TREETOPS ACADEMY, GRAYS

Energy Statement
Contractors Proposals Rev P01
BSD13639-WBS-XX-XX-RP-M-0001

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This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2015, BS EN ISO 14001: 2015 and BS OHSAS 18001:2007)

Issue	Date	Prepared by	Checked by	Approved by
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Comments

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1. Executive Summary

Waterman Building Services Ltd have been instructed to produce a detailed energy analysis for the proposed new development at Treetops Academy, Thurrock, for the purposes of providing predicted energy data for the discharge of planning conditions. The proposed new development comprises of:

- a complete new school development.

Having provided a full breakdown of our assumptions and fundamental details of the input data, we have shown within the body of this report that the overall energy consumption figures are predicted as given in table 1

This report will show that the development meets the Thurrock County Council's requirement for at least a 15% energy reduction from renewable and/or low carbon technologies calculated using the compliance calculation software with respect to the approved document ADL2A 2013 of the Building Regulations. This energy reduction includes for both regulated and unregulated loads. The building is predicted to achieve the CO_2 emissions required by ADL2A 2013.

Table 1: Energy Consumption – Proposed Scheme

Model	Regulated Energy (kWh/yr)	Unregulated Energy (kWh/yr)	PV Energy generated (kWh/yr)	Total Carbon Emissions (kgCO2/yr) SAP2012	Total Carbon Emissions (kgCO2/yr) SAP10
Part L 2013 TER	229,147	56,073	-	80,695	48,417
Part L 2013 BER	208,680	56,073	48,092	80,695	37,374

As the above table demonstrates, the proposed scheme achieves energy reductions of 18%. To achieve the percentage reduction a roof mounted photovoltaic array 48,096kWhrs (300m^2) is required.

Key Energy Efficiency Initiatives

- Fabric improvements above that required to meet building regulations
- Low energy ventilation strategy with heat recovery
- Variable speed drives on pumps and fans
- Low energy lamps and good lighting controls (L.E.D lighting)
- Renewable energy – 300m^2 of roof mounted, south facing, high efficiency photovoltaic modules.

This provides an EPC asset rating of 35, achieving a B rating for the proposed new build.

2. Introduction

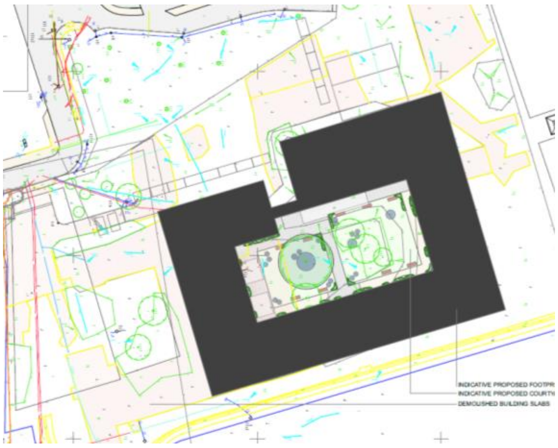
Waterman Building Services Ltd has been instructed to produce a detailed energy analysis for the proposed new development at Treetops Academy, Thurrock, for the purposes of providing predicted carbon emission data to clear planning conditions.

The focus of the design approach has been to limit building energy consumption and CO2 emissions through optimising the performance of the building envelope, together with energy efficiency measures. The main areas of energy usage that we shall be looking at are:

- Heating Loads
- Cooling Loads
- Domestic Hot Water loads.
- Lighting Loads
- Auxiliary Energy Loads (associated with pumps, fans and controls).

To conduct all the relevant simulations/calculations for the energy usage of the proposed building, Integrated Environmental Solutions Virtual Environment (IES VE) software has been used.

Figure 1: Site Plan



In conducting the analysis for the energy statement, the building geometry is modelled; the HVAC systems are defined, and the building fabric details and room templates are assigned throughout the building. Renewable technologies are then detailed to achieve the required carbon savings to meet Local Planning Policy requirements.

3. Applicable Planning Policy and Legislation

3.1 Local Planning Policy

Thurrock's Local Development Framework, Core Strategy, adopted in January 2015, suggests that to be in accordance with the East of England plan 2008, a minimum of 10% of the energy consumed should come from low and zero carbon sources. There is a further development in PMD13 which states that this figure will increase to 15% from 2015 and 20% from 2020. We are therefore looking to ensure our scheme provides at least a 15% contribution of the entire sites energy consumption to be derived from low and zero carbon sources.

3.2 Building Regulations Approved Document L2A – New Buildings Other than Dwellings

In order to meet the requirements of the Energy White Paper and the Energy Performance of Buildings Directive (EPBD), the government released the new edition of Approved Document L2A (ADL2A) (for new buildings that are not dwellings) which will apply to the school. The introduction of Part L2 2010 in October required a 25% improvement over the previous 2006 energy target (regulated emissions). The most recent Part L2 revision is the 2013 edition, implemented from April 2014, which represents a further improvement on 2010, with an aggregate of 9% carbon reductions across all building types. The air permeability standard is tightened to a target figure of $5m^3/m^2$/hour at 50 Pa (reduced from $10m^3/m^2$/hour). The calculations appended with this report have been extracted from IES Virtual Environment software suite which has been used to dynamically evaluate the building model's performance against the three-dimensional notional building and to demonstrate compliance.

3.3 Building Energy Labelling

The Energy Performance of Buildings (Certificates and Inspections) Regulations 2007 were introduced to raise awareness of energy use in buildings, but also to enable an energy comparison between buildings.

This energy label will become a quality mark which will help prospective purchasers make informed decisions on building procurement, and will also include recommendations on how a building's energy performance can be improved.

An EPC is classed as an asset rating, which is required for all buildings when they are constructed, sold or rented out. An EPC will provide a rating of the efficiency of the building fabric and fixed building services, which will be an assessment based on the calculated performance for a defined pattern of use.

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4. Modelling Input Data

4.1 drawings

The modelling has been based on drawings provided by Bond Bryan Architects, namely: -

Table 2: Drawings used for modelling

Number	Description	Revision
NZBTS-BBA-ZZ-GF-DR-A-2201	Ground Floor Plan	P01
NZBTS-BBA-ZZ-ZZ-DR-M2-A-3201	Elevations	P01

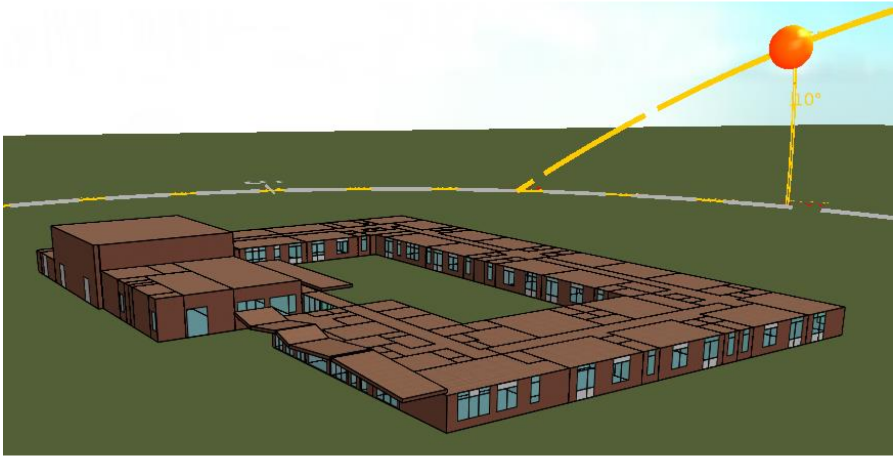
4.2 Building Fabric

The building fabric has been assigned throughout based on the following u-values below.

Table 3: U-values for constructions

Construction	Description	EN-ISO U-value (W/m^2K)
Walls	Insulated cavity wall	0.16
Floor	Ground floor	0.22
Roof	Warm Roof	0.14
Glazing	g-value = 0.35	1.7
Doors	Personnel Doors	2.20

Figure 2: IES Thermal Model



Source: Waterman Building Services

4.3 Air Permeability

The air permeability has been assumed to achieve 3.0m^3/hr/m^2@50Pa, which is the figure assigned to the Notional Building for Approved Document Part L2A 2013.

4.4 System Parameters

The input parameters for the carbon emissions are defined by the National Calculation Method (NCM). This provides a series of templates that define the use of the building, which include occupancy and plant, with editable parameters for lighting and system inputs.

The system parameters are defined within this section of the report.

4.4.1 Heating

The core base load for the site is based on electric heating throughout the site with electric panel radiators and direct electric point of use for hot water.

Table 4: Heating System Comparison

System and Type	Generator	Actual
Main System	Fuel	Electricity
Electric heating	Heat Pump	No
	Seasonal Efficiency	1
	Delivery Efficiency	0.8000
	SCop kW/kW	0.8000
DHW System	Fuel	Electricity
Electric heating	Seasonal Efficiency	1

4.4.2 Cooling/Ventilation

The proposed building has limited areas of active cooling, to include:

- ICT Suites
- Server Room

These are cooled via direct expansion (DX) units, with high efficiencies (SEER = 4) (COP =4)

Ventilation is via natural ventilation openings or mechanical ventilation with heat recovery. Details of energy use are given under ‘Auxiliary Energy’.

4.4.3 Hot Water – Point of use

Table 5: Hot Water Parameters

Hot Water Generator	Houses
DHW delivery efficiency	1
Storage capacity (litres)	80

4.4.4 Air Supply

Table 6: System Air Supply

Air Supply	
Outside air supply condition	External Air

The model assumes that all air used to ventilate the internal spaces is taken from external air. That is to say the energy used to condition the air is taken from the temperature within the weather file, where present, applied prior to energy being expended to heat or cool it to room temperature.

4.4.5 Auxiliary Energy

The energy used by fans and pumps is known as the 'auxiliary energy' within the SBEM and DSM software. The Auxiliary Energy Values (AEV) and Specific Fan Powers (SFP) are shown in the table below. The values used for these are based on manufacturer's details and compared to the Non-Domestic Building Services Compliance Guide: 2013 Edition.

Table 7: Auxiliary Energy Comparison

System	SFP (W/(l/s))	Heat Recovery Efficiency (%)
Kitchen AHU	1.6	-
Classroom's MVHR	1.6	0.9
WC's MVHR	1.6	0.9
Admin WC	0.3	-

4.4.6 Efficient Lamps with Automatic Control

Low energy lighting has become an essential feature of building design in recent years. New concepts of lamp and ballast design have led to higher efficiency fluorescent T5 and LED lamps and higher frequency control gear becoming standard in most new installations.

Changes to standards such as Part L of the Building Regulations have pushed the standards for efficiency in lighting installations and promote the use of lighting controls systems.

Lighting controls can comprise simple presence detection which, when combined with daylight control can switch luminaires on/off automatically or regulate the lighting levels to suit the outside conditions. These systems should be used in conjunction with each other for the most energy efficient installation. Daylight control can only be utilised in perimeter zones where daylight is received, and this will depend upon the internal building layout. The scheme as currently designed will incorporate daylight linking to the perimeter zones of the building, where there are larger areas of windows.

In terms of our design goals for this development we are looking to achieve the following benchmarks: -

Significant energy performance targets within the electrical design:

- Toilets: 99 luminaire lumens per circuit Watt and a light output ratio of 1.0
- Classrooms: 133 luminaire lumens per circuit Watt and Light Output Ratio of 1.00
- General areas: 133 luminaire lumens per circuit Watt and Light Output Ratio of 1.00
- Plant / store room: 100 luminaire lumens per circuit Watt and Light Output Ratio of 1.00

Day lighting sensors will control perimeter zones within the offices, classrooms and foyer luminaries, whilst presence detection will be incorporated into the corridors and WC’s.

Design development will be required post planning with the aspiration to increase lighting efficiency further.

4.5 Avoidance of Summer Overheating

Treetops school has been reviewed using Criterion 3 – limiting solar gains calculations that form part of the compliance calculation package. Glazing areas and properties have been reviewed to ensure that the limiting criteria of Part L2A are not exceeded.

The results files show that the current building orientation and glazing proportions are maintaining solar gain within the required limits. The table over the next page shows the Criterion 3 output from the BRUKL documentation.

Table 8: Criterion 3

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains		
Zone	**Solar gain limit exceeded? (%)**	**Internal blinds used?**
Heads Office - ADM11	NO (-51.4%)	NO
Deputy Office - ADM13	NO (-73.9%)	NO
Deputy Office - ADM13	NO (-73.9%)	NO
ICT / FM - OFF15	N/A	N/A
Parents Room	NO (-100%)	NO
General Office - ADM05	NO (-64.1%)	NO
Sick Room - ADM04	NO (-50.2%)	NO
VB Office - ADM13	N/A	N/A
Secondary Classroon VB - CLA65	NO (-56.5%)	NO
Calm. Room SEN38 (SP)	NO (-53%)	NO
Secondary Classroon VB - CLA65	NO (-56.9%)	NO
Secondary Classroon - PRI70	NO (-56.4%)	NO
Calm. Room SEN38 (SP)	NO (-54%)	NO
Calm. Room SEN38 (SP)	NO (-53.6%)	NO
Secondary Classroon - PRI70	NO (-64.3%)	NO
ICT Hubs - PLA10	N/A	N/A
Secondary Library (ambulant) - LIB60	NO (-52.4%)	NO
Secondary ICT - CLA70	NO (-32.7%)	NO
Calm. Room SEN38 (SP)	NO (-55.8%)	NO
Secondary Classroon - PRI70	NO (-58.2%)	NO
Secondary Classroon - PRI70	NO (-58.2%)	NO
Calm. Room SEN38 (SP)	NO (-55.7%)	NO
Calm. Room SEN38 (SP)	NO (-56.2%)	NO
Secondary Classroom - PRI70	NO (-57.9%)	NO
Secondary Classroom - PR170	NO (-65.9%)	NO
Calm. Room SEN38 (SP)	NO (-62.8%)	NO
Life Skills Room (ambulant) - RES60	NO (-31.4%)	NO
Secondary Art Room - DAT55	NO (-46.1%)	NO
Secondary Food Room - DAT85	NO (-48.2%)	NO
Secondary DT Workshop - DAT95	NO (-48.2%)	NO
Secondary Clarroom VB - PR170	NO (-58.1%)	NO
Calm Room - SEN38	NO (-57.5%)	NO
Satellite Science Prep Room - STT05	N/A	N/A
Secondary Science Studio - SCI50	NO (-66.4%)	NO
Secondary Classroon VB - PRI70	NO (-66.3%)	NO
Calm. Room SEN38 (SP)	NO (-72.3%)	NO
Calm. Room SEN38 (SP)	NO (-72.4%)	NO
Secondary Classroom - PRI70	NO (-72.6%)	NO
Music Classroom - PER50	NO (-73.2%)	NO
Secondary Classroon VB - CLA65	NO (-54.4%)	NO
Calm. Room SEN38 (SP)	NO (-58.8%)	NO
Calm. Room SEN38 (SP)	NO (-59.3%)	NO
Reception Classroom - PRI60	NO (-58.9%)	NO
Soft Play/ Sensory - RES60	N/A	N/A

Source: Waterman Building Services

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5. Renewable Technologies

The Treetops development has first looked to reduce energy consumption through the efficient use of the building fabric and efficient lighting, heating/cooling and ventilation plant.

This section of the report reviews the available technologies and draws conclusions on what will be the most effective and efficient solution for the Treetops Academy Development.

5.1 Combined Heat & Power and Heating Networks

5.1.1 Combined Heat & Power (CHP)

The economic and environmental benefits of CHP schemes are determined from four fundamental parameters:

- Building load profiles;
- Fuel and electricity tariffs;
- CHP plant rating, efficiency and heat to power ratio; and
- CHP plant running hours.

Although these are shown above to be distinct items, in reality they are all interlinked. For any successful application of CHP, all the parameters must be considered together.

Building Load Profiles

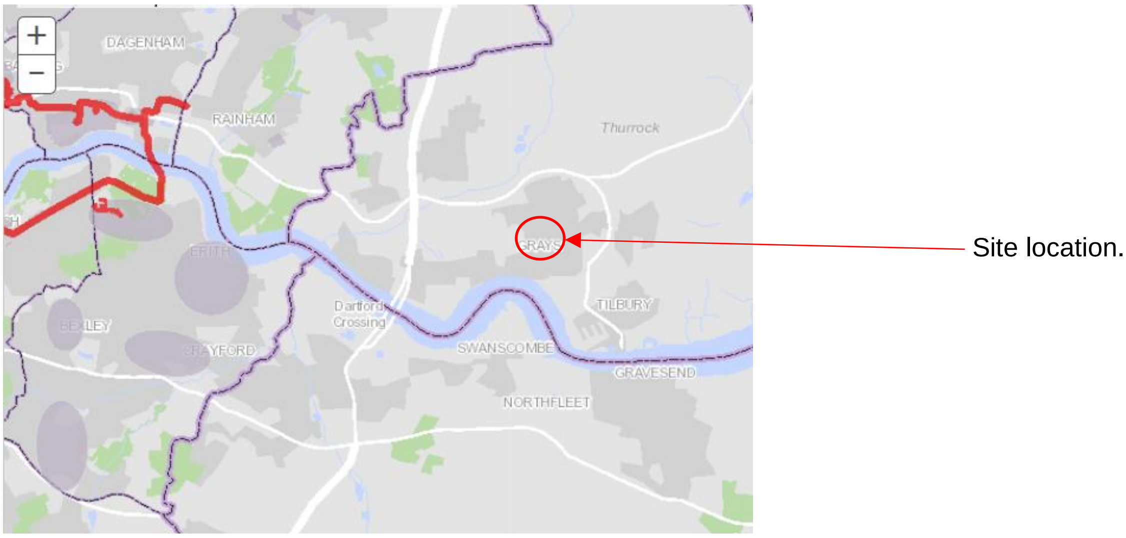
Due to the nature of the building, the base load is relatively small for hot water.

Due to this, there is insufficient base load to ensure effective and consistent running of a CHP engine for this scheme.

5.1.2 Heating Networks

The local area is not highlighted as having potential for decentralised energy, and the potential district heating networks are not shown near to the site to make them feasible at this time. Please see figure 4 over the next page for information.

Figure 3: District Heating Map



Source: *www.londonheatmap.org.uk/Mapping/*

Due to the reasons stated, the proposed development aims to seek carbon emission reductions through the use of onsite renewable energy options.

5.2 Ground Source Heating/Cooling

There are essentially two forms of ground source Heating/Cooling Systems: open loop systems and closed loop systems.

Open loop systems involve drilling wells to tap into the local aquifer and abstracting the ground water for use in absorbing a cooling system's rejected heat or extracting a heating systems thermal energy.

Closed loop systems involve installing loops of pipework in the ground and circulating water through the pipes. Closed loop systems can be horizontal or vertical loops. Typically, horizontal closed loops are formed by several pipe coils buried at between 1.5 to 3m and vertical closed loops are formed by a pair of pipes that run vertically in the ground to a depth of 45 to 90m and are joined with a U shape connector at the bottom of the hole. In both cases, the heat rejection/adsorption takes place as heat exchange between the pipes and the surrounding ground.

Typically, high capital cost is associated with both open loop systems and closed vertical loop systems due to the complications associated to drilling of deep boreholes (around 100m or even more for open loops).

5.2.1 Open Loop System

The groundwater contained in the Thames Valley Chalk aquifer beneath London has been used over many years. This aquifer is under a layer of London clay several meters underground and as such its temperature is shielded from external conditions, which offers a stable all year-round supply of cool water (~12°C in London at 75m deep). A reverse cycle heat pump could make use of this underground constant temperature to cool/heat at higher Energy Efficiency Ratios (EERs) all year around. The seasonal EER of a typical air-cooled chiller would be 4 to 4.5. Groundwater heat rejection improves this to a seasonal EER of 6 to 7.

In an open circuit cooling system, ground water is abstracted via boreholes and passed through a heat exchanger then discharged via a re-charge well. The heat exchanger cools/heats either a treated water circuit or a water-cooled chiller, which in turn cools or heats the building. There is uncertainty and therefore risk involved in this system as the actual capacity of the system depends on the abstraction flow rate which can only be established after drilling the well.

The costs of the investigation and installation of the abstraction well together with the cost of installation of the pump and associated head works must be considered as part of the design life of the overall heating/cooling system. Typically, capital cost for one pair of boreholes in the City of London can exceed £800,000. The anticipated procedure for progressing an open circuit cooling system would be as follows:

Water Features Survey

This includes obtaining details of existing wells and a letter report from the British Geological Survey (BGS) on likely yields. This will give an indication of the number of wells in the vicinity of the site and the range of yields obtained within them.

Consent to Investigate a Groundwater Source

If the decision is made to proceed to this stage, then a 'Consent to Investigate' will need to be obtained from the Environment Agency. There is a risk that this consent may not be granted. The borehole could then be drilled which would typically be to around 100m to 150m deep. It is at this stage that much of capital expenditure is expended. Once drilled, a pump test would need to be carried out which would give an indication of the likely yield of the well and also the impact (if any) of pumping on any nearby wells (water levels would need to be monitored in these wells).

There is some potential for the yield to be improved by acidisation of the well. This process seeks to open up the fissures in the chalk and allow greater movement of groundwater into the well. However, there is no guarantee that this will significantly improve the yield.

Groundwater Abstraction License

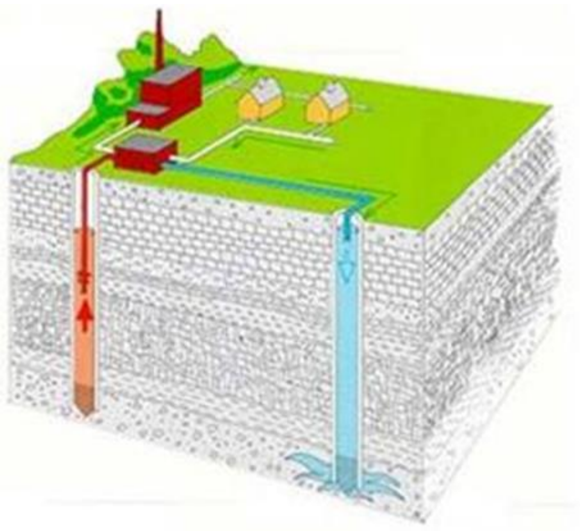
Should the pump test be favourable and it's decided to proceed with development and use of the well, then an application for an Abstraction License will need to be made to the Environment Agency. The application will need to include details of the proposed use of the water, abstraction rates, number of boreholes etc. Processing of such an application can take up to 6 months, and there is further risk associated with this.

Discharge Consent

A Discharge Consent will be required for the abstracted water that is discharged during the pump testing and for the heating/cooling system once it is up and running.

Well Headwork's

1) The well will require the installation of a pump and appropriate head works and pipework to move the water to the heating/cooling system.



Proposed approach for Treetops Academy Development

2) The low carbon approach to energy for the proposed Treetops development has been to ensure that cooling is kept to a minimum within building. The system of open loop heat pumps is therefore not financially viable for a heating only system. The building has also been specifically designed to reduce the heat losses from the fabric and as such this again impacts negatively on the financial viability of an open loop design. ***It is therefore proposed to not pursue the open water loop system further.***

5.2.2 Closed loop system

A closed loop system circulates a fluid, usually water, through the buried loop field pipes. In a closed loop system there is no direct interaction between the fluid and the earth; only heat transfer across the pipe. Horizontal closed loops require a high site footprint to net internal ratio which is not available at the Treetops Academy development and for this reason only vertical loops would be viable.
The heating/cooling available from the vertical loops required is a function of the ground formation thermal conductivity, deep earth temperature, and also depends on the balance between the amount of heat rejected to and absorbed from the ground during the course of the year. As a guide, the surrounding soil temperature is the average annual temperature for the region. For Essex, this is approximately 14°C.

Figure 4: Vertical Closed Loop Ground Source Heating/Cooling System

A vertical closed loop field is composed of pipes that run vertically in the ground. A hole is bored in the ground, typically, 45 to 100m deep. Pipe pairs are installed in the hole and are joined with a U-shaped cross connector at the bottom of the hole. The borehole is commonly filled with a bentonite grout surrounding the pipe to provide a good thermal connection to the surrounding soil or rock. Vertical loop fields are typically used when there is a limited square meterage of land available. Bore holes are spaced 5–6 m apart and are generally 15 m deep per kWth of capacity.

The incorporation of vertical closed loops becomes more viable when combined with structural piles and when there is a balanced heating and cooling load for the building. Vertical and horizontal loops tend to fail in performance when there is an imbalance across the year between when heat is pumped into the earth during the cooling season and when heat is abstracted from the earth during the winter. As the Treetops project is to have a very small amount of cooling, it is believed that there will be insufficient heat within the ground to service the heating load during the winter months. This is a large risk that cannot be overcome without installing large cooling loads. ***It is not intended therefore, to pursue this option further.***

5.3 Wind Power

Wind power is the conversion of wind energy into electrical power. Common contemporary wind power is generated in the form of electricity by converting the rotation of turbine blades into electrical current by means of an electrical generator. Wind energy is renewable, widely distributed, clean, and reduces toxic atmospheric and greenhouse gas emissions if used to replace fossil-fuel-derived electricity. Horizontal or vertical axis wind turbines could be used to assist in the power requirements for a building. Not as a single solution, but part of a renewable energy strategy.

Figure 5: Small Scale Horizontal Axis Building Mounted Turbine

It is essential that turbines should be sited away from obstructions, with a clear exposure or fetch for the prevailing wind. The only feasible location for wind turbines on a building such as Treetops would be at roof level. However, it is appreciated that the height of the building is critical to the location of the site and its surroundings and as such to install equipment that will increase the height significantly could be deemed unacceptable aesthetically. Also, designing the building to allow for the additional loading, maintenance requirements and access issues would make it extremely difficult to get the building to work.

Further, the noise generated by the wind turbine could also become an issue as most applicable wind turbines emit 60 to 65 dBA of noise. Roof mounted wind turbines, even if building integrated, will also be an issue as they transmit vibrations through to the building causing discomfort for the occupants.

Reviewing the data provided by the RenSmart wind resource data base we see below that unless the turbine is mounted at 45m above ground level there is insufficient wind resource to achieve the minimum recommended average wind speed of 6m/s. As the average speed is just at 6.3m/s at 45 meters, the adjacent structures or the surrounding urban landscape could easily affect this value and make the turbine even less effective in providing any wind resource. ***It is therefore concluded that wind turbines will not be considered further for this project.***

Figure 6: Average Wind Speed for Treetops Academy Site

Location

- Latitude: 51.49139383175606
- Longitude: 0.3565519050764167
- Height above sea level: 86 m

Wind Speeds

estimates from NOABL data

- At 10m above ground level 5 m/s
- At 25m above ground level 5.8 m/s
- At 45m above ground level 6.3 m/s

Source: RenSmart

5.4 Photovoltaics Panels

Solar energy a renewable resource that is inexhaustible and is locally available. It is a clean energy source that allows for local energy independence. The sun's power flow reaching the earth is typically about 1,000 W/m^2, although availability varies with location, cloud cover and time of year. Capturing solar energy typically requires equipment with a relatively high initial capital cost. However, over the lifetime of the solar equipment, these systems can prove to be cost-competitive, as compared to conventional energy technologies. The key to successful solar energy installation is to use quality components that have long lifetimes and require minimal maintenance.

Electricity can be produced from sunlight through the use of photovoltaics (PV), which can be applied, in either a centralized or decentralized fashion. "Photo" refers to light and "voltaic" to voltage. The term describes a solid-state electronic cell that produces direct current electrical energy from the radiant energy of the sun. Solar cells are made of semi-conducting material, most commonly silicon, coated with special additives. A typical silicon PV cell is composed of a thin wafer consisting of an

Ultra-thin layer of phosphorus-doped (N-type) silicon on top of a thicker layer of boron-doped (P-type) silicon. An electrical field is created near the top surface of the cell where these two materials are in contact, called the P-N junction. When sunlight strikes the surface of a PV cell, this electrical field provides momentum and direction to light-stimulated electrons, resulting in a flow of current when the solar cell is connected to an electrical load.

Figure 7: Photovoltaic Array

Proposed approach for Treetops Development

Photovoltaic Panels (PV) have been considered and due to suitability of installation and roof space available, this is considered the best option for this site. The proposed design is aiming to achieve 300 m^2 of PV panels expected to generate ~ 48,096 kWhrs/yr (panels with maximum efficiency of 19%) on the roof at 30° pitch, south facing.

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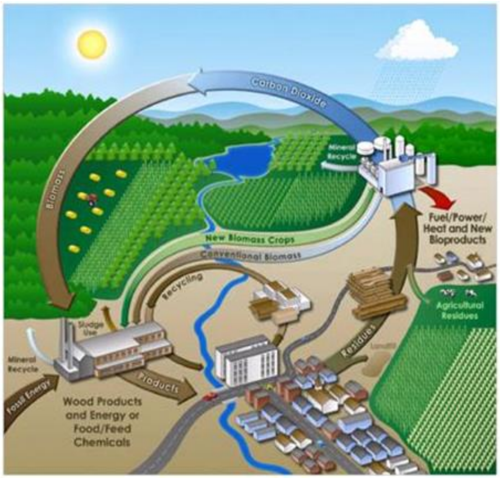
5.5 Biomass

Biomass is the solar energy stored in chemical form in plant and animal materials. It is among the most precious and versatile resource on earth as it provides not only food but also energy, building materials, paper, fabrics, medicines and chemicals. Biomass has been used for energy purposes ever since man discovered fire. Today, biomass fuels can be utilised for tasks ranging from heating your house to fuelling a car and running a computer.

Carbon dioxide from the atmosphere and water from the earth are combined in the photosynthetic process to produce carbohydrates (sugars) that form the building blocks of biomass. The solar energy that drives photosynthesis is stored in the chemical bonds of the structural components of biomass. If we burn biomass efficiently (extract the energy stored in the chemical bonds) oxygen from the atmosphere combines with the carbon in plants to produce carbon dioxide and water. The process is cyclic because the carbon dioxide is then available to produce new biomass.

Figure 8: The Carbon Cycle



Today, wood is still our largest biomass energy resource. But many other sources of biomass can now be used, including plants, residues from agriculture or forestry, and the organic component of municipal and industrial wastes. Even the fumes from landfills can be used as a biomass energy source.

The use of biomass energy has the potential to greatly reduce our greenhouse gas emissions. Biomass generates about the same amount of carbon dioxide as fossil fuels, but every time a new plant grows, carbon dioxide is removed from the atmosphere. The net emission of carbon dioxide will be zero as long as plants continue to be replenished for biomass energy purposes.

Biomass is CO_2 neutral since the CO_2 released during the combustion of the wood is only that taken during the growth of the tree i.e. the CO_2 is simply recycled. However, energy used in the harvesting and transportation of wood fuel can result in CO_2 emissions. Wood also has low sulphur and nitrogen content.

Figure 9: Biomass Wood Pellets

Wood fuel is primarily available for use in the form of “wood pellets”.

Wood Pellet Facts:

- Wood pellets cost 3.9p/kWh (min)
- Wood pellets are generally denser, with larger energy content than other wood fuels
- Wood pellets are easy to transport due to shape and form.
- Wood pellets have low moisture content (8% EU standard) which means no special modifications are required to storage containers.
- Screws feeding pellets to the boiler are low-cost and reliable as pellets flow easily and do not stick together.
- Wood pellets burn very efficiently and residues remain in the burn chamber therefore cyclone extraction is not required.
- Flues must be cleaned once a year.
- Pellets produce less than 1% by volume of ash.
- Pellets have an almost total combustion; the ash produced is fine dust and is a good source of free fertilizer.

A significant constraint is with regards to the delivery of the fuel supply. Wood pellet fuel is often delivered using tankers which blow the pellets through a 100mm diameter hose to the storage silo up to 30 metres away. This uses a specially adapted delivery lorry which is complete with a blower and can deliver the wood pellets direct into a storage hopper. However, it should be noted that the tipper is still required to be partially elevated in order for the pellets to enter the blower system. This option is only suitable with wood pellets because of their shape and form. There is no area within 30m of the boiler room that a delivery lorry can be safely parked and provide suitable storage for the biomass volumes required.

Availability of Wood Fuel

The nominated maintenance contractor will be required to ensure that a suitable delivery strategy is in place with a fuel supplier to ensure sufficient storage is maintained throughout the year. The maintenance contractor will also be required to ensure that the wood fuel storage is kept as dry as possible as the drier the fuel the better the combustion. There are various methods of purchasing the wood fuel from payments per delivery/tonnage to energy services contracts (ESCO's).

Flue and Planning Issues

Biomass boilers require a separate flue from that of the gas fired boilers. This is due to the differences in the flue gas velocities and particulate matter found within Biomass combustion products.

The type of wood fuel used may also dictate the regulations for which the flue design will be required to meet.

The overall flue design would be regulated under the Local Air Pollution Prevention and Control (LAPPC) as detailed within PG1/12.

It should be noted that on occasion with wood fuel biomass boilers there may be an instance where white smoke is visible. This is allowable under the Clean-Air Act Legislation. This smoke can occur during the start-up period and is caused by the moisture content within the wood fuel. Typically, wood pellets have lower moisture content than many other wood fuels.

As it is currently believed that the scheme can achieve the carbon savings without the use of biomass it is not proposed to take this option forward. ***Therefore, biomass boilers are not proposed for this development.***

6. Carbon Emissions

The energy consumption from the development has been assessed using IES Virtual Environment software using the dynamic simulation method. A 15% energy reduction from the estimated site-wide energy consumption is required in accordance with Thurrock Local Development Framework, Core Strategy, adopted in January 2015.

The proposed systems include using electric panel heaters with roof-mounted photovoltaic arrays. The required array size 300m^2 ~ 48,096kWhrs/yr is proposed to meet Thurrock's Core Strategy.

6.1 Results

Table 9: Energy Consumption and Carbon Emissions

Model	Regulated Energy (kWh/yr)	Unregulated Energy (kWh/yr)	PV Energy generated (kWh/yr)	Total Carbon Emissions (kgCO2/yr) SAP2012	Total Carbon Emissions (kgCO2/yr) SAP10
Part L 2013 TER	229,147	56,073	-	80,695	48,417
Part L 2013 BER	208,680	56,073	48,092	80,695	37,374

The savings seen above show that the proposed development achieves **18%** of the consumed energy by generation from the PV, thus complying with the planning condition.

Table 10 below shows a comparison between the Annex 2H benchmarks and our predicted energy usage.

Table 10: Annex 2H – Benchmark Comparison

System	Range	As Designed
Cooling (ICT)	– kWh/m^2/year	0.12 kW/hr/m^2/year
Internal lighting	Up to 13 kWh/m^2/year	5.52 kW/hr/m^2/year
Space heating	45 – 55 kWh/m^2/year	17.8 kW/hr/m^2/year
Domestic hot water	3 – 10 kWh/m^2/year	36.15 kW/hr/m^2/year
Fans and pumps	6 – 15 kWh/m^2/year	4.28 kW/hr/m^2/year

Source: Waterman Building Services

7. Building Regulations

7.1 BRUKL

The proposed building with photovoltaics array is seen to meet the requirements of Part L 2013.

Figure 10: Part L 2013 Compliance

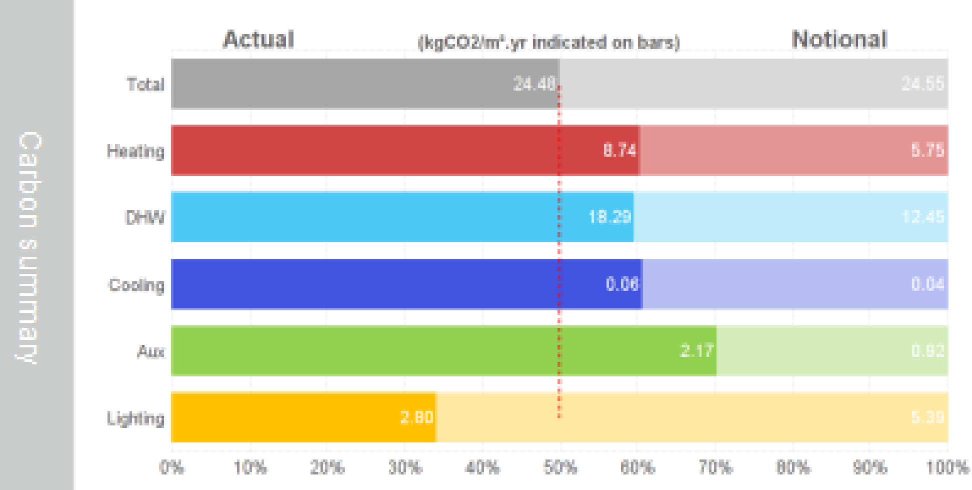


Table 11: Part L 2013 Compliance

Carbon summary

$kgCO_2/m^2.yr$	Actual	Notional
Heating	8.74	5.75
DHW	18.29	12.45
Cooling	0.06	0.04
Aux	2.17	0.92
Lighting	2.80	5.39
Renewables	(-7.58)	(0.00)
Total	**24.48**	**24.55**

Results represent total CO_2 output. BER rating includes applicable adjustment factors.

Source: Building services

Figure 11: Draft BRUKL Document showing compliance with Building Regulations

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Treetops Academy

As designed

Date: Tue Oct 13 12:06:05 2020

Administrative information

Building Details

Address: Grays, RM16 2WU

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.12

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.12

BRUKL compliance check version: v5.6.a.1

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	24.5
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	24.5
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	24.5
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 fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the 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	0.16	0.16	CR00000A:Surf[5]
Floor	0.25	0.22	0.22	CR00000A:Surf[0]
Roof	0.25	0.14	0.14	CR00000A:Surf[1]
Windows***, roof windows, and rooflights	2.2	1.7	1.7	CR00000A:Surf[2]
Personnel doors	2.2	2.2	2.2	CR000014:Surf[9]
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.

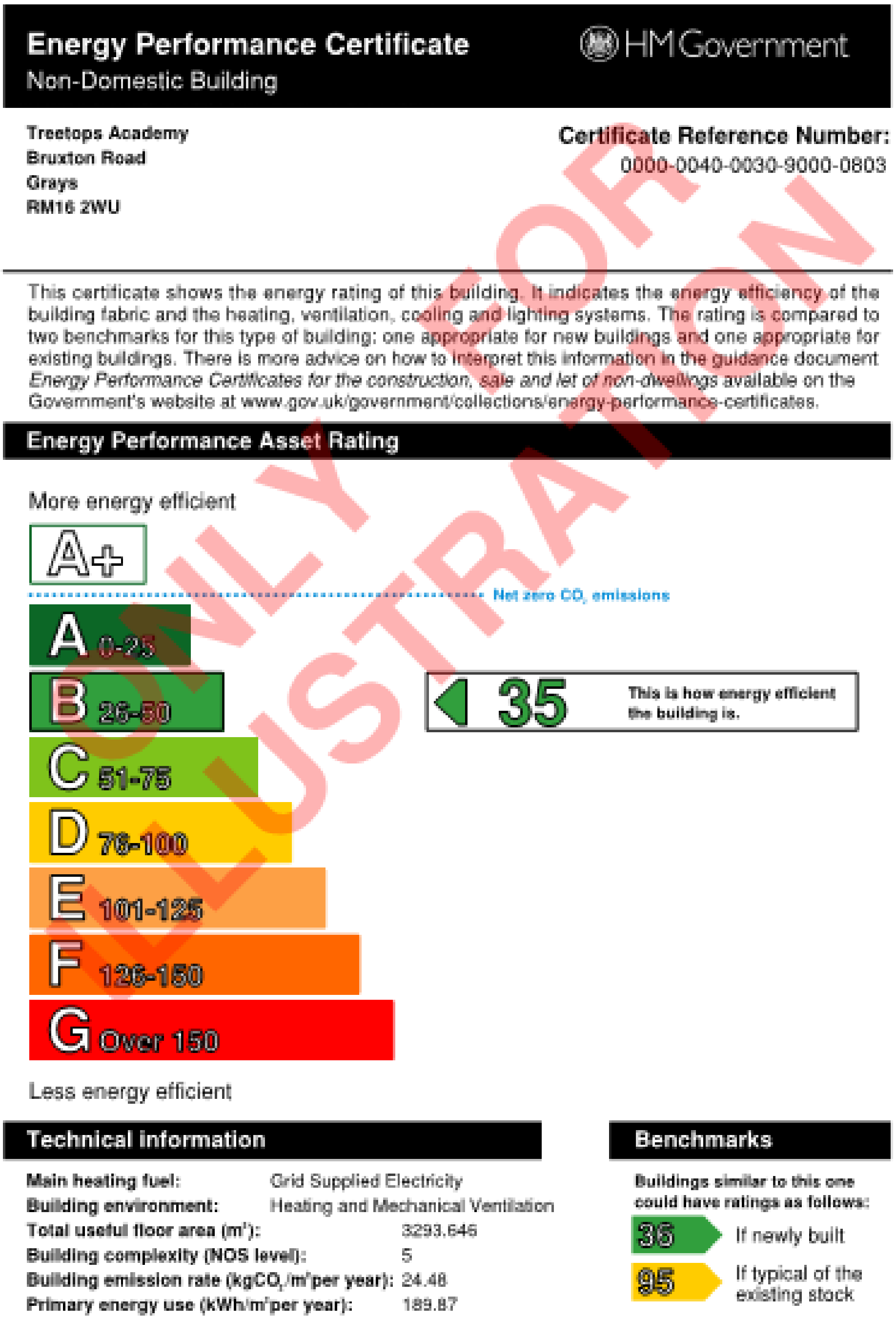
Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	3

Source: Waterman Building Services

7.2 EPC

The proposed development is seen to achieve an EPC asset rating of B (35).

Figure 12: Draft EPC rating



Energy Performance Certificate
Non-Domestic Building

HM Government

Treetops Academy
Bruxton Road
Grays
RM16 2WU

Certificate Reference Number:
0000-0040-0030-9000-0803

This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one appropriate for new buildings and one appropriate for existing buildings. There is more advice on how to interpret this information in the guidance document *Energy Performance Certificates for the construction, sale and let of non-dwellings* available on the Government's website at www.gov.uk/government/collections/energy-performance-certificates.

Energy Performance Asset Rating

More energy efficient

A+

Net zero CO_2 emissions

A 0-25

B 26-50

C 51-75

D 76-100

E 101-125

F 126-150

G Over 150

Less energy efficient

35 This is how energy efficient the building is.

Technical information

Main heating fuel:	Grid Supplied Electricity
Building environment:	Heating and Mechanical Ventilation
Total useful floor area (m^2):	3293.646
Building complexity (NOS level):	5
Building emission rate ($kgCO_2/m^2$ per year):	24.48
Primary energy use (kWh/m^2 per year):	189.87

Benchmarks

Buildings similar to this one could have ratings as follows:

35 If newly built

95 If typical of the existing stock

Source: Waterman Building Services

8. Conclusion

Having provided a full breakdown of our assumptions and fundamental details of the input data we have shown within the body of this report that the energy usage figures are predicted as shown in section 4.

The building requires renewable energy generation in order to achieve the required on-site energy generations targets, in accordance with Thurrock Local Development Framework, Core Strategy, adopted January 2015.

This can be achieved with photovoltaic array size of 300m^2 ~48,096kWhrs/yr for the development with conventional direct electric radiators and direct electric hot water. These are considered the most suitable combination of systems for this project owing choice for this scheme owing to available areas for renewables. A full breakdown of renewable options has been given in Section 5.

The proposed building is seen to provide sufficient energy savings to offset 18% of the predicted regulated and unregulated usage from the site.

The building as proposed complies with Approved Document L2A of Building Regulations 2013.

waterman

UK and Ireland Office Locations