SERVICES PROJECT ENGINEERS LIMITED
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ENERGY STATEMENT

FOR

All Saints Church, The Avenue, Hampton, TW12 3RG

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V1	06.03.2017	Minor revisions

Notes

This report is based on building information available at Planning Stage and is subject to further revisions at detailed design stage.

Contents

1.0 EXECUTIVE SUMMARY

This report sets out the energy strategy for the proposed mixed use development at The Avenue, Hampton, TW12 2RG London. It describes how the development will achieve the energy and carbon dioxide emissions reduction requirements of the London Borough of Richmond sustainable policies.

The structure of this energy statement is in accordance with the London Plan's energy hierarchy:

- Step 1 - Use less energy (be lean)
- Step 2 - Supply energy efficiently (be clean)
- Step 3 - Use renewable energy (be green)

Energy efficiency measures to be implemented for the Church Hall include:

- Good air tightness and an excellent thermal envelope.
- Installation of high efficiency condensing boiler to provide space heating
- Low energy LED lighting and controls
- Natural ventilation in church hall

After the implementation of the energy efficiency measures the Building Emissions Rate (BER) is still higher than the Target Emissions Rate (TER).

The proposed installation of a Solar PV array with an area of 61m^2 would provide the 35% reduction in CO_2 emissions from renewable energy and achieve Part L Building Regulations (2013) compliance.

The roof mounted 12.4kWp Solar PV system would offset approximately 5,437kgCO_2 per annum. The Solar PV array system would be grid connected so that any electricity generated that is not required would be exported to the National Grid.

The figures in the table below are emissions per year:

Table 1 – Summary of CO_2 emissions for Church Hall

Design	kgCO_2/annum	% saving
Baseline emissions (Notional Building - TER)	8,736	-
Actual Building emissions (BER) with energy efficiency measures + unregulated energy	11,116	0%
Emissions with proposed renewable energy - Solar PV array	5,679	35%

Energy efficiency measures to be implemented for the dwellings include:

- Good air tightness and an excellent thermal envelope.
- Installation of high efficiency gas fired boilers to meet space heating demand
- Low energy LED lighting and controls

In combination with the proposed energy efficiency measures, the installation of a Solar PV array for each dwelling would contribute to provide the minimum 35% reduction in regulated CO_2 emissions over Part L Building Regulations (2013).

2.0 INTRODUCTION

Services Project Engineers (SPE) has been appointed by All Saints Church to act as Building Services Consulting Engineers on the proposed development at The Avenue, Hampton, TW12 2RG.

The role of SPE is to prepare an energy statement to meet local planning requirements and guidance of the London Plan as detailed in section 2.1 below and this requires a minimum 35% reduction in on site CO_2 emissions over Building Regulations (2013).

This Energy Statement is submitted together with a Sustainability statement which includes a BREEAM 2014 pre-assessment and addresses the ENE04 credit – feasibility study of installation of low and zero carbon technologies.

The outline of this report is in accordance with the London Plan's energy hierarchy and is as follows:

- Section 3 outlines predicted baseline energy consumption in kWh/annum and associated CO_2 emissions for the proposed development.
- Section 4 Use less energy (be lean) - provides a number of energy efficiency measures to reduce the site's energy consumption and associated carbon dioxide emissions per year.
- Section 5 Supply energy efficiently (be clean) - analyses the suitability of installing CHP technology within the development.
- Section 6 Use renewable energy (be green) - reviews the commercially available renewable energy technology for installation at the development and proposes possible plant size and CO_2 savings that would be achieved if installed.
- Section 7 outlines the various capital grant schemes and clean energy cash back schemes available.
- Section 8 provides recommendations and concludes the most suitable renewable technology suitable for inclusion within the design.

2.1 Planning Policy and Guidance

London Borough of Richmond is committed to environmentally sustainable forms of development and Policies CP1 and 2 of the Core Strategy incorporates the following London Plan 2015 policies to reduce CO_2 emissions on site:

Table 2 – London Plan 2015 Policy Summary

Policy 5.2: Minimising CO_2 Emissions	
Item	**Description**
A	Development proposals should make the fullest contribution to minimising CO_2 emissions in accordance with the energy hierarchy: i. Be lean: use less energy; ii. Be clean: supply energy efficiently; iii. Be green: use renewable energy;
B	Major developments should meet carbon targets improving on Part L 2010. For non-residential development the targets are as follows: i. 2010 – 2013: 25% improvement on TER ii. 2013 – 2016: 40% improvement on TER iii. 2016 – 2019: as per building regulations iv. 2019 – 2031: zero carbon
C	Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy;

D	Assessments should include: i. Regulated and unregulated emissions; ii. Proposals for efficiency measures; iii. Proposals for CHP; iv. Proposals for renewable energy;
E	The carbon reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide saving elsewhere.

Policy 5.3: Sustainable Design and construction	
Item	**Description**
A	**Strategic** The highest standards of sustainable design and construction should be achieved in London to improve the environmental performance of new developments and to adapt to the effects of climate change over their lifetime.
B	**Planning decisions** Development proposals should demonstrate that sustainable design standards are integral to the proposal, including its construction and operation, and ensure that they are considered at the beginning of the design process.
C	Major development proposals should meet the minimum standards outlined in the Mayor's supplementary planning guidance and this should be clearly demonstrated within a design and access statement. The standards include measures to achieve other policies in this Plan and the following sustainable design principles: a minimising carbon dioxide emissions across the site, including the building and services (such as heating and cooling systems) b avoiding internal overheating and contributing to the urban heat island effect c efficient use of natural resources (including water), including making the most of natural systems both within and around buildings d minimising pollution (including noise, air and urban runoff) e minimising the generation of waste and maximising reuse or recycling f avoiding impacts from natural hazards (including flooding) g ensuring developments are comfortable and secure for users, including avoiding the creation of adverse local climatic conditions h securing sustainable procurement of materials, using local supplies where feasible, and i promoting and protecting biodiversity and green infrastructure.
D	**LDF preparation** Within LDFs boroughs should consider the need to develop more detailed policies and proposals based on the sustainable design principles outlined above and those which are outlined in the Mayor's supplementary planning guidance that are specific to their local circumstances.

2.2 Description of the site

The site is located at The Avenue, Hampton, TW12 2RG. The scheme proposes construction of new church hall with two residential flats above, a new Narthex link to church and 3No 4 bedroom houses and 1No 3 bed house. The non-residential development would have a total floor area of approximately 480m^2.
The site is primarily surrounded by other residential properties.

Figure 1 – Proposed Ground Floor Layout and Site Plan

3.0 ESTIMATED SITE ENERGY DEMANDS

This section of the report details baseline figures for energy demand and carbon dioxide emissions per annum for the proposed mixed use development and are based on the Part L Building Regulations 2013.

The church hall areas (non residential) of the development has been modelled using IES virtual environment software dynamic simulation modelling application.

The building type for the church hall area was selected from the NCM building category list within SBEM as follows:

Part L Building Area Type	D1: Community/Day Centre

The London CIBSE TRY weather data was selected to simulate external conditions as it represents a typical years worth of recorded data.

Annual energy demands for the 6No dwellings have been calculated using BSRIA benchmark figures.

A dynamic thermal model of the new church hall building was created using the latest architect drawings and various simulations were run using different values for the passive building parameters and building services plant.

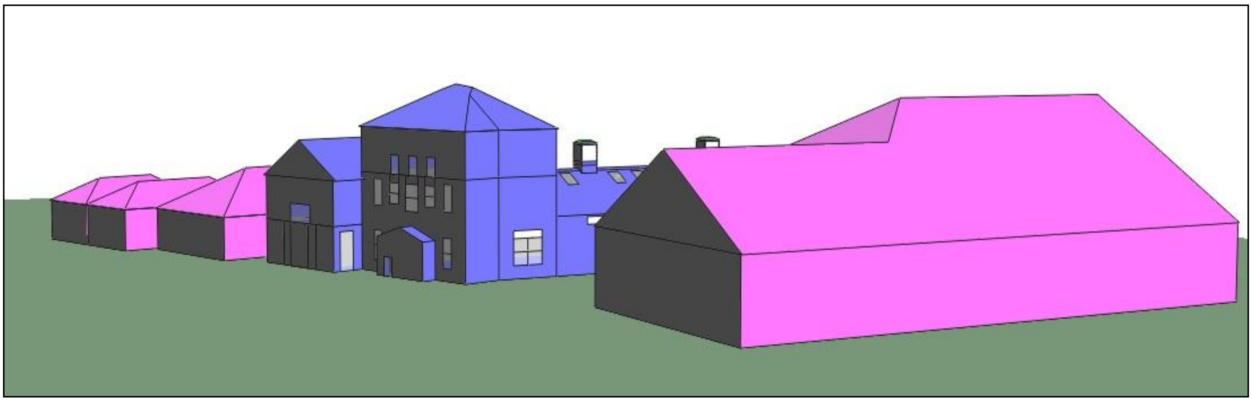
The following architect drawings were used to develop model of the proposed building:

Table 3 – Architect Drawings

Drawing No.	Title	Format
L1137/2.1/05	Site Plan	DWG
L1137/2.1/06	Ground & First Floor Plan	DWG
L1137/2.1/07	Second & Roof Plan	DWG
L1137/2.1/08	Front & Rear Elevations	DWG

Figure 2 below shows a preliminary model layout of the building.

Figure 2 – Model Layout of Proposed Development at All Saints Church, Hampton.



Based on the analysis performed using the dynamic simulation modelling for the church hall and use of the energy benchmark figures for the dwellings, the baseline CO_2 emissions (TER - 2013 Building regulations Part L notional building) and energy demands are shown in the tables 4 - 6 respectively below:

Table 4 - Church Hall Annual Baseline CO_2 Emissions

CO_2 Emissions ($kgCO_2/yr$)	TER ($kgCO_2/m^2$)	Area (m^2)	Total ($kgCO_2$)
D1: Church Hall	18.2	480	8,736

(TER = Target Emissions Rate)

Table 5 - Dwellings Annual Baseline CO_2 Emissions

CO_2 Emissions ($kgCO_2/yr$)	Area (m^2)	Total ($kgCO_2$)
Dwellings		
Flat 1	75	3,087
Flat 2	52	2,140
House 1 (4 bedroom)	128	5,270
House 2 (4 bedroom)	128	5,270
House 3 (4 bedroom)	128	5,270
House 4 (3 bedroom)	108	4,446

Table 6 - Church Hall Annual Baseline Energy Demands

Energy Demand (kWh/yr)	Space Heating & Domestic Hot Water	Lighting & Auxiliary Power	Additional Unregulated Electricity*	Total (kWh/yr)
D1: Community Hall Areas	24,120	9,700	1,905	35,725

* Refer to Appendix 4 for calculation of unregulated emissions

4.0 ENERGY EFFICIENCY MEASURES (BE LEAN)

This section introduces energy efficiency measures to be implemented within the development to reduce the energy demand of the building in line with London Borough of Richmond and London Plan 2015 policies.

The following energy efficiency measures are proposed for the Church Hall development:

a) Building Fabric

The building fabric U-Values shown in table 7 are proposed to enhance the building thermal envelope. Improvement in building U-Values can reduce the heat loss from the building resulting in a reduction of heating energy consumption and associated CO_2 emissions.

Table 7 - Construction Summary

Building Element Target U-Value	Part L (W/m^2K)	Actual (W/m^2K)
External Wall	0.35	0.26
External Glazing	2.2	1.7
Roof	0.22	0.16
Floor	0.20	0.21
External Doors	2.2	1.7

b) Air Tightness

Air tightness is a key part of a thermally efficient building and a reduction in air leakage through the building can reduce the energy used for heating. Air permeability rate for the building shall be $5m^3/(m^2hr)$ at 50 Pa (50% better than the minimum performance required by the 2013 Part L building regulations).

c) Heating & Controls

Space heating to the building will be provided by means of high efficiency condensing boilers to serve low temperature hot water radiator heating system. All pipework shall be thermally insulated to minimise system losses.

Room thermostats and controllers will be provided to allow appropriate control of heating and occupant comfort. Central control panel will be installed to provide time clock control and optimum start for heating system.

d) Natural Ventilation

Cross ventilation will be provided to main hall areas by natural means via external wall louvers and roof terminals.

e) Power Factor correction

It is proposed to install a power factor correction unit to ensure the electrical supply to the building is corrected to >0.95.

f) Lighting

The fixed lighting shall use low energy light fittings throughout and the design will aim to limit the electrical energy consumption to $7W/m^2$ in all areas.

The design will include the following control features:

- Occupancy detection sensors in all areas to ensure lighting is only in operation when required and switch lights off after a period of 15 minutes after the sensors fail to detect movement.
- Within rooms with perimeter windows, the lighting control system will use integral photocell controls such that rows of luminaires adjacent to windows are switched off when adequate daylighting is present. This will therefore maximize the use of natural daylighting and minimise the use of artificial lighting.

External lighting will use energy efficient fittings with limited upward light transmission and will be controlled via photocell and time clock.

The following energy efficiency measures are proposed for the dwellings:

a) Building Fabric

The building fabric U-Values shown in table 8 are proposed to enhance the building thermal envelope. Improvement in building U-Values can reduce the heat loss from the building resulting in a reduction of heating energy consumption and associated CO_2 emissions.

Table 8 - Construction Summary

Building Element Target U-Value	Part L (W/m^2K)	Actual (W/m^2K)
External Wall	0.35	0.26
External Glazing	2.2	1.7
Roof	0.22	0.16
Floor	0.20	0.21
External Doors	2.2	1.7

b) Air Tightness

Air tightness is a key part of a thermally efficient building and a reduction in air leakage through the building can reduce the energy used for heating. Air permeability rate for the building shall be $5m^3/(m^2hr)$ at 50 Pa (50% better than the minimum performance required by the 2013 Part L building regulations).

c) Heating

Space heating to each flat will be provided by means of high efficiency condensing boilers (SEDBUK 'A' rated) to serve radiator heating system. All pipework shall be thermally insulated to minimise system losses. Space heating to communal areas will also be provided by high efficiency condensing boiler located in plantroom.

d) Hot Water

Thermal insulation will be provided to all domestic hot water cylinders and all associated distribution pipework to minimise heat losses.

e) Controls

Room thermostats and controllers will be provided to allow appropriate control of heating energy consumption and occupant comfort. Controller will incorporate time clock control and weather compensation.

f) Lighting

Energy efficient lighting will be installed in 100% of internal fittings within the dwellings. Where appropriate LED lighting will be used further to reduce energy demand.

With the above energy efficiency measures incorporated into the design, the overall CO_2 emissions for the proposed development when compared to the baseline (2013 Building regulations Part L notional building) are shown in tables 9 - 12 below:

Table 9 – Church Hall CO_2 Emissions after Energy Efficiency measures

CO_2 Emissions ($kgCO_2/yr$)	Area (m^2)	TER ($kgCO_2/m^2$)	BER ($kgCO_2/m^2$)	CO_2 reduction %	Total ($kgCO_2/yr$)
D1: Community Hall Areas	480	18.2	21.1	0%	10,128

TER = Target Emissions Rate
BER = Building Emissions Rate

Table 10 – Dwellings CO_2 Emissions after Energy Efficiency measures

CO_2 Emissions ($kgCO_2/yr$)	Area (m^2)	Baseline Emissions ($kgCO_2/m^2$)	CO_2 reduction %	Total ($kgCO_2/yr$)
Flat 1	75	3,087	5%	2,933
Flat 2	52	2,140	5%	2,033
House 1 (4 bedroom)	128	5,270	5%	5,007
House 2 (4 bedroom)	128	5,270	5%	5,007
House 3 (4 bedroom)	128	5,270	5%	5,007
House 4 (3 bedroom)	108	4,446	5%	4,224

Table 11 – Summary – Church Hall Overall Annual CO_2 emissions after energy efficiency measures and including unregulated energy

Stage	CO_2 Emissions ($kgCO_2/yr$)
Baseline Emissions (TER)	8,736
As-Designed building with efficiency measures - (BER)	10,128
Total emissions including for unregulated energy	11,116

To ensure compliance the proposed renewable technology will need to be sized to meet the following criteria:

1) BER to be lower than TER therefore ensuring Building Regulations Part L (2013) compliance

2) 35% CO_2 reduction on TER to comply with London Borough of Richmond sustainable policies.

Table 12 indicates the carbon dioxide offset required to achieve above criteria.

Table 12 – CO_2 Emissions Reduction Target

Target Emissions Rate (TER) – Baseline emissions	Actual Building Emissions Rate (BER) with energy efficiency measures and unregulated energy	Required BER
8,736 $kgCO_2$	11,116 $kgCO_2$	5,679 $kgCO_2$
Reduction in carbon dioxide required to pass Part L (2013) Compliance and comply with London Borough of Richmond sustainable policies		5,437 $kgCO_2$

5.0 SUPPLYING ENERGY EFFICIENTLY (BE CLEAN)

This section describes how energy can be generated efficiently in line with London Borough of Richmond and London Plan sustainable policies.

Combined Heat and Power (CHP) is the onsite generation of electricity and heat and is an alternative to boilers for generation of heating in low pressure hot water systems. Conventional generation of electricity is usually associated with heat as a waste by product of the process. CHP is based on this concept and generates electricity while recovering heat for use in heating systems.

CHP technology offers numerous benefits such as reduced energy costs, efficient utilisation of fuel and reduction in CO_2 emissions. When considering CHP installations it is important that base heat and power demands for the building are assessed accurately in order that the optimum CHP size may be selected in terms of environmental and financial benefits.

Due to the high capital cost of the equipment CHP is economically viable when it operates approximately 5000 hours per year. Shorter paybacks on initial capital investment can be achieved when there is a significant year round demand for heating and power.

CHP is deemed unsuitable as there is minimal year round demand for heating and power. The estimated CHP running hours for the year would be less than two thousand and therefore installation of CHP is not economically viable.

Should CHP be considered for installation at a future date, additional plant space will be formed to house CHP unit and associated pipework and controls.

6.0 RENEWABLE ENERGY TECHNOLOGY (BE GREEN)

This section of the reports reviews the various renewable energy technologies available and assesses their suitability for installation at the proposed development.

6.1 Solar Thermal Panels

Principles of Operation

A solar water heating system consists of 'solar collector panels'. The collectors are designed to absorb heat energy from the sun and transfer this to the collector fluid which flows through the collector. A controller determines the rate of flow through the collector, based on the temperatures of the fluid flowing into and out of the collector. The most common place to site such panels is on the roof of the building. They are relatively lightweight and integrate well into most roof designs.

Suitability

Solar thermal energy would be suitable for installation at the development for the following reasons:

- South facing roof available for location of solar thermal panels.
- Building is free from any shading from other buildings or trees.
- Benefit from renewable heat incentive.

6.2 Wind Turbines

Principles of Operation

Wind turbines can produce electricity without carbon dioxide emissions ranging from watts to megawatt outputs. The most common design is for three blades mounted on a horizontal axis, which is free to rotate into the wind on a tall tower. The blades drive a generator either directly or via a gearbox (generally for larger machines) to produce electricity. The electricity can either link to the grid or charge batteries. An inverter is required to convert the electricity from direct current (DC) to alternating current (AC) for feeding into the grid.

Modern wind turbines are becoming viable in low density areas, where ease of maintenance and immediate connection to the grid or directly for use of the electricity in a building, may make them cost effective, however, for such systems to be viable, the annual average wind speed needs to be in excess of 5 m/s.

Suitability
Data indicates that average wind speed available at the site would be 4.5m/s at a height of 10m above ground level. This is below average wind speed requirement of 5.0m/s and is considered insufficient. This together with the noise generated by wind turbine and its visual impact in a residential area does not make it a viable proposition.

6.3 Photo Voltaic

Principles of Operation

Photo-Voltaic (PV) systems convert energy from the sun into electricity through semi conductor cells. Systems consist of semi-conductor cells connected together and mounted into modules. Modules are connected to an inverter to turn their direct current (DC) output into alternating current (AC) electricity for use in buildings. Photo-voltaics supply electricity to the building they are attached to or to any other load connected to the electricity grid. Excess electricity can be sold to the National Grid when the generated power exceeds the local need. PV systems require only daylight, not sunlight to generate electricity (although more electricity is produced with more sunlight), so energy can still be produced in overcast or cloudy conditions.

Photo-voltaic systems can be discreet through being designed as an integral part of the roof. Ideally photo-voltaics should face between south-east and south-west, at an elevation of about 30-40°.

Suitability

Solar PV is flexible and predictable method for generating renewable electricity.
Solar PV would be suitable for installation for the following reasons:

- South facing roof available for location of solar PV panels. The PV panels would be mounted at inclination of 20°.
- Building is free from any shading from other buildings or trees.
- PV requires negligible maintenance and has a longer lifespan than solar thermal panels.
- The system would be grid connected so that any electricity generated that is not required by the development would be exported to the National Grid.

The solar PV array for the Church Hall would consist of high efficiency photovoltaic modules with a minimum efficiency of 20.4%. A roof area of $61m^2$ consisting of 38 Sunpower E20-333W photo-voltaic panels mounted at inclination of 20° would be needed to achieve the required reduction in CO_2 emissions. The proposed Solar PV panel is detailed in Appendix 5.

The Solar PV system size would be approx 12.4kWp and would offset approximately 5,437KgCO_2 per annum.

6.4 Air Source Heat Pumps (ASHP)

Principles of Operation

Air source heat pumps extract energy from the outside air for use in space and hot water heating. There are two types of air source heat pumps, air to air and air to water. The Coefficient of Performance (COP) for an air source heat pump is generally between 2 and 5 but varies throughout the year depending on the outside temperature.

ASHPs operate taking low grade energy from surrounding air using a fan and passing it over a heat exchanger (evaporator) where it is the upgraded and released via another heat exchanger in this case the condenser.
ASHPs work best providing the base load and when supplying low grade heat for systems such as underfloor heating.

Suitability

The installation of an ASHP is feasible however as the heating demands are low this technology would have to be installed in combination with other renewable technologies to meet the required CO_2 reduction. As gas heating is a viable alternative and solar PV is preferred technology ASHPs are discounted.

6.5 Ground Source Heat Pumps (GSHP)

Principles of Operation

Ground source heat pumps are used to extract heat from the ground to provide space and water heating. Heat pumps take in heat at a certain temperature and release it at a higher temperature, using the same process as a refrigerator. As the ground stays at a fairly constant temperature throughout the year heat pumps can use the ground as the source of heat. The ground temperature is not necessarily higher than ambient air temperature in winter but it is more stable whereas air has a vast temperature range. This makes system design more robust.

The ground pipe system can be horizontal or vertical. For horizontal systems, a coiled pipe network is buried at around two metres depth below ground level, thus requiring a large area of open space depending on the size of the system. For vertical systems, the pipes are placed in holes bored straight into the ground to a depth of 100 to 150 metres depending on ground conditions and size of system. Vertical systems thus require very little ground space but do require access for the drilling rig at the construction stage.

One of the major benefits of heat pump technology is the efficiency at which it operates, known as Coefficient of Performance (COP). Heat pump units can have a COP of four meaning for every 1 kW of input power consumed there is an output of 4 kW of heating or cooling.

Suitability

From the site plan it can be seen there is insufficient space for a vertical ground source heat pump. The low heat demands and capital cost of a GSHP installation are not justified when gas heating is a viable alternative.

6.6 Biomass boilers

Principles of Operation

Biomass can be burnt directly to provide heat in buildings. Wood from forests, urban tree pruning, farmed coppices or farm and factory waste, is the most common fuel and nowadays is used commercially in the form of wood chips or pellets, although traditional logs are also used.

Biomass is normally considered a carbon neutral fuel, as the carbon dioxide emitted on burning has been (relatively) recently absorbed from the atmosphere by photosynthesis and no fossil fuel is involved. The wood is seen as a by-product of other industries and the small quantity of energy for drying, sawing, pelleting and delivery are discounted. Biomass from coppicing is likely to have some external energy inputs, for fertiliser, cutting, drying etc. and these may need to be considered in the future. In this study, all biomass fuels are considered to have zero net carbon emissions. Maintenance arrangements for ash disposal must be made.

Suitability

Biomass boilers are not considered suitable for installation at this project for the following reasons:

- Large fuel storage area required.
- Large plantroom area required
- Detrimental impact of local air quality from particulate matter in biomass boiler emissions.

6.7 Biomass Combined Heat and Power (CHP)

Principles of Operation

CHP technology generates on site heat and power offering significant CO_2 savings. Conventionally CHP is normally gas fired but can also operate using biomass as a fuel. Biomass CHP would provide a share of the development's heating and power base load.

Due to the high capital cost of the equipment CHP is economically viable when it operates approximately 5000 hours per year. Shorter paybacks on initial capital investment can be achieved when there is a significant year round demand for heating and power.

Suitability

Biomass CHP is deemed unsuitable for the following reasons:

- As the site does not have a year round demand for heating and power, installation of biomass CHP is not economically viable.
- Detrimental impact of local air quality from particulate matter in biomass boiler emissions.
- CHP has poor efficiency at low loading.
- Large plantroom space is required to accommodate biomass CHP unit and fuel store.
- An acoustic enclosure is required to prevent noise escaping from biomass CHP plant.

6.8 Summary

Table 13 - Summary of suitable Sustainable Energy Systems

Sustainable Technology	System	Consider/Reject
Solar Thermal Panels	Solar thermal panels are suitable for installation due to roof orientation and no shading provided from local buildings and trees. Due to the low demand for water heating solar thermal panels would have to be installed in combination with other renewable technologies to achieve the required CO_2 reduction. As solar PV is preferred technology solar thermal panels for heating domestic hot water are discounted.	**Reject**
Solar PV Panels	South facing roof available for location of solar PV panels. - Building is free from any shading from other buildings or trees. - PV requires negligible maintenance - Solar PV installation would benefit from Feed in Tariffs A 12.4kWp solar PV array with a minimum area of 61m^2 (subject to final module specification) would offset 5,437kgCO_2 per annum.	**Accept**
Air Source Heat Pumps (ASHP)	Installation of an ASHP is feasible however as the heating demands are low this technology would have to be installed in combination with other renewable technologies to meet the required CO_2 reduction. Solar PV is preferred technology and therefore ASHPs are discounted.	**Reject**
Ground Source Heat Pumps (GSHP)	Insufficient ground area on site to install a vertical ground source heat pump and rejected based on capital cost.	**Reject**
Wind Turbines	Average wind speed available at the site is 4.5m/s at a height of 10m above ground level. This is below average wind speed requirement of 5.0m/s and together with the noise generated by wind turbine and it's visual impact in a residential area does not make it a viable proposition.	**Reject**
Biomass Boilers	Not suitable due to impact on air quality and space requirement	**Reject**
Biomass CHP	Not suitable due to lack of year around demand for heat and power and impact on air quality	**Reject**

Table 14 – Church Hall CO_2 Emissions after proposed Renewable energy systems

		Baseline Emissions	Energy Efficiency Measures		Proposed Renewable Energy – Solar PV Panels			
	Area (m^2)	TER ($kgCO_2/m^2$)	BER ($kgCO_2/m^2$)	CO_2 reduction %	PV required (kWp)	BER ($kgCO_2/m^2$)	CO_2 reduction % on TER	Total ($kgCO_2$)
D1: Community Hall Areas	480	18.2	21.1	0%	12.4	11.83	35%	5,679

Table 15 – Dwellings CO_2 Emissions after proposed Renewable energy systems

		Baseline Emissions	Energy Efficiency Measures		Proposed Renewable Energy – Solar PV Panels			
	Area (m^2)	Baseline Emissions ($kgCO_2/m^2$)	Dwelling Emissions ($kgCO_2/m^2$)	CO_2 reduction %	PV required (kWp)	PV Area (m^2)	Total Dwelling Emissions ($kgCO_2/m^2$)	CO_2 reduction %
Flat 1	75	3,087	2,932	5%	2.1	11	2006	35%
Flat 2	52	2,140	2,033	5%	1.5	7.2	1391	35%
House 1 (4bedroom)	128	5,270	5,007	5%	3.6	17.5	3425	35%
House 2 (4bedroom)	128	5,270	5,007	5%	3.6	17.5	3425	35%
House 3 (4bedroom)	128	5,270	5,007	5%	3.6	17.5	3425	35%
House 4 (3bedroom)	108	4,446	4,224	5%	3.0	15	2889	35%

Tables 14 - 15 incorporate the contribution a solar PV panel array would have into reducing the onsite CO_2 emissions.

7.0 CLEAN ENERGY CASHBACK SCHEMES

7.1 Clean Energy Cash-back Schemes

Two clean energy cash-back schemes have been introduced by the government to encourage the uptake of renewable energy technology:

- Feed in Tariffs (FITs)
- Renewable Heat Incentive (RHI)

Feed in Tariffs (FITs)

FITs are a payment (p/kWh) for low carbon electricity generation. Different tariffs apply to different renewable energy technologies and systems up to 5MW are eligible. The scheme started in April 2010 and has the following structure:

- Fixed payment from electricity supplier for every kWh of renewable electricity generated.
- Additional payment from electricity supplier for every kWh exported to the grid.
- Generators are encouraged to use the electricity generated on site to offset some of the electricity they would have had to buy.
- The tariff period (lifetime) for solar PV are linked to the RPI and will be guaranteed for 20 years.

The technologies eligible for FITs are: Hydro, solar PV, wind, anaerobic digestion and Micro-CHP.

The FITs payment scales are set out as follows in table 16 are for Solar PV installations only and come into effect from 1st January 2017:

Table 16 – Summary of Solar PV FITs payment structure

Band (kW)	Generation tariff between 1st Jan 2017 - 31st March 2017
<10kW	4.11
>10-50kW	4.32

Renewable Heat Incentive (RHI)

The Renewable Heat Incentive are payments made for every kWh of renewable heat generated. Applicable technologies include biomass, biogas, solar thermal panels, ground source heat pumps and air source heat pumps.
This scheme started in November 2011. Details of the payment structure are shown below in Table 17 and may be subject to change.

Table 17 – RHI payment structure

Tariff name	Eligible technology	Tariff (pence / kWth) from 1st Jan 2017 - 31st March 2017
Biomass	Biomass	4.21
Water/Ground -source heat pumps	Ground-source heat pumps & water source heat pumps	19.33
Air-Source heat pumps	Air-source heat pumps	7.51
All solar collectors	Solar thermal collectors	19.74

8.0 CONCLUSIONS AND RECOMMENDATIONS

The structure of this report is in accordance with the London Plan's energy hierarchy.

Energy efficiency measures to be implemented for the Church Hall development include:

- Excellent thermal envelope with low U-Values.
- Low air permeability
- Natural ventilation in Church Hall
- Installation of high efficiency gas fired condensing boiler to meet space heating demand
- Low energy lighting and controls

Energy efficiency measures to be implemented for the dwellings include:

- Excellent thermal envelope with low U-Values.
- Low air permeability
- Installation of high efficiency gas fired condensing boilers to meet space heating demand.
- Low energy lighting and controls

For the Church Hall after the implementation of the energy efficiency measures the Building Emissions Rate (BER) is still higher than the Target Emissions Rate (TER).

To achieve Part L compliance and comply with London Borough of Richmond sustainable policies on 35% CO_2 reduction, installation of a 12.4kWp solar PV array with an area of $61m^2$ would generate 10,476kWh/yr of renewable electricity and reduce CO_2 emissions by 5,473kgCO2 per year. The Solar PV array system would be grid connected so that any electricity generated that is not required would be exported to the National Grid.

Table 14 and 15 show that through the use of energy efficiency measures and the proposed renewable energy installation compliance with London Borough of Richmond sustainable policies can be achieved.

Solar PV panels have been selected for the dwellings to achieve 35% reduction in on site CO_2 emissions.

Main advantages of solar PV panels are listed below:

Advantages:

- Easy to install and maintain
- Negligible maintenance
- Benefit from Feed in Tariffs (FITs)
- Less plantroom space requirements
- Can achieve CO_2 emissions reduction target to meet planning requirements

Appendix 1 - BRUKL Output (Page 1 only) at Stage 2 after energy efficiency measures

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

All Saints Church

As designed

Date: Sun Mar 05 09:41:13 2017

Administrative information

Building Details

Address: The Avenue, London, TW12 2RG

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.6

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.6

BRUKL compliance check version: v5.2.g.3

Owner Details

Name: All Saints Church

Telephone number:

Address: The Avenue, Hampton, London, TW12 2RG

Certifier details

Name: Shirome Bhandari

Telephone number: 0208 428 4000

Address: 3 Colburn Avenue, Hatch End, London, HA5 4PQ

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

The building does not comply with England Building Regulations Part L 2013

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	18.2
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	18.2
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	21.1
Are emissions from the building less than or equal to the target?	BER > TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	Surface where the maximum value occurs*
Wall**	0.35	0.20	0.20	GF000002:Surf[1]
Floor	0.25	0.21	0.21	GF000002:Surf[0]
Roof	0.25	0.16	0.16	HL000000:Surf[10]
Windows***, roof windows, and rooflights	2.2	1.7	2	GF000013:Surf[1]
Personnel doors	2.2	1.77	2.2	GF00000A:Surf[4]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	5

Page 1 of 6

Appendix 2 - BRUKL Output (Page 1 only) at Stage 3 after renewable energy system

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

All Saints Church

As designed

Date: Sun Mar 05 09:55:49 2017

Administrative information

Building Details

Address: The Avenue, London, TW12 2RG

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.6

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.6

BRUKL compliance check version: v5.2.g.3

Owner Details

Name: All Saints Church

Telephone number:

Address: The Avenue, Hampton, London, TW12 2RG

Certifier details

Name: Shirome Bhandari

Telephone number: 0208 428 4000

Address: 3 Colburn Avenue, Hatch End, London, HA5 4PQ

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	18.2
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	18.2
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	11.3
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	Surface where the maximum value occurs*
Wall**	0.35	0.20	0.20	GF000002:Surf[1]
Floor	0.25	0.21	0.21	GF000002:Surf[0]
Roof	0.25	0.16	0.16	HL000000:Surf[10]
Windows***, roof windows, and rooflights	2.2	1.7	2	GF000013:Surf[1]
Personnel doors	2.2	1.77	2.2	GF00000A:Surf[4]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	5

Page 1 of 6

Appendix 3 - Church Hall Renewable Energy CO_2 Offset Calculation

The outline calculations below have been made in accordance with the DCLG Strategic Guide for Low or Zero Carbon Energy Sources.

Symbol	Units	Description	Value	Calculations
C_s	kg	Carbon dioxide emissions saving target		5,437
I_{max}	kWh/m^2/year	Maximum annual irradiation at the specific location		1,100
K_E	%	Module conversion efficiency		20.4
K_P	%	Positioning factor based on system tilt and orientation		95%
K_I	%	Inverter efficiency		90%
K_L	%	System losses		5.0%
K_D	%	Packing Density		95%
U	kWh/m^2	Output per functional unit installed	I_{max} x K_E x K_P x K_I x K_L x K_D	173
R	kWpeak/m2	Module rated output		0.204
Cf_{de}	kgCO2/kWh	Carbon dioxide factor for grid-displaced electricity	0.519	
Q_e	kWh	Annual electricity output to meet carbon dioxide target	C_s/ Cf_{de}	10,476
A	m^2	Area of the PV system required	Q_e/U	61
P	kWpeak	PV system rated output	R x A	12.4

Appendix 4 – Unregulated Emissions Calculations

Unregulated emissions to account for small power load for Church Hall and Kitchen.

Small Power load for Church Hall:
Church hall area = 205m^2
Small power = 5W/m^2

Small power load = 5W/m^2 x 205m^2 = 1025W

Energy consumptions and CO_2 emissions:
Energy consumption per day = 1025W x 8hrs = 8.2kWh

Approx Hall use 200 days/year

Energy consumption per year = 200days x 8.2kWh = 1640kWh

CO_2 emissions per year = 1640kWh x 0.519kgCO_2/kWh = 851kgCO_2

Small Power load for Kitchen
Kitchen Area = 33m^2
Small power = 5W/m^2

Small power load = 5W/m^2 x 33m^2 = 165W

Energy consumptions and CO_2 emissions:
Energy consumption per day = 165W x 8hrs = 1.32kWh

Approx Kitchen use 200 days/year

Energy consumption per year = 200days x 1.32kWh = 264kWh

CO_2 emissions per year = 264kWh x 0.519kgCO_2/kWh = 137kgCO_2

Total unregulated CO_2 emissions for community hall and kitchen =
851 + 137 = 988kgCO_2

Appendix 5 – Solar PV Panel (manufacturer details)

SUNPOWER E20/333 and E20/327 SOLAR PANELS

E20 SERIES

20% EFFICIENCY

SunPower E20 panels are the highest efficiency panels on the market today, providing more power in the same amount of space

TRANSFORMERLESS INVERTER COMPATIBILITY

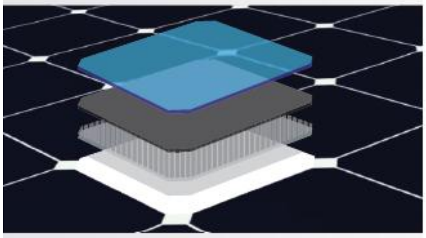
Comprehensive inverter compatibility ensures that customers can pair the highest-efficiency panels with the highest-efficiency inverters, maximizing system output

POSITIVE POWER TOLERANCE

Positive tolerance ensures customers receive the rated power or higher for every panel

RELIABLE AND ROBUST DESIGN

SunPower's unique Maxeon™ cell technology and advanced module design ensure industry-leading reliability



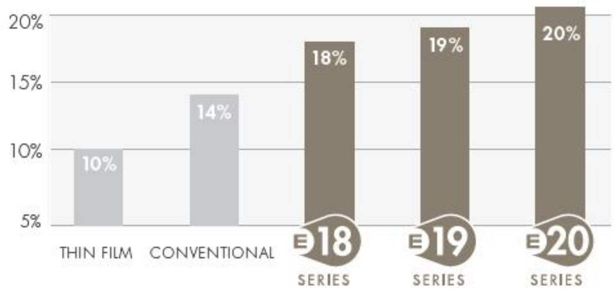
MAXEON™ CELL TECHNOLOGY

Patented all-back-contact solar cell, providing the industry's highest efficiency and reliability.

THE WORLD'S STANDARD FOR SOLAR™

SunPower™ E20 Solar Panels provide today's highest efficiency and performance. Powered by SunPower Maxeon™ cell technology, the E20 series provides panel conversion efficiencies of up to 20.4%. The E20's low voltage temperature coefficient, anti-reflective glass and exceptional low-light performance attributes provide outstanding energy delivery per peak power watt.

SUNPOWER'S HIGH EFFICIENCY ADVANTAGE



sunpowercorp.com

SUNPOWER E20/333 and E20/327 SOLAR PANELS

MODELS: SPR-333NE-WHT-D, SPR-327NE-WHT-D

ELECTRICAL DATA

Measured at Standard Test Conditions (STC): Irradiance 1000W/m², AM 1.5, and cell temperature 25° C

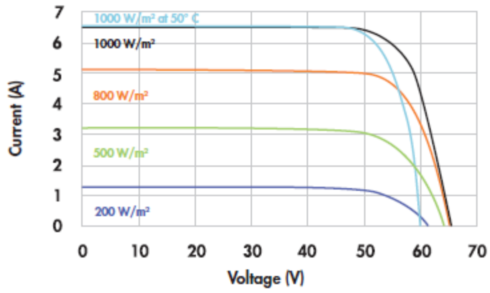
Nominal Power (+5/-0%)	P_{nom}	333 W	327 W
Cell Efficiency	η	22.9 %	22.5 %
Panel Efficiency	η	20.4 %	20.1 %
Rated Voltage	V_{mpp}	54.7 V	54.7 V
Rated Current	I_{mpp}	6.09 A	5.98 A
Open-Circuit Voltage	V_{oc}	65.3 V	64.9 V
Short-Circuit Current	I_{sc}	6.46 A	6.46 A
Maximum System Voltage	IEC	1000 V	
Temperature Coefficients	Power (P)	– 0.38 %/K	
	Voltage (V_{oc})	– 176.6 mV/K	
	Current (I_{sc})	3.5 mA /K	
NOCT		45° C +/– 2° C	
Series Fuse Rating		20 A	
Limiting Reverse Current (3 strings)	I_R	16.2 A	
Grounding		Positive grounding not required	

ELECTRICAL DATA

Measured at Nominal Operating Cell Temperature (NOCT): Irradiance 800W/m², 20° C, wind 1 m/s

Nominal Power	P_{nom}	247 W	243 W
Rated Voltage	V_{mpp}	50.4 V	50.4 V
Rated Current	I_{mpp}	4.91 A	4.82 A
Open-Circuit Voltage	V_{oc}	61.2 V	60.8 V
Short-Circuit Voltage	I_{sc}	5.22 A	5.22 A

I-V CURVE



Current/voltage characteristics with dependence on irradiance and module temperature.

TESTED OPERATING CONDITIONS

Temperature	– 40° C to +85° C
Max load	550 kg/m² (5400 Pa), front (e.g. snow) w/specified mounting configurations
	245 kg/m² (2400 Pa) front and back (e.g. wind)
Impact Resistance	Hail: 25 mm at 23 m/s

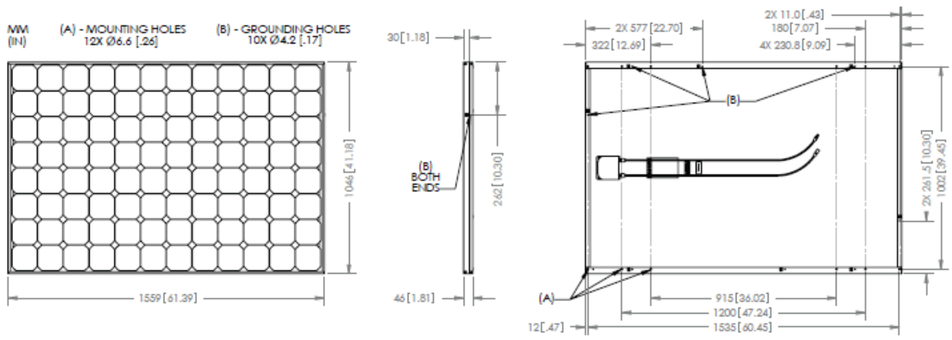
WARRANTIES AND CERTIFICATIONS

Warranties	25-year limited power warranty
	10-year limited product warranty
Certifications	IEC 61215 Ed. 2, IEC 61730 (SCII)

MECHANICAL DATA

Cells	96 SunPower Maxeon™ cells	Output Cables	1000 mm cables / Multi-Contact (MC4) connectors
Front Glass	High-transmission tempered glass with anti-reflective (AR) coating	Frame	Anodised aluminium alloy type 6063 (black)
Junction Box	IP-65 rated with 3 bypass diodes	Weight	18.6 kg
	32 x 155 x 128 mm		

DIMENSIONS



Please read safety and installation instructions before using this product, visit sunpowercorp.com for more details.

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