

## *A Mixed-Use Scheme – Retail*

FEBRUARY 2020





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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<sup>2</sup>) 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<sup>2</sup> emissions. As of June 2019, the UK Government amended the Climate Change Act<sup>1</sup> 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.

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<sup>1</sup> 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 purpose built retail unit 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 ( $\leq$ ) 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<sup>2</sup>. For a building to pass the exacting requirements of Part L2A it must be designed and

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<sup>2</sup> 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 ( $BER \leq TER$ ). A building that is constructed to the limiting parameters of Part L2A will fail Criterion 1, which is the Criterion that requires the  $BER \leq TER$ .

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 – although this was not necessary for retail units. This is because it was not possible for some asset types 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 0.5% 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)*

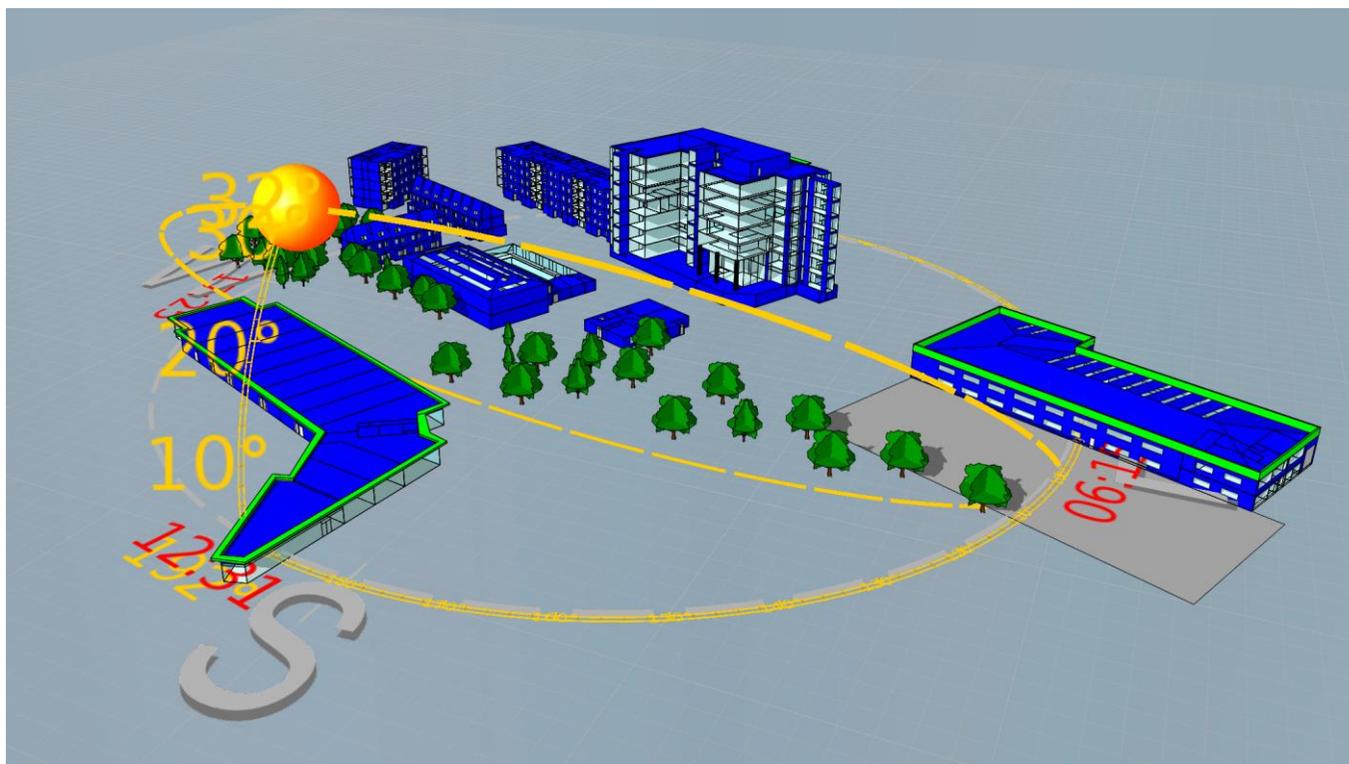
To prepare this report we have used building information models or BIMs created in IES engineering software - the Virtual Environment or VE. PDF drawings were provided to EVORA EDGE by GBC on a proposed residential development in Guildford adapted for this study. These were converted into DWG files and 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:

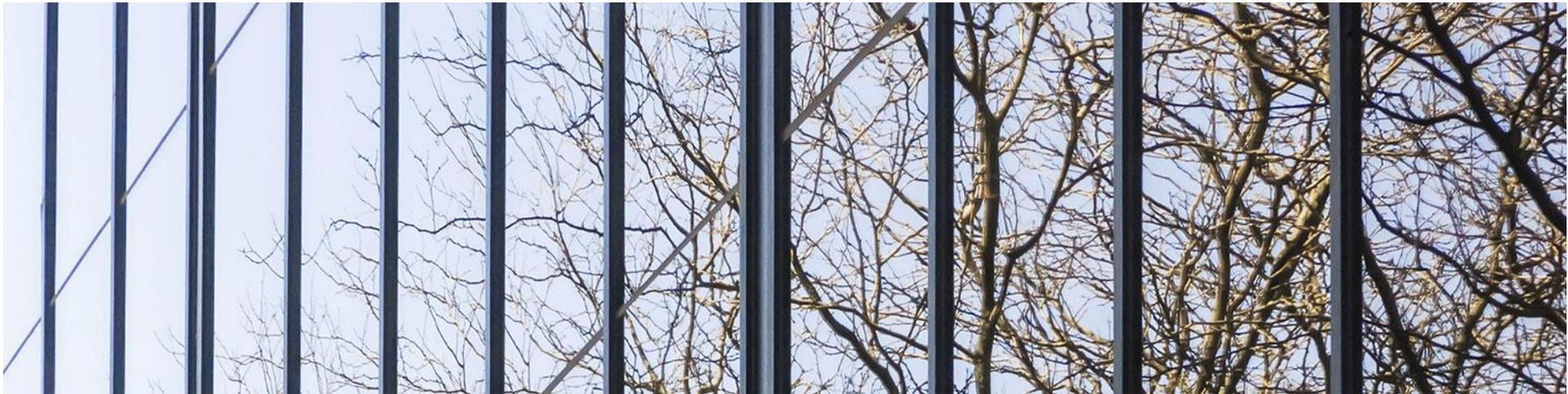
- Structure
- Orientation and Massing
- HVAC and Lighting Types
- Combination of HVAC and Fuel Types
- LZC Technologies

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)<sup>3</sup>, 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.



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<sup>3</sup> 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 (the 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<sup>4</sup> 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

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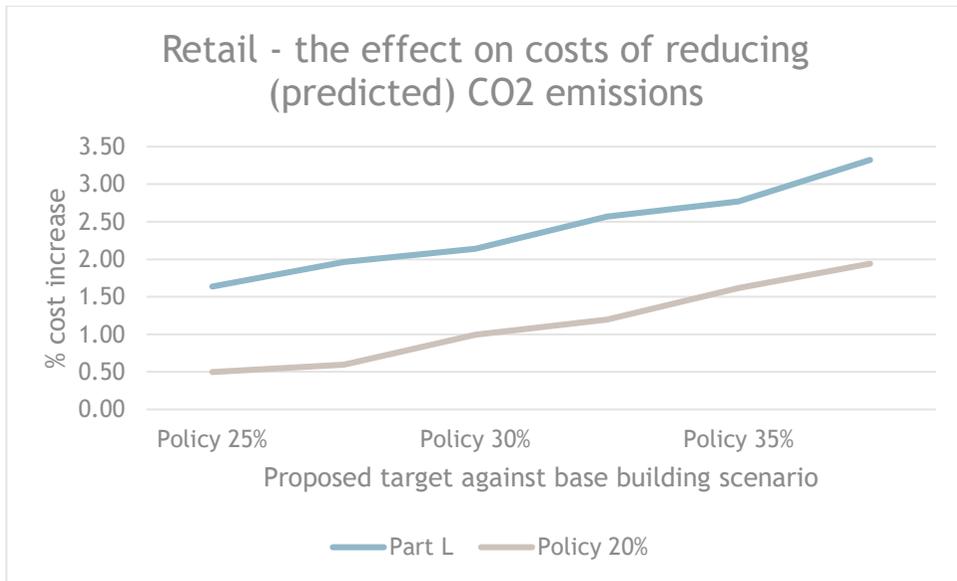
<sup>4</sup> The BER is targeted to be at least 25% lower than the TER



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	1.64% to 1.96%	2.14% to 2.57%	2.77% to 3.32%
Existing policy (20% target)	0.50% to 0.60%	1.00% to 1.20%	1.62% to 1.94%

*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<sub>2</sub> emissions.

CO<sub>2</sub> 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 1 is generally more cost-effective than System 2.

The second metric assesses the cost (£) of reducing CO<sub>2</sub> emissions. 0 = Zero operational carbon, the further away from zero the higher the cost (£) per Tonne (T) of CO<sub>2</sub> saved<sup>5</sup>. In this case System 2 Benchmark 5 as **highlighted in green** shows that for each £ invested per m<sup>2</sup> a greater amount of CO<sub>2</sub> savings are achieved. As a result, it is likely that operational running costs and life cycle costs will be the lowest for this system, and indeed System 2 is likely to prove more cost-effective than System 1 across all simulations.

Benchmark	System 1 BER kg CO <sub>2</sub> /m <sup>2</sup>	System 2 BER kg CO <sub>2</sub> /m <sup>2</sup>	System 1 Cost per m <sup>2</sup> v carbon metric	System 2 Cost per m <sup>2</sup> v carbon metric
1. The BER ≤ TER. This is a requirement of Criterion 1 of Part L2A	48.6	34.0	£1,579.70 / m <sup>2</sup>	£1,645.90 / m <sup>2</sup>

<sup>5</sup> Calculated as: BER \* system cost / 1,000 (= Tonnes of CO<sub>2</sub>)



Benchmark	System 1 BER kg CO <sub>2</sub> /m <sup>2</sup>	System 2 BER kg CO <sub>2</sub> /m <sup>2</sup>	System 1 Cost per m <sup>2</sup> v carbon metric	System 2 Cost per m <sup>2</sup> v carbon metric
			£76.80 / TCO <sub>2</sub>	£56.00 / TCO <sub>2</sub>
2. The BER must be 20% lower than the TER. This is the Extant Policy	39.3	34.0	£1,612.20 £63.50 / TCO <sub>2</sub>	£1,645.90 / m <sup>2</sup> £56.00 / TCO <sub>2</sub>
3. The BER must be 25% lower than the TER. This is a proposed borough policy	37.2	32.0	£1,624.30 / m <sup>2</sup> £60.40 / TCO <sub>2</sub>	£1,675.10 / m <sup>2</sup> £53.60 / TCO <sub>2</sub>
4. The BER must be 30% lower than the TER. This is a proposed borough policy	34.6	30.4	£1,634.50 / m <sup>2</sup> £56.60 / TCO <sub>2</sub>	£1,681.20 / m <sup>2</sup> £51.50 / TCO <sub>2</sub>
5. The BER must be 35% lower than the TER. This is a proposed borough policy	32.0	27.8	£1,644.60 / m <sup>2</sup> £52.60 / TCO <sub>2</sub>	£1,691.40 / m <sup>2</sup> £47.0 / TCO <sub>2</sub>

### 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 4. This does not mean that (for example) Simulation 2 to 3 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: Variable Air Volume (heating, cooling and fresh air)

Simulation	Building	BER kg CO <sub>2</sub> /m <sup>2</sup>	TER kg CO <sub>2</sub> /m <sup>2</sup>	Indicative costs of construction	Technical detail
1.	<p><b>Building type</b> Typical Retail Unit(s).</p> <p><b>Benchmark</b> The BER ≤ TER. This is a requirement of Criterion 1 of Part L2A.</p> <p><b>Summary - pass</b> In order to pass Criterion 1 of Part L2A a 4kWp PV system is required.</p>	48.6	49.9	£1,579.70 per functional unit (m2)	<p><b>Building fabric</b> Air permeability at 50 Pa (m<sup>3</sup>/(h.m<sup>2</sup>) = 5 Fabric U values, as per the Notional Building Glazing g values, as per the Notional Building</p> <p><b>HVAC</b> <u>Heating</u> A ducted variable air volume system provided heating, cooling and fresh air. Dampers are adjusted based on temperature demand, reducing fan speed which saves energy.</p>



Simulation Building	BER kg CO <sub>2</sub> /m <sup>2</sup>	TER kg CO <sub>2</sub> /m <sup>2</sup>	Indicative costs of construction	Technical detail
				<p>The boiler efficiency is taken at 91% gross and this together with wider system details and efficiencies are as per the Notional Building.</p> <p>10% of the heating load has been assumed to be met by electric over door air curtains.</p> <p>Pumps are variable speed with multiple pressure sensors.</p> <p><u>Air conditioning</u> Air-cooled chillers with a cooling SSEER of 3.6<sup>6</sup> as per the Notional Building.</p> <p><u>Ventilation</u> Ventilation is provided mechanically. The system SFP<sup>7</sup> is taken at 1.6 w/l/s as the Notional Building appears to also model SFP at 1.6 w/l/s, however,</p>

<sup>6</sup> SSEER is a measure of cooling efficiency over a season. For every unit of energy input 3.6 units of cooling or coolth is transferred into the conditioned space.

<sup>7</sup> Specific Fan Power (SFP) is a parameter that quantifies the energy-efficiency of fan air movement systems. It is a measure of the electric power that is needed to drive a fan (or collection of fans), relative to the amount of air that is circulated through the fan(s)



Simulation Building	BER kg CO <sub>2</sub> /m <sup>2</sup>	TER kg CO <sub>2</sub> /m <sup>2</sup>	Indicative costs of construction	Technical detail
				<p>technically to adhere to the requirements of Part L2A 0.3 w/l/s should be added to this SFP to account for the heat exchangers. In other words, the Notional Building SFP is better than required under Part L2A.</p> <p>Air exchange rates for WC/bathroom areas have been taken at 10 air changes per hour, and the SFP of local exhaust systems at 0.3 w/l/s as per the requirements of Part L2A, and it assumed that these will have an integral heat exchanger.</p> <p><b>Domestic Hot Water</b> Provided at source through electric unvented water heaters with a combined storage capability of 50 litres.</p> <p><b>Lighting</b> 60 lumens per circuit-watt, 200 lux – back of house/non-office or retail 60 lumens per circuit-watt, 500 lux office areas 60 lumens per circuit-watt, 600 lux for retail sales</p>



Simulation Building	BER kg CO <sub>2</sub> /m <sup>2</sup>	TER kg CO <sub>2</sub> /m <sup>2</sup>	Indicative costs of construction	Technical detail
				<p>The light efficacy in the Notional Building is 60 lumens per circuit-watt.</p> <p><b>Lighting controls</b>            Photoelectric – typically yes            Motion sensors – typically no, as this would be impractical for retail sales (PIR to common areas and office area only).</p> <p><b>Renewable energy systems</b>            4kWp mono crystalline PV system on roof mounts facing due south-east at a 30 degree incline. This will require around 48 m<sup>2</sup> of flat roof space – the flat roof of the proposed property extends to about 359 m<sup>2</sup>.</p> <p><b>Design challenges/considerations</b>            N/A</p>



Simulation Building		BER kg CO <sub>2</sub> /m <sup>2</sup>	TER kg CO <sub>2</sub> /m <sup>2</sup>	Indicative costs of construction	Technical detail
4.	<p><b>Building type</b> Typical Retail Unit(s).</p> <p><b>Benchmark</b> The BER must be 20% lower than the TER. This is the Extant Policy for out of town retail only.</p> <p><b>Summary - pass</b></p>	39.3	39.9 (this is the target under the Extant Policy. It is the TER less 20%)	£1,616.20 per functional unit (m <sup>2</sup> )	<p>As per Simulation 1 but with a 13kWp mono crystalline PV system on roof mounts facing due south-east at a 30 degree incline.</p> <p>This will require around 156 m<sup>2</sup> of flat roof space – the flat roof of the proposed property extends to about 359 m<sup>2</sup>.</p>
5.	<p><b>Building type</b> Typical Retail Unit(s).</p> <p><b>Benchmark</b> The BER must be 25% lower than the TER.</p> <p><b>Summary - pass</b></p>	37.2	37.4 (this is the TER less 25%)	£1,624.30 per functional unit (m <sup>2</sup> )	<p>As per Simulation 4, but with a PV system of increased capacity to 15 kWp requiring a flat roof area of 180 m<sup>2</sup> - the flat roof of the proposed property extends to about 359 m<sup>2</sup>.</p>
6.	<p><b>Building type</b> Typical Retail Unit(s).</p>	34.6	34.9 (this is the TER less 30%)	£1,634.50 per functional unit (m <sup>2</sup> )	<p>As per Simulation 5, but with a PV system of increased capacity to 17.5 kWp requiring a flat roof</p>



Simulation Building		BER kg CO <sub>2</sub> /m <sup>2</sup>	TER kg CO <sub>2</sub> /m <sup>2</sup>	Indicative costs of construction	Technical detail
	<p><b>Benchmark</b></p> <p>The BER must be 30% lower than the TER.</p> <p><b>Summary - pass</b></p>				area of 210 m <sup>2</sup> - the flat roof of the proposed property extends to about 359 m <sup>2</sup>
7.	<p><b>Building type</b></p> <p>Typical Retail Unit(s).</p> <p><b>Benchmark</b></p> <p>The BER must be 35% lower than the TER.</p> <p><b>Summary - pass</b></p>	32.0	32.4	£1,644.60 per functional unit (m <sup>2</sup> )	As per Simulation 6, but with a PV system of increased capacity to 20 kWp requiring a flat roof area of 240 m <sup>2</sup> - the flat roof of the proposed property extends to about 359 m <sup>2</sup>

### 3.4 System 2: VRV/F with mechanical ventilation

Simulation Building		BER kg CO <sub>2</sub> /m <sup>2</sup>	TER kg CO <sub>2</sub> /m <sup>2</sup>	Indicative costs of construction	Technical detail
1 to 4.	<p><b>Building type</b></p> <p>Typical Retail Unit(s).</p>	34.0	44.4	£1,645.90 per functional unit (m <sup>2</sup> )	<p><b>Building fabric</b></p> <p>Air permeability at 50 Pa (m<sup>3</sup>/(h.m<sup>2</sup>)) = 5</p> <p>Fabric U values, as per the Notional Building</p>



Simulation Building	BER kg CO <sub>2</sub> /m <sup>2</sup>	TER kg CO <sub>2</sub> /m <sup>2</sup>	Indicative costs of construction	Technical detail
<p><b>Benchmark</b></p> <p>The BER ≤ TER. This is a requirement of Criterion 1 of Part L2A.</p> <p><b>Summary – pass</b></p> <p>Using this type of system, it is easy to pass both Part L and the existing policy of 20% for out-of-town retail units.</p>				<p>Glazing g values, as per the Notional Building</p> <p><b>HVAC</b></p> <p><u>Heating</u></p> <p>A VRV/F air-source-heat-pump (ASHP) system to all areas other than plant room.</p> <p>The CoP of the ASHP is 3.9<sup>8</sup> which is a requirement of the Energy Technology List and is higher than the Notional Building.</p> <p><u>Ventilation</u></p> <p>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).</p>

<sup>8</sup> For every unit of energy input 3.9 units of heat is delivered as an output under test conditions



Simulation Building	BER kg CO <sub>2</sub> /m <sup>2</sup>	TER kg CO <sub>2</sub> /m <sup>2</sup>	Indicative costs of construction	Technical detail
				<p>Air handling unit (AHU) and ductwork leakage have been taken at CEN standards Class D and L1.</p> <p><u>Air conditioning</u> The SSEER of the VRV/F system is 3.6 (requiring an SEER of 4.9) as per the Notional Building.</p> <p>NB this is higher than the requirements of the ETL, but several such systems are readily available on the open market.</p> <p><b>Domestic Hot Water</b> Provided at source through electric unvented water heaters with a combined storage capability of 50 litres.</p> <p><b>Lighting</b> 60 lumens per circuit-watt, 200 lux – back of house/non-office or retail 60 lumens per circuit-watt, 500 lux office areas 60 lumens per circuit-watt, 600 lux for retail sales</p>



Simulation Building		BER kg CO <sub>2</sub> /m <sup>2</sup>	TER kg CO <sub>2</sub> /m <sup>2</sup>	Indicative costs of construction	Technical detail
					<p>The light efficacy in the Notional Building is 60 lumens per circuit-watt.</p> <p><b>Lighting controls</b>            Photoelectric – typically yes            Motion sensors – typically no, as this would be impractical for retail sales (PIR to common areas and office area only)</p> <p><b>Design challenges/considerations</b>            N/A</p>
5.	<p><b>Building type</b>            Typical Retail Unit(s).</p> <p><b>Benchmark</b>            The BER must be 25% lower than the TER.</p> <p><b>Summary – pass</b></p>	32.0	33.3 (this is the TER less 25%)	£1,675.10 per functional unit (m <sup>2</sup> )	As per Simulation 1, but with a PV system of 2 kWp requiring a flat roof area of 24 m <sup>2</sup> - the flat roof of the proposed property extends to about 359 m <sup>2</sup> .



Simulation Building		BER kg CO <sub>2</sub> /m <sup>2</sup>	TER kg CO <sub>2</sub> /m <sup>2</sup>	Indicative costs of construction	Technical detail
6.	<p><b>Building type</b> Typical Retail Unit(s).</p> <p><b>Benchmark</b> The BER must be 30% lower than the TER.</p> <p><b>Summary – pass</b></p>	30.4	31.08 (this is the TER less 30%)	£1,681.20 per functional unit (m <sup>2</sup> )	As per Simulation 5, but with a PV system of 3.5 kWp requiring a flat roof area of 42 m <sup>2</sup> - the flat roof of the proposed property extends to about 359 m <sup>2</sup> .
7.	<p><b>Building type</b> Typical Retail Unit(s).</p> <p><b>Benchmark</b> The BER must be 35% lower than the TER.</p> <p><b>Summary – pass</b></p>	27.8	28.86 (this is the TER less 35%)	£1,691.40 per functional unit (m <sup>2</sup> )	As per Simulation 6, but with a PV system of 6 kWp requiring a flat roof area of 72 m <sup>2</sup> - the flat roof of the proposed property extends to about 359 m <sup>2</sup> .

### 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 £1,660 per m<sup>2</sup> has been adopted as a base build cost, however this sum includes a basic fit out<sup>9</sup> and 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<sup>10</sup>. The following weighting rules have been adopted throughout the project:

Property type	HVAC system type	Unadjusted weighting	BSRIA	Less allowance for lifts <sup>11</sup> 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

<sup>9</sup> Retail units are often let after construction in shell and core only

<sup>10</sup> In other words we would expect the project Cost per m<sup>2</sup> to be within the range provided by SPONS 2017 after an adjustment for location.

<sup>11</sup> 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<sup>2</sup>.



## 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, small / simple store fitted out )	11	1,660.00	359	0.79	470,792.60	451,960.90	1,258.94	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	8.855	359	1	3,178.95	3,051.79	8.50	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	13.64	359	1	4,896.76	4,700.89	13.09	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	14.993	359	1	5,382.49	5,167.19	14.39	1
5.5	Heat source (HS) - boilers (SPONS M&E 2020 - median cost)	11	7.59	359	1	2,724.81	2,615.82	7.29	1
5.6	LTHW heating, plantroom and risers (SPONS M&E 2020 - median cost)	11	15.18	359	1	5,449.62	5,231.64	14.57	1
5.6	CHW plant room and risers (SPONS M&E 2020 - median cost)	11	36.3	359	1	13,031.70	12,510.43	34.85	1
5.6	Ductwork plant room and risers (SPONS M&E 2020 - median cost)	11	69.85	359	1	25,076.15	24,073.10	67.06	1
5.6	Air curtains (SPONS M&E 2020 - median cost)	11	1.155	359	1	414.65	398.06	1.11	1
5.7	Ventilation systems WC & Misc. (VS) (SPONS M&E 2020 - median cost)	11	15.18	359	1	5,449.62	5,231.64	14.57	1
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	61.93	359	1	22,232.87	21,343.56	59.45	1
5.8.5	Local electricity generation systems (SPONS M&E 2020 - median cost)	11	1518.75	4	1	6,075.00	5,832.00	16.25	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	2.2	359	1	789.80	758.21	2.11	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	8.8	359	1	3,159.20	3,032.83	8.45	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	39.49	359	1	14,176.91	13,609.83	37.91	1
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	359	1	7,898.00	7,582.08	21.12	1



<b>Guildford Project</b>	<b>Simulation V1 - Simulation 1.0</b>								
	<b>Project cost</b>			<b>0.23947344</b>	<b>1,339.28</b>	<b>320.72</b>	<b>567,099.95</b>	<b>1,579.67</b>	

## 5. SYSTEM 1, SIMULATION 4

<b>Guildford Project</b>	<b>Simulation V1 - Simulation 4.0</b>								
<b>ID</b>	<b>Description</b>	<b>Code</b>	<b>Rate</b>	<b>Quantity</b>	<b>Weight</b>	<b>Base cost £</b>	<b>Cost £</b>	<b>Cost £ / FU</b>	<b>TPI</b>
6.1.1	Complete buildings (SPONS A&B 2020 - median cost, small / simple store fitted out )	11	1,660.00	359	0.79	470,792.60	451,960.90	1,258.94	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	8.855	359	1	3,178.95	3,051.79	8.50	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	13.64	359	1	4,896.76	4,700.89	13.09	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	14.993	359	1	5,382.49	5,167.19	14.39	1
5.5	Heat source (HS) - boilers (SPONS M&E 2020 - median cost)	11	7.59	359	1	2,724.81	2,615.82	7.29	1
5.6	LTHW heating, plantroom and risers (SPONS M&E 2020 - median cost)	11	15.18	359	1	5,449.62	5,231.64	14.57	1
5.6	CHW plant room and risers (SPONS M&E 2020 - median cost)	11	36.3	359	1	13,031.70	12,510.43	34.85	1
5.6	Ductwork plant room and risers (SPONS M&E 2020 - median cost)	11	69.85	359	1	25,076.15	24,073.10	67.06	1
5.6	Air curtains (SPONS M&E 2020 - median cost)	11	1.155	359	1	414.65	398.06	1.11	1
5.7	Ventilation systems WC & Misc. (VS) (SPONS M&E 2020 - median cost)	11	15.18	359	1	5,449.62	5,231.64	14.57	1



Guildford Project	Simulation V1 - Simulation 4.0								
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	61.93	359	1	22,232.87	21,343.56	59.45	1
5.8.5	Local electricity generation systems (SPONS M&E 2020 - median cost)	11	1518.75	13	1	19,743.75	18,954.00	52.80	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	2.2	359	1	789.80	758.21	2.11	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	8.8	359	1	3,159.20	3,032.83	8.45	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	39.49	359	1	14,176.91	13,609.83	37.91	1
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	359	1	7,898.00	7,582.08	21.12	1
	<b>Project cost</b>						<b>580,221.95</b>	<b>1,616.22</b>	

## 6. 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, small / simple store fitted out )	11	1,660.00	359	0.79	470,792.60	451,960.90	1,258.94	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	8.855	359	1	3,178.95	3,051.79	8.50	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	13.64	359	1	4,896.76	4,700.89	13.09	1



Guildford Project	Simulation V1 - Simulation 5.0								
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	14.993	359	1	5,382.49	5,167.19	14.39	1
5.5	Heat source (HS) - boilers (SPONS M&E 2020 - median cost)	11	7.59	359	1	2,724.81	2,615.82	7.29	1
5.6	LTHW heating, plantroom and risers (SPONS M&E 2020 - median cost)	11	15.18	359	1	5,449.62	5,231.64	14.57	1
5.6	CHW plant room and risers (SPONS M&E 2020 - median cost)	11	36.3	359	1	13,031.70	12,510.43	34.85	1
5.6	Ductwork plant room and risers (SPONS M&E 2020 - median cost)	11	69.85	359	1	25,076.15	24,073.10	67.06	1
5.6	Air curtains (SPONS M&E 2020 - median cost)	11	1.155	359	1	414.65	398.06	1.11	1
5.7	Ventilation systems WC & Misc. (VS) (SPONS M&E 2020 - median cost)	11	15.18	359	1	5,449.62	5,231.64	14.57	1
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	61.93	359	1	22,232.87	21,343.56	59.45	1
5.8.5	Local electricity generation systems (SPONS M&E 2020 - median cost)	11	1518.75	15	1	22,781.25	21,870.00	60.92	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	2.2	359	1	789.80	758.21	2.11	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	8.8	359	1	3,159.20	3,032.83	8.45	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	39.49	359	1	14,176.91	13,609.83	37.91	1
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	359	1	7,898.00	7,582.08	21.12	1
	<b>Project cost</b>						<b>583,137.95</b>	<b>1,624.34</b>	

## 7. 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, small / simple store fitted out )	11	1,660.00	359	0.79	470,792.60	451,960.90	1,258.94	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	8.855	359	1	3,178.95	3,051.79	8.50	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	13.64	359	1	4,896.76	4,700.89	13.09	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	14.993	359	1	5,382.49	5,167.19	14.39	1
5.5	Heat source (HS) - boilers (SPONS M&E 2020 - median cost)	11	7.59	359	1	2,724.81	2,615.82	7.29	1
5.6	LTHW heating, plantroom and risers (SPONS M&E 2020 - median cost)	11	15.18	359	1	5,449.62	5,231.64	14.57	1
5.6	CHW plant room and risers (SPONS M&E 2020 - median cost)	11	36.3	359	1	13,031.70	12,510.43	34.85	1
5.6	Ductwork plant room and risers (SPONS M&E 2020 - median cost)	11	69.85	359	1	25,076.15	24,073.10	67.06	1
5.6	Air curtains (SPONS M&E 2020 - median cost)	11	1.155	359	1	414.65	398.06	1.11	1
5.7	Ventilation systems WC & Misc. (VS) (SPONS M&E 2020 - median cost)	11	15.18	359	1	5,449.62	5,231.64	14.57	1
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	61.93	359	1	22,232.87	21,343.56	59.45	1
5.8.5	Local electricity generation systems (SPONS M&E 2020 - median cost)	11	1518.75	17.5	1	26,578.13	25,515.00	71.07	1



Guildford Project	Simulation V1 - Simulation 6.0								
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	2.2	359	1	789.80	758.21	2.11	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	8.8	359	1	3,159.20	3,032.83	8.45	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	39.49	359	1	14,176.91	13,609.83	37.91	1
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	359	1	7,898.00	7,582.08	21.12	1
	<b>Project cost</b>						<b>586,782.95</b>	<b>1,634.49</b>	

## 8. SYSTEM 1, SIMULATION 7

Guildford Project	Simulation V1 - Simulation 7.0								
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI
6.1.1	Complete buildings (SPONS A&B 2020 - median cost, small / simple store fitted out )	11	1,660.00	359	0.79	470,792.60	451,960.90	1,258.94	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	8.855	359	1	3,178.95	3,051.79	8.50	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	13.64	359	1	4,896.76	4,700.89	13.09	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	14.993	359	1	5,382.49	5,167.19	14.39	1
5.5	Heat source (HS) - boilers (SPONS M&E 2020 - median cost)	11	7.59	359	1	2,724.81	2,615.82	7.29	1



Guildford Project	Simulation V1 - Simulation 7.0								
5.6	LTHW heating, plantroom and risers (SPONS M&E 2020 - median cost)	11	15.18	359	1	5,449.62	5,231.64	14.57	1
5.6	CHW plant room and risers (SPONS M&E 2020 - median cost)	11	36.3	359	1	13,031.70	12,510.43	34.85	1
5.6	Ductwork plant room and risers (SPONS M&E 2020 - median cost)	11	69.85	359	1	25,076.15	24,073.10	67.06	1
5.6	Air curtains (SPONS M&E 2020 - median cost)	11	1.155	359	1	414.65	398.06	1.11	1
5.7	Ventilation systems WC & Misc. (VS) (SPONS M&E 2020 - median cost)	11	15.18	359	1	5,449.62	5,231.64	14.57	1
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	61.93	359	1	22,232.87	21,343.56	59.45	1
5.8.5	Local electricity generation systems (SPONS M&E 2020 - median cost)	11	1518.75	20	1	30,375.00	29,160.00	81.23	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	2.2	359	1	789.80	758.21	2.11	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	8.8	359	1	3,159.20	3,032.83	8.45	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	39.49	359	1	14,176.91	13,609.83	37.91	1
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	359	1	7,898.00	7,582.08	21.12	1
	<b>Project cost</b>						<b>590,427.95</b>	<b>1,644.65</b>	

## 9. SYSTEM 2, SIMULATIONS 1 TO 4

Guildford Project	Simulation V2 - Simulations 1.0 to 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, small / simple store fitted out )	11	1,660.00	359	0.79	470,792.60	451,960.90	1,258.94	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	8.855	359	1	3,178.95	3,051.79	8.50	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	13.64	359	1	4,896.76	4,700.89	13.09	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	14.993	359	1	5,382.49	5,167.19	14.39	1
5.5	Heat source (HS) - heat pumps cost per m2	1	165	359	1	59,235.00	56,865.60	158.40	1
5.6	Ductwork plant room and risers (SPONS M&E 2020 - median cost)	11	69.85	359	1	25,076.15	24,073.10	67.06	1
5.6	Air curtains (SPONS M&E 2020 - median cost)	11	1.155	359	1	414.65	398.06	1.11	1
5.7	Ventilation systems WC & Misc. (VS) (SPONS M&E 2020 - upper end cost to account for reduced SFP)	11	17.16	359	1	6,160.44	5,914.02	16.47	1
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	61.93	359	1	22,232.87	21,343.56	59.45	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	2.2	359	1	789.80	758.21	2.11	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	8.8	359	1	3,159.20	3,032.83	8.45	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	39.49	359	1	14,176.91	13,609.83	37.91	1
	<b>Project cost</b>						<b>590,875.97</b>	<b>1,645.89</b>	



## 10. 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, small / simple store fitted out )	11	1,660.00	359	0.79	470,792.60	451,960.90	1,258.94	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	8.855	359	1	3,178.95	3,051.79	8.50	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	13.64	359	1	4,896.76	4,700.89	13.09	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	14.993	359	1	5,382.49	5,167.19	14.39	1
5.5	Heat source (HS) - heat pumps cost per m2	1	165	359	1	59,235.00	56,865.60	158.40	1
5.6	Ductwork plant room and risers (SPONS M&E 2020 - median cost)	11	69.85	359	1	25,076.15	24,073.10	67.06	1
5.6	Air curtains (SPONS M&E 2020 - median cost)	11	1.155	359	1	414.65	398.06	1.11	1
5.7	Ventilation systems WC & Misc. (VS) (SPONS M&E 2020 - upper end cost to account for reduced SFP)	11	17.16	359	1	6,160.44	5,914.02	16.47	1
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	61.93	359	1	22,232.87	21,343.56	59.45	1
5.8.5	Local electricity generation systems (SPONS M&E 2020 - median cost)	11	1518.75	2	1	3,037.50	2,916.00	8.12	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	2.2	359	1	789.80	758.21	2.11	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	8.8	359	1	3,159.20	3,032.83	8.45	1



Guildford Project	Simulation V2 - Simulation 5.0									
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	39.49	359	1	14,176.91	13,609.83	37.91	1	
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	359	1	7,898.00	7,582.08	21.12	1	
<b>Project cost</b>							<b>601,374.05</b>	<b>1,675.14</b>		

## 11. 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, small / simple store fitted out)	11	1,660.00	359	0.79	470,792.60	451,960.90	1,258.94	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	8.855	359	1	3,178.95	3,051.79	8.50	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	13.64	359	1	4,896.76	4,700.89	13.09	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	14.993	359	1	5,382.49	5,167.19	14.39	1
5.5	Heat source (HS) - heat pumps cost per m2	1	165	359	1	59,235.00	56,865.60	158.40	1
5.6	Ductwork plant room and risers (SPONS M&E 2020 - median cost)	11	69.85	359	1	25,076.15	24,073.10	67.06	1
5.6	Air curtains (SPONS M&E 2020 - median cost)	11	1.155	359	1	414.65	398.06	1.11	1
5.7	Ventilation systems WC & Misc. (VS) (SPONS M&E 2020 - upper end cost to account for reduced SFP)	11	17.16	359	1	6,160.44	5,914.02	16.47	1



Guildford Project	Simulation V2 - Simulation 6.0								
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	61.93	359	1	22,232.87	21,343.56	59.45	1
5.8.5	Local electricity generation systems (SPONS M&E 2020 - median cost)	11	1518.75	3.5	1	5,315.63	5,103.00	14.21	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	2.2	359	1	789.80	758.21	2.11	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	8.8	359	1	3,159.20	3,032.83	8.45	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	39.49	359	1	14,176.91	13,609.83	37.91	1
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	359	1	7,898.00	7,582.08	21.12	1
	<b>Project cost</b>						<b>603,561.05</b>	<b>1,681.23</b>	

## 12. SYSTEM 2, SIMULATION 7

Guildford Project	Simulation V2 - Simulation 7.0								
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI
6.1.1	Complete buildings (SPONS A&B 2020 - median cost, small / simple store fitted out )	11	1,660.00	359	0.79	470,792.60	451,960.90	1,258.94	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	8.855	359	1	3,178.95	3,051.79	8.50	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	13.64	359	1	4,896.76	4,700.89	13.09	1



Guildford Project	Simulation V2 - Simulation 7.0								
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	14.993	359	1	5,382.49	5,167.19	14.39	1
5.5	Heat source (HS) - heat pumps cost per m2	1	165	359	1	59,235.00	56,865.60	158.40	1
5.6	Ductwork plant room and risers (SPONS M&E 2020 - median cost)	11	69.85	359	1	25,076.15	24,073.10	67.06	1
5.6	Air curtains (SPONS M&E 2020 - median cost)	11	1.155	359	1	414.65	398.06	1.11	1
5.7	Ventilation systems WC & Misc. (VS) (SPONS M&E 2020 - upper end cost to account for reduced SFP)	11	17.16	359	1	6,160.44	5,914.02	16.47	1
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	61.93	359	1	22,232.87	21,343.56	59.45	1
5.8.5	Local electricity generation systems (SPONS M&E 2020 - median cost)	11	1518.75	6	1	9,112.50	8,748.00	24.37	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	2.2	359	1	789.80	758.21	2.11	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	8.8	359	1	3,159.20	3,032.83	8.45	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	39.49	359	1	14,176.91	13,609.83	37.91	1
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	359	1	7,898.00	7,582.08	21.12	1
	<b>Project cost</b>						<b>607,206.05</b>	<b>1,691.38</b>	

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