Charterhouse Square Campus - Techno Economic Audit Report
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1. JOHN VANE SCIENCE CENTRE

SITE INFORMATION

<table>
<thead>
<tr>
<th>Asset Name</th>
<th>John Vane Science Centre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Type</td>
<td>Research</td>
</tr>
<tr>
<td>Floor Area</td>
<td>11,613 m²</td>
</tr>
<tr>
<td>Campus</td>
<td>Charterhouse Square</td>
</tr>
<tr>
<td>Survey Date</td>
<td>10/06/2016</td>
</tr>
</tbody>
</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>ELEC SAVING TOTAL (KWH)</th>
<th>GAS SAVING TOTAL (KWH)</th>
<th>ANNUAL COST SAVING</th>
<th>INVESTMENT REQUIRED</th>
<th>PAYBACK PERIOD (YEARS)</th>
<th>CARBON SAVINGS (TONNES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T8 Lighting Upgrade to LED</td>
<td>31,100</td>
<td>0</td>
<td>£3,100</td>
<td>£13,100</td>
<td>4.2</td>
<td>15</td>
</tr>
<tr>
<td>BMS Optimisation</td>
<td>74,900</td>
<td>361,400</td>
<td>£18,300</td>
<td>£15,000</td>
<td>0.8</td>
<td>104</td>
</tr>
<tr>
<td>Insulation Improvement for Steam Boiler</td>
<td>0</td>
<td>180,700</td>
<td>£5,400</td>
<td>£10,000</td>
<td>1.9</td>
<td>33</td>
</tr>
<tr>
<td>Engagement Strategy</td>
<td>69,400</td>
<td>0</td>
<td>£6,900</td>
<td>£5,000</td>
<td>0.7</td>
<td>34</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>175,400</strong></td>
<td><strong>361,400</strong></td>
<td><strong>£43,100</strong></td>
<td><strong>£43,100</strong></td>
<td><strong>187</strong></td>
<td></td>
</tr>
</tbody>
</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.

Unaccounted Baseload Identification and Management:

A 10% reduction was multiplied against the total annual load which the model was not able to identify (i.e. unaccounted baseload).

TOTAL ENERGY CONSUMPTION

Total consumption of the John Vane Science Centre for the period January to December 2015 is shown in Figure 1 below:
Electricity and gas consumption has been broken down monthly by meter number and is shown in Figure 2 below. It can be seen that gas usage follows a seasonal profile, falling by almost four fifths between January and June. There is no clear pattern in the electricity consumption.

Figure 2: Total monthly consumption broken down by fuel and meter

**DATA ANALYSIS - ELECTRICITY**

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, the graph below shows that weekend electricity use is lower than weekday electricity use. This trend is more pronounced for meter 1200010124656. This meter shows three peaks – January, July, and December – whereas meter 1200010124674 shows a clear peak in August. This would be the time that chillers kick in to meet cooling demand.
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. The high baseload over warmer months for meter 1200010124656 may suggest that cooling equipment is left on throughout the night.

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 2pm before reducing
to its lowest point at 12am. On average for both meters, usage on Saturdays and Sundays appears to be significantly lower.

**Figure 5**: Average daily gas profiles by day of the week

**DATA ANALYSIS - GAS**

Figure 6 below shows the daily gas usage from the available half-hourly data, which feeds Dawson Hall and John Vane via District Heating Pipework. Each dot represents the total gas consumption for that day. Green dots represent weekdays and orange dots represent weekends. On the whole, there appears to be very little variation between weekend and weekday gas usage. Peak usage is seen in January and gas consumption reduces to a consistent low level in summer months before increasing in October.

**Figure 6**: Total daily gas consumption
Figure 7 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 8pm and 5am, before it peaks at 7am before reaching dropping to a lower, more consistent level for the rest of the day. 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.
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 John Vane Science Building is demonstrated below.