100-102 Arlington Road 16-18 Delancey Street NW1
Concept Design Renewable Energy Report

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1. Introduction

Background

The 1997 Kyoto Protocol on climate change set internationally agreed and set binding targets for the reduction of greenhouse gases for the period up to 2012. The target for the United Kingdom is to reduce our emissions by 12.55 below 1990 levels. In addition to the main Kyoto target the Government has also set a domestic target to reduce CO_2 emissions by 20% below the 1990 levels by 2010.

The need to reduce developments dependence on unsustainable energy sources such as fossil fuels forms a fundamental theme within the Government Energy White Paper and has been integrated throughout national, regional and local planning policy.

Because the design of the development has not been progressed to the level of detailed thermal modelling a combination of preliminary thermal analysis, benchmark figures and informed judgement figures based on the developments environmental aspirations have been used.

In particular the Mayor's "London Renewables Toolkit" (LRT) which provides a comprehensive methodology for undertaking a comparative annual energy analysis for various building types including residential, offices and retail has been used as reference in preparation of this document

Therefore the figures contained within this document should only be used for guidance and may change once detailed analysis and thermal analysis has been undertaken during post planning stages of the design process.

2. Energy Efficiency

The proposed development includes a mix of retail and residential uses. The expected mix of uses for the development is as follows

- 375m² restaurant, and
- 1020m² Residential dwellings

In regards to energy efficiency all elements of the development have committed to achieving a minimum EcoHomes rating of "Very Good" ensuring a high level of energy efficiency. It is expected, backed up by preliminary thermal analysis, that the residential elements of the development will - through correct massing, improved façade performance and energy efficient systems– only consume 50% of the energy used in a typical UK dwelling, saving 25kg CO_2 per m² of residential development per year.

Currently not enough information is known about the non-residential elements of the development to confidently state performance values and therefore industry standard figures have been used in this analysis. However we are confident that similar energy saving strategies will be implemented during the detailed design stage and that further carbon savings will be realised.

Some of the energy saving strategies implemented into the scheme are as follows.

Correct massing and orientation are vital to the success of any sustainable development. With it significant savings in energy can be achieved with not net increase in capital cost.

Although due to the existing urban site constraints limited options in regards to massing and orientation are available great care has been taken to gain maximum benefit where possible.

The development has been designed to harness this opportunity, without being prescriptive, in order to preserve the urban design strategy

Fortuitously the site, due to it being a corner site, enjoys access to both the southwest and southeast ideal for residential use. Living rooms have been purposely located on either the southwest or southeast elevation to ensure good access to sunlight for a large proportion of the day all year round vital for human well-being but also a free source of heating. Bedrooms have also been located where possible to enjoy good access to the sun which although not vital is preferable, however where this is not possible, in very limited occasions in the inner corner, this loss of access has been compensated for by the provision of rooflights.

To reduce CO_2 emissions further, in addition to these passive strategies, the performance of the building fabric and its systems has been improved.

The intention is to:

- Maximise the building envelope performance (very low Uvalues, high performance glazing, very low infiltration) thus lowering the energy consumption for the development.
- To incorporate Controls and monitoring to limit energy wastage throughout e.g. thermostatic radiator valves, daylight light sensors, localised switching to allow for individual light control, time switching and set controls for daytime and 'out of hours' use.
- To chose Building systems chosen based on efficiency, reliability and effectiveness in operation monitored against current and future environmental conditions.
- To harness the mixed use nature of this site and ensure symbiosis between different modes of operation, i.e. centralised heating and cooling ring will allow the bar and restaurant to expel unwanted heat, via heat exchangers in the exhaust and to provide welcomed free heat to the residential units.

- To use high-efficiency centralised plant located within the energy centre. The use of centralised plant allows for a greater system efficiency to be achieved, reducing overall energy consumption.
- Low energy light fittings with intelligent control
- To use heat recovery, well insulated pipe runs, variable speed pump and fan technology, increased thermal insulation on storage vessels, specification of low-energy light fittings, and the use of a Building management system and sub-metering that will monitor and control energy use, allowing the systems to operate more efficiently.

3. Energy Consumption

Energy consumption figures have been based on the energy efficient measures highlighted where applicable. Where not enough information about the specific use of certain elements of the development is known, industry recognised benchmark figures have been used. Reference to the source of the consumption figures used in the generation of the energy figures can be found in the table.

Element	Area m2		Heating	Cooking	Auxillary Electricity	Lighting	Hot Water			
			Natural gas	Natural gas	Electricity	Electricity	Natural gas			
Residential	1020	kWh/m2/yr	30	10	30	7	22	**101**	**MWh/yr**	
Preliminary Total Development TAS Calculations (appliances included in Auxillary Electricity load)		kWh/yr	30600	10200	30600	7140	22440	**7**	**Tonnes C/yr**	
		kgC/m2/yr	1.557377049	0.519125683	3.3	0.77	1.142076503	99	kWh/m2/yr	
		KgC/yr	1588.52459	529.5081967	3366	785.4	1164.918033	7	kgC/m2/yr	
								27	kgC02/m2/yr	
	SFA									
Restaurant	375	kWh/m2/yr	1100	inc	650	inc	inc	**656**	**MWh/yr**	
Figures taken from renewable Toolkit		kWh/yr	412500	inc	243750	inc	inc	**48**	**Tonnes C/yr**	
		kgC/m2/yr	57.10382514	inc	71.5	inc	inc	1750	kWh/m2/yr	
		KgC/yr	21413.93443	inc	26812.5	inc	inc	129	kgC/m2/yr	
								471	kgC02/m2/yr	
Total	1395	kWh/m2/yr	317.6344086	7.311827957	196.6666667	5.11827957	16.08602151	**757**	**MWh/yr**	
		kWh/yr	443100	10200	274350	7140	22440	**56**	**Tonnes C/yr**	
		kgC/m2/yr	16	0	22	1	1	204	**Tonnes C02/yr**	
		KgC/yr	23002.45902	529.5081967	30178.5	785.4	1164.918033	543	kWh/m2/yr	
								40	kgC/m2/yr	
								146	kgC02/m2/yr	
								10.00%	Renewable Contribution	
								20	**Tonnes C02/yr saved**	

For the development to provide a minimum of 10% of the total estimated total associated carbon emissions for the development from renewable energy sources a minimum of 20 tonnes of CO_2 per year is required to be saved. However it is worth noting due to the different processes involved in producing natural gas and grid electricity, saving 10% CO_2 is not necessary the same as saving 10% energy, as grid electricity creates around twice as much carbon then gas for the same energy consumption. However as CO_2 emissions are widely regarded as the critical issue in regards to climate change a critical target of 10% reduction in CO_2 emissions has been progressed

For the development the feasible renewable energy options have been explored and prescribed a target to achieve a minimum of 10%. In addition the feasible possibility of exceeding this proportion, without significant complication, beyond 10% in the future, once payback periods become more realistic has been explored.

4. Renewable Energy Systems

Recognised renewable energy systems available are as follows:

- Wind turbines
- Photovoltaics
- Solar thermal
- Biomass
- Biomass CHP
- Ground source heating
- Ground source cooling

From the initial review, the following options are deemed unfeasible:

- Wind turbines –

Due to height restrictions and acoustic issues to the residential flats the turbines cannot be installed onto of the buildings. There is not sufficient open area to install a turbine to supply enough energy.

As a result of this initial study it has been concluded that the options considered feasible are Photovoltaics, Solar Thermal, Ground Source Heat Pumps and Biomass. Taking this result and the table below showing the costs into consideration, it appears that Biomass & GSHP would seem the best economic and technically feasible solution for the development.

Renewable Technology	**Output Range**	**Cost Range**	
Wind Turbine	600W - 3.6MW	£2,500 - £5,000	/kWe
Photovoltaics	1kWp generates 700 - 750 kWh/yr	£5,000 - £8,000	/kWp for roof mounted systems
		£10,000 - £15,000	/kWp for façade or atrium systems
Solar Thermal	450 - 580 kWh/yr	£650 - £1,000	/m^2 (average per flat)
Biomass CHP	No inherent limit	to £2,700	/kWe
Ground Source Heating/Cooling	0.022 - 0.044 kW/m^2	£1,000	/kW

5. Biomass Heating

Biomass is a carbon free form of fuel produced from renewable material sources including wood, waste and recycled oil. The choice of biomass is dependent upon availability, calorific content and storage needs.

Initial energy calculations suggest that the heating load for the residential element of the development will be in the region of 107MWh/yr - 10% of the total energy demand.

Description of calculation step	Value	Units
Calculate end use DEMAND met accounting for system efficiency	475740	kWh/year
Specify the proportion of end use DEMAND met by biomass heating	22.6	%
Calculate annual energy DEMAND for heating & hot water met by biomass heating	107517.2	kWh/year
Determine total DELIVERED gas energy in base building	475740	kWh/year
Calculate DELIVERED gas requirement substituted by biomass heating	107517.2	kWh/year
Calculate the remaining requirement for DELIVERED gas (to serve conventional heating & hot water, and catering) after application of biomass heating	368222.8	kWh/year
Look up carbon emissions factor for gas	0.05	kgC/kWh
Calculate carbon emissions due to DELIVERED gas in building with biomass heating	19115.39	kgC/year
Calculate total DELIVERED electricity in base building	281490	kWh/year
Look up carbon emissions factor for electricity	0.11	kgC/kWh
Calculate carbon emissions due to DELIVERED electricity in building with biomass heating (same as base building)	30963.9	kgC/year
Calculate total building carbon emissions in building with biomass heating	50079.29	kgC/year
Calculate base building total carbon emissions	55660.79	kgC/year
Calculate reduction in carbon emissions due to application of biomass heating	5581.496	kgC/year
Calculate percentage carbon emissions reduction due to application of biomass heating	**10.03%**	%

6. Ground Source Heat Pumps

Ground Source Heat Pumps use the free heat that is stored in the ground to heat and potentially cool the development.

Although, without detailed analysis and site measurements it is very hard to accurately predict the site potential for GSHP, it is most likely that due to the low density nature of the development – that enough GSHP's could be installed as a vertical closed loop system to meet the peak heat loading.

To meet the 10% requirement, GSHP will be required to provide 75% of the total heating load (based on a coefficient of performance of 3)

Ground Source Heat Pumps Toolkit

To provide 100% of the heat demand for the warehouse and office - 9.17% of the total energy demand

Description of calculation step	Value	Units	Calculation step*
Determine the total DELIVERED gas energy requirement in the base building for end uses that are to be served by GSHP. (Scenario calculations base GSHP sizing on delivered energy for space heating and hot water.)	443100	kWh/year	(1) = Q
Determine heating system efficiency in base building	100	%	(2)
Calculate end use DEMAND met accounting for system efficiency	443100	kWh/year	(3) = (1) x (2)
Specify proportion of end use DEMAND met by GSHP	75	%	(4)
Calculate annual energy DEMAND for heating & hot water met by GSHP	332325	kWh/year	(5) = (3) x (4)
Specify CoP of the ground source heat pump	3	# (>1)**	(6)
Calculate electrical energy used by heat pump	110775	kWh/year	(7) = (5)/(6)
Calculate total DELIVERED gas energy in base building	475740	kWh/year	(8) = S
Calculate DELIVERED gas requirement substituted by GSHP	332325	kWh/year	(9) = (5)/(2)
Calculate remaining requirement for DELIVERED gas (to serve conventional heating & hot water, and catering) after application of GSHP	143415	kWh/year	(10) = (8) - (9)
Look up carbon emissions factor for gas	0.05	kgC/kWh	(11)***
Calculate carbon emissions due to DELIVERED gas in building with GSHP	7445	kgC/year (	(12) = (10) x (11)
Calculate total DELIVERED electricity in base building	281490	kWh/year	(13) = Z
Calculate DELIVERED electricity requirement for building with GSHP	392265	kWh/year	(14) = (7) + (13)
Look up carbon emissions factor for electricity	0.11	kgC/kWh	(15)***
Calculate carbon emissions due to DELIVERED electricity in building with GSHP	43149	kgC/year (	(16) = (14) x (15)
Calculate total building carbon emissions in building with ground source heat pumps	50594	kgC/year (	(17) = (12) + (16)
Calculate base building total carbon emissions	55661	kgC/year (	(18) = (8) x (11) + (13) x (15)
Calculate reduction in carbon emissions due to application of ground source heat pumps	5067	kgC/year	(19) = (18) - (17)
Calculate percentage carbon emissions reduction due to application of ground source heat pumps	**10.01%**	%	(20) = (19)/(17)
Calculate percentage energy reduction due to application of ground source heat pumps	**43.89%**	%	(21) = ((5) - (7)) / ((8) + (13))

* letters relate to Table 8 showing end use breakdown of DELIVERED energy

** # indicates a number without units. CoPs are greater than 1.

*** see section 4.4 regarding selection of applicable emissions factors.

7. Conclusion

From the analysis carried out it is quite clear that in order to achieve the 10% target, Biomass Heating and/or GSHP will be required in the development.

The advantage of GSHP's is that they harness free energy and require no further input or create local emissions. Although very efficient at reducing energy consumption, however, GSHP's do not reduce carbon emissions significantly – unless their cooling potential is harnessed, as the development has been specifically designed to negate the need for cooling. This benefit will not accurately be harnessed, although should rises in global temperature increase, the potential to provide cooling may prove valuable.

Biomass on the other hand is an efficient way to reduce carbon emissions although it would require trucks to deliver the fuel and emissions from the flue would need to be controlled to ensure air pollution effects are mitigated against.

If biomass is to be used, the flue stack height and scrubbing systems will be designed specifically to ensure no local air quality issues are caused due to the development.

Future-Proofing

The flat roofs and shadow-free nature of the site provide an ideal opportunity to install significant quantities of Photovoltaics and Solar Thermal tubes in the future.

Appendix A

Water Strategy

Responses:

The average UK resident uses over 55.3m^3/person/year of highly treated mains water per day, up to a third of which is flushed down the toilet. People in recently built homes with power showers use more like 230 litres per day or 84m^3 per year. The development aims to reduce the water demand to 35m^3/person/year.

In order to achieve this target the development shall implement the use of a number of water efficient appliances and water resource management systems.

Low-Flush Toilet:

A typical toilet uses 7.5 to 9 litres per flush and accounts for 25% of our annual household water consumption. The development shall be fitted with 2 and 4 litre dual flush toilets, saving 11m^3/person/year.

Bathing and Showering:

Bathing and showering account for 17% of household water consumption. The development is to be fitted with carefully selected shower fittings instead of the standard power showers, which use as much water as a bath, saving a further 11m^3/person/year.

Spray Taps:

Self-regulating flow restrictors shall be installed to taps reducing pressure and flow rates and minimise wastage through splashing. This reduces water consumption by around two thirds, saving 9.5m^3/person/year.

Water Resource Management Systems:

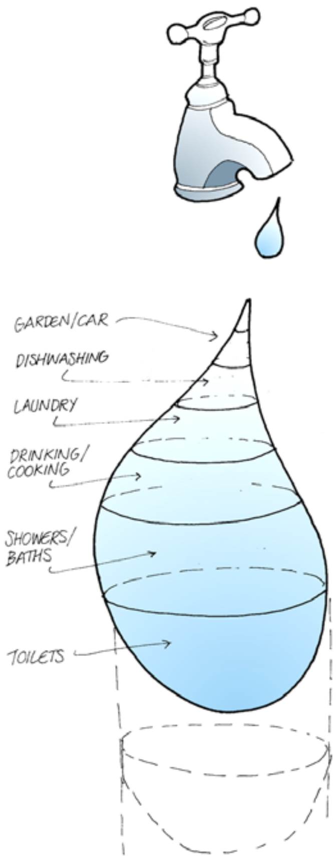
Water use shall be monitored throughout the development through the inclusion of pulsed output water meters. By identifying usage patterns and highlighting wastage, informed water saving measures can be identified and implemented during the operation of the building.

Meters for the commercial element of the design shall be programmed to identify through an audible alarm, excessive periods of water use and periods of excessive high water flow rate in order prevent leakage and the associated waste of water and damage to property.

Rainwater Collection:

Correctly collected and stored rainwater shall be used in the development for toilet flushing in the restaurant and bar.

Water collected from the roof will be stored in a stand-alone rainwater tank, sized to provide ten days storage from where water will be gravity fed to flush toilets within the restaurant and bar.



A secondary flow and return greywater system shall also be installed to allow for the inclusion of a greywater treatment system for residential dwellings in the future. The pipe systems will be totally separate to the mains potable system.

The system shall not only allow rain/greywater to be collected, but also greywater to serve WCs in the dwellings and rainwater to serve WCs, washing machines and irrigation systems.

In addition to reducing water consumption the development has integrated ways to reduce its impact on the water infrastructure. As a minimum, the development will not increase its net impact from the current conditions several measures shall be integrated to reduce its impact. The provision of green roofs and water recycling will reduce quantities of rainwater, through increased evaporation and alternative use, from entering the water infrastructure, reducing peak flow rates in storm conditions.