Network Rail

Kings Cross Station Enhancement

Energy Statement

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Rep 205

August 2006

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Job number

ARUP

Job title	Kings Cross Station E	Job number	54200-61
Document title	Energy Statement Report 205	File reference	
Document ref			

Revision	Date	Filename	Kings Cross Energy Statement.doc		
Draft 1	13/08/06	Description	First draft		
			Prepared by	Checked by	Approved by
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Issue	14/08/06	Filename	0003Kings Cross Station Enhancement Energy Strategy Issue 1.doc		
		Description	Second draft		
			Prepared by	Checked by	Approved by
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		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

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1 Executive summary

This document describes how the proposed development at Kings Cross Station Enhancement (KXSE) addresses the energy efficiency and renewable energy requirements of the London Plan as defined in the London Plan Policy 4A.7, 8 and 9.

In accordance with the London Plan, the development incorporates design features that significantly reduce energy consumption by more than 20% compared with other developments of its kind.

An evaluation of renewables using the guidelines of the London Renewables toolkit shows that photovoltaics and biomass boilers are renewable technologies that are suitable for application to this development.

Consideration will be given to installing biomass boilers burning wood pellets to provide heating to the office accommodation. As a result, it is calculated that about 2% of the base energy demand would be generated from renewable sources, as calculated using the London Renewables Toolkit. The problem of the severe shortage of space for fuel storage will be addressed in the detailed design phase of this project.

Where economically and technically feasible, it is proposed to install photovoltaic arrays for the production of electrical energy.

The exact type and configuration of renewable energy approaches will be decided as the detailed design of the project progresses post-planning.

2 Introduction

The design team has followed an holistic approach to sustainability and a series of measures has been incorporated in the design to reduce the carbon emissions of the development. This is achieved by reducing the energy demand from the office development and the retail accommodation spaces as well as ensuring an efficient delivery of the energy required. At this stage, the measures considered to achieve this goal include:

- Passive solar shading devices and natural ventilation of the concourse
- Improvement of the office façade thermal performance
- Reuse of heat from the retail units to heat the concourse
- Low energy lighting and enhanced lighting control
- Wood-pellet-fired boilers

Preliminary estimates show that the carbon emissions of the proposed scheme are more than 20% lower than those given as a benchmark in the London Renewables Toolkit. These measures are inline with the approach taken by the GLA and defined in the 'Energy Hierarchy' of the Energy Strategy in the London Plan.

This document addresses the requirements of the London Plan and considers the feasibility of a number of renewable technologies and evaluates their impact in terms of cost and carbon emissions following the guidelines proposed in the London Renewables Toolkit.

3 Baseline carbon emissions

The energy demand of the development has been calculated following the method proposed by the London Renewables Energy Toolkit (section 4.3.2 of the Toolkit), taking into account the following end uses:

- Space heating
- Lights and appliances

The figures below show the ‘Benchmark carbon emissions’ and are taken from Table 6 in section 4.3.3 of the London Energy Partnership document entitled ‘Integrating renewable energy into new developments: Toolkit for planners, developers and consultants’ dated September 2004 which will be referred to as ‘The Toolkit’ in this report.

	Gross Internal floor area	**Benchmark predicted annual delivered energy requirements**		**Benchmark carbon emissions arising from**		**Benchmark total carbon emissions**
		Electricity	**Gas**	**Electricity**	**Gas**	
Carbon emission factor	-	-	-	0.113	0.053	
	m²	**kWh/year**	**kWh/year**	**kgC/year**	**kgC/year**	**kgC/year**
Office *	3,827	489,856	371,219	55,354	19675	75,029
Retail **	1,611	161,100	0	18,204	0	18,204
Restaurant	1,684	1,094,600	1,852,400	123,690	98,177	221,867
Concourse***	5525	1,215,500	0	137,352		137,352
Total						**452,452**

Note: *The Office figure is based on a Type 3 Standard Office

****** The retail figure is based on the benchmark of 100 kWh/m²/year which corresponds to a Catalogue Store (all electric), (see London Renewables Toolkit, Section 4.3.3)

*** This figure is based on the estimate of 220 kWh/m²/year on a space with 24 hour access

4 Proposed energy efficiency design measures

4.1 Office building energy efficient design

4.1.1 Façade

The office building is an existing structure that is Grade 1 listed, and as a result the amount of refurbishment that can be achieved is limited. However, it is proposed to add secondary double-glazing to the windows, which will improve the performance of the façade in terms of both heat transfer and air leakage.

4.1.2 Building location

The building benefits from existing windows that are not excessively large and that there is a very good degree of external shading afforded by the existing concourse to the east and the new concourse to the west.

Both concourses will serve to moderate the environment immediately external to the offices, thereby reducing the heating and cooling demands over the year.

4.1.3 Roof

It is intended that during the refurbishment, the roof covering and insulation will be renovated and replaced where necessary to improve the insulation levels to comply with new Part L Building Regulations requirements. This will serve to reduce heat loss in winter and heat gain in summer.

4.1.4 Combined heat and power

Initial assessments have been undertaken that suggest that a gas-fired CHP installation will not be feasible because there is very little hot water heating requirement for the development. Without a significant heating demand the installation would not be energy efficient and would not be commercially viable.

Calculations show that using waste heat from a generator installation to drive an absorption chiller for chilled water production is more carbon intensive than using a conventional chiller installation using mains supplied electricity. This is particularly the case when the primary fuel source is natural gas which has low carbon intensity and can be converted to electricity with efficiencies of up to 58% in combined-cycle gas-fired power stations. As a result, there is no carbon benefit in using an absorption chiller in this situation.

4.1.5 Building Systems Controls

A full Building Management System (BMS) will be installed to minimise the building plant hours of operation, vary the water flow rate for heating and cooling, prevent simultaneous heating and cooling in the same zone, and control plant capacity to ensure good part-load efficiencies.

4.1.6 Lighting Control

A lighting control system will be installed to allow zonal switching based on occupancy detectors. Lighting will be switched off after a fixed time when people are no longer detected in the zone.

Daylight controlled lighting will be installed adjacent to the building perimeter. This will automatically dim the artificial lighting when the daylighting conditions inside the office allow.

4.2 Retail units and concourse energy efficient design

The retail units and concourse benefit from the following energy saving features:

- The retail units are located within the concourse, which is a naturally ventilated space, and as a result they are shielded from the extremes of the external atmospheric conditions.

- The concourse has a closed roof, which means that the internal temperatures are moderated.
- The concourse benefits from warm air transfer from the retail units extract, thereby reusing the heat generated within the retail units.
- Low energy lighting will be installed throughout the concourse
- An intelligent lighting control system will be installed to control the lighting within the Concourse. The lighting will be controlled with time clocks, light sensors and presence detectors where suitable to reduce the amount of electrical demand.

5 Baseline carbon emissions and predicted energy demand

As a result of the energy efficiency designs described above, the following approximate energy consumption improvements have been calculated in comparison with the benchmark figures:

Office Accommodation - 30% improvement

Retail - 20 % improvement

Restaurant - 20% improvement

Concourse - 33% improvement

As a result, baseline energy demand for the KXSE development is calculated as:

Breakdown of site baseline carbon emissions

	Gross Internal Floor Area	**Baseline predicted annual delivered energy requirements**		**Baseline carbon emissions arising from….**		**Baseline total carbon emissions**
		Electricity	**Gas**	**Electricity**	**Gas**	
Carbon emission factor		-	-	**0.113**	**0.053**	
	m²	**kWh/year**	**kWh/year**	**kgC/year**	**kgC/year**	**kgC/year**
Office	3,827	342,899	259,853	38,748	13,772	52,520
Retail	1,611	128,880	0	14,563	0	14,563
Restaurant	1,684	875,680	1,481,920	98,952	78,542	177,494
Concourse	5525	818,967	0	92,543		92,543
Baseline Total						**337,120**

6 Renewables

The following evaluation of renewable technologies and estimates of energy demand, carbon emissions, and costs constitute a planning stage assessment and should not be relied on as a detailed design assessment.

6.1 Renewable technologies shortlist

The Mayor's Energy Strategy sets a target of 10% of the base energy demand to be generated from renewable sources where feasible, and proposes a list of renewable energy technologies to be considered for new London residential developments:

- Wind generators
- Photovoltaic cells
- Solar water heating
- Biomass heating
- Biomass CHP
- Ground source heat pumps

The feasibility of each technology has been evaluated following the guidance provided in the London Renewables Toolkit (paragraphs 4.1.1 to 4.1.10), taking into account the particular constraints of this development.

6.1.1 Wind generators

The low average wind speed on the site (expected to be lower than 6m/s) and the turbulence created by the buildings around the development would significantly affect the performance of stand alone wind generators at ground level and on the roofs of the office building.

The only suitable location identified on the development is on top of the existing listed building. Concern has been raised about the suitability of installing a wind turbine in this location in terms of the structural support that may be required. This would affect the building fabric, which is a listed structure.

On this basis, wind generators are not considered technically feasible.

6.1.2 Photovoltaic cells

The energy output of photovoltaic (PV) cells depends greatly on their orientation and is a maximum for south facing arrays not subject to overshadowing from nearby buildings. Consequently, a study has been undertaken to install PV cells on the roof of the concourse, offices, and the taxi drop-off canopy.

6.1.3 Solar water heating

The development does not present a year round domestic hot water demand. Therefore, solar water heating systems are not suitable for this development.

6.1.4 Biomass Heating

The development will consider the installation of a wood pellet fired boiler to serve the office building. The system would be sized to supply approximately 60% of the theoretical maximum peak heating load in the buildings. The wood pellets are manufactured using a combination of sawdust (from saw mills) and ground wood chips and are almost carbon neutral in their production.

Fuel pellets would be delivered using 10 tonne blower delivery trucks, which would discharge the pellets into a fuel silo. The total amount of fuel required for the development is expected to be approximately 30 tonnes of fuel per annum. This would require approximately 3 deliveries of fuel between the months of October to March.

6.1.5 Ground source heat pumps for heating and cooling

Ground source heat pumps need to be used for both heating and cooling as a year-on-year excess of either heat absorption or rejection into the ground will make it colder or warmer, eventually to the point where the system ceases to function efficiently.

Vertical pipe loops in bore holes present the highest potential output and the installation considered in this analysis consists of vertical pipes in bore holes distributed over the whole site.

The site is directly over the numerous underground railway lines and utilities distribution that serve Kings Cross and as a result, ground source heat pumps are not considered feasible for this development.

6.2 Contribution of photovoltaics to renewable energy

6.2.1 Energy output

The feasibility of using photovoltaics has been evaluated in more detail. The energy output of the photovoltaic array has been estimated using the benchmark figures proposed by the London Renewables Toolkit.

There are several areas of roof that could be considered for installation of PV:

- Main train sheds: these are ‘listed’ and any work is subject to English heritage approval; installation of PV is unlikely to be acceptable
- Offices: the roof is to be renewed and presents an area of flat surface that may be used
- Concourse: much of the concourse is tilted away from the sun and so reduces the efficiency of collection of solar energy by PV; a small proportion of the roof may be used
- Taxi canopy: the main canopy to the south provides a flat surface that may be used

The area roof suitable for installation of PV is approximately 1570m² and because of its inclination and orientation, will cause the PV to under perform by around 15% relative to optimum conditions.

Based on polycrystalline PV cells, the installed array will produce a total of 123,440 kWh of electricity each year which will save the equivalent of 13,950 kg.C/annum. This willreduce the total carbon consumption of the development by 4.1%.

6.2.2 Cost of PV installation

Preliminary studies indicate that PV would contribute to the reduction of carbon emissions. With regard to costs, this planning application does not take into account any possible grant assistance since there is no guarantee that it will be available in the future.

The following table details the cost efficiency of the PV installation:

Technology	Reduction of base carbon emissions	Estimated cost of installation	Reduction in carbon emissions	Cost efficiency
	%	£	kgC / annum	£ / kgC saved
Photovoltaic cells	4.1%	1,256,000	13,950	90

At a cost of 7p per kW/hr of electricity the overall energy saving would be £8,640 per annum which would mean that the initial cost of the photovoltaic array would be paid back in 145 years. This does not take into account any annual maintenance costs, replacement costs or finance costs, which would increase the payback time. Nor does the analysis take into account electrical price inflation (which is considered likely), which would also reduce the payback time.

As a result, without significant financial grants, photovoltaic cells are not considered to be a viable option due to their limited carbon savings and relatively high cost.

6.3 Contribution of wood pellet boilers to renewable energy

Using the London Toolkit, the development is expected to generate carbon emissions of 337,120 kgC/year. The carbon emissions arising from heating the offices are calculated to be 13,772 kgC/year, which is 4% of the total carbon emissions of the development. It is proposed that at least 60% of this heating load will be supplied using wood pellets.

Using Table 2 of the Building Regulations, Part L2 the carbon emission factor given for Natural Gas is 0.194 $kgCO_2/kWh$ and the carbon emissions factor given by biomass is 0.025 $kgCO_2/kWh$. As a result the biomass fuel source emits (0.025 / 0.194) 12.9% of the carbon of the natural gas fuel source.

The saving in carbon by using biomass instead of natural gas is therefore calculated as follows:-

Baseline carbon emissions for the whole development is		337,120 kgC/annum
Baseline carbon emissions for the offices gas heating is		13,772 kgC/annum
Carbon from natural gas (proposed 40%) = 13,772 x 0.40	=	5,509 kgC/annum
Carbon from wood pellets (80%) = 13,772 x 0.60 x 0.129	=	1,066 kgC/annum
Total carbon using proposed boiler combination	=	6,575 kgC/annum
Giving a saving of (13,772 – 6,575)	=	7,197 kgC/annum

Which is a percentage saving of (7197 / 337120) x 100 = 2.1 %

7 Conclusion

An energy demand calculation for the building has been undertaken using figures given in the London Toolkit.

There is sufficient space to generate a saving of 4.1% in carbon using polycrystalline PV cells, but the payback period exceeds 100 years. This is not an economically viable option, but consideration will be given to providing some areas of PV.

Consideration will be given to the installation of a wood pellet boiler installation, which is shown to reduce the carbon emissions for the whole development by approximately 2.1%.

There is a severe shortage of space for fuel storage. The next stage of detailed design will seek a solution.