British Postal Museum & Archive (BPMA) - New Centre

Renewable Energy Plan

Rev B

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MAX FORDHAM

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1.0 EXECUTIVE SUMMARY

Max Fordham LLP have carried out a pre-implementation review of the of the renewable energy generation technologies proposed for Calthorpe House as required by clause 2.24 of the section 106 agreement for the project. The key purpose of this is to ensure that the design developed for tender offsets 20% of the regulated carbon emissions estimated for the project through the use of renewables.

The measures set out by Clause 2.24 are outlined below:

1. Details of how the Owner will further reduce the Development's carbon emissions from renewable energy technologies located on the Property ensuring the Owner will use reasonable endeavours to target a reduction of at least 20% in carbon emissions in relation to the Property using a combination of complementary low and zero carbon technologies;

   This is addressed in section 2.0 below. A photovoltaic (PV)array is proposed which is predicted to achieve a reduction in regulated CO2 emissions of 25.8%. This has been calculated using the Building Regulations Part L compliance methodology.

2. Provide separate metering of all low and zero carbon technologies to enable the monitoring of energy and carbon emissions and savings;

   PV energy generation is to have an independent meter which will record all energy developed. As part of a building wide metering system it will be possible to interrogate energy production as a percentage of the buildings reduction. Further details are provided in section 3.0

3. Provide a building management system being an electronic system to monitor the Development's heating cooling and the hours of use of plant;

   A Building Management System is included to control and monitor all major plant in the building. This will allow the building user to refine control time schedules so that the number of running hours on plant is limited as far as possible. Further details are provided in section 4.0.

4. Measures to enable future connection to a local energy network at the boundary of the Property;

   The location of spare connection points to be provided for future incorporation of a heat interface unit is described in section 5.0. This will connect to the heating system and allow a district heating network to replace the gas fired boilers currently installed.

The pre-implementation review of the renewable energy generation was performed by Max Fordham LLP as part of the BREEAM pre-assessment modelling (refer to section 106 clause 2.28) and as such are deemed an appropriately qualified and recognised independent verification body as stipulated within Section 106, Clause 2.24, item e).

BPMA have committed to appoint as an appropriately qualified and independent verification body, i.e. a BREEAM Assessor, to undertaken the post construction review of the development as per Section 106, Clause 2.24, item f). This will ensure that the measures incorporated into the Renewable Energy Plan have been achieved and will be maintainable in the operation of BPMA.

2.0 RENEWABLE ENERGY GENERATION

It is intended that the BPMA will use a photovoltaic array as a source of zero carbon energy generation for Calthorpe House. The proposed array will offset 25.8% of the buildings predicted regulated carbon emissions as described below. This is in excess of the target reduction stipulated by clause 2.24(a) of the section 106 agreement.

2.1 Photovoltaic Panels

Figure 1: Roof mounted photovoltaic panels

Photovoltaic panels (PVs) require little maintenance and have relatively low visual impact. They are therefore considered a good Low/Zero Carbon (LZC) technology for use in urban areas.

For optimum performance in the UK, PVs should be installed around 30-40º and south facing. These requirements are well suited to the existing saw tooth roof light profile of Calthorpe House. The proposed location of the PV panels is shown in Figure 2 adjacent. Full details of the installation proposed is shown in the appendix.

Feed-in Tariffs (FITs), a government subsidy currently available for energy generated by PV panels, can significantly reduce the payback period of an installation.

2.2 Energy Modelling

The Postal Museum project at Calthorpe House project involves the refurbishment of an existing building. As such a full carbon emissions compliance model is not required for Part L. However an energy model has been built using the dynamic thermal modelling software IES VE to assess the energy credit score for BREEAM 2008 Bespoke as part of the sustainability report in line with clause 2.28 of the section 106 agreement.

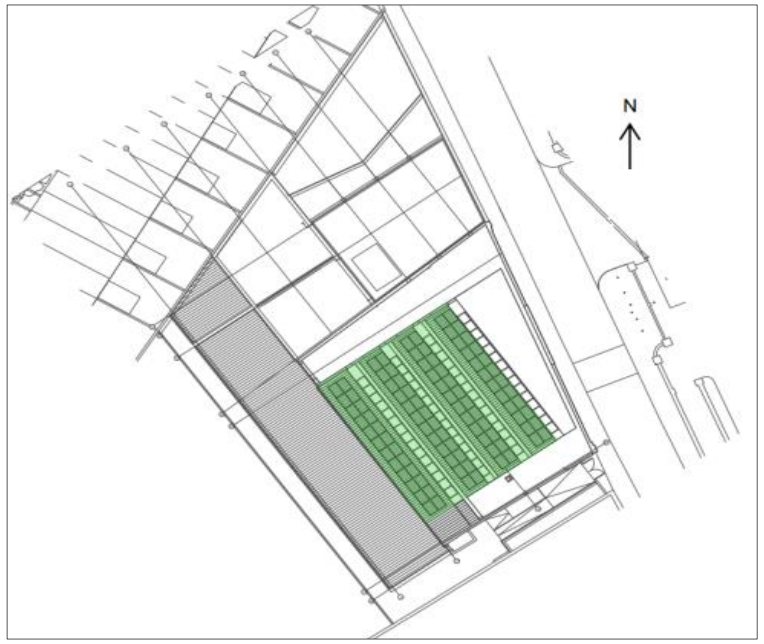

Figure 2: Green hatching illustrates PV location on saw tooth roofs

This model (shown in Figure 3) has been used to also assess the impact of PVs on the total regulated carbon emissions for the building. It should be noted that this analysis is in fact based on the 2006 version of Part L calculation methodology as stipulated by BREEAM 2008. As updates to Part L methodology have tended to drive down energy consumption this approach is actually conservative in assessing carbon reductions due to PV panels. This is because if the energy consumption of the building is reduced then so is the amount of energy which must be generated by photovoltaics to achieve the target percentage contribution.

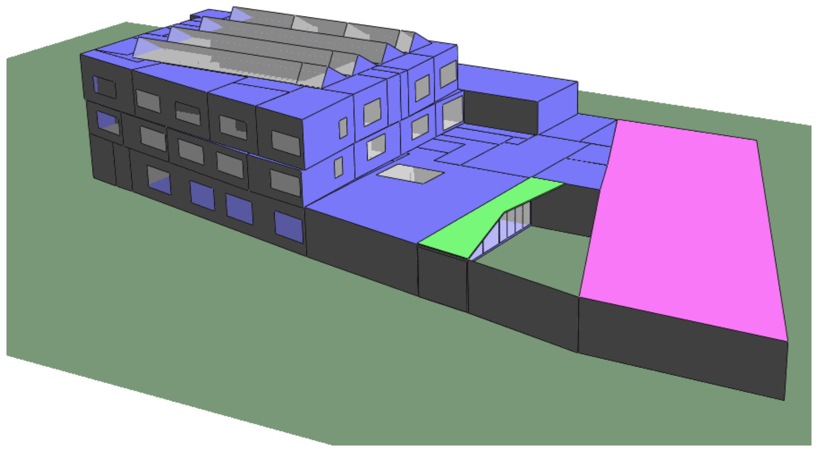

Figure 3: Dynamic Thermal Model in IES VE

Figure 4 shows the output from the carbon emissions modelling. The first column is the Target Emissions Ratio (TER) set by the Part L notional building. The breakdown in carbon emissions for the building emissions ratio (BER) without PV is shown in the next column, a 7.1% reduction in emissions has been achieved through energy saving technologies as described in section 5.0. The final column shows the reduction in emissions achieved through the use of PV. It can be seen that the PV array contributes a 25.6% reduction in emissions.

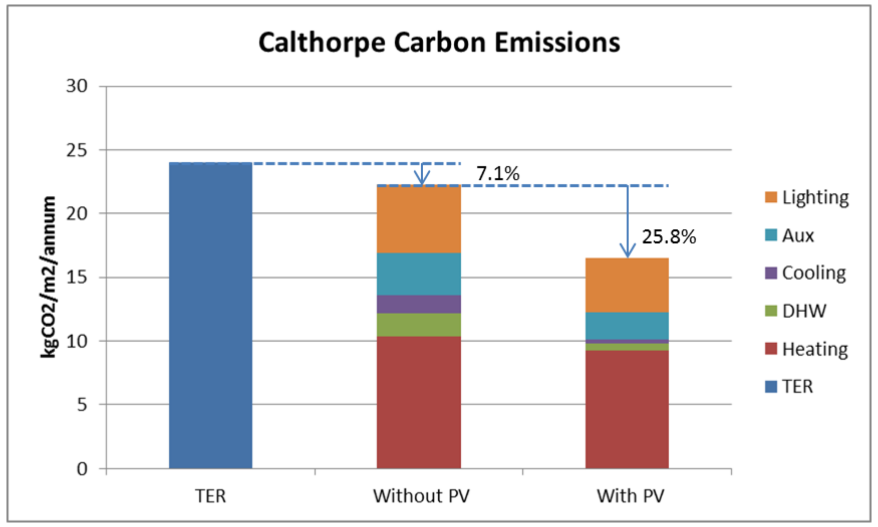

Figure 4: Target Emissions Ratio for Cremer Street

The table in Figure 5 demonstrates how these reductions were calculated.

IES VE Modelling Output			
	Carbon Emission		% Reduction
TER	24	kgCO2/sqm pa	
BER	22.29	kgCO2/sqm pa	7.1%
BER with PV	16.54	kgCO2/sqm pa	25.8%

Figure 5: Percentage carbon emission due to PV

2.3 Payback Period

The need to demonstrate 20% reduction in carbon savings notwithstanding PV's are also proposed for the Postal Museum because the payback period is relatively short; anticipated to be 8-10 years as can be seen in the calculation below.

- Estimated cost of PV array : £47,400
- Annual estimated output of array : 27,800kWh
- Feed in Tariff annual revenue at 12.13p per kWh: £3,372
- Annual revenue for 100% export to grid at 4.77p per kWh: £1,326
- Annual revenue if 100% used in building (8p per kWh): £2,224
- Simple payback period range: 8.5-10.1 years

Note: Feed in Tariffs and Export prices are currently subject to public consultation and are therefore subject to change.

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3.0 METERING SYSTEM

An automatic meter reading and targeting system (AM&T) is being provided for the Postal Museum project at Calthorpe House to provide the following:

- Monitor energy and water consumption such that at least 90% of 'end-use' energy is measured and recorded via a web based front end interface allowing multiple users to access the system from a variety of locations.
- Energy consumption to include heat metering on cooling and heating systems.
- Store consumption data for all meters for a period of no less than 25 months
- Allow the BPMA to analyse the consumption data in both graphical and tabular format.
- Allow individual metering data to be independently interrogated
- Allow aggregation of common meter types according to system, building or both
- Allow "grouping" of meters to be saved such that reports can be generated on a like for like ongoing basis
- Be available for download to 3rd party applications such as MS Excel or Office.
- Be in accordance with the standards set out by CIBSE TM39 Building Energy Metering To display data in graphical and tabular formats so that operating patterns and energy wastage areas can easily be identified.

3.1 Metering of Renewable Energy Technologies

Clause 2.24(b) of the section 106 Calthorpe House agreement indicates that energy generation from renewable energy generating technologies needs to be metered separately.

Figure 6 is an extract from the electrical distribution schematic for Calthorpe House and indicates how this requirement will be implemented. A meter is provided on the sub-mains cable linking the PV array to the main incoming switch panel and will record electrical energy produced.

This data will then be available to the client in the form of a report which will give cumulative electrical energy generation alongside to electrical energy consumption of the building.

Note that this meter is separate to the one which will be provided by the utility for export payment calculations.

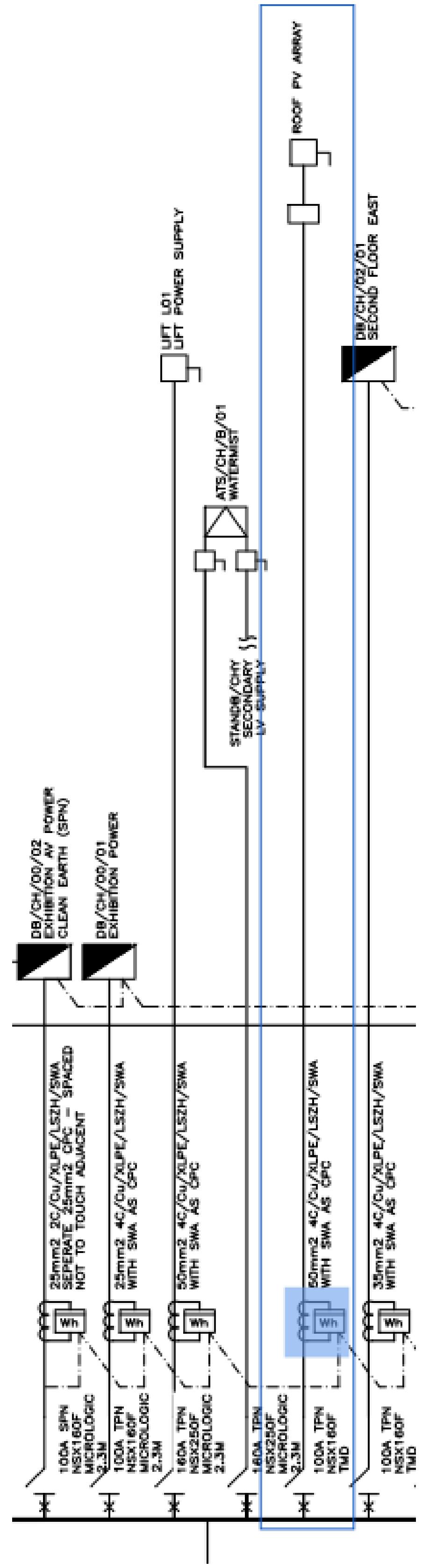

Figure 6: Metering of PV array

4.0 BUILDING MANAGEMENT SYSTEM

A building management system (BMS) is to be provided for Calthorpe House. This will include control and monitoring of mechanical plant as required by clause 2.24(c) of the section 106 agreement. A description of the proposed system is included below.

An intelligent Building Management System will be provided to control and/or monitor the following items of plant:

- heating plant;
- chilled water plant;
- close control air-conditioning plant to the exhibition space;
- close control air conditioning plant to the archives;
- close control air conditioning plant to the search rooms;
- general ventilation systems;
- kitchen ventilation systems;
- WC ventilation systems
- packaged refrigerant air conditioning systems;
- natural ventilation actuators;
- domestic water plant;
- lifts.
- central battery
- Metering systems

The system will be IP based, with a series of distributed intelligent and passive outstations. BMS software and controllers will be open protocol using BACNET, and be based around Schneider Struxtureware.

The BMS will operate over a secure technical LAN separate from the general ICT networks.

The BMS shall monitor and control all plant and equipment, to ensure space conditions match the requirements for human comfort and/or conservation of sensitive materials. The set points used to control plant will include temperature, CO_2, Humidity.

The system will include the following time schedules which are editable by the BPMA in order to ensure plant doesn't run in areas where there is no occupancy or requirement for conservation conditions. This will allow the BPMA to control the hours of use of mechanical plant and target energy savings.

PLANT OR AREA	DAY OF WEEK	TIME	SIGNAL	NOTES
Exhibition	1-7	0000-2400	Enable	Air handling plant is enabled at all times unless under manual control.
	1-7	0800-2000	Occupied	Occupied used to indicate mode of operation of plant
General Spaces	1-7	0700 – 2000	Enable	
Search Room	1-7	0000-2400	Enable	Air handling plant is enabled at all times unless under manual control.
	1-7	0800-2000	Occupied	Occupied used to indicate mode of operation of plant
Archive	1-7	0000-2400	Enable	
Education and Hire Space	1-7	0900-2000	Enable	Push buttons to be provided in spaces outlined below to extend operation of plant by 2 hours • Education Space • Hire Space

Figure 7: User editable occupancy schedules.

Redundancy of connections shall be provided to all critical control areas including the exhibition and archive spaces to ensure that in the event of a single data connection failure a connection back to the main control network is maintained.

Mechanical control panels will be provided in the main plant rooms to provide power and control to all major plant.

Outstations will be provided as required around the building to serve local fan units, humidifiers, sensors and control valves.

It is a fundamental requirement that control systems interfaces with end users are clear, logically set out and intuitive in nature.

The maintenance of gallery conditions within agreed design parameters and to agreed tolerances is essential.

A proportional control sequence will be employed along with duplicate sensors to ensure stable conditions are maintained.

BMS sensors will be provided in sufficient numbers and in appropriate locations in all spaces to control and monitor the installed plant, daylight control and lighting to maintain the desired temperature and humidity set points and internal light levels in each space, as applicable.

Leak detection will be linked to the BMS as will any flood detection systems installed in the building.

5.0 CONNECTION TO DISTRICT HEAT NETWORKS

Clause 2.24(d) of the section 106 Calthorpe House requires that there is provision for connection to a district heating network should one be available in the future.

The blue zone in Figure 8 is the gas meter room for the project. Sufficient space has been left to allow a heat interface unit to be installed in the future.

Connections will be provided to allow the heat interface unit to connect to the primary header of the heating system. These will rise up to the boiler plant room which is located in a on the first floor directly above the gas meter room.

Future connection to a district network in the future will reduce the use of the gas fired boilers which are to be installed as part of this scheme.

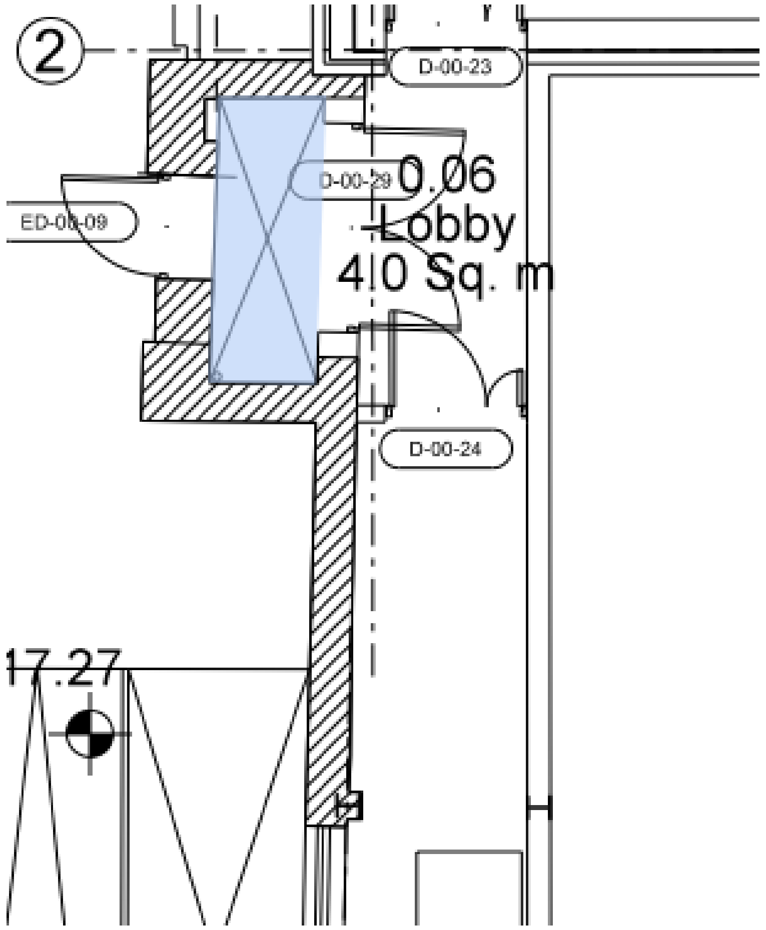

Figure 8: Zone in blue allows future installation of heat interface unit

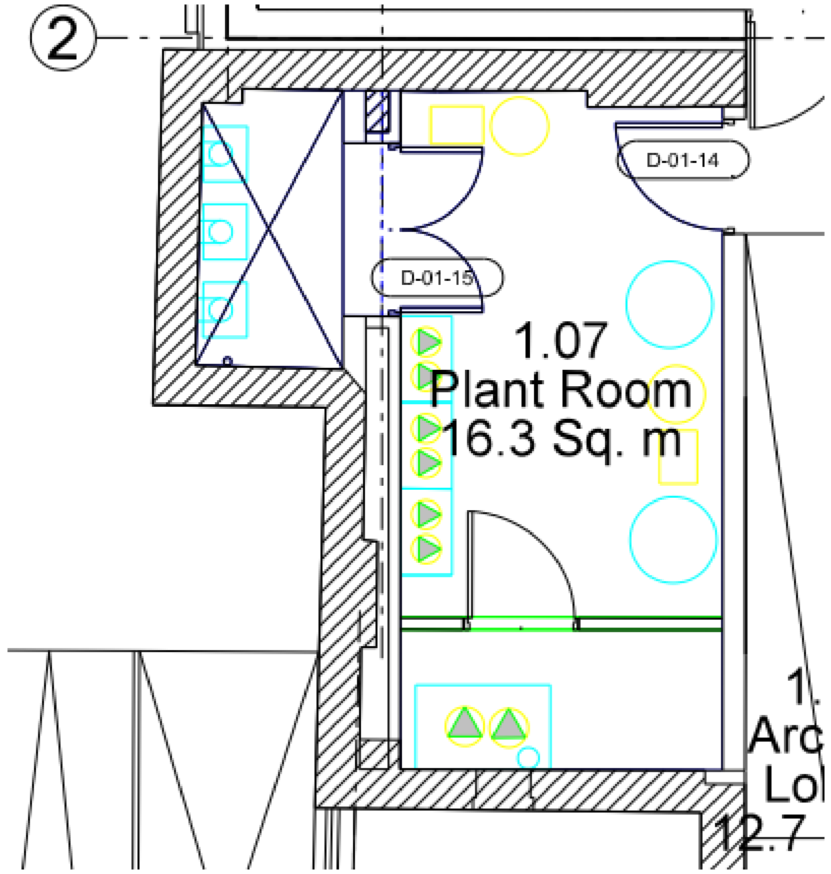

Figure 9: Boiler Room on First Floor

6.0 SUMMARY OF ADDITIONAL ENERGY SAVING MEASURES

Additional energy saving measures which are included in the Calthorpe House building services design have been summarised below.

6.1 Passive Energy Reduction:

- improved thermal insulation to the existing roof,
- net reduction in the wall area of high U-value existing external facades, as some external façade become internal,
- Heavy weight (high thermal mass) construction of the new archive areas in order to reduce fluctuations in internal conditions and minimise mechanical plant intervention.
- Replacement of existing single glazed rooflights and external windows
- Maximising the use of natural daylight in appropriate spaces
- Provision of fixed solar shading to South/ South West office glazing to minimise solar gain
- Existing external walls will be internally lined to meet the requirements of Part L2B.

6.2 High Efficiency Plant, Equipment and Controls

- Use of modular central plant in a cascade arrangement to most closely match plant operation with building demand
- replacement of existing boiler and heating system with modular condensing high efficiency boilers and improved heating controls
- replacement of existing air conditioning systems with new modular air cooled chiller and space specific VRV refrigerant units
- Mechanical ventilation will be demand based to avoid unnecessary operation of ventilation plant.
- Mechanical ventilation fans will generally be variable speed to dramatically reduce electrical energy consumption.
- Mechanical ventilation systems will be arranged such that outside air is used directly to condition spaces without mechanical heating or cooling where appropriate
- Use of heat recovery on mechanical ventilation where necessary.
- All pipework and ductwork containing heated or cooled media will be insulated to minimise heat loss or gain and avoid the formation of condensation on material surfaces.

6.3 High Efficiency Lighting and Controls:

- New high-efficiency lighting general based on LED technology to replace existing installations
- Lighting circuits arranged to compliment natural daylighting
- Building wide lighting controls are provided to reduce the output of, or extinguish artificial lighting when sufficient day light exists or a space is no longer occupied
- Master “kill” switch to off all lighting when the building is unoccupied.

6.4 Energy Management in Use:

- New metering system encompassing electrical, gas and heat consumption to be provided as described earlier.

6.5 Water Conservation:

- Water consumption will be integrated into the new intelligent metering system, with end use metering provided as appropriate.
- Water leak detection will be provided as part of the metering package
- Motorised isolating valves will be provided to toilet and welfare areas to enable hot and cold water supplies to be isolated out of occupied hours or when a particular space is unoccupied.
- Taps and fittings will generally be of the “low flow” type to reduce water consumption. Where such fittings are not available, DEFRA approved flow regulators will be provided to limit water consumption to accepted flow rates.

7.0 LOW OR ZERO CARBON TECHNOLOGIES NEGLECTED

As a record the following renewable energy sources were been neglected after careful consideration.

7.1 Ground Source and Air Source Heat Pump

Heat pump systems use electricity and refrigerant to provide space heating. The ratio of heat developed to electricity used is called the "Coefficient of Performance", or COP. The higher the COP, the lower the amount of electricity required to generate heat or cooling

Air source heat pumps (ASHP) do not require connection to the ground, however their COP in winter is generally significantly worse than ground source heatpump (GSHP)systems (as less heat is available from cold air than from the ground) and noise and visual planning issues become more significant as well as the structural issues of roof support.

A COP for heating of 3.0 is realistic for most UK systems (according to BSRIA data). In reality, the COP in London, where ambient temperatures are elevated due to the heat island effect, may be higher (possibly as high as 4.0), but without full weather based modelling, it would be unwise to use a higher value.

GSHP involves extracting heat from the ground to heat the building, by circulating water through buried pipes. The pipes may run horizontally in trenches (as in the picture), or vertically as U-tubes. On a restricted urban site, the vertical arrangement of ground loops allows a higher output.

The low grade heat extracted from the ground is passed through a heat pump, which provides higher grade heat (in the form of hot water) to the building. The system can also be used in reverse to provide cooling in summer. By coupling the heat pump with the ground, a higher COP (5-7 typical) is achieved when compared to air source heat pumps

The main issue with GSHP is the location and expense of vertical boreholes or a horizontal array. There is no space on site for an effective horizontal array, and a borehole-fed system is expected to attract an initial capital cost of at least 8-10 times more than an equivalent boiler installation (not accounting for possible RHI payments).

7.2 Wind

A wind turbine harnesses the power of the wind to produce electricity. The turbine rotor converts linear air movement to rotation, which drives a generator. Wind turbines are available in a wide range of sizes, from large 'wind-farm' scale turbines to small domestic roof-mounted versions.

The table below shows the predicted average wind speed for Cremer Street at various heights above ground level (these figures don't account for the turbulence from surrounding sites).

Height above ground, m	Average Wind speed, m/s
45	6.1
25	5.5
10	4.6

Figure 10: Average predicted wind speeds at the site from UK Department of Energy and Climate Change National Wind Database

The UK Renewable Energy Association indicates that the minimum average wind speed of 4.5m/s is required for wind turbines to be viable . When the effect of turbulence from an urban environment is factored in then this is unlikely to be achieved below a height of 25m (particularly given the proposed building height is 20m). With the above in mind it was felt that wind turbines are not appropriate to this project given the relatively small saving that would be achieved relative to the significant impact visually and acoustically.

7.3 Biomass

A typical biomass installation includes a large storage area for the fuel, a hopper to deliver the fuel from the store to the boiler, a boiler, and a buffer vessel to take the excess heat if demand drops off when the boiler is hot and there is no demand for heat. Fuel is delivered weekly or fortnightly and the boiler must be emptied of ash regularly. This imposes significant maintenance and logistical demands on the building operator.

The feasibility of using biomass for heating depends largely on the fuel availability and the heat demand of the building.

With a suitable local fuel source, biomass heating can be a cost-effective way to save significant amounts of CO_2.

However, we expect the project to have a relatively low heating demand and, although schemes exist within London, we are yet to be convinced about the long term role of imported biomass in the urban environment for a number of reasons:

- Imports of fuel from outside of London strip supply from where it can be sensibly used in the regions.
- Transporting fuel by truck has a significant impact on CO2 emissions and impacts air quality in towns
- A large storage area for fuel is required, even for a modest period of heating.
- Ash deposits have to be transported from site.
- Sulphur Dioxide emissions as a result of wood burning systems have in the past lead to problems with Smog in urban environments.

For the reasons given above, biomass heating was not considered for this project.

7.4 Solar Thermal Hot Water

Like PVs, solar thermal systems require little maintenance and have relatively low visual impact. They are more efficient than PVs at converting solar energy into a useful form, and are therefore more cost-effective. This cost is also potentially offset by the Renewable Heat Incentive (RHI) subject to government decisions on the future of the scheme.

However, hot water represents a small proportion of the buildings energy demand and the potential for making CO_2 savings using solar thermal is therefore limited, and only a domestic scale of system would be appropriate.

For this reason, it was determined that solar thermal water heating wouldn't be investigated further.

8.0 CONCLUSIONS

In conclusion Max Fordham LLP have carried out a pre-implementation review of the of the renewable energy generation technologies proposed for Calthorpe House as required by clause 2.24 of the section 106 agreement for the project.

The measures set out by Clause 2.24 are summarised below:

1. 2.24 (a) - A photovoltaic (PV)array is proposed which is predicted to achieve a reduction in regulated CO2 emissions of 25.8%. This has been calculated using the Building Regulations Part L compliance methodology.

2. 2.24(b) – PV energy generation is to have an independent meter which will record all energy developed. As part of a building wide metering system it will be possible to interrogate energy production as a percentage of the buildings reduction. Note that this meter will be separate to that provided by the utility for export calculations

3. 2.24 (c) – A Building Management System is included to control and monitor all major plant in the building. This will allow the building user to refine control time schedules so that the number of running hours on plant is limited as far as possible.

4. 2.24 (d) - Spare connection points are to be provided for future incorporation of a heat interface unit. This will connect to the heating system and allow a district heating network to replace the gas fired boilers currently installed.

5. 2.24 (e) - The pre-implementation review of the renewable energy generation was performed by Max Fordham LLP as part of the BREEAM pre-assessment modelling (refer to section 106 clause 2.28) and as such are deemed an appropriately qualified and recognised independent verification body as stipulated.

6. 2.24 (f) – BPMA have committed to appoint as an appropriately qualified and independent verification body, i.e. a BREEAM Assessor, to undertaken the post construction review of the development as per this clause of the Section 106. This will ensure that the measures incorporated into the Renewable Energy Plan have been achieved and will be maintainable in the operation of BPMA.

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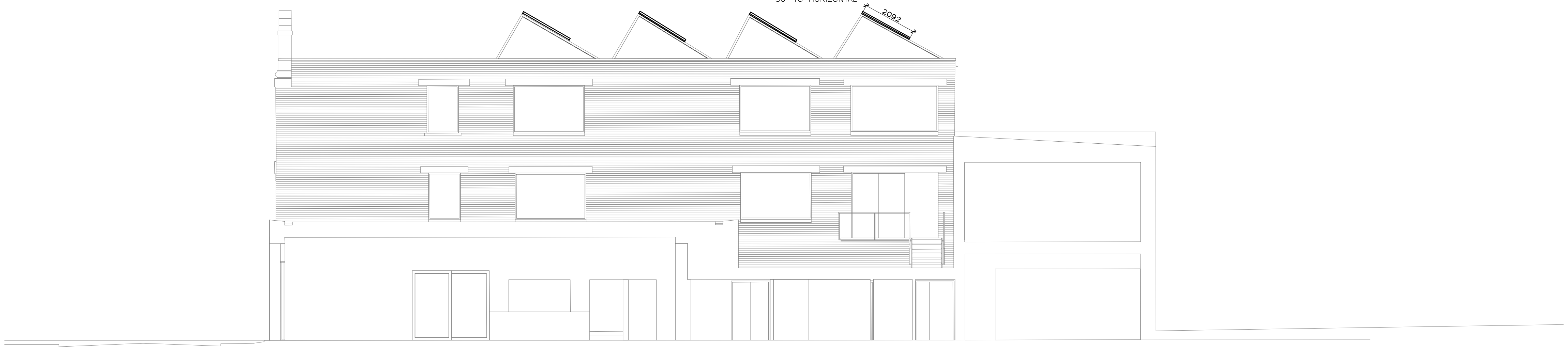
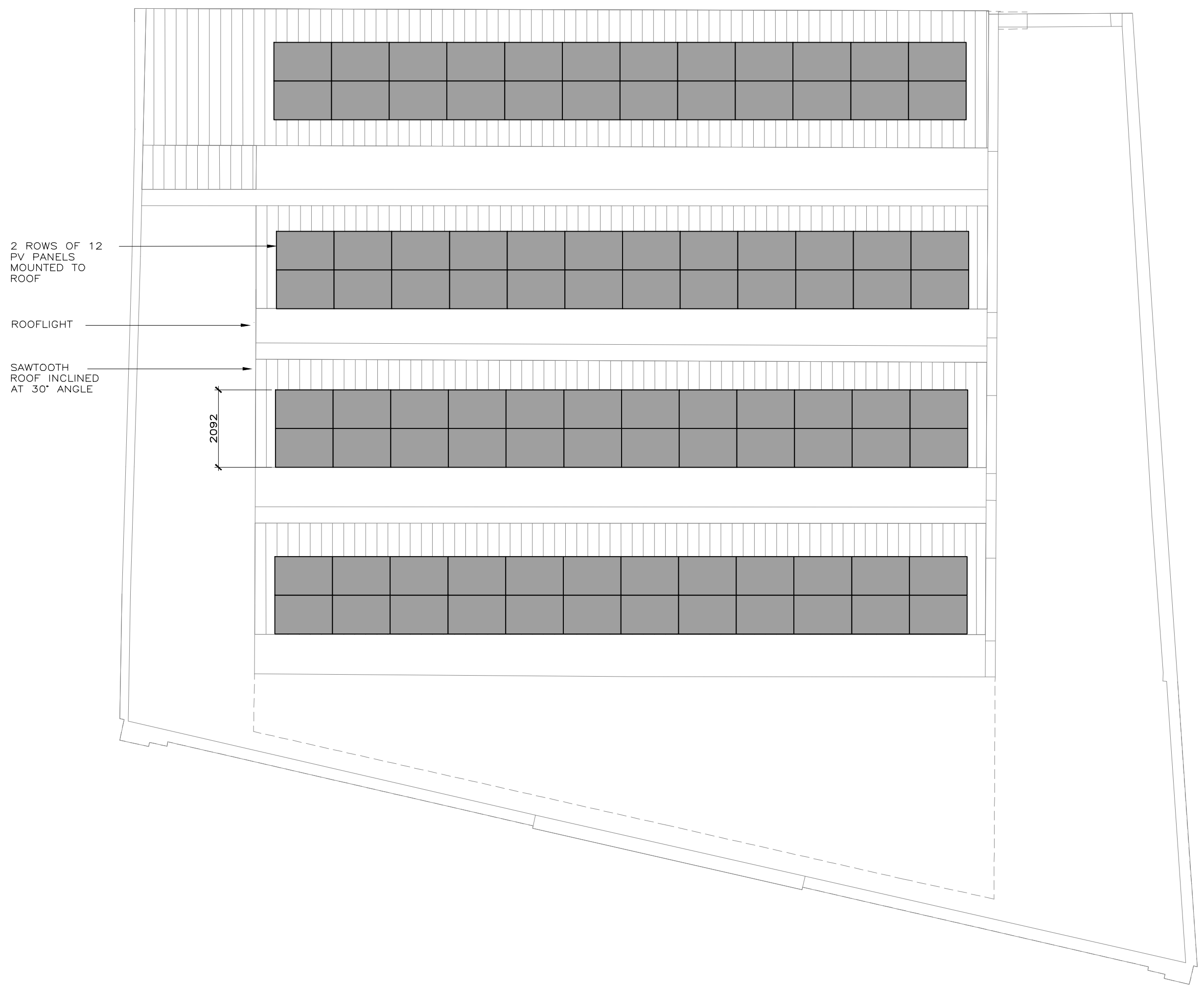
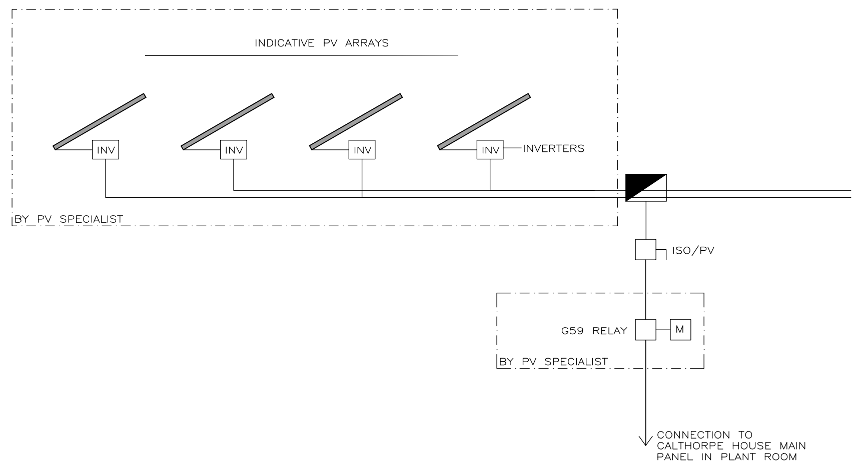
9.0 APPENDIX – SOLAR PV PROPOSAL



NOTES:

1. PVS ARE TO BE HIGH-EFFICIENCY MONOCRYSTALLINE. ALLOW FOR [SUNPOWER X-SERIES] OR EQUIVALENT.
2. REFER TO ARCHITECTS DETAILS FOR END DECORATIVE SHEILDING PANELS REQUIRED AS A PLANNING CONDITION
3. READ IN CONJUNCTION WITH ALL RELEVANT SPECIFICATIONS





PV SYSTEM MINIMUM REQUIREMENTS	
TOTAL ARRAY CAPACITY	33.12kWp
MODULE EFFICIENCY	21.5%
ANNUAL SYSTEM OUTPUT*	kWh/yr
TOTAL PV MODULE AREA	156.6m²
BALANCE OF SYSTEM (BOS)	%**

* ANNUAL SYSTEM OUTPUT TO MEET THE PROJECT'S PLANNING COMMITMENTS.

**BALANCE OF SYSTEM (BOS) TO INCLUDE FOR INVERTERS THAT HAVE A MINIMUM EFFICIENCY OF 90%.

BENCHMARK PV MODULE AS USED IN THIS EXAMPLE ROOF ARRANGEMENT				
MAKE	SUNPOWER			
MODEL	X-21 SERIES			
MODULE DIMENSIONS	1046MM X 1559MM X 40MM			
MODULE EFFICIENCY	21.5%			
FOOTPRINT AREA BY ORIENTATION/ INCLINATION	INCLINATION		LANDSCAPE	PORTRAIT
		30°		
CIRCULATION ZONE (MIN)	700 MM			
OVERSHADING ZONE (MIN)	TBC			

LOTTERY FUNDED

	date	description	eng
T1	22/07/15	STAGE E+ TENDER	LB
T1	13/07/15	STAGE E+ TENDER	LB
*	13/04/15	STAGE E ISSUE	LB

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drawing title
PV LAYOUT ROOF

job no	dwg no	rev
J4383	**V[10]120**	**/T1**