Whitechapel Campus - Techno Economic Audit Report
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Version Control:

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<th>Date</th>
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<td>Final version for Client</td>
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<td>04/10/2016</td>
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# 1. BLIZARD BUILDING

## SITE INFORMATION

<table>
<thead>
<tr>
<th>Asset Name</th>
<th>Blizard Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Type</td>
<td>Research and teaching</td>
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<tr>
<td>Floor Area</td>
<td>7,941 m²</td>
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<tr>
<td>Campus</td>
<td>White Chapel</td>
</tr>
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<td>Survey Date</td>
<td>05/05/2016</td>
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## SUMMARY OF OPPORTUNITIES

Through the baseline process, a number of specific actions for reducing consumption have been identified, combined with a range of strategic areas for energy performance improvement. Carbon Credentials believes that taking a strategic project based approach to specific areas of consumption will be the most effective way of achieving long term energy and carbon savings. Specific recommendations to achieve energy savings are shown in the table below.

<table>
<thead>
<tr>
<th>ENERGY CONSERVATION MEASURE</th>
<th>INVESTMENT REQUIRED</th>
<th>ELEC SAVING TOTAL (KWH)</th>
<th>GAS SAVING TOTAL (KWH)</th>
<th>ANNUAL COST SAVING</th>
<th>PAYBACK PERIOD (YEARS)</th>
<th>CARBON SAVINGS (TONNES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T8 Lighting Upgrade to LED</td>
<td>£1,200</td>
<td>2,100</td>
<td>0</td>
<td>£200</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Metal Halide Upgrade to LED</td>
<td>£5,100</td>
<td>27,100</td>
<td>0</td>
<td>£2,700</td>
<td>1.9</td>
<td>13</td>
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<td>BMS Optimisation</td>
<td>£15,000</td>
<td>76,300</td>
<td>Gas data unavailable</td>
<td>£9,000</td>
<td>1.7</td>
<td>45</td>
</tr>
<tr>
<td>Installation of Variable Speed Drives</td>
<td>£10,000</td>
<td>24,300</td>
<td>0</td>
<td>£2,400</td>
<td>4.2</td>
<td>12</td>
</tr>
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<td><strong>TOTAL</strong></td>
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<td><strong>£14,300</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>71</strong></td>
</tr>
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Carbon Credentials uses a tailored version of the ‘TM22’ methodology, developed by the Chartered Institute of Building Services Engineers (CIBSE). This industry standard methodology has been developed by Carbon Credentials to provide a prediction of typical consumption profiles for the building. If available these predicted profiles are reconciled with average profiles calculated using actual consumption data, resulting in confidence that the calculated consumption of each item is suitably accurate. Energy conservation measures are then calculated in the following way:

**Lighting Opportunities:**

Total kWh of lighting demand has been calculated through multiplying the amount of lamps counted during the site audit by the kW rating of the units (e.g. 10 x 58W T8s) multiplied by the burning hours which equates to the opening times of the site.

The cost saving opportunity is calculated by identifying the percentage reduction of the power rating of an LED lamp compared to the existing fitting. This percentage reduction is multiplied by the total kWh of electricity consumed by the inefficient lights in a year. The investment required is calculated by multiplying the count of all inefficient lights by the cost of the replacement fitting.

**Heating, Ventilation and Air-Conditioning Opportunities:**

- **Installation of variable speed drives** – The total consumption of pumps and air handling units which do not have an attached variable speed drive is multiplied by a 15% reduction.
TOTAL ENERGY CONSUMPTION

Total consumption of the Blizard building for the period January to December 2015 is shown in Figure 1 below:

![Figure 1: Total annual consumption](image1)

Electricity and gas consumption has been broken down monthly by meter number and is shown in Figure 2 below. Electricity is seen to peak in August when the chiller units run on higher loads. A full year of gas data was not available for analysis.

![Figure 2: Total monthly consumption broken down by fuel and meter](image2)
Figure 3 below shows the daily electricity usage from the available half-hourly data. Each dot represents the total electricity consumption for that day. Green dots represent weekdays and orange dots represent weekends. On the whole, both meters see lower electricity use at the weekend. Peak usage for the first meter (1200051579321) takes place in August, while for the second (1200051579330) consumption is relatively stable over two distinct periods of January to May, and November to December.

The average electricity consumption over a 24 hour period is shown below in Figure 4. The darker coloured lines represent the winter months and the lighter colours represent the summer months. There is clear seasonal variation for meter 1200051579321 where peak and overnight usage during the winter is considerably higher. The high baseload seen in June, July and August suggests that chiller systems are left running overnight.
Figure 4: Average daily electricity profiles broken down by month

Figure 5 demonstrates the average daily electricity profile by weekday. The chart shows that average consumption during the week follows a consistent trend. Electricity usage generally reaches a peak at around 10am for 1200051579321, and 4pm for 1200051579330, before reducing to its lowest point at 4am for both meters. On average, usage on Saturdays and Sundays is lower.

Figure 5: Average daily electricity profiles by day of the week

DATA ANALYSIS - GAS

A full year of gas data was not available for analysis. Given the large site, Carbon Credentials highly recommends the installation of automatic meter reading (AMR) device able to collect half-hourly data. This would give an understanding of operational activity and allow the identification of energy waste.
Carbon Credentials uses a tailored version of the ‘TM22’ methodology, developed by the Chartered Institute of Building Services Engineers (CIBSE). This industry standard methodology has been developed by Carbon Credentials to provide a prediction of typical consumption profiles for the building. If available these predicted profiles are reconciled with average profiles calculated using actual consumption data, resulting in confidence that the calculated consumption of each item is suitably accurate.

The combined modelled breakdown of the Blizard Building is demonstrated below.

Figure 6: Combined modelled annual electricity consumption breakdown
2. ABERNATHY BUILDING

**SITE INFORMATION**

<table>
<thead>
<tr>
<th>Asset Name</th>
<th>Abernethy Building</th>
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</thead>
<tbody>
<tr>
<td>Asset Type</td>
<td>Research and teaching</td>
</tr>
<tr>
<td>Floor Area</td>
<td>3,066 m²</td>
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<td>Campus</td>
<td>White Chapel</td>
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<td>Survey Date</td>
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**SUMMARY OF OPPORTUNITIES**

Through the baseline process, a number of specific actions for reducing consumption have been identified, combined with a range of strategic areas for energy performance improvement. Carbon Credentials believes that taking a strategic project based approach to specific areas of consumption will be the most effective way of achieving long term energy and carbon savings. Specific recommendations to achieve energy savings are shown in the table below.

<table>
<thead>
<tr>
<th>ENERGY CONSERVATION MEASURE</th>
<th>INVESTMENT REQUIRED</th>
<th>ANNUAL ELECTRICITY SAVING (kWh)</th>
<th>ANNUAL GAS SAVING (kWh)</th>
<th>ANNUAL COST SAVING</th>
<th>PAYBACK PERIOD (YEARS)</th>
<th>CARBON SAVINGS (TONNES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T8 Lighting Upgrade to LED</td>
<td>£1,000</td>
<td>5,900</td>
<td>0</td>
<td>£600</td>
<td>1.7</td>
<td>3</td>
</tr>
<tr>
<td>PL-L Upgrade to LED</td>
<td>£1,700</td>
<td>4,500</td>
<td>0</td>
<td>£500</td>
<td>3.4</td>
<td>2</td>
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<tr>
<td>Installation of VSDs on Pumps</td>
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<td>37,300</td>
<td>£3,200</td>
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</table>

Carbon Credentials uses a tailored version of the ‘TM22’ methodology, developed by the Chartered Institute of Building Services Engineers (CIBSE). This industry standard methodology has been developed by Carbon Credentials to provide
a prediction of typical consumption profiles for the building. If available these predicted profiles are reconciled with average profiles calculated using actual consumption data, resulting in confidence that the calculated consumption of each item is suitably accurate. Energy conservation measures are then calculated in the following way:

**Lighting Opportunities:**

Total kWh of lighting demand has been calculated through multiplying the amount of lamps counted during the site audit by the kW rating of the units (e.g. 10 x 58W T8s) multiplied by the burning hours which equates to the opening times of the site.

The cost saving opportunity is calculated by identifying the percentage reduction of the power rating of an LED lamp compared to the existing fitting. This percentage reduction is multiplied by the total kWh of electricity consumed by the inefficient lights in a year. The investment required is calculated by multiplying the count of all inefficient lights by the cost of the replacement fitting.

**Heating, Ventilation and Air-Conditioning Opportunities:**

- **Plant replacements** - The cost saving is calculated by identifying the percentage reduction of the power rating of efficient plant replacements compared to the existing installation. This is multiplied by the total kWh consumed by the plant in a year.
- **Installation of variable speed drives** – The total consumption of pumps and air handling units which do not have an attached variable speed drive is multiplied by a 15% reduction.
- **Installation of temperature sensors** – 10% reduction of total annual gas usage was applied to calculate the cost saving.

**Engagement Strategy:**

Total usage of all items which is controlled manually by staff has been multiplied by a 15% reduction.

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**TOTAL ENERGY CONSUMPTION**

Total consumption of the Abernathy Building for the period January to December 2015 is shown in Figure 7 below:
Electricity and gas consumption has been broken down monthly by meter number and is shown in Figure 8 below. It can be seen that while both electricity and gas usage follow a seasonal profile, this can be seen more prominently for gas usage which falls by over two thirds in July and August from its peak in January.

![Figure 8: Total monthly consumption broken down by fuel and meter](image)

**DATA ANALYSIS - ELECTRICITY**

Figure 9 below shows the daily electricity usage from the available half-hourly data. Each dot represents the total electricity consumption for that day. Green dots represent weekdays and orange dots represent weekends. The graph shows a clear, consistent trend of electricity use being lower at the weekend than on weekdays. Peak usage is seen to take place between June and August, and it appears that chillers kick in around this time to meet cooling demand.
The average electricity consumption over a 24 hour period is shown below in Figure 10. The darker coloured lines represent the winter months and the lighter colours represent the summer months. Electricity consumption during the summer is higher than during the winter, with July and January diverging by as much as 50 kWh at peak consumption. There is also a similar variance in baseloads between summer and winter months, though by a smaller magnitude, suggesting that chillers are left on overnight during the summer months.
Figure 11 demonstrates the average daily electricity profile by weekday. The chart shows that average consumption during the week follows a consistent trend. Electricity usage generally reaches a peak at around 1pm before reducing to its lowest point at 12am. On average, usage on Saturdays and Sundays is much lower.

**DATA ANALYSIS - GAS**

Figure 12 below shows the daily gas usage from the available half-hourly data. Each dot represents the total gas consumption for that day. Green dots represent weekdays and orange dots represent weekends. Weekend gas use is slightly lower than weekday use, particularly during the colder months. Peak usage is seen in January, which falls by over two thirds in the summer months before increasing again in October.
Figure 13 below shows how the monthly gas demand varies throughout the year, with darker coloured lines representing winter months. This graph shows that gas consumption is highest in winter months and lowest in summer months. In almost all months there is a significant reduction in gas use between 10pm and 6am, before it peaks at 7am. Boilers start in the morning and remain enabled throughout most of the day. There may be opportunity here to change the strategy of how the boilers are run to ensure there is minimised dry-cycling and that boilers are run only when there is heat demand.
MODELLED ENERGY CONSUMPTION ALLOCATION BY END-USE FOR EXISTING BUILDING

Carbon Credentials uses a tailored version of the ‘TM22’ methodology, developed by the Chartered Institute of Building Services Engineers (CIBSE). This industry standard methodology has been developed by Carbon Credentials to provide a prediction of typical consumption profiles for the building. If available these predicted profiles are reconciled with average profiles calculated using actual consumption data, resulting in confidence that the calculated consumption of each item is suitably accurate.

The combined modelled breakdown of the Abernethy Building is demonstrated below.

![Combined modelled annual electricity consumption breakdown](image)

**Figure 14:** Combined modelled annual electricity consumption breakdown
3. WINGATE BUILDING

SITE INFORMATION

<table>
<thead>
<tr>
<th>Asset Name</th>
<th>Asset Type</th>
<th>Floor Area</th>
<th>Campus</th>
<th>Survey Date</th>
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<td>WINGATE BUILDING</td>
<td>Medical Building</td>
<td>1,083 m²</td>
<td>White Chapel</td>
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</table>

SUMMARY OF OPPORTUNITIES

Through the baseline process, a number of specific actions for reducing consumption have been identified, combined with a range of strategic areas for energy performance improvement. Carbon Credentials believes that taking a strategic project based approach to specific areas of consumption will be the most effective way of achieving long term energy and carbon savings. Specific recommendations to achieve energy savings are shown in the table below.

<table>
<thead>
<tr>
<th>ENERGY CONSERVATION MEASURE</th>
<th>INVESTMENT REQUIRED</th>
<th>ANNUAL ELECTRICITY SAVING (kWh)</th>
<th>ANNUAL GAS SAVING (kWh)</th>
<th>ANNUAL COST SAVING</th>
<th>PAYBACK PERIOD (YEARS)</th>
<th>CARBON SAVINGS (TONNES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HALOGEN UPGRADE TO LED</td>
<td>£400</td>
<td>700</td>
<td>0</td>
<td>£100</td>
<td>4.0</td>
<td>0</td>
</tr>
<tr>
<td>PIR INSTALLATION IN CORRIDORS</td>
<td>£500</td>
<td>2,100</td>
<td>0</td>
<td>£200</td>
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<tr>
<td>BMS OPTIMISATION</td>
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<td>250</td>
<td>45,500</td>
<td>£4,600</td>
<td>3.3</td>
<td>8</td>
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<tr>
<td>ENGAGEMENT STRATEGY</td>
<td>£5,000</td>
<td>2,700</td>
<td>0</td>
<td>£300</td>
<td>16.7</td>
<td>1</td>
</tr>
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<td><strong>TOTAL</strong></td>
<td><strong>£20,900</strong></td>
<td><strong>£5,200</strong></td>
<td></td>
<td></td>
<td><strong>11</strong></td>
<td></td>
</tr>
</tbody>
</table>

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The cost saving opportunity is calculated by identifying the percentage reduction of the power rating of an LED lamp compared to the existing fitting. This percentage reduction is multiplied by the total kWh of electricity consumed by the inefficient lights in a year. The investment required is calculated by multiplying the count of all inefficient lights by the cost of the replacement fitting.

**Heating, Ventilation and Air-Conditioning Opportunities:**

- **Plant replacements** - The cost saving is calculated by identifying the percentage reduction of the power rating of efficient plant replacements compared to the existing installation. This is multiplied by the total kWh consumed by the plant in a year.
- **Installation of variable speed drives** – The total consumption of pumps and air handling units which do not have an attached variable speed drive is multiplied by a 15% reduction.
- **Installation of temperature sensors** – 10% reduction of total annual gas usage was applied to calculate the cost saving.

**Engagement Strategy:**

Total usage of all items which is controlled manually by staff has been multiplied by a 15% reduction.

### TOTAL ENERGY CONSUMPTION

Total consumption of the Wingate Building for the period January to December 2015 is shown in Figure 15 below:

<table>
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<tr>
<th>Mpan</th>
<th>Fuel Name</th>
<th>kWh</th>
<th>Estimated Cost</th>
<th>Fuel Name</th>
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<td>9110010010</td>
<td>Natural Gas</td>
<td>910,000</td>
<td>£27,327</td>
<td>Electricity</td>
<td>370,429 kWh</td>
</tr>
<tr>
<td>1200010147421</td>
<td>Electricity</td>
<td>370,429</td>
<td>£37,843</td>
<td>Natural Gas</td>
<td>910,986 kWh</td>
</tr>
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</table>

**Figure 15: Total annual consumption**

Electricity and gas consumption has been broken down monthly by meter number and is shown in Figure 16 below. It can be seen that while both electricity and gas usage follow a seasonal profile, this can be seen more prominently for gas usage which falls by almost two thirds between its peak in January and its trough in July.
Figure 16: Total monthly consumption broken down by fuel and meter

**DATA ANALYSIS - ELECTRICITY**

Figure 17 below shows the daily electricity usage from the available half-hourly data. Each dot represents the total electricity consumption for that day. Green dots represent weekdays and orange dots represent weekends. On the whole, the graph below shows that weekend electricity use is lower than weekday electricity use. Peak usage is seen to take place between June and August, and it appears that chillers kick in around this time to meet cooling demand.
The average electricity consumption over a 24 hour period is shown below in Figure 18. The darker coloured lines represent the winter months and the lighter colours represent the summer months. The graph shows that electricity consumption during the summer is higher than during the winter. Though there is a clear day-night variance in consumption, inter-season variance is more pronounced. The high baseload and inter-season variance suggests that cooling equipment is left on throughout the night.
Figure 19 demonstrates the average daily electricity profile by weekday. The chart shows that average consumption during the week follows a consistent trend. Electricity usage generally reaches a peak at around 12pm before reducing to its lowest point at 12am. On average, usage on Saturdays and Sundays is much lower.

DATA ANALYSIS - GAS

Figure 20 below shows the daily gas usage from the available half-hourly data. Each dot represents the total gas consumption for that day. Green dots represent weekdays and orange dots represent weekends. While weekend gas use is slightly lower than weekday gas use, particularly between January and April, on average there is little difference between the gas usage between weekdays and weekends. Peak usage is seen in January, which falls by over half in the summer months before increasing slowly from August.
Figure 21 below shows how the monthly gas demand varies throughout the year, with darker coloured lines representing winter months. This graph shows that gas consumption is highest in winter months and lowest in summer months. In almost all months, there is a significant reduction in gas use between 4pm and 7am, before it peaks at 8am and at 10am. Boilers start in the morning and remain enabled throughout most of the day. There may be opportunity here to change the strategy of how the boilers are run to ensure there is minimised dry-cycling and that boilers are run only when there is heat demand.

![Figure 21: Average daily gas profiles broken down by month](image)
Carbon Credentials uses a tailored version of the ‘TM22’ methodology, developed by the Chartered Institute of Building Services Engineers (CIBSE). This industry standard methodology has been developed by Carbon Credentials to provide a prediction of typical consumption profiles for the building. If available these predicted profiles are reconciled with average profiles calculated using actual consumption data, resulting in confidence that the calculated consumption of each item is suitably accurate.

The combined modelled breakdown of Wingate Building is demonstrated below.

**Figure 22: Combined modelled annual electricity consumption breakdown**