Energy Report

Energy | Energy Use | Lean | Clean | Green

November 2011

The Old Dairy

Bloomsbury, London Borough of Camden

Carried out for:
S333 Architecture + Urbanism

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About XCO2 Energy

XCO2 Energy are a Low-Carbon Consultancy working in the Built Environment. This multidisciplinary company comprises both architects and engineers, with specialists including CIBSE Low Carbon consultants, Code for Sustainable Homes, EcoHomes, BREEAM and LEED Assessors.

The XCO2 Energy team has developed low-carbon schemes in the UK and abroad, varying from single buildings to large masterplans. XCO2 Energy are at the forefront of low-carbon and sustainability practices in the built environment, regularly participating in industry-wide efforts such as the developers of the methodology for CarbonBuzz, a scheme with CIBSE and RIBA participation, and sitting on the TCPA advisory board for the government's EcoTowns scheme.

	Issue 01	Issue 02	Issue 03	Issue 04
Remarks	Draft			
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Date	11/11/2011			

Executive Summary

This report assess the predicted environmental performance of The Old Dairy development, based on the information provided by the design team. The development consists of 5 high value dwellings and 2 commercial office units.

The development will reduce CO_2 by incorporating a range of energy efficiency measures in line with the three step strategy outlined in The London Plan: Be Lean, Be Clean and Be Green.

Preliminary SAP 2009 and SBEM assessments were used to predict the energy consumption and CO_2 emissions of the development.

Lean

The development at The Old Dairy reduces CO_2 emissions by incorporating a range of energy efficiency measures including efficient lighting, levels of insulation beyond building regulation requirements and high performance windows.

Through the implementation of these measures, annual CO_2 emissions for this development are below levels set out in the current Part L building regulations (2010), prior to considering any potential savings through the use of renewables.

Calculations demonstrate that energy efficiency measures will reduce CO_2 emissions by approximately 16.1 tonnes CO_2/year or 29%.

Clean

Hot water will be supplied by high-efficiency gas condensing boilers in each dwelling.

CHP and communal heating were considered for this project. However they were deemed to be unsuitable due to the low heat density required in the development.

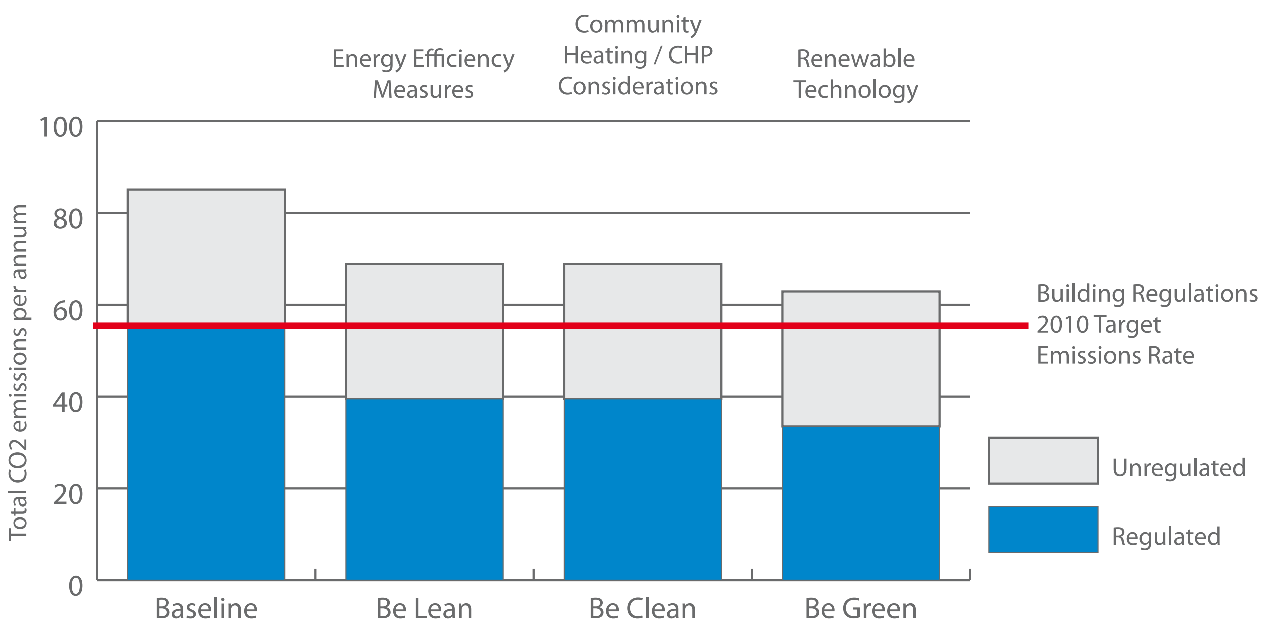
Green

A variety of low carbon technologies and systems were analysed and the use of ground source heat pumps as a renewable energy source was considered to be the optimum solution for reducing CO_2 emissions for this project. A CO_2 saving of 13% would be achieved by the installation of energy piles of about 16m deep across the development.

Conclusion

Through energy efficiency measures and ground source heat pumps, the dwellings will meet Code for Sustainable Homes Level 3 and the offices will meet BREEAM Very Good. Please see the accompanying Sustainability Statement for more information.

Including unregulated energy use, the development is expected to reduce CO_2 emissions by 25% when compared with a building built to current Part L 2010 Building Regulations.



Carbon dioxide emissions and savings (tonnes CO_2 per annum)

	Carbon dioxide emissions (tonnes CO_2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2010 Part L Compliant Development	55.7	29.4	85.1
After energy demand reduction	39.5	29.4	68.9
After CHP	39.5	29.4	68.9
After renewables	34.2	29.4	63.6

	Carbon dioxide savings (tonnes CO_2 per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	16.1	16.1	29.0%	19.0%
Savings from CHP	0.0	0.0	0.0%	0.0%
Savings from renewables	5.3	5.3	13.4%	7.7%
Total Cumulative Savings	21.4	21.4	38.5%	25.2%

Introduction

The Old Dairy is a proposed residential and office development located in the Bloomsbury area of the London Borough of Camden. The development replaces an existing warehouse, once used as a dairy but more recently as a cultural events venue. The proposed development has a gross internal area of approximately 2,900m^2, including 5 dwellings and 1,100m^2 of office space, designed to reflect the form of the warehouse it replaces and the surrounding Georgian town houses.

This report outlines the Energy Strategy for the development, with the aim of reducing CO_2 emissions, by taking into account energy efficiency measures, communal heating systems and low carbon technologies. This is in line with the requirements set out by the London Borough of Camden.

The Camden Core Strategy (November 2010) requires certain energy standards to be achieved: Code for Sustainable Homes Level 3, with 50% of the unweighted credits in the Energy category; and BREEAM 'Very Good' for non-residential developments over 500m^2 with 60% of the unweighted Energy credits (Development Policy DP22). Please refer to the supplementary Sustainability Report on how these standards have been met.

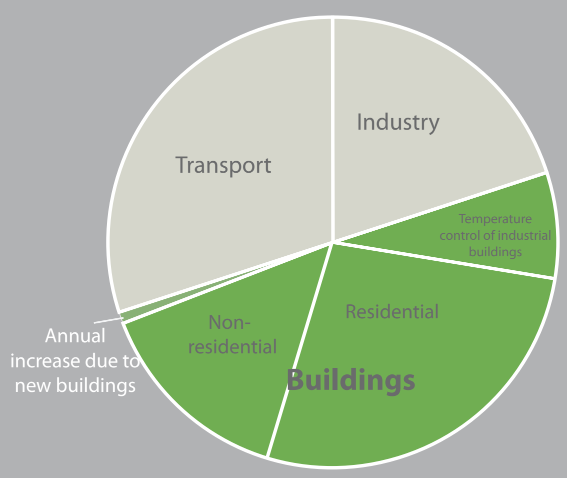
This report shows how the London Plan 2011 target of 25% reduction in CO_2 (Policy 5.2) is met and how the development responds to the 20% CO_2 reduction from renewables target as set by Camden Council (Policy CS13).

Policies outlined in the London Plan to be complied with are the following:

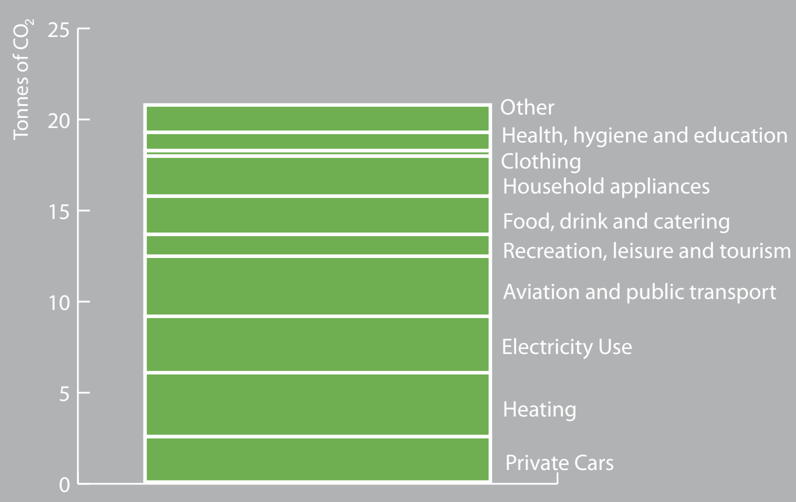
- Policy 5.2 Minimising Carbon Dioxide Emissions
- Policy 5.3 Sustainable Design and Construction
- Policy 5.5 Decentralised Energy Networks
- Policy 5.6 Decentralised Energy in Development proposals
- Policy 5.7 Renewable Energy where feasible.

The methodology employed to determine the potential CO_2 savings for this development, is in accordance with the three step Energy Hierarchy outlined in the London Plan:

- Be Lean - Improve the energy efficiency of the scheme
- Be Clean - Supply as much of the remaining energy requirement with low-carbon technologies such as combined heat and power (CHP)
- Be Green - Offset a proportion of the remaining carbon dioxide emissions by using renewable technologies.



Distribution of energy consumption in the UK
(Source: DTI Energy Statistics)



CO_2 emissions associated with household consumption
(Source: Defra Stockholm Environment Institute)

Energy

The latest version of Part L came into force in October 2010 with the aim of further reducing the energy consumption and CO_2 emissions.

Our analysis uses the methodology set forth in Part L 2010 of the building regulations, by performing preliminary SAP 2009 assessments on a couple of the dwellings. The results were extrapolated across the other dwellings to obtain a baseline for the energy consumption for the 5 dwellings within the development. The Target Emissions Rate (TER) for the typical dwelling was also calculated.

The 2 office units were modelled using SBEM analysis, obtaining values for the Building Emissions Rate (BER) as well as the TER. The results from the SBEM model are included in the Brukl document at the end of this report.

The SAP and SBEM assessments were also used to calculate the energy consumption and CO_2 emissions of the buildings taking into account the following energy efficiency measures:

- Improving the building fabric
- Reducing air infiltration
- High efficiency condensing boilers
- Passive design features
- Low energy lighting

The table below shows the TERs and DERs for the assessed dwellings on SAP 2009.

Dwelling no.	#2	#5
TER	13.29	14.91
Lean DER	11.12	11.70
Clean DER	11.12	11.70
Green DER	10.08	10.54

All emission rates are in $kgCO_2/m^2$

Heat Loss

By reducing heat loss though the fabric of the building during the heating season, the energy required for space heating is minimised. The heat loss through the different elements of the building is dependent upon the U-value of these elements.

The development will achieve the following U-values by incorporating very high levels of insulation.

Element	Building regulations	Proposed	Improvement
Walls	0.30	0.17	43%
Floor	0.25	0.10	60%
Roof	0.20	0.13	35%
Windows	2.00	0.80	60%

All U-values are in W/m^2K

Additional heat loss from buildings occurs due to air infiltration. Although this cannot be eliminated altogether, it can be minimised through good construction detailing and using best practice construction techniques.

Current Part L building regulations set a maximum air permeability of $10m^3/m^2$ at 50Pa. By adopting good practice construction techniques, the development is committed to improve upon this to achieve an air permeability rate of 3 m^3/m^2 at 50Pa.

The dwellings will also minimise heat loss through thermal bridging. Following Accredited Construction Details or designing specifically to reduce the thermal bridging y-value down to less than 0.08 W/m^2K.

Efficiency

The development incorporates measures and systems to ensure that energy is efficiently generated, distributed and used within the development. Efficiency measures considered include low energy lighting.

Low Energy Lighting and Control

100% of lighting will be specified with dedicated low energy light fittings throughout the dwellings, ensuring only compact fluorescent (CFL's) or fluorescent luminaries are used.

Internal and external areas of infrequent use will be fitted with occupant sensors, whereas daylit areas will receive daylight sensors.

High-efficiency condensing gas boilers

All dwellings will incorporate individual high-efficiency condensing gas boilers (SEDBUK rating A).

Passive Design

The development will reduce the requirements for active cooling systems, mechanical ventilation and energy intensive artificial lighting.

Daylighting

The development has been designed to provide good levels of daylight whilst also ensuring excessive solar gain does not cause overheating.

Particular daylighting initiatives include generous window sizing in the living areas of the ground and basement floors and interior walls which are painted in light colours to reflect light into rooms.

In some areas, rooflights and glazed floors are incorporated into the design to enhance the amount of daylight reaching lower floors.

Natural Ventilation

Where openable windows are located on opposite sides of the dwelling, the building is designed to allow cross ventilation to occur, thus reducing the need for cooling when natural ventilation will suffice.

In the office spaces, this ventilation strategy is not always possible so the stairwell is designed to create a stack effect and draw fresh air in through windows along one side of the floors.

	Baseline (Part L 2010)			**Lean**		
	Energy (kWh/year)	CO_2 emissions ($kgCO_2$/year)	CO_2 ($kgCO_2/m^2$)	Energy (kWh/year)	CO_2 emissions ($kgCO_2$/year)	CO_2 ($kgCO_2/m^2$)
Hot Water	22,200	2,900	1.0	16,100	3,200	1.1
Space Heating	172,500	24,200	8.5	55,500	11,000	3.9
Cooling	10,300	5,300	1.9	12,200	6,300	2.2
Auxiliary	25,300	12,900	4.5	18,500	9,500	3.4
Lighting	22,600	10,400	3.7	18,300	9,500	3.3
Equipment (not inc. in Part L)	56,900	29,400	10.4	56,900	29,400	10.4
Total Part L	**252,900**	**55,700**	**19.6**	**120,600**	**39,500**	**13.9**
Total (inc Equip)	**309,700**	**85,000**	**30.0**	**177,500**	**68,900**	**24.3**

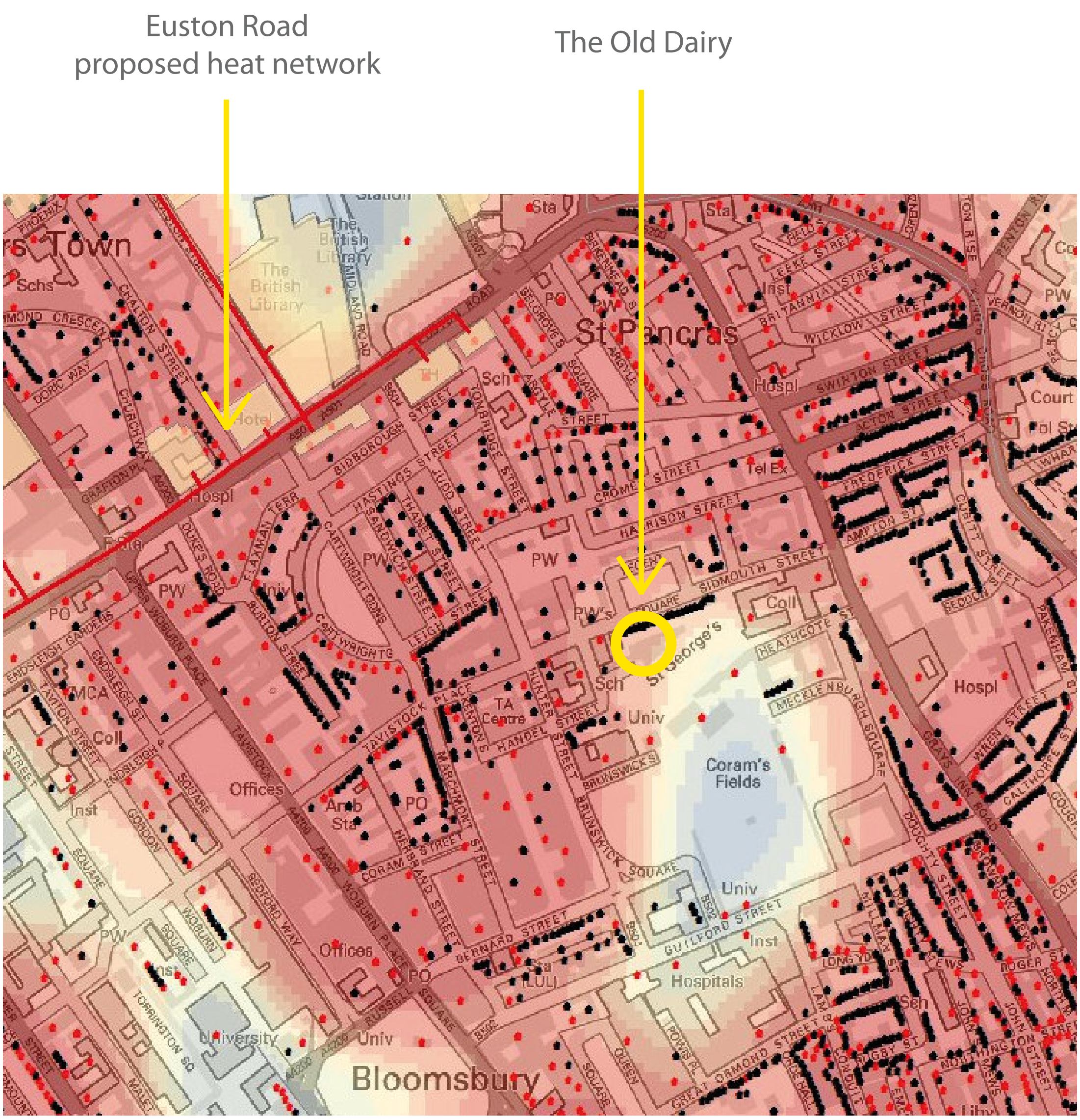
Primary energy and associated CO_2 emissions for Star Lane pre and post efficiency measures

District Heating

The Old Dairy is located in the London Borough of Camden. Below is an excerpt from the London Heat Map, showing heat points and heat networks around the proposed development.

The Old Dairy development is measured to be approximately 500m as the crow flies from the nearest proposed network near St Pancras Station on Euston Road. This network is not considered to be available in time for the development. A connection to this network would be costly given the distance and the road disruption due to laying the network extension would be unreasonable for a small development such as The Old Dairy.

As indicated by the pale colouring just south of the site, The Old Dairy is located at the edge of a low heat density area around Coram's Fields and St. Georges Gardens. The low density shows that a heat network around the development would be unsuitable.



London Heat Map

CHP and Trigeneration

CHP, or Cogeneration, is the production of electricity and useful heat from a single plant, improving the overall energy conversion efficiency from between 25-35% to around 80%.

For a wide range of buildings, CHP can offer an economical method of providing heat and power which is less environmentally harmful than conventional methods.

However, the economic viability of CHP is heavily dependent on the demand for heat and power. For small scale residential developments, the use of a CHP engine is not likely to be feasible.

The major obstacle to implementing CHP at this type of development is the low density of the site. As the dwellings are spread out, a district heating network would have to be installed which would result in heat losses in the distribution network.

Smaller units, designed for individual dwellings, are only just coming to market now and are yet to be proven. Studies from the Carbon Trust have shown that they may not be effective at reducing CO_2 emissions and have a much higher capital cost than conventional gas boilers.

A theoretical CHP system has been investigated as shown below, calculations based on the SAP 2009 methodology for communal CHP systems. As residential heat loads tend to be concentrated in the early morning, due to the hot water demand for showering, a large thermal store would have to be installed on site.

For a communal CHP system at this development to operate for more than 6,000 hours per year, it would have a thermal output of approximately 3 kW, this is well below the output of commercially available CHP units and therefore CHP is not viable for the site.

Gas CHP		
Split (CHPt/CHPe)	1.67	
Electrical Efficiency	30	%
Heating Efficiency	50	%
Backup System Efficiency	90	%
Hot Water Produced	13,079	kWh/yr
Electricity Produced	7,848	kWh/yr
Total CO_2 savings	1.8	t/yr
Percentage CO_2 reduction due to Gas CHP	2.7	%

Ener-G CHP unit

Renewables

Once the site-wide energy demand has been minimised, methods of generating low and zero carbon energy can be assessed.

A 20% reduction in total CO_2 emissions through the installation of low-carbon or renewable energy generation is required by the Camden Council (Paragraph 13.11 under Policy CS13 of Camden Council's Core Strategy).

There are several restrictions on renewables, such as the limited space on site, close proximity to other buildings and the aesthetic design that is to reflect the surrounding buildings.

The lean building development proposed that high-efficiency condensing gas boilers could be installed into each dwelling and the clean building development concluded that CHP was not a suitable alternative technology. Further CO_2 savings can be achieved through renewable technologies.

The following low carbon technologies were reviewed for the development. These technologies can all contribute to the 20% renewables target:

- Biomass
- Ground Source Heat Pumps
- Air Source Heat Pumps
- Wind Turbines
- Photovoltaic Panels
- Solar Thermal Collectors

Where possible, each system has been sized to meet a 20% CO_2 reduction.

A summary and comparison of the technologies is provided at the end of this document.

	Carbon dioxide emissions (tonnes CO_2 per annum)		
	Regulated	Unregulated	Total
Baseline	55.7	29.4	85.1
Lean	39.5	29.4	68.9
Clean	39.5	29.4	68.9

CO_2 emissions prior to the incorporation of renewable technologies for The Old Dairy

Biomass Heating

A biomass system for The Old Dairy development, would likely be fuelled by wood pellets due to the small plant space available. Wood pellets have a greater energy content per unit of weight, therefore they require a lower storage volume. Pellet boilers also require less maintenance and produce considerably less ash residue.

Realistically, individual biomass boilers located in each dwelling would not be feasible due to cost, space and technical limitations. Therefore, similarly to CHP (see page 9), a small heating network would be required to distribute hot water to each dwelling from a centralised biomass plant.

Analysis shows that there are several reasons why biomass is not an appropriate technology for this development:

- there are concerns over local air quality and the increase of NOx emissions as a result of burning wood as fuel;
- no available central plant room space is available on site;
- the narrow access to The Old Dairy would be a concern for biomass pellet deliveries;
- there may be issues in finding a local biomass supplier;
- a 20% reduction cannot be achieved by a biomass boiler, even if it is sized to meet 100% of the heat demand.

Example of pellet boiler and pellet storage room. Source: Energy Crops Limited

Example of wood pellet fuel

Biomass Heating	
% of heat supplied	100 %
Biomass System Efficiency	90 %
Carbon Intensity of Biomass	0.028 $kgCO_2/kWh$
Backup System Efficiency	90 %
Carbon Intensity of Backup	0.198 $kgCO_2/kWh$
Space Heating Demand Met	49,944 kWh/yr
Hot Water Demand Met	14,532 kWh/yr
Total CO_2 savings	12.2 t/yr
Lean CO_2	68.9 t/yr
Percentage CO_2 reduction	17.7 %

Ground Source Heat Pumps

The are a few options regarding types of ground source systems, which could be used in this development. Ground source heat exchangers can either be horizontal (buried in trenches), or vertical. Due to the limited space on site, a horizontal trench system would not be suitable.

Vertical closed loops can either be within boreholes of 30m-100m or incorporated within the foundations as a series of energy piles. Energy piles are an innovative way of limiting groundworks on site to within the building footprints, whilst still supplying a free source of heat to the building.

Energy piles of approximately 12m-16m would be spaced at 5m centres beneath the ground floor slabs of the development. Thermal fluid would be circulated around the closed ground loop absorbing heat from the ground and relaying this heat via an electrically run heat pump for use in the building.

The system would deliver space heating through a low-temperature efficient distribution network such as underfloor heating. Approximately 90% of the space heating demand can be supplied by the ground source heat pump if it is sized to approximately 50% of the peak heating load. A high efficiency gas boiler would provide top-up heat and domestic hot water.

The energy pile heating and cooling strategy would reduce the site wide CO_2 emissions by 7.7%.

Energy pile before installation

Energy piles in place

GSHP		
COP Heat	3.5	
Carbon Intensity of electricity	0.517	$kgCO_2/kWh$
Proportion of space heating met by GSHP	90	%
Proportion of hot water met by GSHP	0	%
Space heating demand met by GSHP	44,950	kWh/yr
Cooling demand met by GSHP	24,658	kWh/yr
Electricity used by GSHP	12,843	kWh/yr
Total CO_2 savings	5.3	t/yr
Lean CO_2	68.9	t/yr
Percentage CO_2 reduction	7.7	%

Air Source Heat Pumps

Air source heat pumps employ the same technology as GSHPs. However, instead of using heat exchangers buried in the ground, heat is extracted from the external ambient air.

ASHP external unit

A benefit of ASHP is that they produce space heating and hot water through electricity, thereby negating the need for a gas connection to each unit.

ASHPs tend to have a lower COP than GSHPs due to variable air temperature throughout the year, when compared to ground temperature. This is because heat pumps are more efficient when the temperature difference between the heat source (the air in this instance) and the space demand is lower.

Another factor to consider is the location of ASHP evaporators. These need to be located outside of the building. Any noise associated with the units, could potentially be an issue, particularly at night. In addition, outdoor plant space would be required for this option.

Sizing an air source heat pump system to 90% of the space heating and cooling only provides a 6.3% CO_2 reduction. In addition to the outdoor space requirements and the noise issues mean ASHP was not considered further for The Old Dairy.

ASHP		
COP Heat	3.2	
Carbon Intensity of electricity	0.517	$kgCO_2/kWh$
Proportion of space heating met by ASHP	90	%
Proportion of hot water met by ASHP	0	%
Space heating demand met by ASHP	40,950	kWh/yr
Cooling demand met by ASHP	24,658	Wh/yr
Electricity used by ASHP	14,046	kWh/yr
Total CO_2 savings	4.3	t/yr
Lean CO_2	68.9	t/yr
Percentage CO_2 reduction	6.3	%

Wind Turbines

The development could be installed with wind turbines to achieve the 20% renewable energy target target. Turbines in this case would be building-integrated due to lack of space on site.

Wind turbine outputs are based on the mounting height, turbine wind curve and wind data for the site from the BERR website. This was used in the Carbon Trust Wind Yield Estimation Tool.

The average annual wind speed at a mounting height of 20m above the surrounding building canopy is estimated to be 3.8 m/s. It is not generally recommended that wind turbines should be installed in any area where average wind speeds fall beneath 5m/s.

Two Proven wind turbines were considered for installation. Two 12kW wind turbines would achieve a 27.6% reduction in CO_2 emissions across the site of The Old Dairy, while alternatively seven smaller 2.5kW turbines could be installed for a 20.3% saving.

The visual impact would also not be suited to the surrounding Georgian built environment. Due to the restrictions on site and the number of turbines required, this technology is not considered to be suitable for The Old Dairy.

A building-mounted 2.5kW Proven wind turbine

Two 12kW Proven Wind turbines

Wind Power - 2.5kW		
Average windspeed at site	3.8	m/s
Electricity offset by turbine	3,780	kWh/yr
Carbon intensity of offset electricity	0.529	$kgCO_2$/kWh
Total CO_2 savings	2	t/yr
Lean CO_2	68.9	t/yr
Percentage CO_2 reduction by 2.5kW wind turbine	2.9	%
No. of turbines required to meet 10% CO_2 reduction	7	turbines

Wind Power - 12kW		
Average windspeed at site	3.8	m/s
Electricity offset by turbine	18,000	kWh/yr
Carbon intensity of offset electricity	0.529	$kgCO_2$/kWh
Total CO_2 savings	9.5	t/yr
Lean CO_2	68.9	t/yr
Percentage CO_2 reduction by 6kW wind turbine	13.8	%
No. of turbines required to meet 10% CO_2 reduction	2	turbines

Photovoltaic Panels

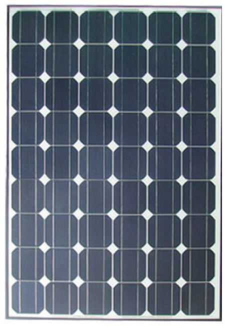
Currently, there are four types of solar cells available: mono-crystalline, poly-crystalline, thin film and hybrid. Mono-crystalline and hybrid cells are the most expensive to produce but are the most efficient (12-20%), poly-crystalline cells are cheaper but their efficiency is lower (9-15%) and thin film cells are only 5-8% efficient but can be produced as thin flexible sheets.

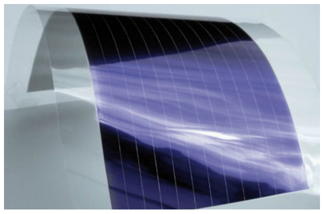
South facing arrays with an optimum inclination of about 35° would achieve the best performance. In this development, the roofs face east and west direction, so their output would not be optimum. The inclination of these roofs is around 22°.

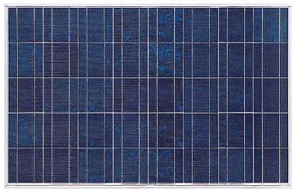
A mono-crystalline panel system of 16% efficiency was sized to meet the 20% CO_2 reduction for the development of The Old Dairy. This would result in 446 m² of photovoltaic panels, rated at about 71 kWp. This equates to approximately 64 m² or 10 kWp of photovoltaics per building.

Due to inadequate roof space, in terms of orientation and area; large amounts of shading from nearby trees; and the difficulties in incorporating panels into the architecture of the proposed development, this technology is not considered suitable for The Old Dairy.


A hybrid PV Panel


A monocrystalline PV Panel


Thin film PV


A polycrystalline PV Panel

Photovoltaic Panels Distributed Across Site		
Orientation	E/W-Facing with Heavy Shading	
Inclination assumed	30	degrees
Predicted site solar energy	457	kWh/m²/yr (S facing)
System losses	20	%
System peak power	71.3	kWp
Total array area (to be distributed across site)	445.8	m²
Primary electricity offset by PV array	26,051	kWh/yr
Total CO_2 savings	13.8	t/yr
Clean CO_2	68.9	t/yr
Percentage CO_2 reduction	20.0	%

Solar Thermal
Solar thermal modules would be installed in a similar way to PV arrays, i.e. there orientation and inclination would be dependent on the roofs that they are able to be installed onto.

Evacuated tube and flat plate collectors are both commercially available. Although more expensive than flat plate collectors, their higher efficiencies and higher temperatures make evacuated tube collectors a better choice for the UK climate.

The proposed system would be used for domestic hot water only, not space heating since this is not required during the season when solar thermal is the most effective.

A suitable solar thermal system would supply approximately 50% of the annual hot water consumption (the maximum feasible due to seasonal variations), and would be topped up with high efficiency gas boilers.

Calculations show that even by having a solar fraction of 100% solar thermal does not meet the 20% CO_2 renewables target. With a 50% solar fraction, 88m^2 of solar thermal would reduce CO_2 emissions by 5.2%.

As with PV, the site shading issues and orientation limitation also deem solar thermal unsuited to the development.

Evacuated Shell and Tube Solar Thermal Panel

Solar Thermal	
System Efficiency	40 %
Orientation	E/W-Facing with Heavy Shading
Predicted site solar energy	457 kWh/m^2/yr
Solar fraction	100 %
Total collector area	88 m^2
Primary gas energy offset by Solar Thermal system	17,941 kWh/yr
Total CO_2 savings	3.6 tonnes
Lean CO_2	68.9 t/yr
Percentage CO_2 reduction	5.2 %

Renewable Energy Summary

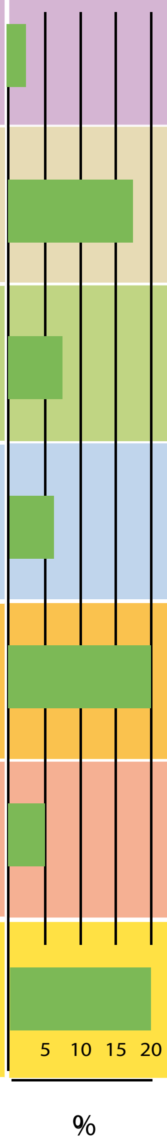
The table below summarises the renewable systems analysed and the different aspects taken into consideration, including estimated capital cost, simplified payback, lifetime, level of maintenance and level of impact on external appearance.

The final column (site feasibility) indicates how viable the technology is for the development (10 being the most feasible and 0 being unfeasible).

It is important to note that the information provided is indicative and costs are based upon initial estimates. Payback calculations do not take into consideration any grants or inflation. Current feed in tariffs have been included.

Where the payback is N/A this means the simple payback is greater than the lifetime of the system.

	% CO_2 Reduced	Simple Payback	Tonnes CO_2 per year	Lifetime	Maintenance	Impact on External Appearance	Site Feasibility
CHP		N/A	1.8	20yrs	High	Low	2
Biomass		15-20yrs	12.2	15yrs	Med	Low	5
GSHP		10-15yrs	5.3	30yrs	Low	Low	9
ASHP		10-15yrs	6.3	25yrs	Med	High	7
Wind		N/A	14.0	25yrs	Med	High	1
Solar Thermal		N/A	3.6	20yrs	Med	Low	3
PV		N/A	13.8	25yrs	Low	Low	5



Renewable Energy Strategy Conclusion

Due to the limitations of the site, ground source is considered the only renewable technology feasible for The Old Dairy. Energy piles are proposed as the more suited type of ground source loop as no additional groundworks on site will be required. This innovative technology will provide 90% of the buildings annual heating and also offer cooling when needed in the summer.

A series of energy piles distributed throughout the development footprint, does not make the 20% CO_2 reduction target through renewable energy, but it is the only suitable technology and still contributes a 13% reduction when compared to regulated lean building emissions

The following technologies have been ruled out for integration into the project:

- Biomass - local air pollution and difficulties surrounding fuel deliveries to the site mean that biomass is not suitable for this location.
- Wind turbines - this technology is not suitable for the site due to the low predicted annual mean wind speed and the aesthetic implications of building mounted turbines.
- ASHP - While ASHP is a low cost technology, it runs at a lower CoP than the proposed ground source option. The visual impacts of the outside units will also have design implications.
- PV - the heavy site shading is the main reason PV is not suitable. Visual implications and non-optimum roof orientation are also taken into account.
- Solar thermal - reasons for not adopting this technology are the same as for PV

For these reasons, Ground Source Heat Pump technology has been considered the optimum solution for this project.

	Carbon dioxide emissions (tonnes CO_2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2010 Part L Compliant Development	55.7	29.4	85.1
After energy demand reduction	39.5	29.4	68.9
After CHP	39.5	29.4	68.9
After Renewables	34.2	29.4	63.6

	Carbon dioxide savings (tonnes CO_2 per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	16.1	16.1	29.0%	19.0%
Savings from CHP	0.0	0.0	0.0%	0.0%
Savings from renewables	5.3	5.3	13.4%	7.7%
Total Cumulative Savings	21.4	21.4	38.5%	25.2%

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L 2010

Project name

111027 Old Dairy office units

As designed

Date: Thu Oct 27 16:31:34 2011

Administrative information

Building Details

Address: Address 1, Address 2, City, Postcode

Certification tool

Calculation engine: SBEM

Calculation engine version: v4.1.c.3

Interface to calculation engine: Virtual Environment

Interface to calculation engine version: v6.4.0

BRUKL compliance check version: v4.1.c.2

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	28.1
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	28.1
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	15.6
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

2.a Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.1	0.1	HRZN0026_W1_-1
Floor	0.25	0.08	0.09	FFC10004_F_2
Roof	0.25	0.1	0.1	HRZN0027_C_2
Windows***, roof windows, and rooflights	2.2	0.92	0.94	HRZN0027_C-W0
Personnel doors	2.2	-	-	"No heat loss personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No heat loss vehicle access doors"
High usage entrance doors	3.5	-	-	"No heat loss high usage entrance doors"

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	3

2.b Building services

The building services parameters listed below are expected to be checked by the BCO against guidance. No automatic checking is performed by the tool.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	0.9 to 0.95

1- Main system

Heating seasonal efficiency	**Cooling seasonal efficiency**	**SFP [W/(l/s)]**	**HR seasonal efficiency**
3.5	4	1.5	0.75
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system			YES

1- SYST0000-DHW

Heating seasonal efficiency	**Hot water storage loss factor [kWh/litre per day]**
Hot water provided by HVAC system	-

"No zones in project where local mechanical ventilation or exhaust is applicable"

General lighting and display lighting

Zone	General lighting [W]	Display lamps efficacy [lm/W]
Off2 Basement Stairwell	300	-
Off2 Basement	1650	-
Off2 Ground Stairwell	350	-
Off2 Ground	1000	-
Off2 First Stairwell	300	-
Off2 First	1050	-
Off1 Basement	1400	-
Off1 Basement Stairwell	150	-
Off1 Ground	950	-
Off1 First	950	-
Off1 First Stairwell	200	-
Off1 Ground Stairwell	150	-

Criterion 3: The spaces in the building should have propriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Off2 Basement	NO (-18.9%)	NO
Off2 Ground	NO (-68.8%)	NO
Off2 First Stairwell	NO (-89.8%)	NO
Off2 First	NO (-83.2%)	NO
Off1 Basement	NO (-44.8%)	NO
Off1 Ground	NO (-67.8%)	NO
Off1 First	NO (-62%)	NO
Off1 First Stairwell	NO (-92.9%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	1111	1111
External area [m^2]	2109.4	2109.4
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	5
Average conductance [W/K]	357.85	1096.95
Average U-value [W/m^2K]	0.17	0.52
Alpha value* [%]	37.94	14.02

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
100	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Telephone exchanges
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	1	7.53
Cooling	6.85	9.25
Auxiliary	8.6	22.01
Lighting	12.91	14.54
Hot water	0.76	0.97
Equipment*	37.78	37.21
TOTAL	**30.12**	**54.3**

* Energy used by equipment does not count towards the total for calculating emissions.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Indicative Target
Heating + cooling demand [MJ/m^2]	104.26	190.46
Total consumption [kWh/m^2]	30.12	54.3
Total emissions [kg/m^2]	15.6	28.1

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Chilled ceilings or passive chilled beams and displacement ventilation, [HS] Heat pump (electric): ground or water sourc										
	Actual	11.4	92.8	1	6.9	8.6	3.15	3.73	3.5	4
	Notional	67.6	122.9	7.5	9.2	22	2.43	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.1	HRZN0026_W1_-1
Floor	0.2	0.06	HRZN0026_F_-1
Roof	0.15	0.1	HRZN0027_C_2
Windows, roof windows, and rooflights	1.5	0.91	HRZN0026_W1-W0
Personnel doors	1.5	-	"No heat loss personnel doors"
Vehicle access & similar large doors	1.5	-	"No heat loss vehicle access doors"
High usage entrance doors	1.5	-	"No heat loss high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	3