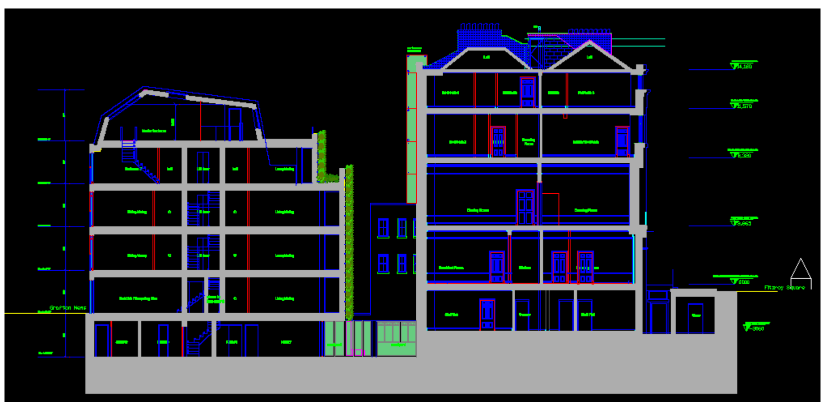
Fitzroy Square Energy Strategy



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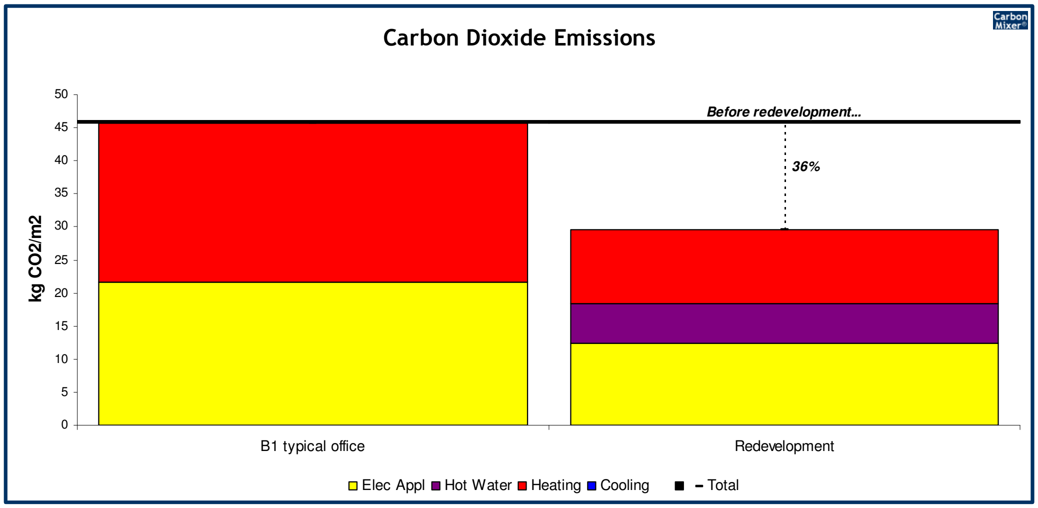
Client	

Executive Summary

This report assesses carbon dioxide emissions for various energy strategies for the proposed development at Fitzroy Square, Camden, comprising of the refurbishment of a large Georgian townhouse, currently used as offices, and the rebuilding of an existing office block at the rear of the house as a new block of apartments.

This assessment looks at strategies for reducing CO_2 emissions by minimum of 10% up to an aspiration of 20%, in line with the current and pending policies of Camden Council and the London Plan.

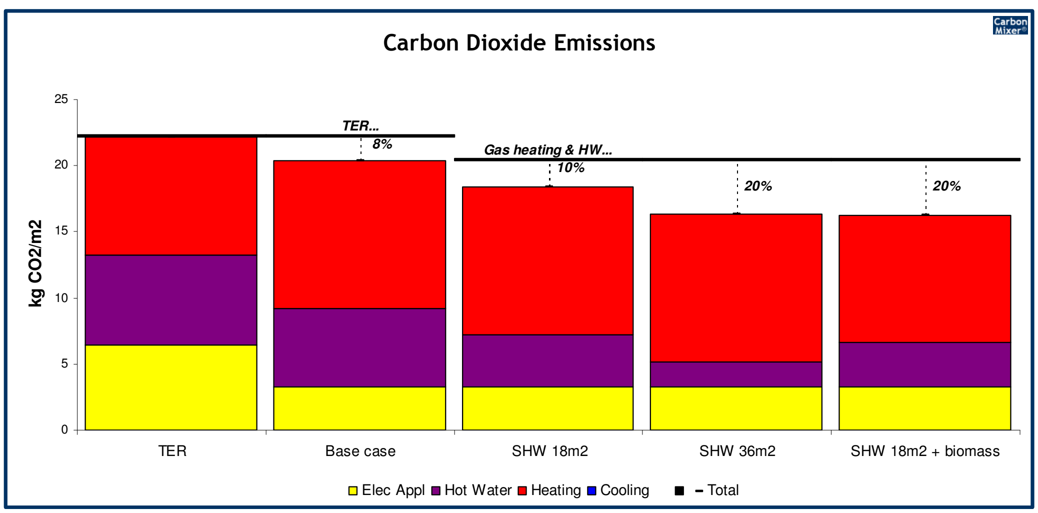
The graph below shows that conversion and refurbishment of the site could yield CO_2 savings of 36% compared to a "standard" office of the same floor area.



Possible reduction in CO_2 emissions for the site due to change in use and refurbishment

Note that in this comparison, CO_2 emissions from electrical appliances have been included in both scenarios to provide a fair comparison.

Considering the development as a whole once completed, strategies for reducing baseline CO_2 emissions by the use of renewable energy technologies are shown in the following graph.



Strategies for reducing CO_2 emissions from the development using renewable energy technologies

Note that this comparison is based on the Code for Sustainable Homes (CSH)/SAP methodology which does not include electrical loads from appliances. For the highest level of the code, level 6, these must be considered, but in this development only 10 or 20% reductions are being sought, so the appliance load is not considered.

The model suggests that a 10% reduction could be achieved with just 18m^2 of solar hot water (SHW) panels, equivalent to 2m^2 for each of the nine individual properties in the development. Note: the Nanny's apartment has been included in the calculations as a separate dwelling due to its occupancy pattern even though it is technically part of the main house.

The optimal amount of SHW panels for the whole development is approximately 34m^2. This means that during the summer months the SHW system could meet all the hot water requirements of the development. With this area of panels a 19% reduction in CO_2 emissions is possible. To obtain a 20% reduction, 36m^2 of panels are required, shown in the fourth scenario in the graph above. This would mean the panels may be overproducing in the summer but would give a higher yield during the spring, autumn and winter months.

The target of 20% emissions reduction could also be achieved by a combination of 18m^2 of SHW panels plus a relatively small contribution from a biomass boiler. The first 10% is provided by the panels and the additional 10% is provided by biomass boiler(s) which would need to supply approximately 16% of the heating and hot water demand, with the remainder or these loads coming from gas boilers. This option has been included for completeness however the previous option of solar hot water is the favoured option as it will achieve the desired CO_2 reduction and give the best overall solution for the developer and the residents.

Contents

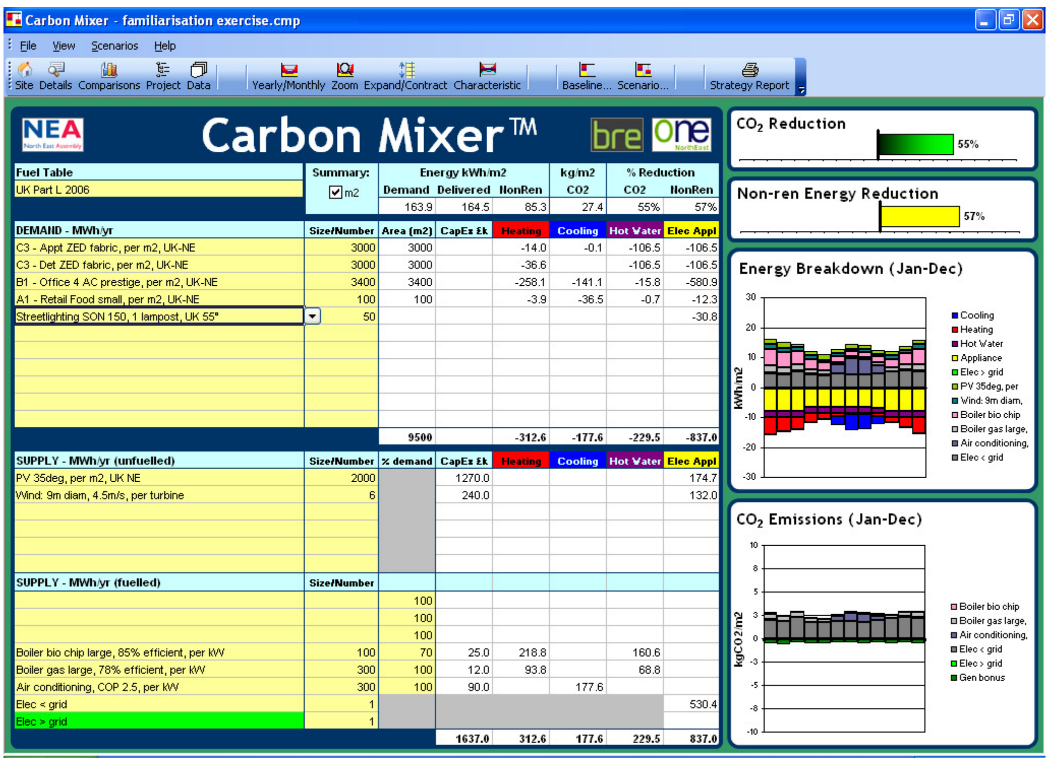
1 Introduction

1.1 Overview

This report presents an energy and carbon dioxide strategy for the development at Fitzroy Square, Camden. The aim is to show ways in which 10 and 20% CO_2 emissions reductions can be achieved using renewable energy technologies. Note that the development is considered as a whole, not as discrete units.

1.2 Carbon Mixer®

Carbon Mixer® has been used throughout this study. It is a software tool developed to allow rapid assessment of the benefits of various approaches to an optimum energy and carbon emissions strategy. Carbon Mixer® has been approved by the BRE for use by planners and developers carrying out initial energy assessments of new developments. For more information visit www.bobbygilbert.co.uk.



Carbon Mixer has been adopted by local authorities in the North East of England

2 Site Energy Demands

The energy demands of the development were assessed using the full SAP 2005 assessment procedure. This is the standard procedure in the UK for determining the heating, hot water and electrical requirements of buildings. The SAP assessment was carried out by Oliver Del Mar and is outside the scope of this project, except that the results of the assessment were used as inputs to Carbon Mixer as the loads which are to be partially met by renewables.

The first baseline performance is called the Target Emissions Rate. This is the emissions for a "notional" building of the same dimensions as the buildings being studied, calculated under SAP using a standard set of constructions. This is the minimum standard a building must meet to conform to Part L of the current building regulations. The TER is the baseline used for measuring improvements under the Code for Sustainable Homes.

The second baseline is called the "SAP" calculation and is based on the actual building as it exists or will exist when built. This is the baseline which is used in this study to measure the CO_2 reductions against. The TER baseline is shown on the graphs to show how the development compares: in this case the development as a whole is 8% below (better than) the TER for emissions.

The table below shows the assumptions made in the SAP Calcs for the proposed development in terms of element U-values

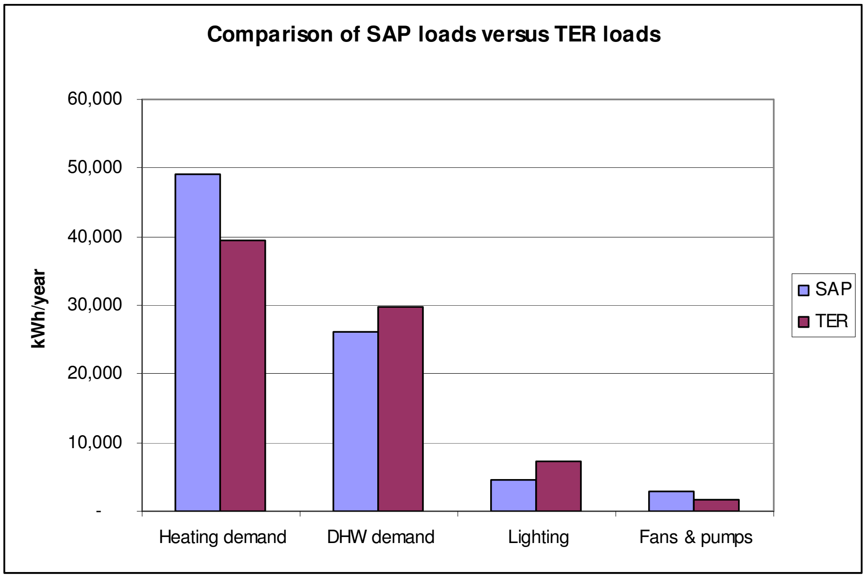
Criterion	Specification
External wall – approx 120mm insulation	0.2w/m²K
Corridor wall – approx 80mm insulation	0.35w/m²K
Roof – approx 300mm insulation	0.13w/m²K
Floor – approx 100mm insulation	0.17w/m²K
Glazing	1.5w/m²K, fully openable
Doors	1.8w/m²K
Thermal bridging	Accredited details (y = 0.08)
Infiltration @ 50pa	3
Ventilation	Centralised extract. SFP: 0.3W/l/second
Heating	Mains gas, seasonal efficiency: 90%. No secondary
Heating controls & delivery	Programmer, thermostat & TRVs into radiators
Hot water	150 litre tank with 80mm foam insulation

The house has two sets of u-values for the walls and windows: one for the unlisted rear aspect, and a second set for the listed front of the property:

	Front of house	Rear of house
External wall	2.1w/m²K	0.2w/m²K
Roof	0.13w/m²K	0.13w/m²K
Floor	1.2w/m²K	1.2w/m²K
Glazing	4.8w/m²K	1.5w/m²K
Doors	3w/m²K	1.8w/m²K

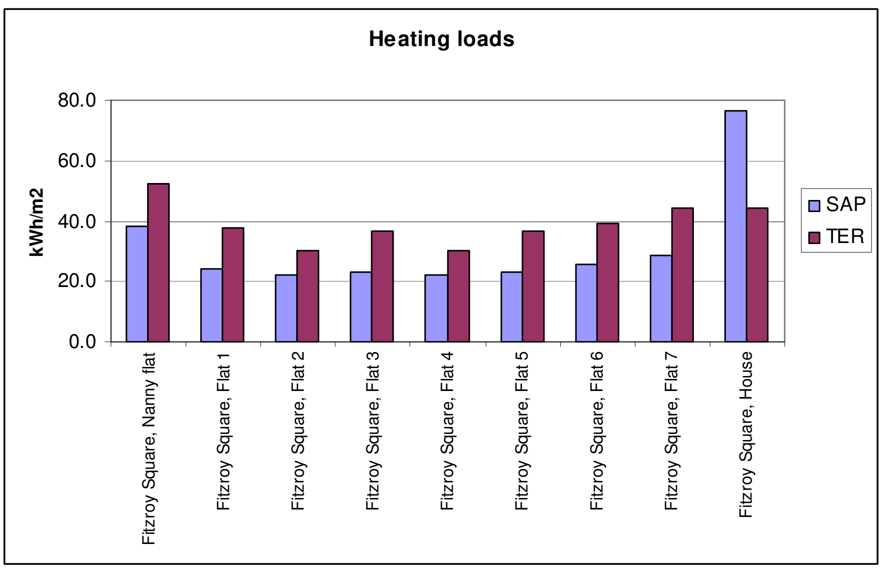
"Old" u-values taken from appendix S of SAP 2005

The following graph shows how the expected loads for this development compare to the TER for energy loads. It shows that whilst above the TER for heating and fans/pumps, it is below TER for hot water and lighting demand.



Comparison of the loads calculated using SAP and the TER for the equivalent notional building

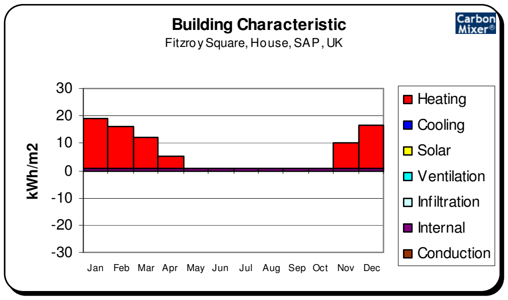
However this masks the fact that the old house is still way above the TER for heating, but this is made up for by the higher standards in the new flats, as shown in the following graph.

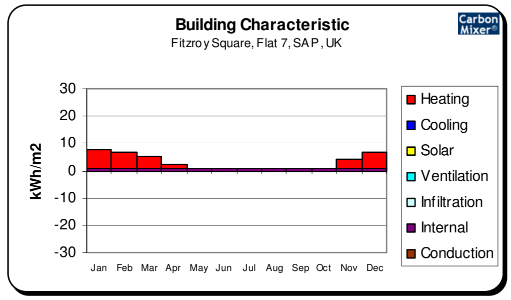


Comparison of the expected heating load (SAP) versus the TER for the different units of the development

2.1 Heating

The heating demand is substantially different in the two main blocks of the development. The house is an old building, which despite improvements still has a high heating requirement compared to the new-built flats. The building characteristic graphs below show all the demands of house (left) one of the flats, flat 7 (right). The demands are dominated by the red bars, showing that heat is by far the largest demand in both buildings; however the demand is much higher in the house. Note that the monthly distribution of heating loads is calculated from the annual load using a method based on degree days in the Thames region





Heating will be assumed to be supplied by standard high efficiency gas boilers. Under one of the CO2 reduction scenarios biomass boilers are proposed which would reduce the gas requirement.

2.2 Cooling

There will be no cooling systems installed in the dwellings and so no energy demand is assumed. Attention should be paid to shading details to mitigate the risk of overheating as well as having a ventilation strategy which prevents build up of heat during the day when the dwellings are unoccupied.

The SAP target emissions rate development is also assumed to have no cooling demand even though it is unlikely that a standard house would be designed with great care for overheating risk and so in reality some cooling energy may in fact be used.

2.3 Hot Water

The hot water energy demand was calculated using SAP assumptions based on the floor area of each dwelling. The demands were in the range of 13-69 kWh/m^2 per year depending on the floor area. Smaller dwellings have higher kWh/m^2 as the base load is assumed to be a higher proportion.

2.4 Appliances

Historically only lighting is considered in SAP assessments, the energy use of other appliances not being considered a function of the house. For the renewables part of the assessment the appliance loads are not included. In the change of use comparison, appliance loads were considered to provide a fair comparison against the “typical office” which does include appliances (office equipment) in its loads[1]. In this case the appliance loads were calculated using the formula recommended in the CSH normally for use when assessing for code level 6, which includes appliance loads.

2.4.1 Lighting

For calculations from the baseline (TER) energy demand was based on the SAP calculation methodology assuming that 30% of fixed lights were low energy fittings. This gave a demand of 4.5-5.0 kWh/m^2 per year.

2.4.2 Cooking and other appliances

These demands were ignored when calculating the reduction in emissions from the TER, as is normal practice under code levels 1-5. They were included in the change of use comparison, as explained above.

[1] In the Carbon Mixer database the building names contain “+ appliances” to indicate this.

2.5 Summary of energy demands

The following tables and graphs summarise the energy demands assumed for the development and compares these with the TER version of the development.

DEMAND - MWh/yr	Size/Number	Area (m2)	CapEx £k	Heating	Cooling	Hot Water	Elec Appl
Fitzroy Square, Flat 1, SAP, UK	1	56		-1.3		-2.5	-0.5
Fitzroy Square, Flat 2, SAP, UK	1	49		-1.1		-2.3	-0.5
Fitzroy Square, Flat 3, SAP, UK	1	56		-1.3		-2.5	-0.5
Fitzroy Square, Flat 4, SAP, UK	1	49		-1.1		-2.3	-0.5
Fitzroy Square, Flat 5, SAP, UK	1	56		-1.3		-2.5	-0.5
Fitzroy Square, Flat 6, SAP, UK	1	93		-2.4		-3.1	-0.7
Fitzroy Square, Flat 7, SAP, UK	1	64		-1.9		-2.6	-0.6
Fitzroy Square, House, SAP, UK	1	490		-37.4		-6.1	-3.3
Fitzroy Square, Nanny flat, SAP, UK	1	38		-1.5		-2.2	-0.4
		949		-49.1	0.0	-26.0	-7.4

Energy demands for the Fitzroy Square development

DEMAND - MWh/yr	Size/Number	Area (m2)	CapEx £k	Heating	Cooling	Hot Water	Elec Appl
Fitzroy Square, Flat 1, TER, UK	1	56		-2.1		-2.9	-0.7
Fitzroy Square, Flat 2, TER, UK	1	49		-1.5		-2.8	-0.6
Fitzroy Square, Flat 3, TER, UK	1	56		-2.0		-2.9	-0.8
Fitzroy Square, Flat 4, TER, UK	1	49		-1.5		-2.8	-0.7
Fitzroy Square, Flat 5, TER, UK	1	56		-2.0		-2.9	-0.9
Fitzroy Square, Flat 6, TER, UK	1	93		-3.7		-3.5	-1.4
Fitzroy Square, Flat 7, TER, UK	1	64		-2.8		-3.1	-1.1
Fitzroy Square, House, TER, UK	1	490		-21.7		-6.2	-7.8
Fitzroy Square, Nanny flat, TER, UK	1	38		-2.0		-2.6	-0.5
		949		-39.3	0.0	-29.8	-14.5

Energy demands for TER baseline development

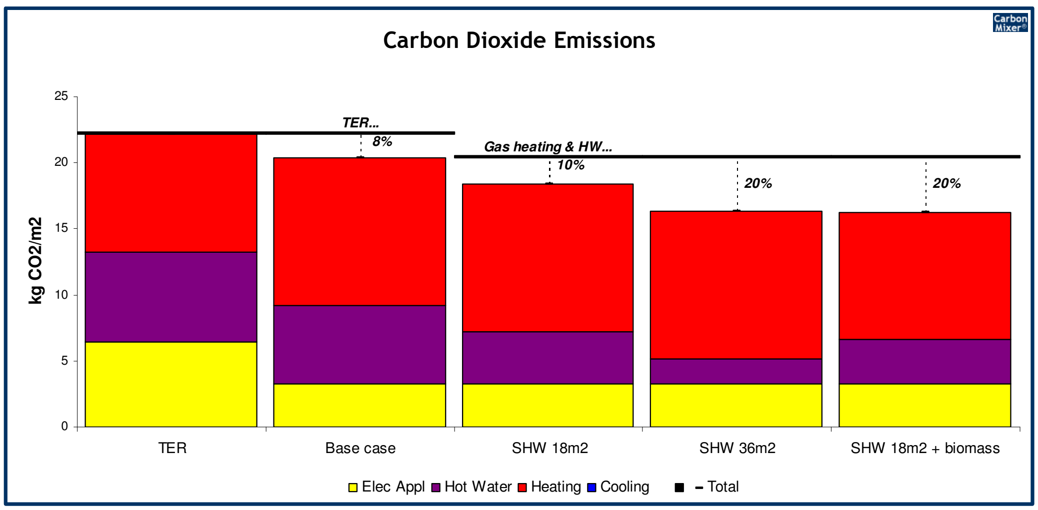
3 CO_2 Emissions reduction strategy

The developer's aim in this development is to reach a 20% CO_2 reduction compared to the base case building as easily and cost-effectively as possible. The only technologies considered were solar hot water systems and biomass boiler heating and hot water systems. Solar PV was ruled out on cost grounds and ground source heat pumps would not be suitable for an inner-city location such as this. Small wind turbines are also unlikely to be cost effective in a densely built up area such as this and may encounter planning issues.

The CO_2 emissions for the site were calculated for a number of different scenarios. Initially a baseline was set using the TER case to represent a current building regulations development powered by gas boilers and grid electricity.

The refurbishment of the house and rebuilding of the office block to a high specification will result in a reduction in CO_2 emissions of 8% against the TER. This would be higher were it not for the old house which, despite improvements, is still thermally poor because of the listed front façade which cannot be upgraded. Note that the CO_2 reductions achieved by adding renewable energy technologies are measured against this baseline of 20.89 $kgCO_2/m^2/yr$, not the TER in line with the methodology laid out in the London renewable energy toolkit.

The graph below shows the base case compared to the TER, and three renewable energy scenarios considered.



CO_2 emissions reductions

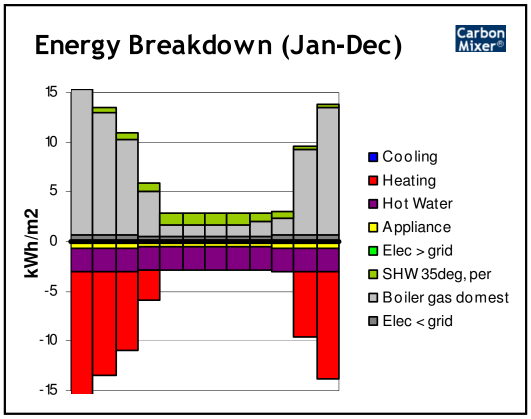
The most important finding is that the mooted 20% CO_2 reduction can be achieved with just $36m^2$ of SHW panels. This assumes the panels are optimally positioned with a south facing aspect, with no overshading at an angle of 35°.

Half this amount of panels would produce 10% CO_2 savings which may be allowable depending on the level finally required under the local regulations.

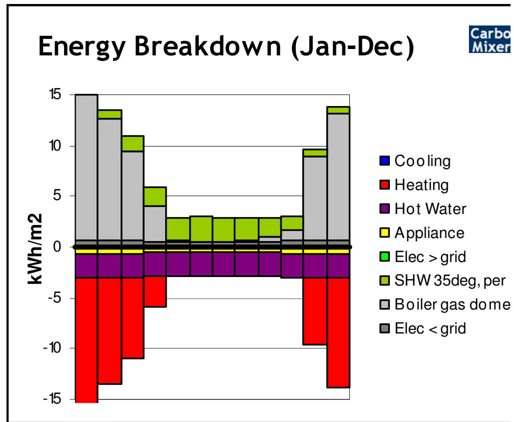
If roof space is an issue, SHW panels could be combined with biomass boilers to get to the 20% reduction target, as illustrated by the third scenario in the previous graph. The biomass system required would only need to meet 16% of the heating and hot water demands of the whole development. Although the issues surrounding the delivery and storage issues for a biomass heating system in Central London are likely to make this option more problematic.

3.1 Energy Breakdown

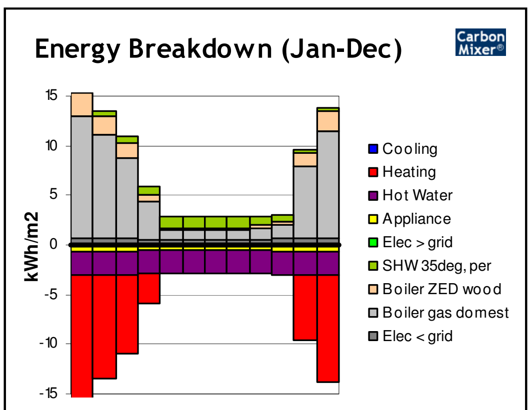
The energy breakdown graphs, below, show the energy demands (negative bars) and sources of energy supply (positive bars) over the year for the development.



Scenario 1 - 18m² of SHW panels: The olive green bars show the contribution from the SHW. The light grey bars show that the boiler is still required in summer for some hot water heating.



Scenario 2 – 36m² of SHW panels: In this scenario the energy breakdown indicates that the SHW system would meet all of the demand for hot water during the summer months, removing any need for the gas boiler for this period of the year.



Scenario 3: 18m² of SHW panels and biomass: This scenario could be considered if there is not enough roof space for enough SHW panels to meet the 20% reduction target. The energy breakdown above shows the contribution of the biomass boiler in pink bars.

No sizing calculations have been performed to determine the size or number of biomass boilers that would be required. However a rule of thumb can be used which says that 1kW of boiler power is required per 10m2 of floor space. This would indicate 95kW for the whole development. If we assume that the energy requirement of 16% for the biomass boiler is equivalent to 16% of the power output required, then we see that one 15kW biomass boiler may be sufficient. In this case it could be a relatively low-cost way of achieving the additional 10% of CO2 reductions sought, since a 15kW biomass boiler costs in the region of £5,200 whereas 18m² of SHW panels would cost well over £10,000. This is currently being explored and an accredited local supplier is supplying a report on the system design and technical capacity of the solar hot water system to be included in the full report.

4 Conclusions and Recommendations

The change of use of the buildings combined with the refurbishment of the house and rebuild of the office block alone will reduce CO_2 emissions by 36% compared to a typical office of the same floor area. Furthermore, the buildings as designed have been assessed using SAP to reduce CO_2 emissions by 8% from the building regulations standards (TER) for such buildings.

To reach the target of 20% CO_2 emissions reductions from the baseline level the most desirable strategy would be to add a large array of approximately 36m^2 of solar hot water panels on the roof of the buildings. This solution uses only one renewable technology and would be simplest to implement as it would require minimal floorspace inside the buildings for water tanks etc. This would be a drawback of a biomass system, because it would require space inside the apartments for the boilers, or space somewhere in the development for an energy centre and fuel store, which do not appear in the current plans. In addition there is no on-going fuel deliveries requirement and maintenance costs are very low.

No economic analysis has been done at this stage to consider if this would be the most cost effective way to reduce emissions.