



Energy Statement

Jacksons Corner

For SG Capital, International House, 1-6 Yarmouth Place, W1J 7BU.

May 2016

XCO2 energy

w: www.xco2energy.com :: e: mail@xco2energy.com
t: +44 (0) 20 7700 1000 :: f: +44 (0) 20 7183 6620
17-18 Hayward's Place :: Clerkenwell :: London :: EC1R 0EQ

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About us:

XCO2 Energy are a low-carbon consultancy working in the built environment. We are a multi-disciplinary company consisting of both architects and engineers, with specialists including CIBSE low carbon consultants, Code for Sustainable Homes, EcoHomes and BREEAM assessors and LEED accredited professionals.

	Issue 01	Issue 02	Issue 03	Issue 04	Issue 05
Remarks	Draft				Final
Prepared by	JC	JC	JC	JC	JC
Checked by	SP	SP	SP	SP	SP
Authorised by	JF	JF	JF	JF	JF
Date	21/03/2016	29/03/2016	30/03/2016	11/4/2016	4/5/2016
Project reference	8_638	8_638	8_638	8_638	8_638

Executive Summary

This report assesses the predicted energy performance and carbon dioxide emissions of the proposed development at Jacksons Corner, based on the information provided by the design team. The development is located on the corner of King's Road and the High Street, southeast of Market Square in Reading.

The proposed scheme comprises the refurbishment of 3 no. non-domestic units on the basement and ground floors, refurbished domestic units from the first to the third floors of the existing building fronting King's Road, and new-build domestic units from the first to the sixth floors at the rear of the development. The scheme would include approximately 1,126m² of non-domestic space in the part retained building, 18 dwellings in the refurbished building and 16 new-build dwellings.

The methodology used to determine the CO₂ emissions is in line with the proposed Energy Hierarchy outlined below:

1. Be Lean - use less energy

The first step deals with the reduction in energy use, through the adoption of sustainable design and construction measures.

In accordance with this strategy, this development will incorporate a range of energy efficiency measures including levels of insulation beyond Building Regulation requirements for the new build portions, insulation levels meeting Part L1B and L2B for the retained portions, the installation of high performance glazing and a mixture of natural ventilation and mechanical ventilation with heat recovery. The implementation of these measures would potentially reduce regulated CO₂ emissions by 50.1%, when compared to the baseline buildings.

2. Be Clean - supply energy efficiently

The second strategy takes into account the efficient supply of energy, by prioritising decentralised energy generation.

The feasibility study showed that no district heating networks are situated within close proximity of the site and due to the size of the development, a CHP unit would not be an economically viable option. Therefore, the installation of high efficiency condensing gas boilers for individual dwellings was deemed to be the more appropriate heating system. This will also minimise distributional heat losses associated with communal heating systems. The retail units will be provided with variable refrigerant flow systems with external units for heating and cooling as part of the tenants' fit-out works.

There is no further reduction in CO₂ emissions in addition to the 'Be Lean' stage.

3. Be Green - use renewable energy

The third strategy covers the use of renewable technologies. Reading Borough Local Development Framework Core Strategy (2015), states that all developments of more than 10 dwellings or 1,000m² floorspace should incorporate on-site generation of energy from renewable sources to off-set at least 20% of predicted carbon dioxide emissions. The development will aim to achieve a 20% reduction in carbon emission for the new build portion of the development through the implementation of renewables. A feasibility study was carried out to determine the most appropriate renewable technology to reach this target. The analysis included a biomass heating system, ground-source heat pumps, air-source heat pumps, photovoltaic panels, solar thermal and wind turbines.

The analysis demonstrated that photovoltaic panels for the new build residential portion of the development were the most suitable technologies. The installation of 60m² of photovoltaic panels with a rated output of 11.4kWp will reduce the new-build dwellings' regulated CO₂ emissions by 21.7% and the whole development's regulated emissions by 2.7% over the baseline buildings. The development will achieve a 20% CO₂ reduction target for the new-build portion of the scheme. Any additional provision of PV or other technologies is considered to be financially infeasible.



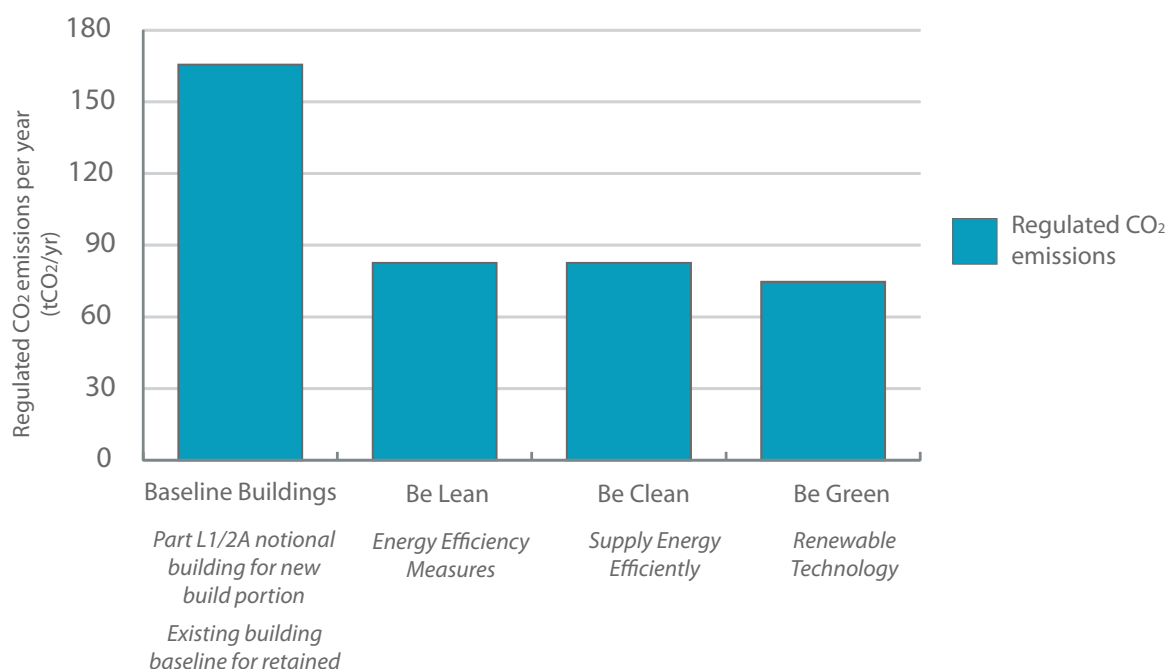
Conclusion

The graph below provides a summary of the regulated CO₂ savings at each stage of the Energy Hierarchy. The solid green line indicates the baseline condition which is equivalent to a notional building built to Part L Building Regulations (2013) for the new build portion of the scheme and the existing building baseline for the retained portion of the

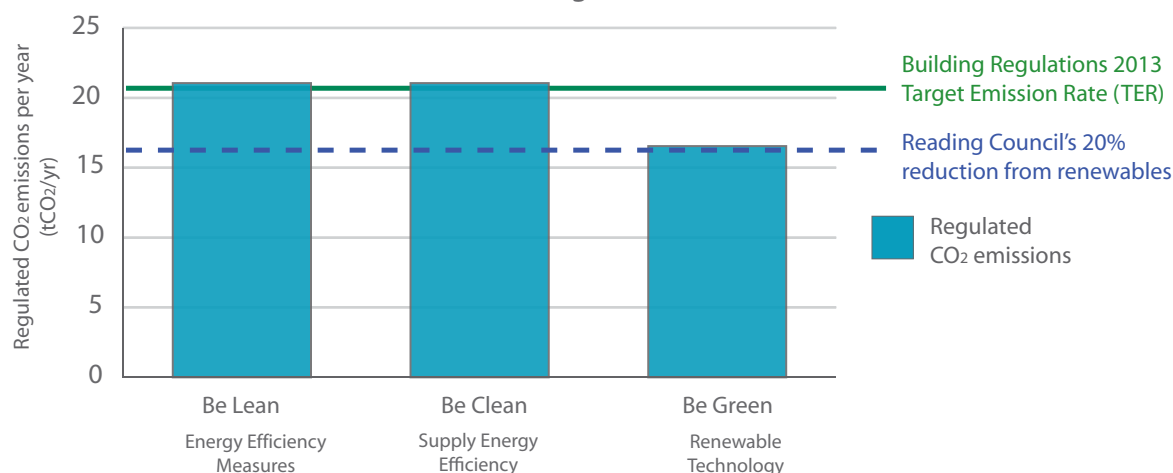
scheme.

It can be seen on the graphs that significant savings is made through the provision of efficient building fabric and services system for the whole scheme, with further reduction made through the provision of suitable renewable technologies.

**Energy Hierarchy for Jackson's Corner
- whole development**



**Energy Hierarchy for Jackson's Corner
- new-build dwellings**



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The tables below outlines the regulated CO₂ saving at each stage of the energy hierarchy.

In total, the development is expected to reduce regulated CO₂ emissions by 52.9% when compared to the baseline buildings (existing buildings baseline for the retained portion of the scheme, and Part L 2013 notional baseline for the new build dwellings), which is a significant saving for a development of this nature..

Carbon Dioxide Emissions After Each Stage of the Energy Hierarchy

	Carbon dioxide emissions (tonnes CO ₂ per annum)	
	Regulated	Unregulated
Building Regulations 2013 Part L and existing buildings baseline	165.5	92.2
After energy demand reduction	82.5	92.2
After efficient energy supply	82.5	92.2
After Renewable technologies	78.0	92.2

Regulated Carbon Dioxide Savings From Each Stage of the Energy Hierarchy

	Regulated Carbon Dioxide Savings		
	Tonnes CO ₂ / year	% over last stage	% over baseline
Savings from energy demand reduction	83.0	50.1%	50.1%
Savings from efficient energy supply	0.0	0.0%	0.0%
Savings from renewable energy	4.5	2.7%	1.7%
Total Cumulative Savings	87.5	52.9%	33.9%

Introduction

The site is located on the corner of the Kings Road and the High Street, southeast of Market Square, Reading. The proposed scheme comprises the refurbishment of 3 no. non-domestic units on the basement and ground floors, refurbished domestic units from the first to the third floors of the existing building fronting King's Road, and new-build domestic units on from the first to the sixth floors at the rear of the development. The scheme would include approximately 1,126m² of non-domestic space in the part retained building, 18 dwellings in the refurbished building and 16 new-build dwellings.

The purpose of this report is to demonstrate to Reading Borough Council how the development fulfils its relevant energy policies. This report outlines the expected energy performance of the development as well as the energy efficiency measures that will be employed to reduce CO₂ emissions to meet BREEAM Domestic Refurbishment for the dwellings within the retained building, and BREEAM Shell and Core for the retail units.

The methodology employed to determine the potential CO₂ savings for this development is similar to the three step Energy Hierarchy outlined in the London Plan for new developments. The hierarchy although primarily intended for use for new developments in London, is also well established and often cited for developments outside of London. The hierarchy is as follows:

- 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.

Energy calculations were carried out using the FSAP 2012 methodology for the residential units, and SBEM for the retail units. It should be noted that, due to the refurbishment nature of parts of the scheme, the buildings with their current fabric and system properties is used as the baseline condition for the retained and refurbished portion of the development. The new build dwellings have been compared to a notional building constructed to current Part L 2013 Building Regulations.

Code for Sustainable Homes was withdrawn by the Government in April 2015. Therefore, the proposed new build residential component at Jacksons Corner will not be required to achieve Code compliance.

Nevertheless, the sustainability measures in line with Code principles will be adopted in the design of the residential units, to minimise the scheme's construction and operational environmental impact, as well as improve the occupants' wellbeing. BREEAM pre-assessments has been undertaken for the non-domestic component, as well as the dwellings within the retained building. The non-energy related policies are discussed in the accompanying Sustainability Statement for this scheme.

Demand Reduction (Be Lean)

Passive Design Measures

Enhanced Building Fabric

The heat loss of different building elements is dependent upon their U-value. The lower the U-value, the better the level of insulation of a particular element. A building with low U-values has a reduced heating demand during the cooler months.

The new build portions of proposed development of Jacksons Corner will incorporate high levels of insulation and high-performance glazing on all of the facades to significantly reduce the demand for space heating (refer to the table below). The refurbished buildings will meet the u-value targets set out in Building Regulations Part L1B/2B.

New Build Residential U-Values (W/m²K)

Element	Building Regulations	Proposed	% Improvement
Walls	0.30	0.15	50%
Floor	0.25	0.10	60%
Roof	0.20	0.15	25%
Windows	2.0	1.30	35%

Air Tightness

Heat loss may also occur due to air infiltration. Although this cannot be eliminated altogether, good construction detailing and the use of best practice construction techniques can minimise the amount of air infiltration into a building.

Current Part L Building Regulations (2013) sets a maximum air permeability rate of 10m³/m² at 50Pa. The new build portion of the development is likely to improve upon this to achieve at least 5m³/m² at 50Pa through the application of best practice construction techniques.

Daylight

The residential units will have good access to daylight to improve the health and well-being of the occupants. The non-domestic spaces are supplied with natural light where possible.

Active Design Measures

High Efficacy Lighting

The development intends to incorporate low energy lighting fittings throughout the buildings. 100% of all light fittings will be specified as low energy lighting, and will accommodate compact fluorescent (CFL's) or fluorescent luminaries only.

Internal areas of infrequent use will be fitted with occupant sensors, whereas day lit areas will incorporate daylight sensors.

Heat Recovery Ventilation

Mechanical ventilation is proposed for the commercial units and the dwellings in the retained building for air quality reasons, whilst the new build dwellings will be naturally ventilated.

The mechanical ventilation system will include heat recovery (MVHR) in order to achieve ventilation in the most energy-efficient way.

In all areas of the building, windows will be operable to achieve passive cooling in summer where required. The design team will utilise window configurations which allow effective single-sided or cross ventilation to occur. Passive extract at this scale would be too complex and would have an unacceptable aesthetic impact.



Energy Demand

The table below shows a breakdown of energy consumption for heating and electricity demand. These figures indicate baseline figures and Lean figures, once energy efficiency measures have been applied.

This table demonstrates the energy savings achieved through energy efficiency measures (Lean stage of the Energy Hierarchy).

Breakdown of Energy Consumption and CO₂ Emissions

	Baseline Buildings			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	178,150	39,260	10.3	73,750	16,740	4.4
Space Heating	371,000	80,260	21.9	141,620	36,790	9.7
Cooling	25,260	12,78	3.4	23,170	11,730	3.1
Auxiliary	12,270	6,270	1.6	10,050	5,130	1.3
Lighting	47,420	24,170	6.4	23,020	11,780	3.1
Equipment (not incl. in Part L)	177,710	92,230	24.2	177,710	92,230	24.2
Total Part L	634,110	165,540	43.5	271,610	82,500	21.6
Total (incl. Equip)	811,820	257,770	67.8	449,320	174,780	45.8

CO₂ Emissions

The table below shows the regulated and unregulated carbon dioxide emissions for the baseline scheme and the emissions after the passive and active lean measures have been implemented.

A saving of 50.1% is expected from the regulated CO₂ emissions while an overall CO₂ savings of 32.2% is expected to be achieved based on the total CO₂ emissions of the development.

CO₂ Emissions Breakdown

	Carbon Dioxide emissions (tonnes CO ₂ per annum)		
	Regulated	Unregulated	Total
Baseline buildings	165.5	92.2	257.7
After energy demand reduction (Lean)	82.5	92.2	174.7

	Carbon dioxide savings (tonnes CO ₂ per annum)		Carbon dioxide savings from baseline (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	50.1%	32.2%	50.1%	32.2%



Heating and Cooling Infrastructure (Be Clean)

Energy System Hierarchy

Local heat and power sources minimise distribution losses and achieve greater efficiency when compared to separate energy systems, thus reducing CO₂ emissions. The energy systems for Jacksons Corner have been determined in accordance with the following hierarchy:

1. Connection to existing heating and cooling networks
2. Site wide CHP network
3. Communal heating and cooling

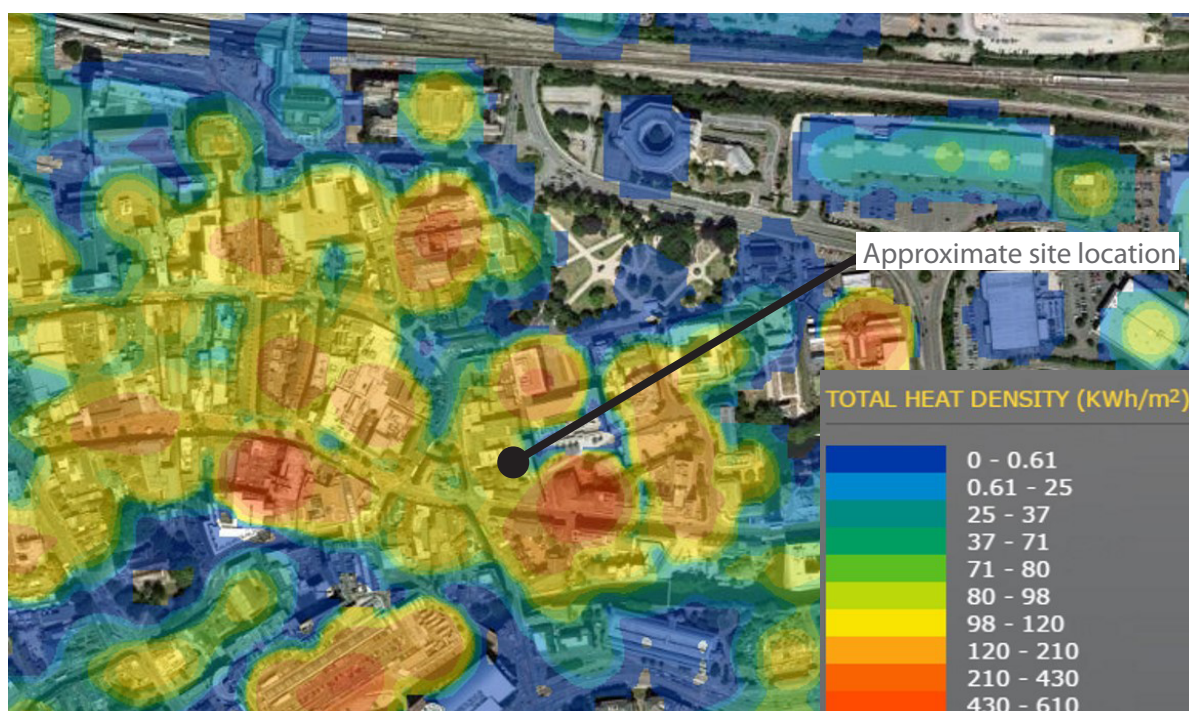
Local supply of heat and power minimise distribution losses, thereby achieving a greater efficiency and reducing CO₂ emissions, when compared to the individual systems.

In a communal energy system, energy in the form of heat, cooling, and/or electricity is generated from a central source and distributed via a network to surrounding residencies and commercial units.

Connection to Existing Low Carbon Heat Distribution Networks

Below is an excerpt from the Department of Energy & Climate Change National Heat Map, showing areas with potential connection to a district heating network.

As indicated by the colouring on the map below, the site is located in a medium density heat demand zone. The data assumes that there is a moderate demand for heat within the vicinity of the site. However, the data shows that no existing CHP or district heating network exist within 500m of the site. Therefore, connection to an existing district heating network would not be feasible in this location.



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Combined Heat and Power (CHP)

CHP, or Co-generation is the production of electricity and useful heat from a single engine. Unlike conventional electricity generation, heat is re-used in a CHP system, primarily for hot water, thereby improving the overall energy conversion from 25-35% to around 80%.

Due to the type and size of the development, this technology would not be suitable for this site. The hot water load of the site would not be sufficient to justify the use of this technology.

Trigeneration

In some circumstances it can be suitable to combine CHP with an absorption chiller in order to produce chilled water for cooling purposes. This is known as Trigeneration or Combined Cooling Heat and Power. If cooling loads are sufficient, then CCHP can offer an economical and lower CO₂ emissions method of providing cooling, heat and power when compared to conventional systems.

The proposed development of Jacksons Corner is too small to take advantage of commercially available trigeneration systems and therefore it would not be an economically viable solution for the site.

Heating and hot water for the dwellings will be supplied by individual high efficiency gas boilers, and that for the retail units will be met by energy efficient Variable Refrigerant Flow (VRF) systems with external condensers, to be installed as part of the tenants fit-out works.



An example of a CHP engine (courtesy of Baxi)

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CO₂ Emissions

The table below shows the regulated and unregulated carbon dioxide emissions for the baseline scheme as well as the reduced emissions once Lean (energy efficiency) and Clean (communal heating system or CHP) measures have been implemented.

The table below illustrate that there will be no savings achieved at the Clean Stage.

CO₂ Emissions Breakdown

	Carbon Dioxide emissions (tonnes CO ₂ per annum)		
	Regulated	Unregulated	Total
Baseline building	165.5	92.2	257.7
After energy demand reduction (Lean)	82.2	92.2	174.7
After communal heating (Clean)	82.2	92.2	174.7

	Carbon dioxide savings (tonnes CO ₂ per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	50.1%	32.2%	50.1%	32.2%
Savings from communal heating	0.0%	0.0%	0.0%	0.0%

Renewable Energy (Be Green)

Once the energy demand has been minimised, methods of generating low and zero carbon energy can be assessed for the Jacksons Corner development. The renewable technologies to be considered for the development are:

- Biomass
- Ground/water source heat pumps
- Air source heat pump
- Wind energy
- Photovoltaic panels
- Solar thermal panels

The table in the following page summarises the factors taken into account in determining the appropriate renewable technology for this project. This includes estimated lifetime, level of maintenance, and level of impact on external appearance. The final column indicates the feasibility of the technology in relation to the site conditions (10 being the most feasible and 0 being infeasible).

The feasibility study concludes that photovoltaic panels are the most feasible option for the site. Details of the proposed PV array are presented on the following pages.

Variable Refrigerant Flow (VRF) systems with external condensers, will be installed to the retail units as part of the tenants fit-out works. A standard efficiency have been assumed for the energy calculations presented in this report, and it is likely that the actual units to be installed will be of a higher efficiency than the value assumed.

Jacksons Corner					
	Comments	Lifetime	Maintenance	Impact on External Appearance	Site Feasibility
Biomass 	Not adopted -burning of wood pellets releases high NOx emissions and there are limitations for their storage and delivery within an urban location.	20yrs	High	High	1
PV 	Adopted Technology	25yrs	Low	Med	9
Solar Thermal 	Not adopted -solar thermal array would require additional plumbing, space for hot water storage. And will result in limited savings.	25yrs	Low	Med	3
GSHP 	Not adopted -the installation of ground loops require significant space, additional time at the beginning of the construction process and very high capital costs.	20yrs	Med	Low	1
ASHP 	Variable Refrigerant Flow system with external condensers, to be adopted for the retailed units as part of tenant fit out. Standard efficiency assumed in the energy assessment.	20yrs	Med	Med	9
Wind 	Not adopted -wind turbines would achieve low CO ₂ savings in this site due to space limitations. In addition, they would have a significant visual impact on the neighbourhood.	25yrs	Med	High	1

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Photovoltaic Panels

Four types of solar cells available at present are mono-crystalline, poly-crystalline, thin film and hybrid. Although mono-crystalline and hybrid cells are the most expensive, they are the most efficient (12-20%). Poly-crystalline cells are cheaper but they are less efficient (9-15%). Thin film cells are only 5-8% efficient but have the advantage of being produced as thin and flexible sheets.

The feasibility study for Jacksons Corner showed that photovoltaics to be the most suitable renewable technology for the following reasons:

- There is sufficient roof space available to install enough PV modules to have an impact on carbon dioxide emissions of the new build portion of the development;
- The installation of photovoltaics is much simpler when compared to other renewable technologies;
- photovoltaics sited on the roof are less visually intrusive when compared to wind turbines.

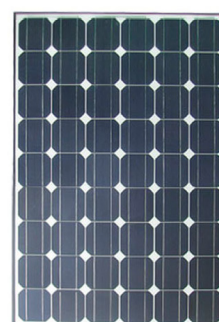
Photovoltaic Panels		
Module Efficiency	19	%
Collector orientation	South	
Tilt of collector	Horizontal	
Predicted site solar energy	950	kWh/m ² /yr
System losses	20	%
System peak power	11.4	kWp
Array area	60	m ²
Primary electricity offset by PV array	8,670	kWh/yr
Total CO ₂ savings	4.5	t/yr
Regulated Clean CO ₂ emissions	82.5	t/yr
Total Clean CO ₂ emissions	174.7	t/yr
Regulated CO ₂ reduction from clean stage	5.5	%
Total CO ₂ reduction from clean stage	2.6	%
Regulated CO ₂ reduction from baseline	2.7	%
Total CO ₂ reduction from baseline	1.7	%

The installation of 60m² of photovoltaic panels with a rated output of 11.4kWp will reduce the new build dwelling emissions by 21.7% (which meets Reading Borough Council's 20% CO₂ reduction from renewables target) and total development emissions by 2.7% over the baseline.

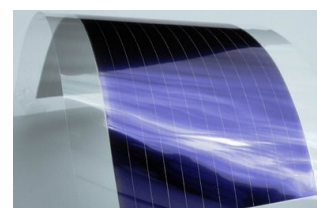
This technology will be implemented as part of the 'Be Green' strategy for this proposed development.



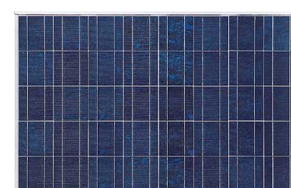
Hybrid PV Panel



Monocrystalline PV Panel



Thin film PV



Polycrystalline PV Panel

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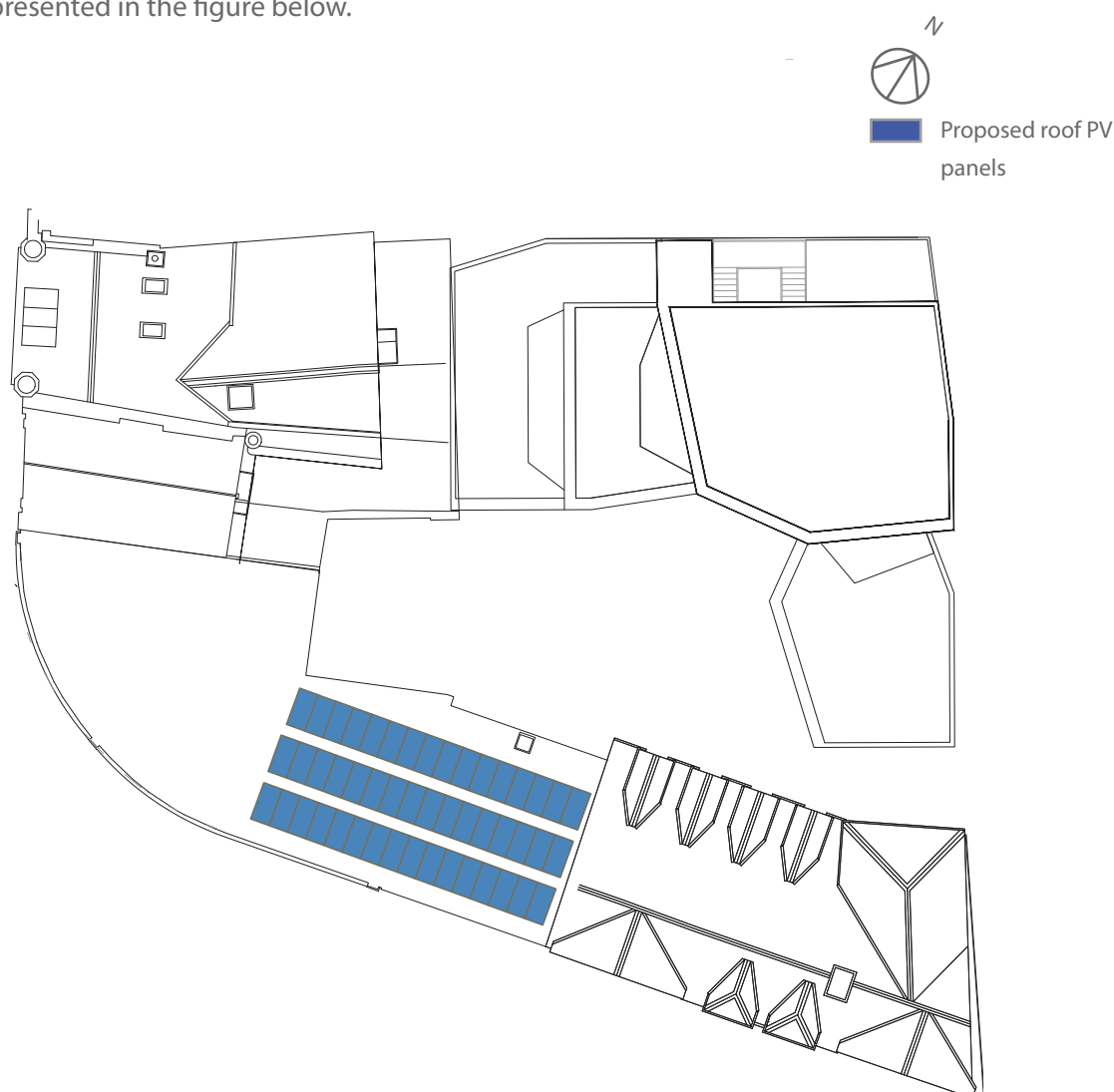
Layout of Photovoltaic Panels

An appropriate location for the proposed photovoltaic panels was identified once the site constraints were taken into account. The factors taken into consideration included:

- avoiding any potential overshadowing from adjacent PV panels;
- avoiding visibility from street level;
- space required for maintenance including all health and safety requirements for roof access;

A 60m² array of 19% efficiency PV modules, with a rated output of 11.4 kWp would offset 2.7% of regulated CO₂ emissions from baseline. An indicative PV layout is presented in the figure below.

Proposed distribution of PV array at Jacksons Corner	
Area of PV array (m ²)	60
No. of PV panels	48
Peak power (kWp)	11.4



- Proposed roof PV plan at Jacksons Corner

CO₂ Emissions

The table below shows the regulated and unregulated carbon dioxide emissions for the baseline scheme and the emissions after the lean, clean and green measures have been implemented.

The savings achieved through renewable technologies are significant, amounting to an additional 2.7% reduction in regulated emissions and a 1.7% reduction in total carbon dioxide emissions.

Overall, proposed scheme at Jacksons Corner achieves a reduction in regulated CO₂ emissions of 52.9% in comparison the baseline building.

CO₂ Emissions Breakdown

	Carbon Dioxide emissions (tonnes CO ₂ per annum)		
	Regulated	Unregulated	Total
Baseline buildings	165.5	92.2	257.7
After energy demand reduction (Lean)	82.2	92.2	174.7
After CHP (Clean)	82.2	92.2	174.7
After PV (Green)	78.0	92.2	170.2

	Carbon dioxide savings (tonnes CO ₂ per annum)		Carbon dioxide savings from baseline (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	83.0	83.0	50.1%	32.3%
Savings from CHP	0.0	0.0	0.0%	0.0%
Savings from PV	4.5	4.5	2.7%	1.7%
Cumulative savings	87.5	87.5	52.9%	33.9%

Conclusion

In line with the three step hierarchy, the regulated CO₂ emissions for this development have been reduced by 52.9%, one the energy efficiency measures and renewable are taken into account.

The tables on the following page provides a breakdown of the CO₂ savings made at each stage of the Energy Hierarchy. The reductions made through each step have been outlined below:

1. Be Lean - use less energy

In accordance with this strategy, this development will incorporate a range of energy efficiency measures including levels of insulation beyond Building Regulation requirements for the new build portions, and insulation levels meeting Part L1B and L2B for the retained portions, the installation of high performance glazing and a mixture of natural ventilation and mechanical ventilation with heat recovery. The implementation of these measures would potentially reduce regulated CO₂ emissions by 50.1%, when compared to baseline buildings.

2. Be Clean - supply energy efficiently

The feasibility study showed that no district heating networks currently exist within close proximity to the site. Therefore high efficiency individual gas boilers have been proposed for the dwellings. The retail units will be provided with variable refrigerant flow systems with external units for heating and cooling as part of the tenants' fit-out works.

3. Be Green - use renewable energy

The feasibility study analysed a number of renewable technologies for their suitability for the site. The analysis included a biomass heating system, ground-source heat pumps, air-source heat pumps, photo voltaic panels, solar thermal and wind turbines.

The analysis demonstrated that photovoltaic panels for the new build residential portion of the development were the most suitable technologies. The installation of 60m² of photovoltaic panels with a rated output of 11.4kWp will reduce the new build dwelling emissions by 21.7% and total development emissions by 2.7% over the baseline building.

Overall, the proposed development achieves a 52.9% reduction in regulated CO₂ emissions over the baseline building, which is a significant reduction for a scheme of this nature. This demonstrates the client and design team's commitment to ensure satisfactory energy performance at Jacksons Corner.

CO₂ Emissions Breakdown

	Carbon Dioxide emissions (tonnes CO ₂ per annum)		
	Regulated	Unregulated	Total
Baseline building	165.5	92.2	257.7
After energy demand reduction (Lean)	82.2	92.2	174.7
After district heating system (Clean)	82.2	92.2	174.7
After PV (Green)	78.0	92.2	170.2

CO₂ Savings Breakdown

	Carbon dioxide savings (tonnes CO ₂ per annum)		Carbon dioxide savings over baseline (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	83.0	83.0	50.1%	32.2%
Savings from district heating system	0.0	0.0	0.0%	0.0%
Savings from PV	4.5	4.5	2.7%	1.7%
Cumulative savings	87.5	87.5	52.9%	33.9%