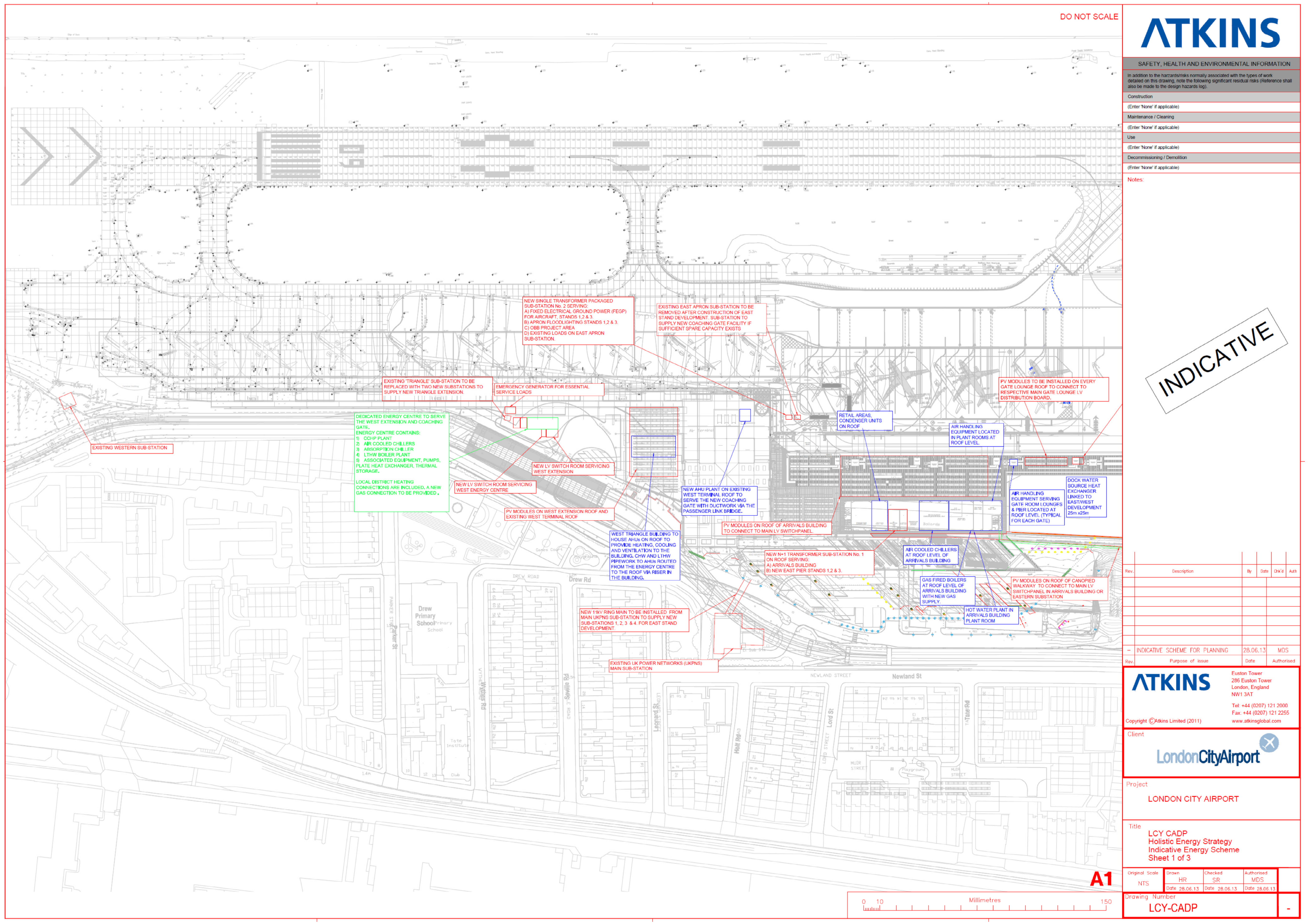
Preliminary : Based on early stage IES thermal model

Options Tested vs base case V01:	V01 Energy Efficient Measures (Base Case)	V02 Energy Efficient Measures + 134m2 PV	V03 Use mini-CHP system for part load	V04 Use CCHP system for part load	V05 Use water cooled chillers (dock water heat rejection)
Pro's	• No specialised equipment so more easily maintainable	• Can make significant carbon savings. • Almost certainly required to meet the 25% improvments required over Part L.	• CHP considered in GLA energy hierarchy as an efficient energy supply option	• C/CHP considered in GLA energy hierarchy as an efficient energy supply option	• LBN seem to have expressed an interest in this technology
Con's		• Long payback but with increasing energy prices may pay back within life	• Would needs constant thermal & power loads throughout year that match CHP output. Load profiles for this building would not be suitable. • Additional plant & plant space requirements	• Would needs constant thermal & power loads throughout year that match CHP output. Load profiles for this building would not be suitable. • Additional plant & plant space requirements	• Potential ecological impacts • Need to discuss further with relevant authorities incl EA, EA fisheries, RODMA etc
% CO2 savings vs base Case	0.0	51.5	NA	NA	NA
Consider / Discount		Consider further, subject to further evaluation. Almost certain to be required in order to meet 25% improvement over Part L.	Load profiles for this building would not be suitable for CHP. Building too far away from energy centre and loads too small to be feasible for connectivity to Energy Centre. Other localised energy efficient systems would be better suited.	Load profiles for this building would not be suitable for CCHP. Building too far away from energy centre and loads too small to be feasible for connectivity to Energy Centre. Other localised energy efficient systems would be better suited.	Building too far away from docks and loads too small to be feasible.
Green : Consider further Amber : Investigate further as an option Red : Unviable/unlikely					

	BER	2010 Target (TER)	GLA target (25%)	Future Target (40%)	BER	2010 Target (TER)	GLA target (25%)	Future Target (40%)
Carbon emission $kgCO_2/m^2$	23.1	18.6	14.0	11.2	11.2	18.6	14.0	11.2
PV needed for 2010 with GLA improvement (m^2)	103.0				103.0			
PV needed for 2010 with 40% improvement (m^2)	134.0				134.0			

*Variants V01 to V05 indicate system variation options that were evaluated for carbon dioxide savings. Column V02 indicates the system selection that can achieve a 40% carbon improvement over 2010 regulations.

Appendix 2: Holistic Energy Strategy: Drawings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EXISTING WESTERN SUB-STATION
NEW SINGLE TRANSFORMER PACKAGED SUB-STATION No. 2 SERVING: A) FIXED ELECTRICAL GROUND POWER (FEGP) FOR AIRCRAFT, STANDS 1,2 & 3. B) APRON FLOODLIGHTING STANDS 1,2 & 3. C) OBB PROJECT AREA D) EXISTING LOADS ON EAST APRON SUB-STATION.
EXISTING EAST APRON SUB-STATION TO BE REMOVED AFTER CONSTRUCTION OF EAST STAND DEVELOPMENT. SUB-STATION TO SUPPLY NEW COACHING GATE FACILITY IF SUFFICIENT SPARE CAPACITY EXISTS
EXISTING 'TRIANGLE' SUB-STATION TO BE REPLACED WITH TWO NEW SUBSTATIONS TO SUPPLY NEW TRIANGLE EXTENSION.
EMERGENCY GENERATOR FOR ESSENTIAL SERVICE LOADS
DEDICATED ENERGY CENTRE TO SERVE THE WEST EXTENSION AND COACHING GATE. ENERGY CENTRE CONTAINS: 1) CCHP PLANT 2) AIR COOLED CHILLERS 3) ABSORPTION CHILLER 4) LTHW BOILER PLANT 5) ASSOCIATED EQUIPMENT, PUMPS, PLATE HEAT EXCHANGER, THERMAL STORAGE. LOCAL DISTRICT HEATING CONNECTIONS ARE INCLUDED. A NEW GAS CONNECTION TO BE PROVIDED.
NEW LV SWITCH ROOM SERVICING WEST EXTENSION
NEW LV SWITCH ROOM SERVICING WEST ENERGY CENTRE
PV MODULES ON WEST EXTENSION ROOF AND EXISTING WEST TERMINAL ROOF
NEW AHU PLANT ON EXISTING WEST TERMINAL ROOF TO SERVE THE NEW COACHING GATE WITH DUCTWORK VIA THE PASSENGER LINK BRIDGE.
WEST TRIANGLE BUILDING TO HOUSE AHUs ON ROOF TO PROVIDE HEATING, COOLING AND VENTILATION TO THE BUILDING. CHW AND LTHW PIPEWORK TO AHUs ROUTED FROM THE ENERGY CENTRE TO THE ROOF VIA RISER IN THE BUILDING.
RETAIL AREAS, CONDENSER UNITS ON ROOF
AIR HANDLING EQUIPMENT LOCATED IN PLANT ROOMS AT ROOF LEVEL.
PV MODULES TO BE INSTALLED ON EVERY GATE LOUNGE ROOF TO CONNECT TO RESPECTIVE MAIN GATE LOUNGE LV DISTRIBUTION BOARD.
AIR HANDLING EQUIPMENT SERVING GATE ROOM LOUNGES & PIER LOCATED AT ROOF LEVEL (TYPICAL FOR EACH GATE)
DOCK WATER SOURCE HEAT EXCHANGER LINKED TO EAST/WEST DEVELOPMENT 25m x25m
PV MODULES ON ROOF OF ARRIVALS BUILDING TO CONNECT TO MAIN LV SWITCHPANEL.
NEW N+1 TRANSFORMER SUB-STATION No. 1 ON ROOF SERVING: A) ARRIVALS BUILDING B) NEW EAST PIER STANDS 1,2 & 3.
AIR COOLED CHILLERS AT ROOF LEVEL OF ARRIVALS BUILDING
GAS FIRED BOILERS AT ROOF LEVEL OF ARRIVALS BUILDING WITH NEW GAS SUPPLY.
PV MODULES ON ROOF OF CANOPIED WALKWAY TO CONNECT TO MAIN LV SWITCHPANEL IN ARRIVALS BUILDING OR EASTERN SUBSTATION
HOT WATER PLANT IN ARRIVALS BUILDING PLANT ROOM
NEW 11kV RING MAIN TO BE INSTALLED FROM MAIN UKPNS SUB-STATION TO SUPPLY NEW SUB-STATIONS 1, 2, 3 & 4. FOR EAST STAND DEVELOPMENT.
EXISTING UK POWER NETWORKS (UKPNS) MAIN SUB-STATION
Drew Rd
Newland St
NEWLAND STREET
Drew Primary School
A1
Millimetres
ATKINS
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
Construction
Maintenance / Cleaning
Use
Decommissioning / Demolition
Notes:
INDICATIVE
Rev. Description By Date Chk'd Auth
- INDICATIVE SCHEME FOR PLANNING 28.06.13 MDS
Rev. Purpose of issue Date Authorised
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Project
LONDON CITY AIRPORT
Title
LCY CADP
Holistic Energy Strategy
Indicative Energy Scheme
Sheet 1 of 3
Original Scale NTS
Drawn HR Date 28.06.13
Checked SR Date 28.06.13
Authorised MDS Date 28.06.13
Drawing Number
LCY-CADP
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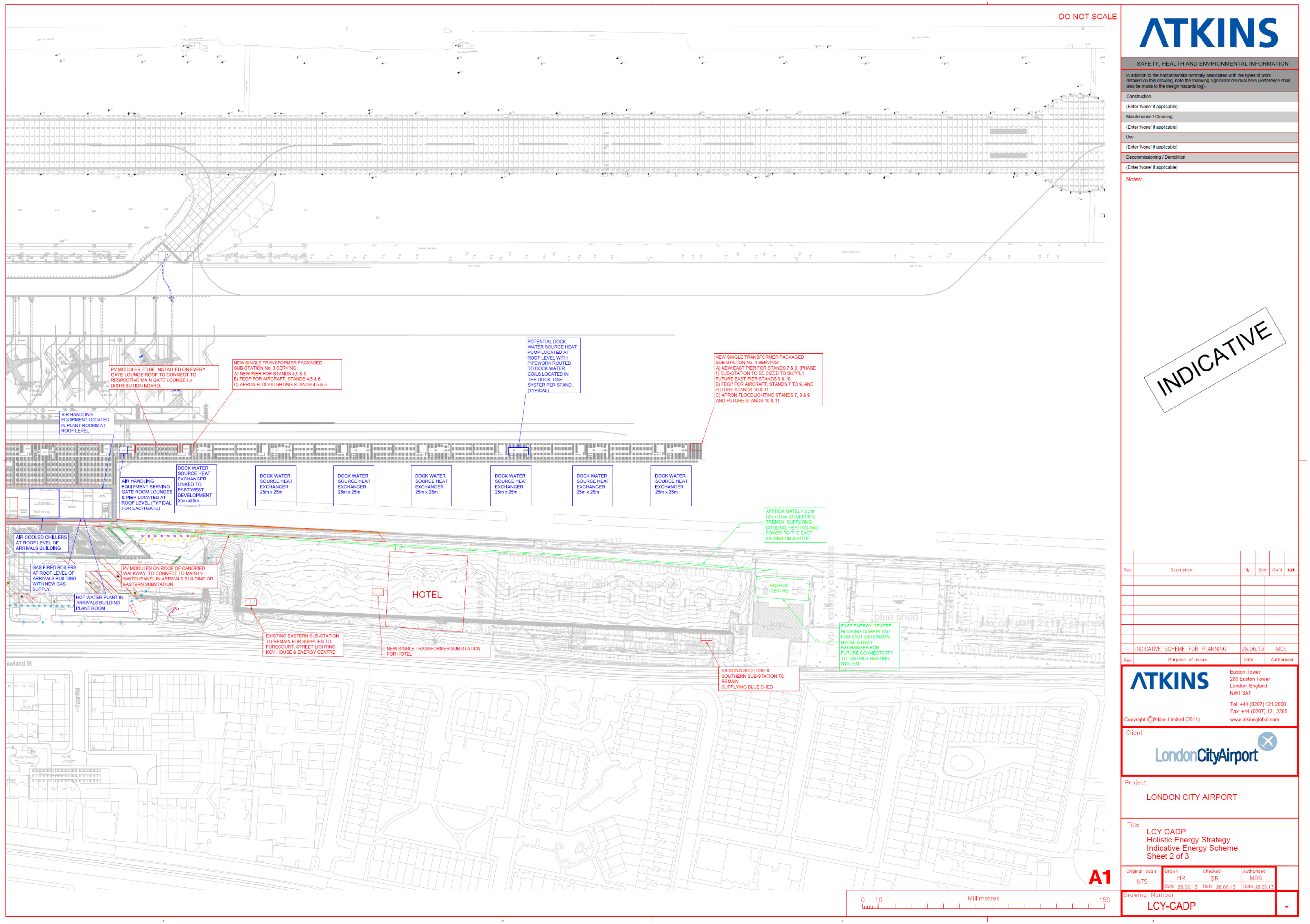
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SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
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Construction
(Enter 'None' if applicable)
Maintenance / Cleaning
(Enter 'None' if applicable)
Use
(Enter 'None' if applicable)
Decommissioning / Demolition
(Enter 'None' if applicable)
Notes:
INDICATIVE
PV MODULES TO BE INSTALLED ON EVERY GATE LOUNGE ROOF TO CONNECT TO RESPECTIVE MAIN GATE LOUNGE LV DISTRIBUTION BOARD.
NEW SINGLE TRANSFORMER PACKAGED SUB-STATION No. 3 SERVING: A) NEW PIER FOR STANDS 4,5 & 6. B) FEGP FOR AIRCRAFT, STANDS 4,5 & 6. C) APRON FLOODLIGHTING STANDS 4,5 & 6.
POTENTIAL DOCK WATER SOURCE HEAT PUMP LOCATED AT ROOF LEVEL WITH PIPEWORK ROUTED TO DOCK WATER COILS LOCATED IN THE DOCK. ONE SYSTER PER STAND. (TYPICAL)
NEW SINGLE TRANSFORMER PACKAGED SUB-STATION No. 4 SERVING: A) NEW EAST PIER FOR STANDS 7 & 8. (PHASE 1) SUB-STATION TO BE SIZED TO SUPPLY FUTURE EAST PIER STANDS 9 & 10. B) FEGP FOR AIRCRAFT, STANDS 7 TO 9, AND FUTURE STANDS 10 & 11. C) APRON FLOODLIGHTING STANDS 7, 8 & 9 AND FUTURE STANDS 10 & 11.
AIR HANDLING EQUIPMENT LOCATED IN PLANT ROOMS AT ROOF LEVEL.
AIR HANDLING EQUIPMENT SERVING GATE ROOM LOUNGES & PIER LOCATED AT ROOF LEVEL (TYPICAL FOR EACH GATE)
DOCK WATER SOURCE HEAT EXCHANGER LINKED TO EAST/WEST DEVELOPMENT 25m x25m
DOCK WATER SOURCE HEAT EXCHANGER 25m x 25m
DOCK WATER SOURCE HEAT EXCHANGER 25m x 25m
DOCK WATER SOURCE HEAT EXCHANGER 25m x 25m
DOCK WATER SOURCE HEAT EXCHANGER 25m x 25m
DOCK WATER SOURCE HEAT EXCHANGER 25m x 25m
DOCK WATER SOURCE HEAT EXCHANGER 25m x 25m
APPROXIMATELY 2.2m (W) x 0.5m (D) SERVICE TRENCH, SUPPLYING COOLING, HEATING AND POWER TO THE EAST EXTENSION & HOTEL.
AIR COOLED CHILLERS AT ROOF LEVEL OF ARRIVALS BUILDING
GAS FIRED BOILERS AT ROOF LEVEL OF ARRIVALS BUILDING WITH NEW GAS SUPPLY.
PV MODULES ON ROOF OF CANOPIED WALKWAY TO CONNECT TO MAIN LV SWITCHPANEL IN ARRIVALS BUILDING OR EASTERN SUBSTATION
HOT WATER PLANT IN ARRIVALS BUILDING PLANT ROOM
HOTEL
ENERGY CENTRE
pax car park 1 (263 spaces)
blue shed
EAST ENERGY CENTRE HOUSING CCHP PLANT FOR EAST EXTENSION, HOTEL & HEAT EXCHANGER FOR FUTURE CONNECTIVITY TO DISTRICT HEATING SYSTEM
EXISTING EASTERN SUB-STATION TO REMAIN FOR SUPPLIES TO FORECOURT, STREET LIGHTING, KGV HOUSE & ENERGY CENTRE
NEW SINGLE TRANSFORMER SUB-STATION FOR HOTEL
EXISTING SCOTTISH & SOUTHERN SUB-STATION TO REMAIN. SUPPLYING BLUE SHED
Scale: NTS
Rev. | Description | By | Date | Chk'd | Auth
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Rev. | Purpose of issue | Date | Authorised
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LCY-CADP
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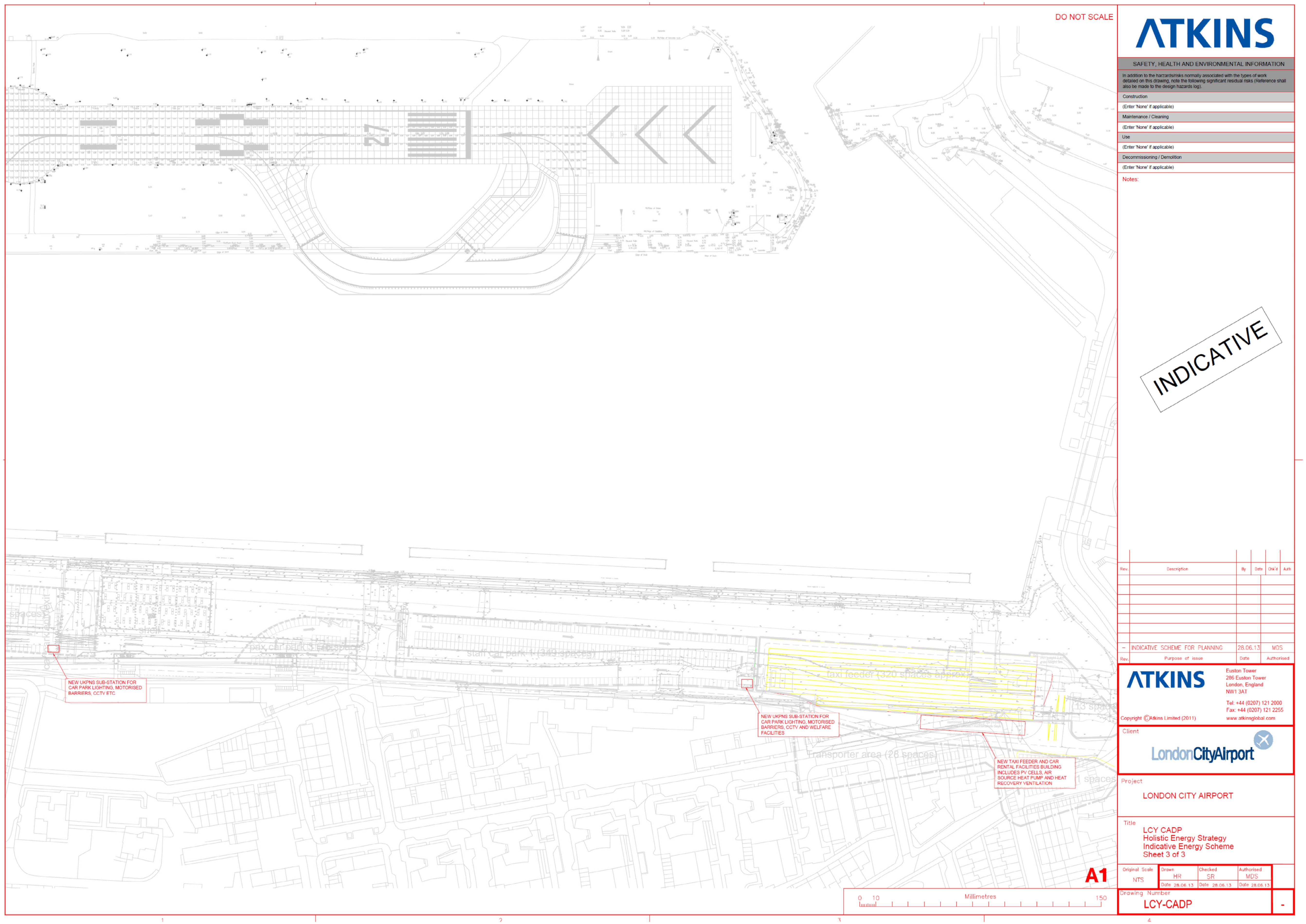
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Construction
(Enter 'None' if applicable)
Maintenance / Cleaning
(Enter 'None' if applicable)
Use
(Enter 'None' if applicable)
Decommissioning / Demolition
(Enter 'None' if applicable)
Notes:
INDICATIVE
NEW UKPNS SUB-STATION FOR CAR PARK LIGHTING, MOTORISED BARRIERS, CCTV ETC
NEW UKPNS SUB-STATION FOR CAR PARK LIGHTING, MOTORISED BARRIERS, CCTV AND WELFARE FACILITIES
NEW TAXI FEEDER AND CAR RENTAL FACILITIES BUILDING INCLUDES PV CELLS, AIR SOURCE HEAT PUMP AND HEAT RECOVERY VENTILATION
taxi feeder
Transporter area
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