EVORA EDGE

BUILDING SIMULATION REPORT FOR GUILDFORD BOROUGH COUNCIL

A Mixed-Use Scheme – large office building

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1. INTRODUCTION

In 2017 Guildford Borough Council (GBC) commissioned EVORA EDGE to determine what the additional cost would be for a developer to reduce carbon dioxide (CO^2) emissions if the target detailed in Action 4 of its Sustainable Design and Construction Supplementary Planning Document (SPD) was strengthened from 10% to 15% or 20%. Following this study GBC has set this target at 20% with the exception of in-town retail. GBC has now asked EVORA EDGE to extend its study to include increased targets of 25%, 30% and 35%.

GBC is not alone in its ambitions to reduce CO^2 emissions. As of June 2019, the UK Government amended the Climate Change Act[1] committing the UK to zero carbon emissions by 2050 while the London Plan's Policy 5.2 already mandates zero carbon construction for residential properties.

The purpose of this extension is to provide an evidence base to GBC to identify typical costs of construction for new build properties that comply with the requirements of building regulations Part L *Conservation of fuel and power*, together with the additional costs to developer for meeting the proposed revised targets now under consideration by GBC.

The purpose of EVORA EDGE's study is therefore to answer three questions:

1. Is it technically feasible to construct buildings that go beyond the requirements of a Target Emission Rate (TER) by between 25% and 35%?
2. What are the indicative cost implications of this type of enhanced policy for developers?
3. What will be the impact of mandating the BRE HQM on residential developments? NB this question is addressed in the main report and the sub-report on residential properties.

[1] Climate Change Act 2008 (2050 Target Amendment) Order 2019

This report summarises the findings of up to seven simulations on two building energy models of a large mechanically ventilated office building covered by Part L2A. These models are based on an actual building that has been adapted for the purpose of this study.

The simulations study the performance of two different but common building services solutions for mechanically ventilated office premises, which we refer to throughout this report as System 1 and System 2.

The base building (the starting point) of the 2017 study was a construction that would comply with Part L2A - this is our fabric first approach. It also allowed us to establish a baseline cost. In all building energy models occupancy and some services remained the same but the heating, ventilation, air conditioning (HVAC) and domestic hot water strategy in each building varies in order to pass the target rates. This includes the use of Low and Zero Carbon (LZC) technologies which are incorporated to augment or replace conventional non-LZC technologies.

1.1. The simulations

The modelled simulations calculate a building's Built Emission Rate (BER) as a result of the energy it is predicted to consume. Templates around occupancy and occupational parameters, such as hours of operation and temperature set points, are provided in a National Calculation Method (NCM) which was developed by the Building Research Establishment (BRE) for government. To comply with Part L2A, a Target Emission Rate (TER) is set and the BER must achieve or better (≤) this target. The TER is based on the performance of the Notional Building which is also defined in the NCM.

Part L2A has five criterion and a requirement for any developer to analyse and take into account the technical, environmental and economic feasibility of using high-efficiency alternative systems in construction, if available[2]. For a building to pass the exacting requirements of Part L2A it must be designed and

[2] These systems are to include decentralised energy supply systems based on energy from renewable sources, cogeneration, district or block heating / cooling, particularly where it is based entirely or partially on energy from renewable sources, and heat pumps.

constructed to a standard that meets or betters the TER of a Notional Building (BER ≤ TER). A building that is constructed to the limiting parameters of Part L2A will fail Criterion 1, which is the Criterion that requires the BER ≤ TER.

There are two key differences between this and the 2017 study. The first is the target rates of 25%, 30% and 35%, and the second is that we have increased (made more challenging) construction thermal values associated with building fabric and fenestration for some of the simulations. This is because it was not possible to meet all target rates through the use of only Part L compliant fabric and fenestration.

The models we used were the ones created in 2017. However, they were updated to the latest version of IES which accounts for modifications and improvements to the software and the NCM. This resulted in a variation of an average of 2.4% between the 2019 simulations and the 2017 simulations which were created in IES VE 2016. This variation was validated by IES as being “typical” with explanations given.

We also updated costs using SPONS 2020 to revise our baseline costs as explained further in Section 4.7.

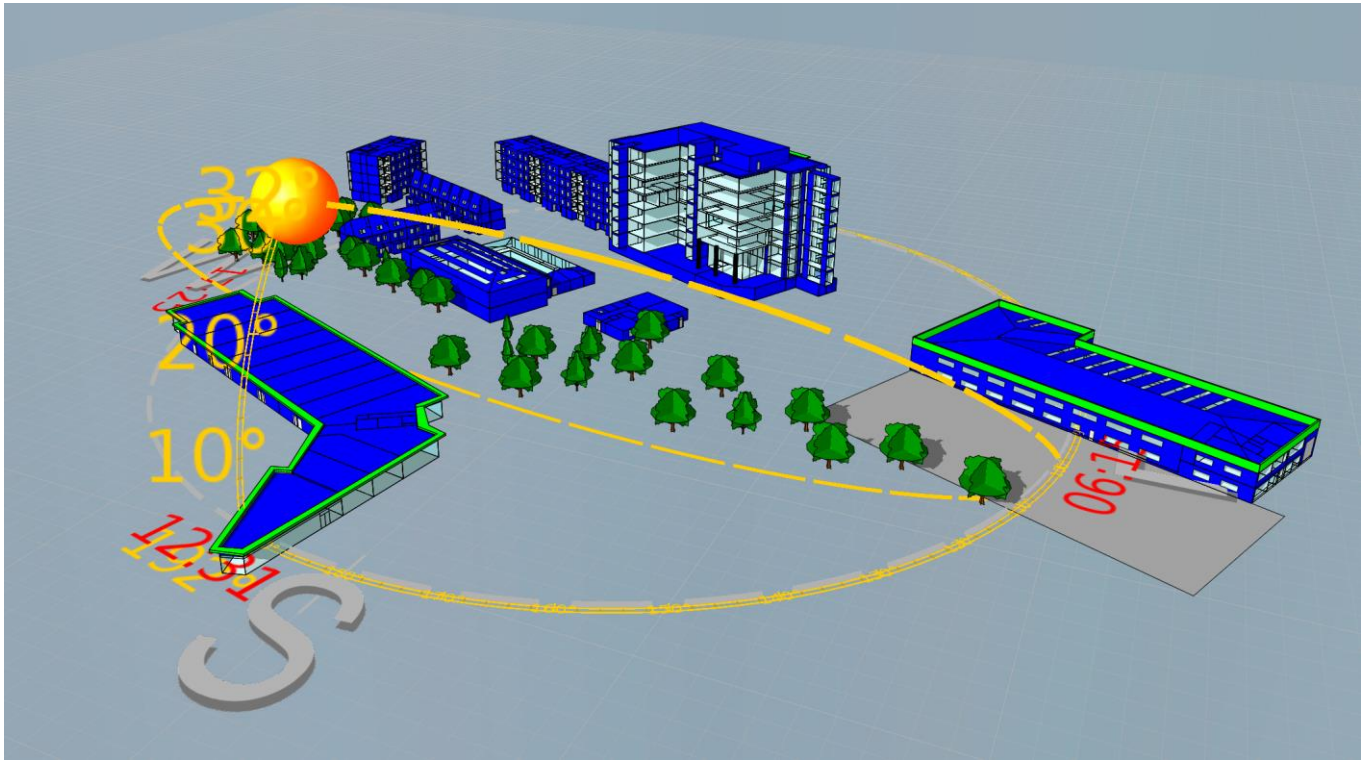
1.2. Building information Model (BIM)

To prepare this report we have used building information models or BIMs created in IES engineering software - the Virtual Environment or VE. PDF drawings were provided to EVORA EDGE by GBC on a proposed residential development in Guildford adapted for this study. These were converted into DWG files and scaled using AutoDesk AutoCad, and then in turn converted to DXF drawings so that they could be imported into the VE. We then imported additional models of commercial buildings from previous projects using gbXML and/or GEM files to create a ‘virtual mixed-use scheme’. This allowed us to model various types and numbers of buildings using a federated BIM which was shared between two principal energy modellers.

The BER and TER calculations and costs were all undertaken in the same model(s) and these are in turn available as IES Cabinet Files for future use.

A representation of the federated / neighbourhood BIM is shown below. Those persons wishing to inspect these models must have access to IES software and must have an IMPACT licence which is available from IES. Nomenclature of itemised costs are based on the RICS New Rules of Measurement *Order of cost estimating and cost planning for capital building works.*

Picture 1; EVORA EDGE's federated BIM of a mixed-use scheme



1.3. Report structure

This report has been arranged into the following sections. An executive summary, a more detailed tabulated section with basic technical information on our energy simulations, a summary of our costing methodology, and an extract from the BIMs showing our cost calculations and cost sources. Methodologies and sources of data have been clearly stated, however, it is important to note project limitations, which are expanded on in the section below.

1.4. Disclaimers / limitations

With any building, existing or proposed, there are almost an infinite number of design parameters for architects and engineers to consider including:

- Structure
- Orientation and Massing
- HVAC and Lighting Types
- Combination of HVAC and Fuel Types
- LZC Technologies

Whilst we have considered many scenarios, it is not possible to cover all potential design parameters. The aim of this research is to identify if it is possible to pass target benchmarks for buildings which are proposed as part of a planning application; while assuming common design parameters and HVAC systems which are based upon a Notional Building or best (typical) market practice.

To do this we have looked at a number of building and system types adopting a hierarchical 'fabric first' approach to favour the most efficient system(s). Where values or efficiencies are detailed in the Notional Building these are adopted. However, where these values are not provided, or where they seem

low when assessed against technologies readily available in the market, then these were replaced by values or efficiencies detailed in either Part L2A, or the Energy Technology List (ETL)[3], or other reputable or market sources.

Costs are indicative and for benchmarking purposes only. They exclude VAT and fees associated with design, professional services and project management including CDM. They do however include for preliminaries, profit and overheads for the services contractor. Greater detail and information on our costing methodology has been provided in Section 4. of this report.

[3] The ETL (or Energy Technology Product List, ETPL) is a government-managed list of energy-efficient plant and machinery, such as boilers, electric motors, and air conditioning and refrigeration systems that qualify for full tax relief.

2. EXECUTIVE SUMMARY

We find that it is technically feasible to construct buildings to the most stringent of the proposed target rates of 35%. We also find that this will attract a cost premium (an extra over cost to the developer) of up to 6.20% when compared to a Part L compliant property, or up to 4.90% when compared to a property that complies with the existing 20% target. We also find that the properties with the higher targets rates are likely to have the lowest life cycle costs. A further finding is that the cost of some LZC technologies have fallen since 2017 – in particular PV. Therefore, where PV is being used to meet target emission rates, the cost as a percentage of the overall build costs has reduced since 2017.

To establish this, we applied two different system types to a model of a large office building. These included a 4-pipe fan coil unit system and a variable refrigerant flow system. The details and the iterative results of each model/simulation are provided in Section 3.0.

The 2017 study demonstrated that it was possible for a property constructed to a PartL2A Notional Building compliant standard on fabric, to then meet the targets set in that study through onsite energy/LZC. However, this study shows that while this is still possible with a 25% improvement target[4] it was not typically possible for the 30% and/or 35% target benchmarks. In order to meet these targets, the fabric typically had to be improved closer to **'Passivehaus'** type standards.

2.1. Results

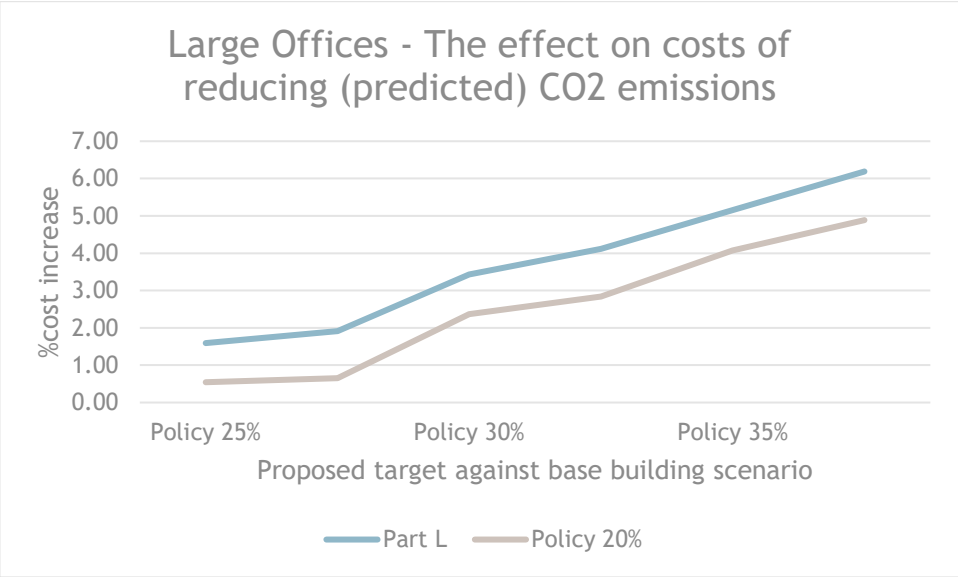
Table 1: The table below shows in column 1 the base building scenario. This is the simulated building's BER set against the required TER. For example, base building scenario 'Part L2A' represents a model that had a BER which was equal to or lower than the TER. 'Existing policy (20% target)' represents

[4] The BER is targeted to be at least 25% lower than the TER

a model that had a BER which is at least 20% lower than the Part L2A TER. The costs in the following columns represent the additional cost of increasing the target BER by the percentage stated (25%, 30% and 35%).

Base building scenario	The additional % cost increase between the base building scenario and a revised 25% target	The additional % cost increase between the base building scenario and a revised 30% target	The additional % cost increase between the base building scenario and a revised 35% target
Part L2A	1.51% to 1.91%	3.43% to 4.12%	5.16% to 6.20%
Existing policy (20% target)	0.54% to 0.65%	2.36% to 2.84%	4.07% to 4.90%

Drawing 1: Results shown as a line schematic



2.2. A Comparison of system performance (potential life cycle costs)

Table 2: The table below compares the results of our simulations so that we can better understand cost-effectiveness alongside the impact on predicted CO_2 emissions.

CO_2 emission are linked to energy consumption (kWh) and therefore, potentially, operational costs and whole life costs. System performance can be judged in two ways. The first, and in all probability, the most relevant to developers is establishing the most cost-effective way to reach proposed targets. **This is highlighted in purple**. In this case System 2 is generally more cost-effective than System 1.

The second metric assesses the cost (£) of reducing CO_2 emissions. 0 = Zero operational carbon, the further away from zero the higher the cost (£) per Tonne (T) of CO_2 saved[5]. In this case System 2 Benchmark 5 as **highlighted in green** shows that for each £ invested per m^2 a greater amount of CO_2 savings are achieved. As a result, it is likely that operational running costs and life cycle costs will be the lowest for this system.

Benchmark	System 1 BER kg CO_2/m^2	System 2 BER kg CO_2/m^2	System 1 Cost per m^2 v carbon metric	System 2 Cost per m^2 v carbon metric
1. The BER ≤ TER. This is a requirement of Criterion 1 of Part L2A	27.0	22.7	£2,213.00 / m^2 £59.80 / TCO_2	£2,185.40 / m^2 £49.60 / TCO_2

[5] Calculated as: BER * system cost / 1,000 (= Tonnes of CO_2)

Benchmark	System 1 BER kg CO_2/m^2	System 2 BER kg CO_2/m^2	System 1 Cost per m^2 v carbon metric	System 2 Cost per m^2 v carbon metric
2. The BER must be 20% lower than the TER. This is the Extant Policy	22.2	18.3	£2,258.40 £50.10 / TCO_2	£2,209.30 / m^2 £40.40 / TCO_2
3. The BER must be 25% lower than the TER. This is a proposed borough policy	20.8	17.0	£2,269.50 / m^2 £47.20 / TCO_2	£2,222.50 / m^2 £37.80 / TCO_2
4. The BER must be 30% lower than the TER. This is a proposed borough policy	19.4	16.1	£2,282.70 / m^2 £44.30 / TCO_2	£2,290.70 / m^2 £36.90 / TCO_2
5. The BER must be 35% lower than the TER. This is a proposed borough policy	17.9	14.7	£2,351.00 / m^2 £42.10 / TCO_2	£2,299.00 / m^2 £33.80 / TCO_2

3. SIMULATION RESULTS

It is important to note that the findings are based on the prevailing NCM which uses SAP 2012 emission factors. As and when a new NCM is adopted these findings will be materially altered as the grid emissions for electricity are out of date. In essence, the moment new emission factors are adopted for Part L (and EPC) purposes it will be difficult, if not impossible, to meet these targets where fossil fuels (primarily natural gas) are the primary fuel source for heating systems.

The following tables provide greater detail and granularity on the modelled buildings. The columns show the simulation number (1 to 7), the building type and target benchmark, the BER and TER, indicative costs and salient technical details. Again, it is important to note that as this study builds upon the 2017 study - we do not show all simulations since some are not relevant to the targets investigated in this study. For example, in System 1 below there is a jump from Simulation 1 to 3. This does not mean that (for example) Simulation 2 does not exist, it means that these simulations did not deliver the results required for this study. We have retained (and will issue) all simulations in their iterative order since they will form part of the evidence base.

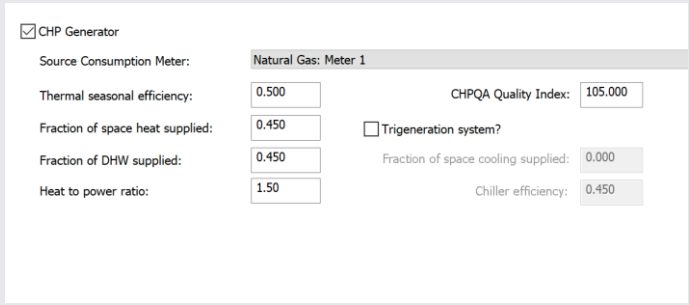
3.1 System 1: 4 Pipe Fan Coil Unit System with Mechanical Ventilation

Simulation	Building and target benchmark	BER kg CO_2/m^2	TER kg CO_2/m^2	Indicative costs of construction	Technical detail
1	**Building type** Large Office Building. **Benchmark** The BER ≤ TER. This is a requirement of Criterion 1 of Part L2A. **Summary - pass**	27.0 BER = TER	28.5	£2,212.98 per functional unit (m^2).	**Building fabric** Air permeability at 50 Pa ($m^3/(h.m^2)$ = 5 Fabric U values, as per the Notional Building Glazing g values, as per the Notional Building **HVAC** <u>Heating</u> A 4 pipe fan coil unit system to all office areas, and a low temperature hot water (LTHW) system to all other areas requiring heating. The heat source is a gas-fired boiler with a gross efficiency of 91% as per the Notional Building.

Simulation	Building and target benchmark	BER kg CO_2/m^2	TER kg CO_2/m^2	Indicative costs of construction	Technical detail
					All pumps are variable speed with multiple pressure sensors. <u>Ventilation</u> Full mechanical ventilation with heat recovery at 70% efficiency, and a specific fan power (SFP) of 1.8 w/l/s as per the Notional Building. The air handling unit (AHU) and ductwork leakage have been taken at CEN standards Class D and L1. <u>Air conditioning</u> Air-cooled chillers with a cooling SSEER[6] of 3.6 as per the Notional Building. NB: technical note - for offices (only) ESEER can be adopted as the SEER. This directly affects the SSEER calculation.

[6] SSEER and ESEET is a measure of air conditioning efficiency over a cooling season. In this example for every unit of energy input 3.6 units of cooling is transferred as an output.

Simulation	Building and target benchmark	BER kg CO_2/m^2	TER kg CO_2/m^2	Indicative costs of construction	Technical detail
					Domestic Hot Water Unvented electric storage heaters located on each floor close to the source of demand with a combined capacity of 1000 litres. Heat loss as per Table 27 of the Non-Domestic Building services Compliance Guide 2013. **Lighting** 60 lumens per circuit-watt, 100 lux – circulation space 60 lumens per circuit-watt, 500 lux all other spaces 60 lumens is the level of efficiency in the Notional Building. **Lighting controls** Photoelectric – typically yes Motion sensors – typically yes **Renewable energy systems** A 23 kWp mono crystalline silicon PV system due south east with little shade. This will require 276 m^2 of flat roof space (to account for spacing and A frames etc.) on a building with 1265 m^2 of flat roof space.

Simulation	Building and target benchmark	BER kg CO_2/m^2	TER kg CO_2/m^2	Indicative costs of construction	Technical detail
					Design challenges/considerations None to mention as this is a fairly typical (building) services solution to large office buildings. NB: For buildings with a large hot water demand then a centralized hot water calorifier system may need to be installed.
3	**Building type** Large Office Building. **Benchmark** The BER must be 20% lower than the TER. This is the extant borough policy. **Summary** - pass	22.2	22.8 (this is the target under the Extant Policy. It is the TER less 20%)	£2,258.44 per functional unit (m2).	Technical details as per Simulation 1 but with: An increased PV system of 100 kWp. This will require 1,200 m^2 of flat roof space (to account for spacing and A frames etc.) on a building with 1265 m^2 of flat roof space. Micro CHP with the following details 

Simulation	Building and target benchmark	BER kg CO_2/m^2	TER kg CO_2/m^2	Indicative costs of construction	Technical detail
					Design challenges/considerations A large PV system of this size would create design challenges in terms of location of external plant/access etc. CHP will need to operate as the lead boiler.
4	**Building type** Large Office Building. **Benchmark** The BER must be 25% lower than the TER. This is the extant borough policy. **Summary - pass**	20.8	21.4 (this is the TER less 25%)	£2,269.53 per functional unit (m2).	Technical details as per Simulation 3 but with: Improved chiller efficiency through the use of free cooling resulting in an SEER of 6.23 and an SSEER of 4.92. **Design challenges/considerations** As per simulation 3
5	**Building type** Large Office Building. **Benchmark** The BER must be 30% lower than the TER.	19.4	20.0 (this is the TER less 30%)	£2,282.73 per functional unit (m2).	Technical details as per Simulation 4 but with an improved lighting design to at least 75 lumens per circuit watt using high quality lamps. **Design challenges/considerations** None

Simulation	Building and target benchmark	BER kg CO_2/m^2	TER kg CO_2/m^2	Indicative costs of construction	Technical detail
	Summary - pass				
6	**Building type** Large Office Building. **Benchmark** The BER must be 35% lower than the TER. **Summary –** pass	17.9	18.5 (this is the TER less 35%)	£2,350.89 per functional unit (m2).	As per Simulation 5 but with: **Improved Building fabric** Air permeability at 50 Pa ($m^3/(h.m^2)$ = 3.5 Fabric U values, typically 0.15 w/m^2K Thermal bridging Ψ-value, 0.01 Glazing U values, 0.8 w/m^2K Glazing g values, 0.5 **Design challenges/considerations** None – this primarily is a cost issue

3.2 System 2: VRV/F System with Mechanical Ventilation

Simulation	Building and target benchmark	BER kg CO2/m2	TER kg CO2/m2	Indicative costs of construction	Technical detail
1	**Building type** Large Office Building. **Benchmark** The BER ≤ TER. This is a requirement of Criterion 1 of Part L2A. **Summary -** pass	22.7	23.0	£2,185.41 per functional unit (m^2).	**Building fabric** Air permeability at 50 Pa (m3/(h.m2) = 5 U values, as per the Notional Building g values, as per the Notional Building **HVAC** <u>Heating</u> A VRV/F air-source-heat-pump (ASHP) system to all office areas, and a low temperature hot water (LTHW) system to all other areas requiring heating. The CoP of the ASHP is 3.9[7] which is a requirement of the Energy Technology List and is higher than the Notional Building. The heat source is a gas-fired boiler with a gross efficiency of 91% as per the Notional Building.

[7] Coefficient of Performance (CoP). For every unit of energy input 3.9 units of heat is delivered as an output under test conditions

Simulation	Building and target benchmark	BER kg CO2/m2	TER kg CO2/m2	Indicative costs of construction	Technical detail
					All pumps are variable speed with multiple pressure sensors. <u>Ventilation</u> Full mechanical ventilation with heat recovery at 70% efficiency, and a specific fan power (SFP) of 1.2 w/l/s as per the Notional Building (a technical anomaly of modelling against the NCM is that the SFP must be lower for system 2 than system 1 and this has been reflected in costs). The air handling unit (AHU) and ductwork leakage have been taken at CEN standards Class D and L1. <u>Air conditioning</u> The SSEER of the VRV/F system is 3.6 (requiring an ESEER of 4.9) as per the Notional Building. **Domestic Hot Water** Unvented electric storage heaters located on each floor close to the source of demand with a combined capacity of 1000 litres. Heat loss as per Table 27 of

Simulation	Building and target benchmark	BER kg CO2/m2	TER kg CO2/m2	Indicative costs of construction	Technical detail
					the Non-Domestic Building services Compliance Guide 2013. **Lighting** 60 lumens per circuit-watt, 100 lux – circulation space 60 lumens per circuit-watt, 500 lux all other spaces **Lighting controls** Photoelectric – typically yes Motion sensors – typically no (to the common areas and office area only). **LZC** PV system of 20 kWp requiring 240 m^2 of flat roof space. **Design challenges/considerations** None to mention as this is a fairly typical (building) services solution to large office buildings.

Simulation	Building and target benchmark	BER kg CO2/m2	TER kg CO2/m2	Indicative costs of construction	Technical detail
					NB: For buildings with a large hot water demand then a centralized hot water calorifier system may need to be installed.
4	**Building type** Large Office Building. **Benchmark** The BER must be 20% lower than the TER. This is the extant borough policy. **Summary -** pass	18.3	18.4 (this is the target under the Extant Policy. It is the TER less 20%)	£2,209.30 per functional unit (m^2).	Technical details as per Simulation 1 but with a PV system of 100 kWp. This will require 1200 m^2 of flat roof space (to account for spacing and A frames etc.) on a building with 1265 m^2 of flat roof space. Improved SEER to 6.1 (more expensive VRV/F system). **Design challenges/considerations** None
5	**Building type** Large Office Building. **Benchmark** The BER must be 25% lower than the TER. **Summary -** pass	17.0	17.25 (this is the TER less 25%)	£2,222.50 per functional unit (m2).	Technical details as per Simulation 4 but with an improved lighting design to at least 75 lumens per circuit watt using high quality lamps. **Design challenges/considerations** None

Simulation	Building and target benchmark	BER kg CO2/m2	TER kg CO2/m2	Indicative costs of construction	Technical detail
6	**Building type** Large Office Building. **Benchmark** The BER must be 30% lower than the TER. **Summary -** pass	16.1	16.1 (this is the TER less 30%)	£2,290.66 per functional unit (m2).	As per Simulation 5 but with: **Improved Building fabric** Air permeability at 50 Pa ($m^3/(h.m^2)$ = 3.5 Fabric U values, typically 0.15 w/m^2K Thermal bridging Ψ-value, 0.01 Glazing U values, 0.8 w/m^2K Glazing g values, 0.5 **Design challenges/considerations** None – this primarily is a cost issue
7	**Building type** Large Office Building. **Benchmark** The BER must be 35% lower than the TER. **Summary -** pass	14.7	14.76 (this is the TER less 35%)	£2,298.80 per functional unit (m2).	As per simulation 6 but replacing the heat source to the LTHW to the common parts with an air to water heat pump with a SCoP of 5.1. **Design challenges/considerations** None – this primarily is a cost issue

3.1. Costs

The costs detailed over the following pages have been taken from the BIMs which are available as cabinet files (CAB files). The headings include an ID, a code which defines the basis of the cost multiplier, a rate (£), quantity, weight, base cost, cost £, and cost £ /. Explanations are provided below:

4.1. ID

The ID is based on the nomenclature of the RICS New Rules of Measurement.

4.2. Code

The code is assigned through the VE and informs the quantity. Code 11, as an example, is the code for multiplying the rate by the quantity which is based on the Gross Internal Floor Area (GIFA), while Code 1 measures the quantity by item. For example, 1 or 2 No. boilers etc.

4.3. Rate

This is the rate (£) to be multiplied by the quantity.

4.4. Quantity

This is the basis of the cost multiplier.

4.5. Weight

This applies a weighted value to the quantity, a weight of 1 = 100% as a multiplier against the quantity. In the costs below a rate of £2,262.50 per m^2 has been adopted as a base build cost, however this sum includes building services. Using BSRIA Rules of thumb as a guide, we have applied a discount rate to allow us to extract typical building services costs from the inclusive development cost. This is so that we can analyse the impact of different building services (on costs). For example, an adjusted weighting of 0.18 results in a weighting of 0.82 (1 – 0.18 = 0.82). The purpose of the exercise is to provide a consistent 'base build cost' across the simulations with the final project inclusive cost (i.e. with building services) reassessed against the range of costs provided in SPONS 2017[8]. The following weighting rules have been adopted throughout the project:

Property type	HVAC system type	Unadjusted BSRIA weighting	Less allowance for lifts[9] etc.	Adjusted weighting
Commercial (Offices)	Natural ventilation and no air conditioning	0.30	0.05	0.25
Commercial (Offices)	Mechanical ventilation and air conditioning	0.34	0.05	0.29
Commercial (Retail)	Mechanical ventilation and air conditioning	0.21	N/A	0.21
Commercial (Care Homes etc.)	Natural ventilation and no air conditioning	0.23	0.05	0.18
Residential	Natural ventilation and no air conditioning	0.23	0.025	0.205

[8] In other words we would expect the project Cost per m2 to be within the range provided by SPONS 2017 after an adjustment for location.
[9] Items included in the BSRIA weighting have been added in our cost modelling as separate line items using the RICS NRM and therefore an allowance needs to be made (discounted) to avoid double counting.

4.6. Base Cost

The base cost is an unadjusted cost (rate x quantity).

4.7. Cost

This is the adjusted cost. It is the cost multiplied by a location adjustment factor, a quality factor, and a complexity factor. In SPONS the location adjustment factor for the south east is 0.96, while a quality and complexity factor of unity (1) has been applied in the BIM representing a medium quality, medium complexity development for the type of building modelled.

Costs are based on SPONS 2020. The base build construction cost is taken verbatim from the 2020 iteration, but the other mechanical, electrical and public health services (MEP) costs were adjusted by (typically) 10% to raise the values identified in 2017 to the values in SPONS 2020. There may therefore be a variation if each item is looked at independently but our comparison of the two cost guides identified 10% as a typical increase for MEP services.

4.8. Cost £ /

This is the cost per functional unit. In this case the functional unit is taken as m^2.

4. SYSTEM 1, SIMULATION 1

Guildford Project	Simulation V1 - Simulation 1.0								
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI
6.1.1	Complete buildings (SPONS A&B 2020 - median cost)	11	2450.00	10,924	0.71	19,002,298.00	18,242,206.08	1,670	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	11.00	10,924	1	120,164.00	115,357.44	11	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	18.70	10,924	1	204,278.80	196,107.65	18	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	25.30	10,924	1	276,377.20	265,322.11	24	1
5.5	Heat source (HS) Boiler ((GIFA x 70w x £50.00 per kW (SPONS M&E 2020))	1	42057.40	1	1	42,057.40	40,375.10	4	1
5.6	Space heating and air conditioning (SHAC) 4 pipe FCU (SPONS M&E 2020 - median cost)	11	203.50	10,924	0.7	1,556,123.80	1,493,878.85	137	1
5.6	Space heating LTHW for non FCU space (SPONS M&E 2020 - median cost)	11	55.00	10,924	0.3	180,246.00	173,036.16	16	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	33.00	10,924	1	360,492.00	346,072.32	32	1
5.8.1	Electrical mains and sub-mains distribution (SPONS M&E 2020 - median cost)	11	44.00	10,924	1	480,656.00	461,429.76	42	1
5.8.2	Power installations (SPONS M&E 2020 - median cost)	11	16.45	10,924	1	179,645.18	172,459.37	16	1
5.8.3	Lighting installations (SPONS M&E 2020 - median cost)	11	79.75	10,924	1	871,189.00	836,341.44	77	1
5.8.5	Stand by generator (SPONS M&E 2020 - median cost)	11	23.10	10,924	1	252,344.40	242,250.62	22	1

Guildford Project	Simulation V1 - Simulation 1.0								
5.8.5	PV panels (SPONS M&E 2020 - median cost, increased by 10% to allow for additional frame work)	11	1670.63	23	1	38,424.38	36,887.40	3	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	1.27	10,924	1	13,818.86	13,266.11	1	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72600.00	4	1	290,400.00	278,784.00	26	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	38.39	10,924	1	419,372.36	402,597.47	37	1
5.12	BMS, Communication, security and cntrol systems (CSC) (SPONS M&E 2020 - median cost)	11	81.84	10,924	1	894,020.16	858,259.35	79	1
	Project cost						**24,174,631.23**	**2,212.98**	

5. SYSTEM 1, SIMULATION 3

Guildford Project	Simulation V1 - Simulation 3.0								
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI
6.1.1	Complete buildings (SPONS A&B 2020 - median cost)	11	2450.00	10,924	0.71	19,002,298.00	18,242,206.08	1,670	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	11.00	10,924	1	120,164.00	115,357.44	11	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	18.70	10,924	1	204,278.80	196,107.65	18	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	25.30	10,924	1	276,377.20	265,322.11	24	1
5.5	Heat source (HS) Boiler ((GIFA x 70w x £50.00 per kW (SPONS M&E 2020))	1	42057.40	1	1	42,057.40	40,375.10	4	1

Guildford Project	Simulation V1 - Simulation 3.0								
5.5	Heat source (HS) gas fired CHP ((GIFA x 35w (50% of load) = (SPONS M&E 2020) 359 kW heat output CHP))	1	214500.00	1	1	214,500.00	205,920.00	19	1
5.6	Space heating and air conditioning (SHAC) 4 pipe FCU (SPONS M&E 2020 - median cost)	11	203.50	10,924	0.7	1,556,123.80	1,493,878.85	137	1
5.6	Space heating LTHW for non FCU space (SPONS M&E 2020 - median cost)	11	55.00	10,924	0.3	180,246.00	173,036.16	16	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	41.80	10,924	1	456,623.20	438,358.27	40	1
5.8.1	Electrical mains and sub-mains distribution (SPONS M&E 2020 - median cost)	11	44.00	10,924	1	480,656.00	461,429.76	42	1
5.8.2	Power installations (SPONS M&E 2020 - median cost)	11	16.45	10,924	1	179,645.18	172,459.37	16	1
5.8.3	Lighting installations (SPONS M&E 2020 - median cost)	11	79.75	10,924	1	871,189.00	836,341.44	77	1
5.8.5	Stand by generator (SPONS M&E 2020 - median cost)	11	23.10	10,924	1	252,344.40	242,250.62	22	1
5.8.5	PV panels (SPONS M&E 2020 - median cost, increased by 10% to allow for additional frame work)	11	2450.25	100	1	245,025.00	235,224.00	22	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	1.27	10,924	1	13,818.86	13,266.11	1	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72600.00	4	1	290,400.00	278,784.00	26	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	38.39	10,924	1	419,372.36	402,597.47	37	1
5.12	BMS, Communication, security and cntrol systems (CSC) (SPONS M&E 2020 - median cost)	11	81.84	10,924	1	894,020.16	858,259.35	79	1
	Project cost						**24,671,173.79**	**2,258.44**	

6. SYSTEM 1, SIMULATION 4

Guildford Project	Simulation V1 - Simulation 4.0								
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI
6.1.1	Complete buildings (SPONS A&B 2020 - median cost)	11	2450.00	10,924	0.71	19,002,298.00	18,242,206.08	1,670	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	11.00	10,924	1	120,164.00	115,357.44	11	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	18.70	10,924	1	204,278.80	196,107.65	18	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	25.30	10,924	1	276,377.20	265,322.11	24	1
5.5	Heat source (HS) Boiler ((GIFA x 70w x £50.00 per kW (SPONS M&E 2020))	1	42057.40	1	1	42,057.40	40,375.10	4	1
5.5	Heat source (HS) gas fired CHP ((GIFA x 35w (50% of load) = (SPONS M&E 2020) 359 kW heat output CHP))	1	214500.00	1	1	214,500.00	205,920.00	19	1
5.6	Space heating and air conditioning (SHAC) 4 pipe FCU (SPONS M&E 2020 - Upper end cost to allow for improved spec)	11	220.00	10,924	0.7	1,682,296.00	1,615,004.16	148	1
5.6	Space heating LTHW for non FCU space (SPONS M&E 2020 - median cost)	11	55.00	10,924	0.3	180,246.00	173,036.16	16	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	41.80	10,924	1	456,623.20	438,358.27	40	1

Guildford Project	Simulation V1 - Simulation 4.0								
5.8.1	Electrical mains and sub-mains distribution (SPONS M&E 2020 - median cost)	11	44.00	10,924	1	480,656.00	461,429.76	42	1
5.8.2	Power installations (SPONS M&E 2020 - median cost)	11	16.45	10,924	1	179,645.18	172,459.37	16	1
5.8.3	Lighting installations (SPONS M&E 2020 - median cost)	11	79.75	10,924	1	871,189.00	836,341.44	77	1
5.8.5	Stand by generator (SPONS M&E 2020 - median cost)	11	23.10	10,924	1	252,344.40	242,250.62	22	1
5.8.5	PV panels (SPONS M&E 2020 - median cost, increased by 10% to allow for additional frame work)	11	2450.25	100	1	245,025.00	235,224.00	22	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	1.27	10,924	1	13,818.86	13,266.11	1	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72600.00	4	1	290,400.00	278,784.00	26	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	38.39	10,924	1	419,372.36	402,597.47	37	1
5.12	BMS, Communication, security and cntrol systems (CSC) (SPONS M&E 2020 - median cost)	11	81.84	10,924	1	894,020.16	858,259.35	79	1
	Project cost						**24,792,299.10**	**2,269.53**	

7. SYSTEM 1, SIMULATION 5

Guildford Project	Simulation V1 - Simulation 5.0								
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI
6.1.1	Complete buildings (SPONS A&B 2020 - median cost)	11	2450.00	10,924	0.71	19,002,298.00	18,242,206.08	1,670	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	11.00	10,924	1	120,164.00	115,357.44	11	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	18.70	10,924	1	204,278.80	196,107.65	18	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	25.30	10,924	1	276,377.20	265,322.11	24	1
5.5	Heat source (HS) Boiler ((GIFA x 70w x £50.00 per kW (SPONS M&E 2020))	1	42057.40	1	1	42,057.40	40,375.10	4	1
5.5	Heat source (HS) gas fired CHP ((GIFA x 35w (50% of load) = (SPONS M&E 2020) 359 kW heat output CHP))	1	214500.00	1	1	214,500.00	205,920.00	19	1
5.6	Space heating and air conditioning (SHAC) 4 pipe FCU (SPONS M&E 2020 - Upper end cost to allow for improved spec)	11	220.00	10,924	0.7	1,682,296.00	1,615,004.16	148	1
5.6	Space heating LTHW for non FCU space (SPONS M&E 2020 - median cost)	11	55.00	10,924	0.3	180,246.00	173,036.16	16	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	41.80	10,924	1	456,623.20	438,358.27	40	1

Guildford Project	Simulation V1 - Simulation 5.0								
5.8.1	Electrical mains and sub-mains distribution (SPONS M&E 2020 - median cost)	11	44.00	10,924	1	480,656.00	461,429.76	42	1
5.8.2	Power installations (SPONS M&E 2020 - median cost)	11	16.45	10,924	1	179,645.18	172,459.37	16	1
5.8.3	Lighting installations (SPONS M&E 2020 - upper cost)	11	93.50	10,924	1	1,021,394.00	980,538.24	90	1
5.8.5	Stand by generator (SPONS M&E 2020 - median cost)	11	23.10	10,924	1	252,344.40	242,250.62	22	1
5.8.5	PV panels (SPONS M&E 2020 - median cost, increased by 10% to allow for additional frame work)	11	2450.25	100	1	245,025.00	235,224.00	22	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	1.27	10,924	1	13,818.86	13,266.11	1	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72600.00	4	1	290,400.00	278,784.00	26	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	38.39	10,924	1	419,372.36	402,597.47	37	1
5.12	BMS, Communication, security and cntrol systems (CSC) (SPONS M&E 2020 - median cost)	11	81.84	10,924	1	894,020.16	858,259.35	79	1
	Project cost						**24,936,495.90**	**2,282.73**	

8. SYSTEM 1, SIMULATION 6

Guildford Project	Simulation V1 - Simulation 6.0								
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI
6.1.1	Complete buildings (SPONS A&B 2020 - median cost)	11	2550.00	10,924	0.71	19,777,902.00	18,986,785.92	1,738	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	11.00	10,924	1	120,164.00	115,357.44	11	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	18.70	10,924	1	204,278.80	196,107.65	18	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	25.30	10,924	1	276,377.20	265,322.11	24	1
5.5	Heat source (HS) Boiler ((GIFA x 70w x £50.00 per kW (SPONS M&E 2020))	1	42057.40	1	1	42,057.40	40,375.10	4	1
5.5	Heat source (HS) gas fired CHP ((GIFA x 35w (50% of load) = (SPONS M&E 2020) 359 kW heat output CHP))	1	214500.00	1	1	214,500.00	205,920.00	19	1
5.6	Space heating and air conditioning (SHAC) 4 pipe FCU (SPONS M&E 2020 - Upper end cost to allow for improved spec)	11	220.00	10,924	0.7	1,682,296.00	1,615,004.16	148	1
5.6	Space heating LTHW for non FCU space (SPONS M&E 2020 - median cost)	11	55.00	10,924	0.3	180,246.00	173,036.16	16	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	41.80	10,924	1	456,623.20	438,358.27	40	1

Guildford Project	Simulation V1 - Simulation 6.0								
5.8.1	Electrical mains and sub-mains distribution (SPONS M&E 2020 - median cost)	11	44.00	10,924	1	480,656.00	461,429.76	42	1
5.8.2	Power installations (SPONS M&E 2020 - median cost)	11	16.45	10,924	1	179,645.18	172,459.37	16	1
5.8.3	Lighting installations (SPONS M&E 2020 - upper cost)	11	93.50	10,924	1	1,021,394.00	980,538.24	90	1
5.8.5	Stand by generator (SPONS M&E 2020 - median cost)	11	23.10	10,924	1	252,344.40	242,250.62	22	1
5.8.5	PV panels (SPONS M&E 2020 - median cost, increased by 10% to allow for additional frame work)	11	2450.25	100	1	245,025.00	235,224.00	22	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	1.27	10,924	1	13,818.86	13,266.11	1	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72600.00	4	1	290,400.00	278,784.00	26	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	38.39	10,924	1	419,372.36	402,597.47	37	1
5.12	BMS, Communication, security and cntrol systems (CSC) (SPONS M&E 2020 - median cost)	11	81.84	10,924	1	894,020.16	858,259.35	79	1
	Project cost						**25,681,075.74**	**2,350.89**	

9. SYSTEM 2, SIMULATION 1

Guildford Project	Simulation V2 - Simulation 1.0								
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI
6.1.1	Complete buildings (SPONS A&B 2020 - median cost)	11	2450.00	10,924	0.71	19,002,298.00	18,242,206.08	1,670	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	11.00	10,924	1	120,164.00	115,357.44	11	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	18.70	10,924	1	204,278.80	196,107.65	18	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	25.30	10,924	1	276,377.20	265,322.11	24	1
5.5	Heat source (HS) - boilers ((GIFA x 0.3 x 70w x £70.00 per kW (SPONS M&E 2020 - median cost between boiler sizes to account for reduced boiler size over Simulation V 1))	1	17600.00	1	1	17,600.00	16,896.00	2	1
5.6	Space heating and air conditioning (SHAC) VRF/V system (SPONS M&E 2020 - upper end to aim for 3.6 SSEER) - additonal uplift as costs seem light	11	180.00	10,924	0.7	1,376,424.00	1,321,367.04	121	1
5.6	Space heating LTHW for non VRF/V space (SPONS M&E2020 - median cost)	11	55.00	10,924	0.3	180,246.00	173,036.16	16	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - upper end cost to acheive improved SFP)	11	46.20	10,924	1	504,688.80	484,501.25	44	1
5.8.1	Electrical mains and sub-mains distribution (SPONS M&E 2020 - median cost)	11	44.00	10,924	1	480,656.00	461,429.76	42	1

Guildford Project	Simulation V2 - Simulation 1.0								
5.8.2	Power installations (SPONS M&E 2020 - median cost)	11	16.45	10,924	1	179,645.18	172,459.37	16	1
5.8.3	Lighting installations (SPONS M&E 2020 - median cost)	11	79.75	10,924	1	871,189.00	836,341.44	77	1
5.8.5	Stand by generator (SPONS M&E 2020 - median cost)	11	23.10	10,924	1	252,344.40	242,250.62	22	1
5.8.5	PV panels (SPONS M&E 2020 - median cost, increased by 10% to allow for additional frame work)	11	2450.25	20	1	49,005.00	47,044.80	4	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	1.27	10,924	1	13,818.86	13,266.11	1	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	11	72600.00	4	1	290,400.00	278,784.00	26	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	38.39	10,924	1	419,372.36	402,597.47	37	1
5.12	BMS, Communication, security and cntrol systems (CSC) (SPONS M&E 2020 - median cost)	11	57.64	10,924	1	629,659.36	604,472.99	55	1
	Project cost						**23,873,440.28**	**2,185.41**	

10. SYSTEM 2, SIMULATION 4

Guildford Project	Simulation V2 - Simulation 4.0								
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI
6.1.1	Complete buildings (SPONS A&B 2020 - median cost)	11	2450.00	10,924	0.71	19,002,298.00	18,242,206.08	1,670	1

Guildford Project	Simulation V2 - Simulation 4.0								
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	11.00	10,924	1	120,164.00	115,357.44	11	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	18.70	10,924	1	204,278.80	196,107.65	18	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	25.30	10,924	1	276,377.20	265,322.11	24	1
5.5	Heat source (HS) - boilers ((GIFA x 0.3 x 70w x £70.00 per kW (SPONS M&E 2020 - median cost between boiler sizes to account for reduced boiler size over Simulation V 1))	1	17600.00	1	1	17,600.00	16,896.00	2	1
5.6	Space heating and air conditioning (SHAC) VRF/V system (SPONS M&E 2020 - upper end to aim for 3.6 SSEER) - additonal uplift for improved SEER (based on Daikin systems)	11	187.00	10,924	0.7	1,429,951.60	1,372,753.54	126	1
5.6	Space heating LTHW for non VRF/V space (SPONS M&E2020 - median cost)	11	55.00	10,924	0.3	180,246.00	173,036.16	16	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - upper end cost to acheive improved SFP)	11	46.20	10,924	1	504,688.80	484,501.25	44	1
5.8.1	Electrical mains and sub-mains distribution (SPONS M&E 2020 - median cost)	11	44.00	10,924	1	480,656.00	461,429.76	42	1
5.8.2	Power installations (SPONS M&E 2020 - median cost)	11	16.45	10,924	1	179,645.18	172,459.37	16	1
5.8.3	Lighting installations (SPONS M&E 2020 - median cost)	11	79.75	10,924	1	871,189.00	836,341.44	77	1
5.8.5	Stand by generator (SPONS M&E 2020 - median cost)	11	23.10	10,924	1	252,344.40	242,250.62	22	1
5.8.5	PV panels (SPONS M&E 2020 - median cost, increased by 20% to allow for additional ENHANCED frame work)	11	2673.00	100	1	267,300.00	256,608.00	23	1

Guildford Project	Simulation V2 - Simulation 4.0								
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	1.27	10,924	1	13,818.86	13,266.11	1	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	11	72600.00	4	1	290,400.00	278,784.00	26	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	38.39	10,924	1	419,372.36	402,597.47	37	1
5.12	Communication, security and cntrol systems (CSC) (SPONS M&E 2020 - median cost)	11	57.64	10,924	1	629,659.36	604,472.99	55	1
	Project cost						**24,134,389.98**	**2,209.30**	

11. SYSTEM 2, SIMULATION 5

Guildford Project	Simulation V2 - Simulation 5.0								
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI
6.1.1	Complete buildings (SPONS A&B 2020 - median cost)	11	2450.00	10,924	0.71	19,002,298.00	18,242,206.08	1,670	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	11.00	10,924	1	120,164.00	115,357.44	11	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	18.70	10,924	1	204,278.80	196,107.65	18	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	25.30	10,924	1	276,377.20	265,322.11	24	1
5.5	Heat source (HS) - boilers ((GIFA x 0.3 x 70w x £70.00 per kW (SPONS M&E 2020 - median cost between boiler sizes to	1	17600.00	1	1	17,600.00	16,896.00	2	1

Guildford Project	Simulation V2 - Simulation 5.0								
	account for reduced boiler size over Simulation V 1))								
5.6	Space heating and air conditioning (SHAC) VRF/V system (SPONS M&E 2020 - upper end to aim for 3.6 SSEER) - additonal uplift for improved SEER (based on Daikin systems)	11	187.00	10,924	0.7	1,429,951.60	1,372,753.54	126	1
5.6	Space heating LTHW for non VRF/V space (SPONS M&E2020 - median cost)	11	55.00	10,924	0.3	180,246.00	173,036.16	16	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - upper end cost to acheive improved SFP)	11	46.20	10,924	1	504,688.80	484,501.25	44	1
5.8.1	Electrical mains and sub-mains distribution (SPONS M&E 2020 - median cost)	11	44.00	10,924	1	480,656.00	461,429.76	42	1
5.8.2	Power installations (SPONS M&E 2020 - median cost)	11	16.45	10,924	1	179,645.18	172,459.37	16	1
5.8.3	Lighting installations (SPONS M&E 2020 - upper cost)	11	93.50	10,924	1	1,021,394.00	980,538.24	90	1
5.8.5	Stand by generator (SPONS M&E 2020 - median cost)	11	23.10	10,924	1	252,344.40	242,250.62	22	1
5.8.5	PV panels (SPONS M&E 2020 - median cost, increased by 20% to allow for additional ENHANCED frame work)	11	2673.00	100	1	267,300.00	256,608.00	23	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	1.27	10,924	1	13,818.86	13,266.11	1	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	11	72600.00	4	1	290,400.00	278,784.00	26	1

Guildford Project	Simulation V2 - Simulation 5.0								
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	38.39	10,924	1	419,372.36	402,597.47	37	1
5.12	Communication, security and cntrol systems (CSC) (SPONS M&E 2020 - median cost)	11	57.64	10,924	1	629,659.36	604,472.99	55	1
	Project cost						**24,278,586.78**	**2,222.50**	

12. SYSTEM 2, SIMULATION 6

Guildford Project	Simulation V2 - Simulation 6.0								
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI
6.1.1	Complete buildings (SPONS A&B 2020 - median cost)	11	2550.00	10,924	0.71	19,777,902.00	18,986,785.92	1,738	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	11.00	10,924	1	120,164.00	115,357.44	11	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	18.70	10,924	1	204,278.80	196,107.65	18	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	25.30	10,924	1	276,377.20	265,322.11	24	1
5.5	Heat source (HS) - boilers ((GIFA x 0.3 x 70w x £70.00 per kW (SPONS M&E 2020 - median cost between boiler sizes to account for reduced boiler size over Simulation V 1))	1	17600.00	1	1	17,600.00	16,896.00	2	1
5.6	Space heating and air conditioning (SHAC) VRF/V system (SPONS M&E 2020 - upper end to aim for 3.6	11	187.00	10,924	0.7	1,429,951.60	1,372,753.54	126	1

Guildford Project	Simulation V2 - Simulation 6.0								
	SSEER) - additonal uplift for improved SEER (based on Daikin systems)								
5.6	Space heating LTHW for non VRF/V space (SPONS M&E2020 - median cost)	11	55.00	10,924	0.3	180,246.00	173,036.16	16	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - upper end cost to acheive improved SFP)	11	46.20	10,924	1	504,688.80	484,501.25	44	1
5.8.1	Electrical mains and sub-mains distribution (SPONS M&E 2020 - median cost)	11	44.00	10,924	1	480,656.00	461,429.76	42	1
5.8.2	Power installations (SPONS M&E 2020 - median cost)	11	16.45	10,924	1	179,645.18	172,459.37	16	1
5.8.3	Lighting installations (SPONS M&E 2020 - upper cost)	11	93.50	10,924	1	1,021,394.00	980,538.24	90	1
5.8.5	Stand by generator (SPONS M&E 2020 - median cost)	11	23.10	10,924	1	252,344.40	242,250.62	22	1
5.8.5	PV panels (SPONS M&E 2020 - median cost, increased by 20% to allow for additional ENHANCED frame work)	11	2673.00	100	1	267,300.00	256,608.00	23	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	1.27	10,924	1	13,818.86	13,266.11	1	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	11	72600.00	4	1	290,400.00	278,784.00	26	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	38.39	10,924	1	419,372.36	402,597.47	37	1
5.12	Communication, security and cntrol systems (CSC) (SPONS M&E 2020 - median cost)	11	57.64	10,924	1	629,659.36	604,472.99	55	1
	Project cost						**25,023,166.62**	**2,290.66**	

13. SYSTEM 2, SIMULATION 7

Guildford Project	Simulation V2 - Simulation 7.0									
ID	Description	Code	Rate	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI
6.1.1	Complete buildings (SPONS A&B 2020 - median cost)	11	2,262.50	2550.00	10,924	0.71	19,777,902.00	18,986,785.92	1,738	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	10	11.00	10,924	1	120,164.00	115,357.44	11	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	17	18.70	10,924	1	204,278.80	196,107.65	18	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	23	25.30	10,924	1	276,377.20	265,322.11	24	1
5.5	Heat source (HS) - air to water heatpumps ((GIFA x 0.3 x 70w x £437 per kW	1	100,249.55	110274.50	1	1	110,274.50	105,863.52	10	1
5.6	Space heating and air conditioning (SHAC) VRF/V system (SPONS M&E 2020 - upper end to aim for 3.6 SSEER) - additonal uplift for improved SEER (based on Daikin systems)	11	170	187.00	10,924	0.7	1,429,951.60	1,372,753.54	126	1
5.6	Space heating LTHW for non VRF/V space (SPONS M&E2020 - median cost)	11	50	55.00	10,924	0.3	180,246.00	173,036.16	16	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - upper end cost to acheive improved SFP)	11	42	46.20	10,924	1	504,688.80	484,501.25	44	1
5.8.1	Electrical mains and sub-mains distribution (SPONS M&E 2020 - median cost)	11	40	44.00	10,924	1	480,656.00	461,429.76	42	1

Guildford Project	Simulation V2 - Simulation 7.0									
5.8.2	Power installations (SPONS M&E 2020 - median cost)	11	14.95	16.45	10,924	1	179,645.18	172,459.37	16	1
5.8.3	Lighting installations (SPONS M&E 2020 - upper cost)	11	85	93.50	10,924	1	1,021,394.00	980,538.24	90	1
5.8.5	Stand by generator (SPONS M&E 2020 - median cost)	11	21	23.10	10,924	1	252,344.40	242,250.62	22	1
5.8.5	PV panels (SPONS M&E 2020 - median cost, increased by 20% to allow for additional ENHANCED frame work)	11	2,430.00	2673.00	100	1	267,300.00	256,608.00	23	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	1.15	1.27	10,924	1	13,818.86	13,266.11	1	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	11	66,000.00	72600.00	4	1	290,400.00	278,784.00	26	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	34.9	38.39	10,924	1	419,372.36	402,597.47	37	1
5.12	Communication, security and cntrol systems (CSC) (SPONS M&E 2020 - median cost)	11	52.4	57.64	10,924	1	629,659.36	604,472.99	55	1
	Project cost							**25,112,134.14**	**2,298.80**	

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