

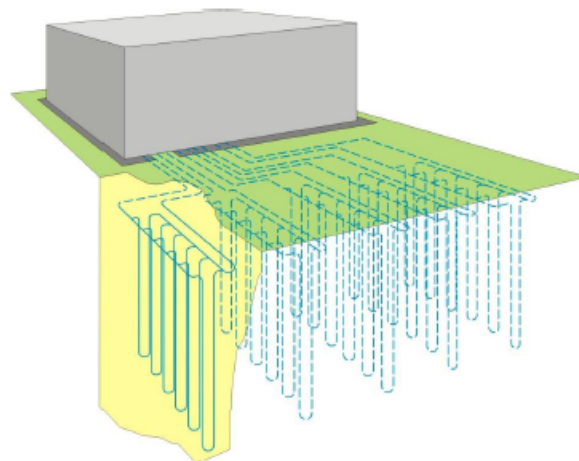


For this development there is no realistic space within the overall development for fuel storage together with the site constraints related to the associated delivery requirements. In addition, there are on-going concerns with regard to the potential impact on local air quality.

For the reasons defined above the use of biomass is not considered viable for the development.

6.06 Ground Source Heating and Cooling

Ground source heating and cooling systems utilise the principle during heating mode of upgrading heat from the ground to a usable temperature and during cooling mode of rejecting heat from the building into the ground. There are two primary methods utilising either open or closed loop systems.



The open loop system extracts water, typically from the chalk aquifer, and uses this water in either the heating or cooling process before rejecting this heat back to the aquifer in a separate borehole. The open loop system requires licence approval from the Environment Agency that typically has a 10 year duration.

The closed loop system dissipates heat to or extracts heat from the ground via pipework circuits that are typically inserted into vertical boreholes. These generally do not require Environment Agency licences as no extraction of water from the aquifer takes place.



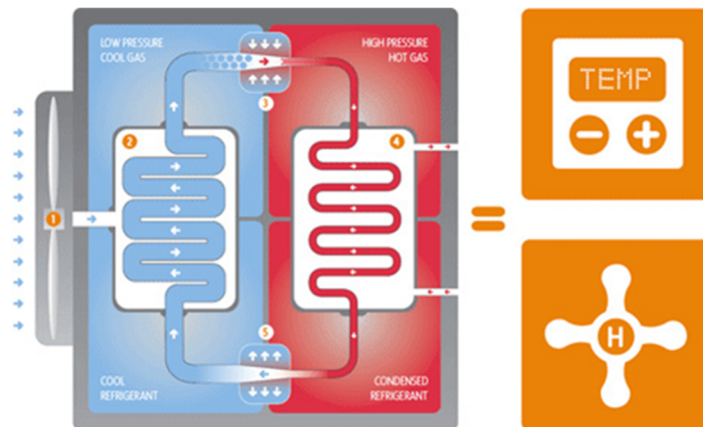
Generally, for both the open and closed loop options heat pumps are used in order to generate the heating and cooling water temperatures needed within a building.

A condensate water system is proposed for the development which will meet the demand of this development. A connection shall be provided to the district energy network when available.

For these reasons a ground source heating and cooling system is not considered viable for the development.

6.07 Air Source Heating and Cooling

Air sourced heat pump (ASHP) works on the same principles as a ground source heat pump (GSHP) however the medium in which heat is extracted is the external air rather than the ground. The ASHP can be reversed to provide cooling when required. ASHP will generally have a lower seasonal coefficient of performance when compared to GSHP.



A condensate water system is proposed for the development which will meet the heating, cooling and hot water demand of this development. The condensate water system will incorporate dry air coolers and heat pumps to meet the demands of the apartment Blocks A to D. As the cooling and heating demand is met by the condensate water system an ASHP installation is not considered viable for this development.

6.08 Fuel Cell

The fuel cell technology essentially converts chemical energy into both electrical and heat energy. The cell needs to be continually supplied with hydrogen (derived from either a piped or storage source) and oxygen (derived from air) which are combined, and the chemical reaction produces electrical energy, heat energy and water vapour.

The fuel cell requires a hydrogen fuel source that can either be from a piped source (not currently available) or from stored gas. However, the more usual approach currently in the UK is to use natural gas in order to generate the hydrogen required to operate the fuel cell.

Fuel cells have various commercial and technical limitations. There is a high initial capital cost together with there being few established suppliers and a very limited specialist design, installation and maintenance capabilities. Certain fuel cell elements require regular replacement imposing a significant on-going cost implication. The fuel cells themselves are generally large, heavy and require fresh air ventilation.



Due to the initial capital cost, space requirements and on-going maintenance costs fuel cells are not considered viable for this development.

6.09 Renewable Energy Analysis

6.09.01 Viable LZCs

The proposed renewable energy sources for the development, applicable to Block A, Block B, Block C and Block D residential areas only, are:

Photovoltaic panels - 30 m² of PV panels to provide a contribution to the electricity demand.

6.09.02 Block A

The thermal model has been repeated incorporating the renewable energy technologies and the results are:

Type	Apartments	Baseline Scheme (kg CO ₂ /m ² /year)	Lean Scheme (kg CO ₂ /m ² /year)	Clean Scheme (kg CO ₂ /m ² /year)	LZC Scheme (kg CO ₂ /m ² /year)
Part L1A : 2013 Total		19.06	14.77	14.75	9.43
Unregulated Power		20.19	20.19	20.19	20.19
Total		39.25	34.96	34.94	29.62

The annual CO₂ emissions for Block A incorporating renewable energy technologies are 9.43 kg CO₂/m².

The improvement with renewable energy technologies over the baseline (TER) scheme is 50.52 %.

The annual CO₂ emissions for Block A allowing for un-regulated energy uses with the renewable energy technologies are 29.62 kg CO₂/m².

The improvement with renewable energy technologies over the baseline (TER) scheme when un-regulated energy uses are incorporated is 27.56 %.

The annual CO₂ emissions resulting from the green scheme with renewable energy technologies equates to 103.85 tonnes without un-regulated uses and then 326.21 tonnes when un-regulated uses are taken into account.

6.09.03 Block B

The thermal model has been repeated incorporating the renewable energy technologies and the results are:

Type	Apartments	Baseline Scheme (kg CO ₂ /m ² /year)	Lean Scheme (kg CO ₂ /m ² /year)	Clean Scheme (kg CO ₂ /m ² /year)	LZC Scheme (kg CO ₂ /m ² /year)
Part L1A : 2013 Total		19.06	14.68	14.65	9.57
Unregulated Power		19.25	19.25	19.25	19.25
Total		38.31	33.93	33.90	28.82



The annual CO₂ emissions for Block B incorporating renewable energy technologies are 9.57 kg CO₂/m².

The improvement with renewable energy technologies over the baseline (TER) scheme is 49.79 %.

The annual CO₂ emissions for Block B allowing for un-regulated energy uses with the renewable energy technologies are 28.82 kg CO₂/m².

The improvement with renewable energy technologies over the baseline (TER) scheme when un-regulated energy uses are incorporated is 27.99 %.

The annual CO₂ emissions resulting from the green scheme with renewable energy technologies equates to 126.67 tonnes without un-regulated uses and then 381.46 tonnes when un-regulated uses are taken into account.

6.09.04 Block C

The thermal model has been repeated incorporating the renewable energy technologies and the results are:

Type	Apartments	Baseline Scheme (kg CO ₂ /m ² /year)	Lean Scheme (kg CO ₂ /m ² /year)	Clean Scheme (kg CO ₂ /m ² /year)	LZC Scheme (kg CO ₂ /m ² /year)
Part L1A : 2013 Total		18.79	14.95	14.66	9.43
Unregulated Power		19.50	19.50	19.50	19.50
Total		38.29	34.45	34.16	28.93

The annual CO₂ emissions for Block C incorporating renewable energy technologies are 9.43 kg CO₂/m².

The improvement with renewable energy technologies over the baseline (TER) scheme is 49.81 %.

The annual CO₂ emissions for Block C allowing for un-regulated energy uses with the renewable energy technologies are 28.93 kg CO₂/m².

The improvement with renewable energy technologies over the baseline (TER) scheme when un-regulated energy uses are incorporated is 27.40 %.

The annual CO₂ emissions resulting from the green scheme with renewable energy technologies equates to 141.92 tonnes without un-regulated uses and then 435.40 tonnes when un-regulated uses are taken into account.

6.09.05 Block D

The thermal model has been repeated incorporating the renewable energy technologies and the results are:

Type	Apartments	Baseline Scheme (kg CO ₂ /m ² /year)	Lean Scheme (kg CO ₂ /m ² /year)	Clean Scheme (kg CO ₂ /m ² /year)	LZC Scheme (kg CO ₂ /m ² /year)
Part L1A : 2013 Total		18.75	14.40	14.36	9.67



Type	Apartments	Baseline Scheme (kg CO ₂ /m ² /year)	Lean Scheme (kg CO ₂ /m ² /year)	Clean Scheme (kg CO ₂ /m ² /year)	LZC Scheme (kg CO ₂ /m ² /year)
Unregulated Power		18.80	18.80	18.80	18.80
Total		37.55	33.2	33.16	28.47

The annual CO₂ emissions for Block D incorporating renewable energy technologies are 9.67 kg CO₂/m².

The improvement with renewable energy technologies over the baseline (TER) scheme is 48.43 %.

The annual CO₂ emissions for Block D allowing for un-regulated energy uses with the renewable energy technologies are 28.47 kg CO₂/m².

The improvement with renewable energy technologies over the baseline (TER) scheme when un-regulated energy uses are incorporated is 27.38 %.

The annual CO₂ emissions resulting from the green scheme with renewable energy technologies equates to 132.79 tonnes without un-regulated uses and then 390.95 tonnes when un-regulated uses are taken into account.



7.00 OVERHEATING

The building design has adopted the following principles in order to reduce potential overheating:

- Balance between solid and glazed elements within the façade whilst taking into account the building design aesthetic requirements
- Energy efficient design measures such as low energy LED lighting with occupancy control and automatic daylight dimming, and variable speed fans to reduce motor heat gain
- High performance glazing to reduce heat losses and solar heat gain
- Mechanical fresh air ventilation system that can provide free cooling during certain times of the year



8.00 OVERALL BUILDING ANALYSIS

8.01 Carbon Reduction – Building Regulation 2013 Baseline

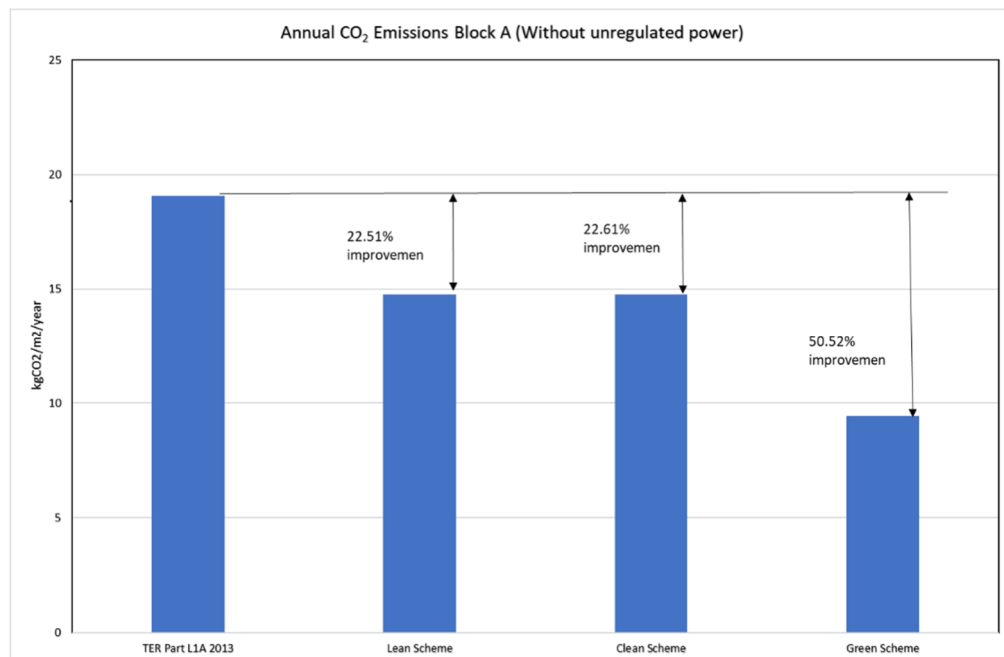
The overall building analysis can then be summarised as follows:

Block A

	Area Weighted kg CO ₂ /m ²			
	Baseline Scheme	Lean Scheme	Clean Scheme	LZC Scheme
Building Regulations Compliant	19.06	14.77	14.75	9.43
Allowing for Un-regulated Uses	39.25	34.96	34.94	29.62

These values are shown in diagrammatic form below that shows the following principles:

- The proposed scheme (LZC) assessment shows a predicted improvement of 50.52 % when compared to the baseline scheme
- The renewable energy technologies show a predicted improvement of 36.15 % over the lean scheme
- When un-regulated energy uses are taken into account the predicted overall improvement is 27.56 % compared to the baseline scheme with renewable energy technologies showing a predicted 15.27 % improvement over the lean scheme



Based on the regulated power results indicated above the proposed scheme incorporating a renewable energy technology provides a carbon emissions reduction of 50.52 % when compared to the baseline Building Regulations 2013 (TER) compliant scheme. This demonstrates that the proposed scheme for Block A archives beyond Reading Plan requirement of 35%.

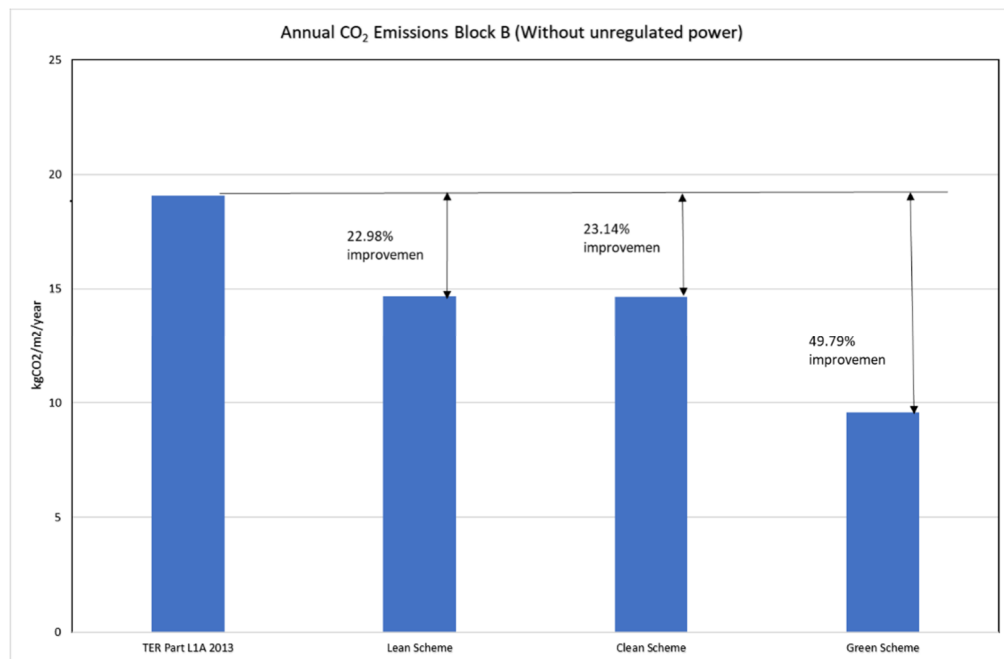


Block B

	Area Weighted kg CO ₂ /m ²			
	Baseline Scheme	Lean Scheme	Clean Scheme	LZC Scheme
Building Regulations Compliant	19.6	14.68	14.65	9.57
Allowing for Un-regulated Uses	38.31	33.93	33.90	28.82

These values are shown in diagrammatic form below that shows the following principles:

- The proposed scheme (LZC) assessment shows a predicted improvement of 49.79 % when compared to the baseline scheme
- The renewable energy technologies show a predicted improvement of 34.81 % over the lean scheme
- When un-regulated energy uses are taken into account the predicted overall improvement is 27.99 % compared to the baseline scheme with renewable energy technologies showing a predicted 15.06 % improvement over the lean scheme



Based on the regulated power results indicated above the proposed scheme incorporating a renewable energy technology provides a carbon emissions reduction of 49.81 % when compared to the baseline Building Regulations 2013 (TER) compliant scheme. This demonstrates that the proposed scheme for Block B archives beyond Reading Plan requirement of 35%.

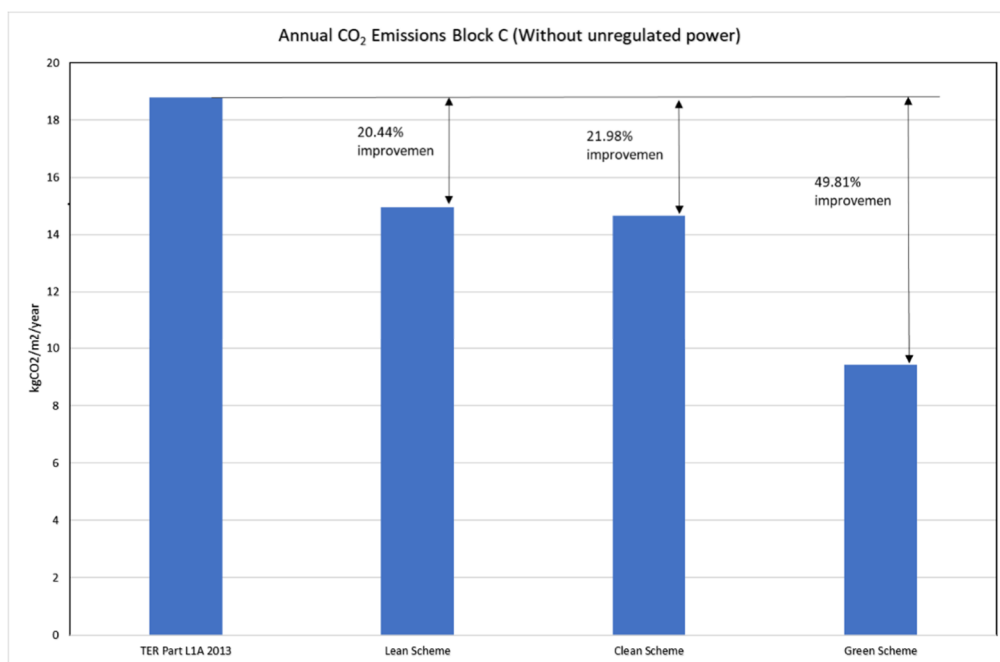


Block C

	Area Weighted kg CO ₂ /m ²			
	Baseline Scheme	Lean Scheme	Clean Scheme	LZC Scheme
Building Regulations Compliant	18.79	14.95	14.66	9.43
Allowing for Un-regulated Uses	38.29	34.45	34.16	28.93

These values are shown in diagrammatic form below that shows the following principles:

- The proposed scheme (LZC) assessment shows a predicted improvement of 49.81 % when compared to the baseline scheme
- The renewable energy technologies show a predicted improvement of 36.92 % over the lean scheme
- When un-regulated energy uses are taken into account the predicted overall improvement is 27.40 % compared to the baseline scheme with renewable energy technologies showing a predicted 16.02 % improvement over the lean scheme



Based on the regulated power results indicated above the proposed scheme incorporating a renewable energy technology provides a carbon emissions reduction of 49.81 % when compared to the baseline Building Regulations 2013 (TER) compliant scheme. This demonstrates that the proposed scheme for Block C archives beyond Reading Plan requirement of 35%.

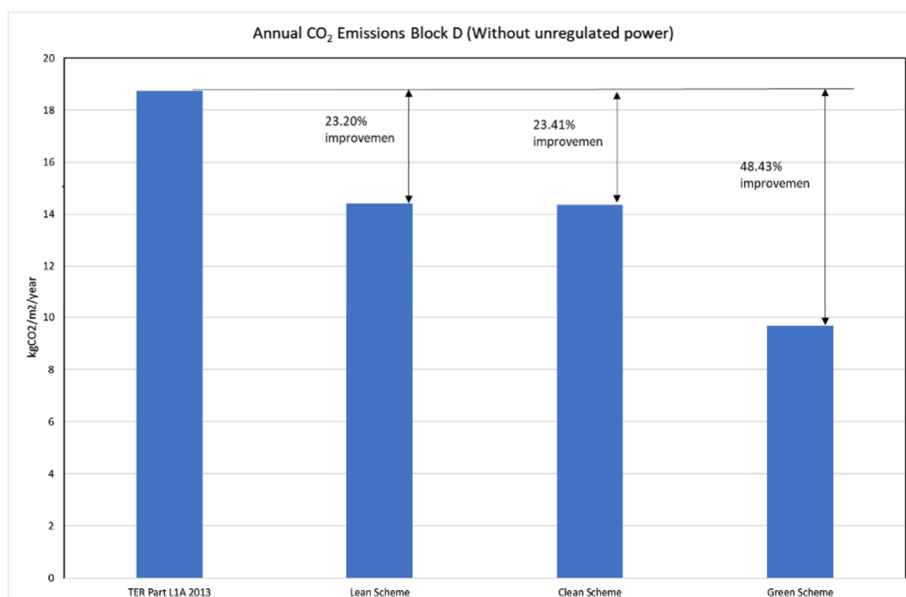


Block D

	Area Weighted kg CO ₂ /m ²			
	Baseline Scheme	Lean Scheme	Clean Scheme	LZC Scheme
Building Regulations Compliant	18.75	14.40	14.36	9.67
Allowing for Un-regulated Uses	37.55	33.2	33.16	28.47

These values are shown in diagrammatic form below that shows the following principles:

- The proposed scheme (LZC) assessment shows a predicted improvement of 48.43 % when compared to the baseline scheme
- The renewable energy technologies show a predicted improvement of 32.85 % over the lean scheme
- When un-regulated energy uses are taken into account the predicted overall improvement is 27.38 % compared to the baseline scheme with renewable energy technologies showing a predicted 14.25 % improvement over the lean scheme



Based on the regulated power results indicated above the proposed scheme incorporating a renewable energy technology provides a carbon emissions reduction of 48.43 % when compared to the baseline Building Regulations 2013 (TER) compliant scheme. This demonstrates that the proposed scheme for Block D archives beyond Reading Plan requirement of 35%.

The predicted annual CO₂ emissions data for the proposed scheme is as follows:

	Tonnes CO ₂ /year			Block D
	Block A	Block B	Block C	
Building Regulations Compliant	103.85	126.67	141.92	132.79
Allowing for Un-regulated Uses	326.21	381.46	435.40	390.95



9.00 CONCLUSIONS

In line with the relevant planning policies and guidelines the energy strategy has demonstrated that the proposed development could adopt the hierarchical approach of using passive and low energy design technologies to reduce the baseline energy demand and hence CO₂ emissions followed by the application of low and zero carbon technologies as appropriate.

The focus of the energy strategy is on CO₂ reduction from the building by adopting a highly efficient building envelope solution together with high efficiency mechanical and electrical services incorporating heat recovery. The renewable energy technologies assessment is based on using solutions that are technically proven with low maintenance implications taking into account the energy efficiency strategies being proposed in the current design.

The analysis has shown that by incorporating passive and low energy design measures there is a predicted reduction in Block A, Block B, Block C and Block D's annual CO₂ emissions, as indicated in the table below, from the baseline scheme.

Regulated CO ₂ Savings	
Tonnes CO ₂ /Year	%
223.53	22.28

This is achieved by the following elements:

- High performance glazing
- Improved building fabric thermal insulation
- Low building air leakage rate
- High efficiency heating and cooling plant
- Variable speed fans and pumps
- Low energy lighting (LED lighting)

The decentralised heating, cooling and power assessment has indicated that the application of a CHP system is viable for the development as there will be a constant demand for hot water from the residential apartments. This technology is now considered obsolete with the de-carbonisation of the electricity grid as described within section 5.00. A condensate heat pump system is proposed with capped off connection to join the district heating network when available. To follow Reading energy reporting hierarchy Lean, Clean and Green scheme are assessed.

The analysis shows that with the clean technology the predicted reduction in the development's annual CO₂ emissions, as indicated in the table below, from the baseline scheme.

Regulated CO ₂ Savings	
Tonnes CO ₂ /Year	%
228.56	22.79

The potential renewable energy technologies have been assessed taking into account the particular development constraints. The strategy is to utilise:



- Photovoltaic cells to provide a contribution to the electrical demand for all block

The analysis has shown that by incorporating this renewable energy technology in addition to the lean energy design measures there is a predicted reduction of annual CO₂ emissions from the baseline scheme as indicated in the table below:

Regulated CO ₂ Savings	
Tonnes CO ₂ /Year	%
497.96	49.64

The proposed scheme meets the requirements set by Building Regulation Part L1A for the new build residential development as well meeting the requirements set by Reading Plan of achieving an on-site carbon reduction of 35 %. To meet the zero-carbon requirement set by Reading, a off-set payment is proposed. The calculation of the payment based on the remaining carbon is demonstrated within executive summary at the beginning of this report.



Appendix 1
Fabric Efficiency



Building envelope thermal performance as detailed below:

Heat loss fabric element	U-Values (W/m ² .K)	Further details
Ground Floor	0.15	
Roof	0.15	
External wall	0.15	
Party walls	0	
Windows	1.4	G-Value:0.5

Air permeability (m³/hr.m² @50Pa for each apartments) to be accompanied by certificate in line with SAP requirements: 3 m³/hr.m² @50Pa



Appendix 2

Reading Heat Map Network

