

A Mixed-Use Scheme – Care Home

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Contents

1. Introduction.....	3
1.1. The simulations.....	4
1.2. Building information Model (BIM).....	5
1.3. Report structure.....	7
1.4. Disclaimers / limitations.....	7
2. Executive summary.....	9
2.1. Results.....	9
2.2. A Comparison of system performance (potential life cycle costs).....	11
3. Simulation results.....	12
3.1. System 1: Domestic Type LTHW Heating System Using Gas Fired Boilers.....	13
3.2. System 2: Air to Water Air Source Heat Pump (ASHP) with Secondary Domestic Hot Water Circulation.....	18
3.3. System 3: District heating using gas fired CHP.....	22
4. Costs.....	26
4.1. ID.....	26
4.2. Code.....	26
4.3. Rate.....	26
4.4. Quantity.....	26
4.5. Weight.....	27
4.6. Base Cost.....	27
4.7. Cost.....	28
4.8. Cost £ /.....	28
5. System 1, Simulation 1.....	29
6. System 1, Simulation 2.....	30
7. System 1, Simulation 3.....	31
8. System 1, Simulation 6.....	32
9. System 1, Simulation 7.....	33
10. System 2, Simulation 1.....	34
11. System 2, Simulation 4.....	35
12. System 2, Simulation 5.....	36
13. System 2, Simulation 6.....	37



14. System 2, Simulation 7	38
15. System 3, Simulation 1	39
16. System 3, Simulation 3	40
17. System 3, Simulation 4	41
18. System 3, Simulation 6	42
19. System 3, Simulation 7	43

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 (CO²) 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 CO² emissions. As of June 2019, the UK Government amended the Climate Change Act¹ 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 three building energy models of a residential care home for the elderly covered by Part L2A. These models are based on an adapted residential development provided to EVORA EDGE by GBC in 2017 for the purpose of this study.

The simulations study the performance of three different building services solutions for care home properties, which we refer to throughout this report as Systems 1, 2 and 3.

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 such as lighting 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 available². 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 ($BER \leq TER$). 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. 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 1.4% 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 as explained further in Section 4.7.

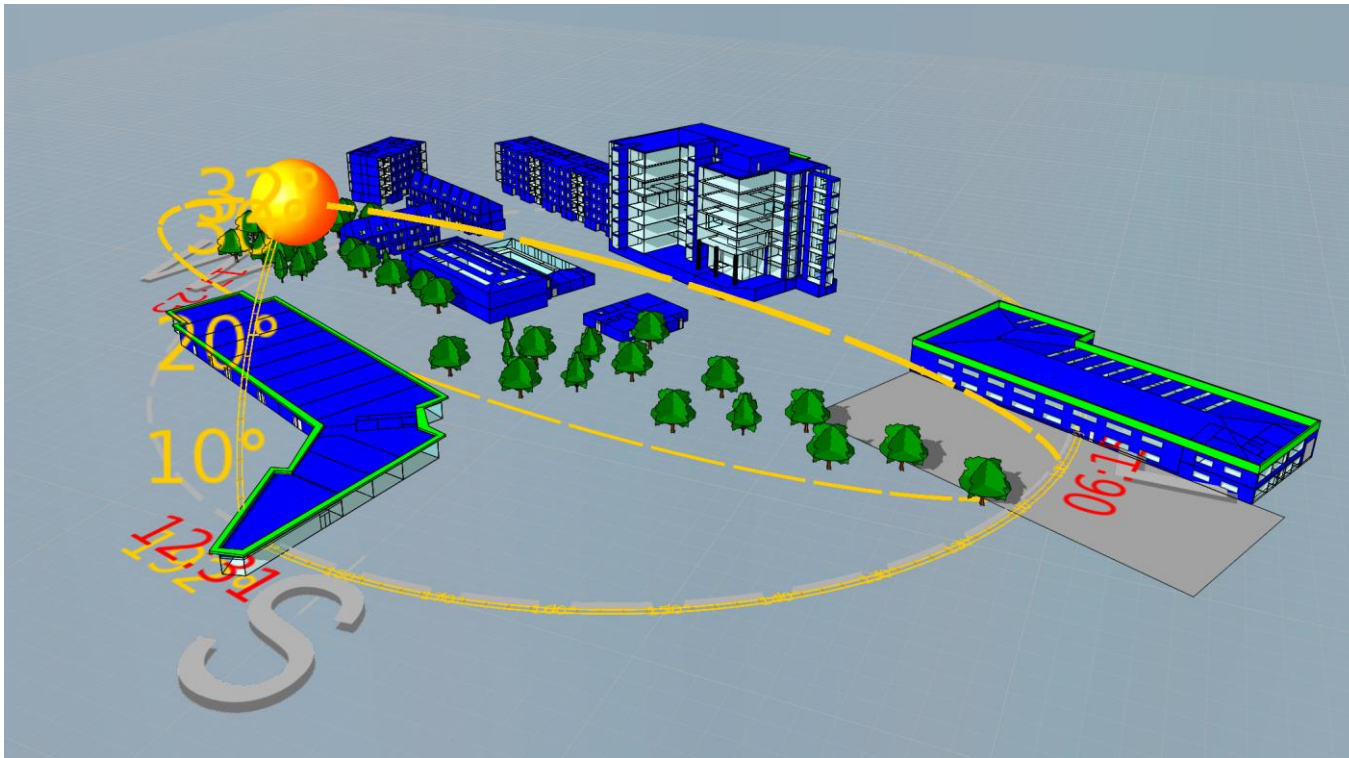
1.2. Building information Model (BIM)

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 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 of up to 8.72% when compared to a Part L compliant property, or up to 7.6% 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 three different system types to a model of a care home. These included a conventional gas fired low temperature hot water system (LTHW), an air to water heat pump system, and a district heating system using gas fired CHP. 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 target⁴ 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

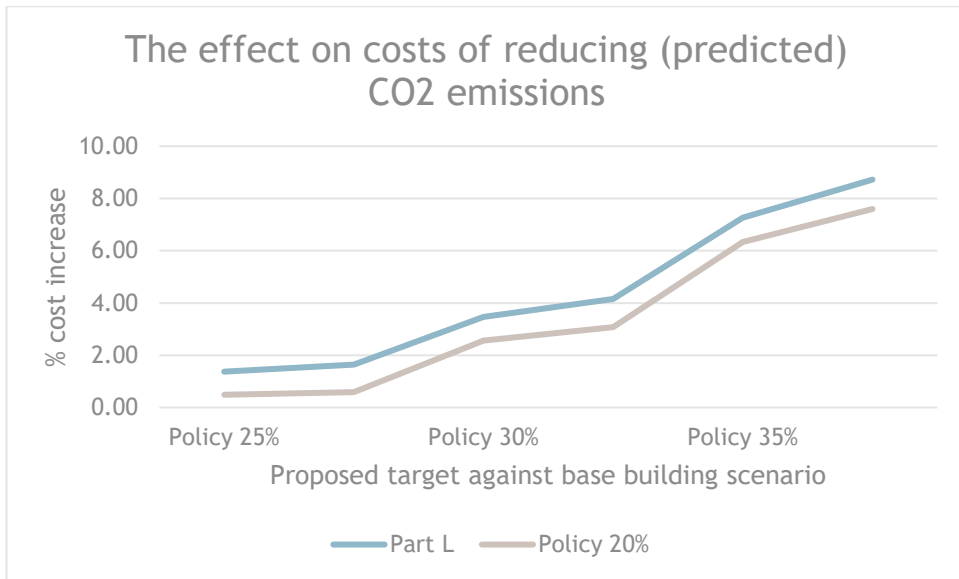
⁴ The BER is targeted to be at least 25% lower than the TER



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	1.37% to 1.65%	3.47% to 4.16%	7.27% to 8.72%
Existing policy (20% target)	0.49% to 0.59%	2.56% to 3.08%	6.33% to 7.6%

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 CO₂ emissions.

CO₂ 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 Systems 1 and 2, below, are the most cost-effective.

The second metric assesses the cost (£) of reducing CO₂ emissions. 0 = Zero operational carbon, the further away from zero the higher the cost (£) per Tonne (T) of CO₂ saved⁵. In this case System 2 Benchmark 5 as **highlighted in green** shows that for each £ invested per m² a greater amount of CO₂ 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 3 BER kg CO ₂ /m ²	System 1 Cost per m ² v carbon metric	System 2 Cost per m ² v carbon metric	System 3 Cost per m ² v carbon metric
1. The BER ≤ TER. This is a requirement of Criterion 1 of Part L2A	30.6	26.4	28.9	£1,671.50 / m ² £51.10 / TCO ₂	£1,703.50 / m ² £45.0 / TCO ₂	£1,739.40 / m ² £50.30 / TCO ₂

⁵ Calculated as: BER * system cost / 1,000 (= Tonnes of CO₂)



Benchmark	System 1 BER kg CO ₂ /m ²	System 2 BER kg CO ₂ /m ²	System 3 BER kg CO ₂ /m ²	System 1 Cost per m ² v carbon metric	System 2 Cost per m ² v carbon metric	System 3 Cost per m ² v carbon metric
2. The BER must be 20% lower than the TER. This is the Extant Policy	27.2	23.8	24.7	£1,705.20 £46.40 / TCO ₂	£1,734.40 / m ² £41.30 / TCO ₂	£1,775.90 / m ² £43.90 / TCO ₂
3. The BER must be 25% lower than the TER. This is a proposed borough policy	25.5	21.2	23.2	£1,712.20 / m ² £43.70 / TCO ₂	£1,744.20 / m ² £37.00 / TCO ₂	£1,781.50 / m ² £41.350 / TCO ₂
4. The BER must be 30% lower than the TER. This is a proposed borough policy	22.4	20.4	21.2	£1,780.80 / m ² £39.90 / TCO ₂	£1,747.00 / m ² £35.60 / TCO ₂	£1,847.30 / m ² £39.00 / TCO ₂
5. The BER must be 35% lower than the TER. This is a proposed borough policy	21.2	19.3	20.1	£1,819.20 / m ² £38.60 / TCO ₂	£1,838.30 / m ² £35.50 / TCO ₂	£1,891.90 / m ² £38.00 / 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 3 to 6. This does not mean that Simulations 4 and 5 do 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: Domestic Type LTHW Heating System Using Gas Fired Boilers

Simulation Building		BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
1.	<p>Building Type Residential Care Home.</p> <p>Benchmark The BER ≤ TER. This is a requirement of Criterion 1 of Part L2A.</p> <p>Summary - pass</p>	<p>30.6</p> <p>The BER is 10.3% less than the TER</p>	34.1	£1,671.50 per functional unit (m ²)	<p>Building fabric Air permeability 5 at 50 Pa (m³/(h.m²) = 5. Fabric U values, as per the notional building. Glazing g values, as per the notional building.</p> <p>HVAC <u>Heating</u> A decentralized hydronic low temperature hot water (LTHW) system has been modelled.</p> <p>The boiler efficiency is taken at 91% gross and wider system details and efficiencies as per the notional building. Pumps are variable speed with multiple pressure sensors.</p> <p><u>Ventilation</u></p>



Simulation Building	BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
				<p>Ventilation is provided naturally with the exception of bathrooms/showers which have localized extraction. Air exchange rates for WC/bathroom areas have been taken at 10 air changes per hour, and the specific fan power (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>Domestic Hot Water Locally sited calorifiers totalling 1700 litres.</p> <p>Lighting 60 lumens per circuit-watt, 100 lux – circulation space 60 lumens per circuit-watt, 300 lux all other spaces</p> <p>The light efficacy in the Notional Building is 60 lumens per circuit-watt.</p> <p>Lighting controls Photoelectric – typically yes Motion sensors – typically no, as this would be impractical (PIR to common areas and office area only)</p> <p>Design challenges/considerations</p>



Simulation Building	BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
				<p>Using BSRIA Rules of Thumb, we estimate that the total domestic hot water (DHW) requirement for this building is 1700 litres. Accounting for diversity (of use) we can reduce a centralized calorifier to circa 1100 litres. However, this system fails Part L2A as the act of introducing secondary circulation increases auxiliary power to more than the Notional Building.⁶</p> <p>To pass Part L2A, one must assume locally sited calorifiers totalling 1700 litres. A saving is made operationally since secondary circulation is not required. However, this may increase capital expenditure since multiple calorifiers and boilers are required.</p> <p>From an operational perspective a developer (or at least an owner/occupier) may choose to install a centralized system and this will require LZC technologies to pass Part L2A.</p>
<p>2. Building type Residential Care Home.</p> <p>Benchmark The BER must be 20% lower than the TER. This is the extant borough policy.</p>	27.2	27.3 (this is the TER less 20%)	£1,705.20 per functional unit (m2)	<p>As per simulation 1 but with an additional 9kWp mono crystalline PV system on roof mounts facing due south-east at a 30 degree incline.</p> <p>This will require around 108 m2 of flat roof space – the flat roof of the proposed property extends to about 214 m².</p>

⁶ NB this type of decentralised system has been modelled in System 2



Simulation Building	BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
Summary - pass				
<p>3. Building type Residential Care Home.</p> <p>Benchmark The BER must be 25% lower than the TER. This is a proposed borough policy</p> <p>Summary - pass</p>	25.5	25.6 (this is the TER less 25%)	£1,712.20 per functional unit (m ²)	As per simulation 2, but with a PV system of increased capacity to 13.5 kWp requiring a flat roof area of 162 m ² - the flat roof of the proposed property extends to about 214 m ² .
<p>6. Building type Residential Care Home.</p> <p>Benchmark The BER must be 30% lower than the TER. This is a proposed borough policy</p> <p>Summary - pass</p>	22.4	23.9 (this is the TER less 30%)	£1,780.80 per functional unit (m ²)	<p>As per simulation 3 but with improved fabric (see below) and a PV system of increased capacity to 17.75 kWp requiring a flat roof area of 213 m² - the flat roof of the proposed property extends to about 214 m².</p> <p>NB although this has resulted in a pass, we note that ALL available roof space will now be occupied by a PV system. In practice building designers may look for alternative solutions to gain the 20% reduction, such as hybrid LZC solutions.</p> <p>We have made an allowance to the construction costs to allow for the increased loading of PV on the roof structure.</p> <p>Improved Building fabric</p> <p>Air permeability 5 at 50 Pa (m³/(h.m²) = 3.5</p> <p>Fabric U values, typically 0.15 w/m²K</p>



Simulation Building	BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
				Thermal bridging Ψ-value, 0.01 Glazing U values, 0.8 w/m ² K Glazing g values, 0.5
<p>7. Building type Residential Care Home.</p> <p>Benchmark The BER must be 35% lower than the TER. This is a proposed borough policy</p> <p>Summary - pass</p>	21.2	21.7 (this is the target under Proposed Policy. It is the TER less 35%. However, the baseline TER has changed to 33.3% to account for MVHR ⁷)	£1,819.20 per functional unit (m ²)	As per simulation 4 but with full MVHR with an SFP of 0.5 w/l/s, heat recovery efficiency of 75% and reduced air permeability 5 at 50 Pa (m ³ /(h.m ²) = 3.0. PV systems now moderately ventilated to improve yield.

⁷ Mechanical ventilation and heat recovery



3.2. System 2: Air to Water Air Source Heat Pump (ASHP) with Secondary Domestic Hot Water Circulation

Simulation Building		BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
1.	<p>Building type Residential Care Home.</p> <p>Benchmark The BER ≤ TER. This is a requirement of Criterion 1 of Part L2A.</p> <p>Summary - pass</p>	26.4	29.9	£1,703.50 per functional unit (m ²)	<p>Building fabric Air permeability 5 at 50 Pa (m³/(h.m²) = 5 Fabric U values, as per the notional building Glazing g values, as per the notional building</p> <p>HVAC <u>Heating</u> A hydronic low temperature hot water (LTHW) system has been modelled. The heat source is an air to water ASHP, a LZC technology. The CoP has been modelled at 3.9⁸ a requirement of the Energy Technology List (ETL)⁹. Pumps are variable speed with multiple pressure sensors.</p> <p><u>Ventilation</u> Ventilation is provided naturally with the exception of bathrooms/showers which have localized extraction. Air exchange rates for WC/bathroom areas have been taken</p>

⁸ For each unit of energy input 3.9 units of heat is delivered as an output under test conditions

⁹ 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



Simulation Building		BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
					<p>at 10 air changes per hour, and the specific fan power (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>Lighting 60 lumens per circuit-watt, 100 lux – circulation space. 60 lumens per circuit-watt, 300 lux all other spaces.</p> <p>The light efficacy in the Notional Building is 60 lumens per circuit-watt.</p> <p>Lighting controls Photoelectric – typically yes Motion sensors – typically no, as this would be impractical (PIR to common areas and office area only).</p> <p>Design challenges/considerations Using BSRIA Rules of Thumb, we estimate that the total domestic hot water (DHW) requirement for this building is 1700 litres. Accounting for diversity (of use) we can reduce a centralized calorifier to circa 1100 litres.</p>
4.	Building type	23.8	23.9 (this the TER less 20%)	£1,734.40 per functional unit (m ²)	As per Simulation 1 but with a 7kWp mono crystalline PV system on roof mounts facing due south-east at a 30 degree incline.



Simulation Building		BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
	<p>Residential Care Home.</p> <p>Benchmark</p> <p>The BER must be 20% lower than the TER. This is the extant borough policy.</p> <p>Summary - pass</p>				<p>This will require around 84m² of flat room space –the flat roof of the proposed property extends to about 214 m².</p>
5.	<p>Building type</p> <p>Residential Care Home.</p> <p>Benchmark</p> <p>The BER must be 25% lower than the TER. This is a proposed borough policy which we refer to as Proposed Policy A.</p> <p>Summary - pass</p>	21.2	22.4 (this is the TER less 25%)	£1,744.23 per functional unit (m ²)	<p>As per simulation 4 but with an additional 14kWp mono crystalline PV system on roof mounts facing due south-east at a 30 degree incline.</p> <p>This will require around 168 m² of flat room space –the flat roof of the proposed property extends to about 214 m².</p>
6.	<p>Building type</p> <p>Residential Care Home.</p> <p>Benchmark</p> <p>The BER must be 30% lower than the TER. This is a proposed borough policy</p> <p>Summary – pass</p>	20.4	20.9 (this is the TER less 30%)	£1,747.03 per functional unit (m ²)	<p>As per Simulation 5 but with a 16kWp PV system requiring 192m² of flat room space –the flat roof of the proposed property extends to about 214 m².</p>



Simulation Building		BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
7.	<p>Building type Residential Care Home.</p> <p>Benchmark The BER must be 35% lower than the TER. This is a proposed borough policy</p> <p>Summary – pass</p>	19.3	19.4 (this is the target under Proposed Policy. It is the TER less 35%. However, the baseline TER has changed to 33.3% to account for MVHR ¹⁰)	£1,838.30 per functional unit (m ²)	<p>As per simulation 6 but with full MVHR with an SFP of 0.5 w/l/s, heat recovery efficiency of 75% and reduced air permeability 5 at 50 Pa (m³/(h.m²) = 3.0.</p> <p>PV systems now increased to 17 kWp and moderately ventilated to improve yield. Roof space required circa 204m².</p> <p>Improved Building fabric Air permeability 5 at 50 Pa (m³/(h.m²) = 3.0 Fabric U values, typically 0.15 w/m²K Thermal bridging Ψ-value, 0.01 Glazing U values, 0.8 w/m²K Glazing g values, 0.5</p>

¹⁰ Mechanical ventilation and heat recovery



3.3. System 3: District heating using gas fired CHP

System 3 utilises a district heating network with gas fired CHP. This will also be impacted by any changes to SAP emissions and it may be the case that in the very near future the heat source will need to be electric, biomass or biogas.

There was a discrepancy identified in our 2017 study between SAP and SBEM generated values around the BER from buildings on this system. When EVORA EDGE updated its 2016 model to the 2019 version of IES this appears to have corrected itself with an improvement to the BER. We investigated this with IES, and it transpires that this is to do with IES incorrectly rounding up emissions factors and correcting this in the most recent release of its software.

Simulation Building		BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
1.	<p>Building type Residential Care Home.</p> <p>Benchmark The BER ≤ TER. This is a requirement of Criterion 1 of Part L2A.</p> <p>Summary - pass</p>	28.9	31.00	£1,739.40 per functional unit (m ²)	<p>Building fabric Air permeability 5 at 50 Pa (m³/(h.m²)) = 5 Fabric U values, as per the notional building Glazing g values, as per the notional building</p> <p>HVAC <u>Heating</u> A hydronic low temperature hot water (LTHW) system has been modelled.</p> <p>The heat source is a district heating scheme using gas fired CHP. Heat is delivered through a primary circuit and transferred through a heat interface unit (HIU) to the secondary circuits to each demise.</p>



Simulation Building	BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
				<p>Pumps are variable speed with multiple pressure sensors.</p> <p><u>Ventilation</u></p> <p>Ventilation is provided naturally with the exception of bathrooms/showers which have localized extraction. Air exchange rates for WC/bathroom areas have been taken at 10 air changes per hour, and the specific fan power (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>Lighting</p> <p>60 lumens per circuit-watt, 100 lux – circulation space. 60 lumens per circuit-watt, 300 lux all other spaces.</p> <p>The light efficacy in the Notional Building is 60 lumens per circuit-watt.</p> <p>Lighting controls</p> <p>Photoelectric – typically yes Motion sensors – typically no, as this would be impractical (PIR to common areas and office area only).</p>



Simulation Building		BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
					<p>Design challenges/considerations</p> <p>Using BSRIA Rules of Thumb, we estimate that the total domestic hot water (DHW) requirement for this building is 1700 litres. We have modelled this on the basis of locally sited calorifiers totalling 1700 litres.</p>
3.	<p>Building type Residential Care Home.</p> <p>Benchmark The BER must be 20% lower than the TER. This is the extant borough policy.</p> <p>Summary – pass</p>	24.7	24.8 (this is the TER less 20%)	£1,775.90 per functional unit (m ²)	<p>As per Simulation 1.0 but with an 11kWp mono crystalline PV system on roof mounts facing due south-east at a 30 degree incline.</p> <p>The system requires 132 m² of flat roof space and the flat roof of the proposed property extends to about 214 m².</p>
4.	<p>Building type Residential Care Home.</p> <p>Benchmark The BER must be 25% lower than the TER. This is a proposed borough policy.</p> <p>Summary – pass</p>	23.2	23.25 (this is the TER less 25%)	£1,781.50 per functional unit (m ²)	<p>As per Simulation 3.0 but with a 15kWp mono crystalline PV system on roof mounts facing due south-east at a 30 degree incline.</p> <p>The system requires 180 m² of flat roof space and the flat roof of the proposed property extends to about 214 m².</p>
6.	<p>Building type Residential Care Home.</p>	21.1	21.7 (this is the TER less 30%)	£1,924,867.54 or £1,847.30 per	As per Simulation 4.0 but with improved building fabric and a 17kWp mono crystalline PV system on roof mounts facing due south-east at a 30 degree incline.



Simulation Building		BER kg CO ₂ /m ²	TER kg CO ₂ /m ²	Indicative costs of construction	Technical detail
	<p>Benchmark The BER must be 30% lower than the TER. This is a proposed borough policy.</p> <p>Summary – pass</p>			functional unit (m ²)	<p>Improved Building fabric Air permeability 5 at 50 Pa (m³/(h.m²) = 3.5 Fabric U values, typically 0.15 w/m²K Thermal bridging Ψ-value, 0.01 Glazing U values, 0.8 w/m²K Glazing g values, 0.5</p>
7.	<p>Building type Residential Care Home.</p> <p>Benchmark The BER must be 35% lower than the TER. This is a proposed borough policy.</p> <p>Summary – pass</p>	20.1	20.28 (this is the target under Proposed Policy. It is the TER less 35%. However, the baseline TER has changed to 33.3% to account for MVHR ¹¹)	£1,891.90 per functional unit (m ²)	<p>As per simulation 6 but with full MVHR with an SFP of 0.5 w/l/s, heat recovery efficiency of 75% and reduced air permeability 5 at 50 Pa (m³/(h.m²) = 3.0.</p> <p>PV systems now increased to 17 kWp and moderately ventilated to improve yield. Roof space required circa 204m².</p> <p>Improved Building fabric Air permeability 5 at 50 Pa (m³/(h.m²) = 3.0 Fabric U values, typically 0.15 w/m²K Thermal bridging Ψ-value, 0.01 Glazing U values, 0.8 w/m²K Glazing g values, 0.5</p>

¹¹ Mechanical ventilation and heat recovery

4. 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 £1,262.50 per m² 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 2017¹². The following weighting rules have been adopted throughout the project:

Property type	HVAC system type	Unadjusted weighting	BSRIA	Less allowance for lifts ¹³ 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

4.6. Base Cost

¹² 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.

¹³ 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.

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 m².



5. SYSTEM 1, SIMULATION 1

Guildford Project		Simulation V1 - Simulation 1.0 - Part L2A compliant asset									
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI		
6.1.1	Complete buildings (SPONS A&B 2020 - median cost - accommodation for the elderly)	11	1,262.50	1,042	0.82	1,078,730.50	1,035,581.28	993.84	1		
5	Services (BES) (typically based on apartment fit out (private))	11	0	0	1	0.00	0.00	0.00	1		
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1		
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1		
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1		
5.5	Heat source (HS) (SPONS M&E 2020 - upper end cost to account for multiple heat sources)	11	13.97	1,042	1	14,556.74	13,974.47	13.41	1		
5.6	Space heating (SPONS M&E 2020 - median cost)	11	88	1,042	1	91,696.00	88,028.16	84.48	1		
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	20	1,042	1	20,840.00	20,006.40	19.20	1		
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1		
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1		
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1		
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1		
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1		
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1		
Project cost							1,741,700.87	1,671.50			



6. SYSTEM 1, SIMULATION 2

Guildford Project		Simulation V1 - Simulation 2.0									
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI		
6.1.1	Complete buildings (SPONS A&B 2020 - median cost - accommodation for the elderly)	11	1,262.50	1,042	0.82	1,078,730.50	1,035,581.28	993.84	1		
5	Services (BES) (typically based on apartment fit out (private))	11	0	0	1	0.00	0.00	0.00	1		
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1		
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1		
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1		
5.5	Heat source (HS) (SPONS M&E 2020 - upper end cost to account for multiple heat sources)	11	13.97	1,042	1	14,556.74	13,974.47	13.41	1		
5.6	Space heating (SPONS M&E 2020 - median cost)	11	88	1,042	1	91,696.00	88,028.16	84.48	1		
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	20	1,042	1	20,840.00	20,006.40	19.20	1		
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1		
5.8.5	PV panels (SPONS M&E 2020 - median cost)	11	1,519	9	1	13,668.75	13,122.00	1.40	1		
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1		
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1		
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1		
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1		
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1		
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	1,042	1	22,924.00	22,007.04	21.12	1		
Project cost							1,776,829.91	1,705.21			



7. 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 - accommodation for the elderly)	11	1,262.50	1,042	0.82	1,078,730.50	1,035,581.28	993.84	1		
5	Services (BES) (typically based on apartment fit out (private))	11	0	0	1	0.00	0.00	0.00	1		
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1		
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1		
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1		
5.5	Heat source (HS) (SPONS M&E 2020 - upper end cost to account for multiple heat sources)	11	13.97	1,042	1	14,556.74	13,974.47	13.41	1		
5.6	Space heating (SPONS M&E 2020 - median cost)	11	88	1,042	1	91,696.00	88,028.16	84.48	1		
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	20	1,042	1	20,840.00	20,006.40	19.20	1		
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1		
5.8.5	PV panels (SPONS M&E 2020 - median cost)	11	1,519	14	1	21,262.50	20,412.00	1.40	1		
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1		
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1		
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1		
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1		
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1		
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	1,042	1	22,924.00	22,007.04	21.12	1		
Project cost							1,784,119.91	1,712.21			



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 - accommodation for the elderly)	11	1,342.50	1,042	0.82	1,147,085.70	1,101,202.27	1,056.82	1	
5	Services (BES) (typically based on apartment fit out (private))	11	0	0	1	0.00	0.00	0.00	1	
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1	
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1	
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1	
5.5	Heat source (HS) (SPONS M&E 2020 - upper end cost to account for multiple heat sources)	11	13.97	1,042	1	14,556.74	13,974.47	13.41	1	
5.6	Space heating (SPONS M&E 2020 - median cost)	11	88	1,042	1	91,696.00	88,028.16	84.48	1	
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	20	1,042	1	20,840.00	20,006.40	19.20	1	
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1	
5.8.5	PV panels (SPONS M&E 2020 - median cost)	11	1,519	18	1	27,337.50	26,244.00	1.40	1	
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1	
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1	
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1	
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1	
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1	
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	1,042	1	22,924.00	22,007.04	21.12	1	
Project cost							1,855,572.90	1,780.78		



9. 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 - accommodation for the elderly)	11	1,342.50	1,042	0.82	1,147,085.70	1,101,202.27	1,056.82	1
5	Services (BES) (typically based on apartment fit out (private))	11	0	0	1	0.00	0.00	0.00	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1
5.5	Heat source (HS) (SPONS M&E 2020 - upper end cost to account for multiple heat sources)	11	13.97	1,042	1	14,556.74	13,974.47	13.41	1
5.6	Space heating (SPONS M&E 2020 - median cost)	11	88	1,042	1	91,696.00	88,028.16	84.48	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	60	1,042	1	62,520.00	60,019.20	57.60	1
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1
5.8.5	PV panels (SPONS M&E 2020 - median cost)	11	1,519	18	1	27,337.50	26,244.00	1.40	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	1,042	1	22,924.00	22,007.04	21.12	1
Project cost							1,895,585.70	1,819.18	



10. 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 - accommodation for the elderly)	11	1,262.50	1,042	0.82	1,078,730.50	1,035,581.28	993.84	1		
5	Services (BES) (typically based on apartment fit out (private))	11	0	0	1	0.00	0.00	0.00	1		
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1		
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1		
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1		
5.5	Heat source (HS) - heat pump (taken at £550 per kW of estimated load @ 70 w x GIFA (source CIBSE))	1	40,150.00	1	1	40,150.00	38,544.00	36.99	1		
5.6	Space heating (SPONS M&E 2020 - upper end cost to account for radiator sizing)	11	96.8	1,042	1	100,865.60	96,830.98	92.93	1		
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	20	1,042	1	20,840.00	20,006.40	19.20	1		
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1		
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1		
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1		
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1		
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1		
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1		
Project cost							1,775,073.22	1,703.53			



11. 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 - accommodation for the elderly)	11	1,262.50	1,042	0.82	1,078,730.50	1,035,581.28	993.84	1		
5	Services (BES) (typically based on apartment fit out (private))	11	0	0	1	0.00	0.00	0.00	1		
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1		
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1		
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1		
5.5	Heat source (HS) - heat pump (taken at £550 per kW of estimated load @ 70 w x GIFA (source CIBSE))	1	40,150.00	1	1	40,150.00	38,544.00	36.99	1		
5.6	Space heating (SPONS M&E 2020 - upper end cost to account for radiator sizing)	11	96.8	1,042	1	100,865.60	96,830.98	92.93	1		
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	20	1,042	1	20,840.00	20,006.40	19.20	1		
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1		
5.8.5	Local electricity generation systems (SPONS M&E 2020 - median cost)	11	1,518.75	7	1	10,631.25	10,206.00	1.40	1		
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1		
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1		
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1		
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1		
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1		
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	1,042	1	22,924.00	22,007.04	21.12	1		
Project cost							1,807,286.26	1,734.44			



12. 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 - accommodation for the elderly)	11	1,262.50	1,042	0.82	1,078,730.50	1,035,581.28	993.84	1		
5	Services (BES) (typically based on apartment fit out (private))	11	0	0	1	0.00	0.00	0.00	1		
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1		
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1		
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1		
5.5	Heat source (HS) - heat pump (taken at £550 per kW of estimated load @ 70 w x GIFA (source CIBSE))	1	40,150.00	1	1	40,150.00	38,544.00	36.99	1		
5.6	Space heating (SPONS M&E 2020 - upper end cost to account for radiator sizing)	11	96.8	1,042	1	100,865.60	96,830.98	92.93	1		
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	20	1,042	1	20,840.00	20,006.40	19.20	1		
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1		
5.8.5	Local electricity generation systems (SPONS M&E 2020 - median cost)	11	1,518.75	14	1	21,262.50	20,412.00	1.40	1		
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1		
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1		
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1		
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1		
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1		
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	1,042	1	22,924.00	22,007.04	21.12	1		
Project cost							1,817,492.26	1,744.23			



13. 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 - accommodation for the elderly)	11	1,262.50	1,042	0.82	1,078,730.50	1,035,581.28	993.84	1		
5	Services (BES) (typically based on apartment fit out (private)	11	0	0	1	0.00	0.00	0.00	1		
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1		
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1		
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1		
5.5	Heat source (HS) - heat pump (taken at £550 per kW of estimated load @ 70 w x GIFA (source CIBSE))	1	40,150.00	1	1	40,150.00	38,544.00	36.99	1		
5.6	Space heating (SPONS M&E 2020 - upper end cost to account for radiator sizing)	11	96.8	1,042	1	100,865.60	96,830.98	92.93	1		
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	20	1,042	1	20,840.00	20,006.40	19.20	1		
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1		
5.8.5	Local electricity generation systems (SPONS M&E 2020 - median cost)	11	1,518.75	16	1	24,300.00	23,328.00	1.40	1		
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1		
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1		
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1		
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1		
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1		
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	1,042	1	22,924.00	22,007.04	21.12	1		
Project cost							1,820,408.26	1,747.03			



14. 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 - accommodation for the elderly)	11	1,342.50	1,042	0.82	1,147,085.70	1,101,202.27	1,056.82	1
5	Services (BES) (typically based on apartment fit out (private)	11	0	0	1	0.00	0.00	0.00	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1
5.5	Heat source (HS) - heat pump (taken at £550 per kW of estimated load @ 70 w x GIFA (source CIBSE))	1	40,150.00	1	1	40,150.00	38,544.00	36.99	1
5.6	Space heating (SPONS M&E 2020 - upper end cost to account for radiator sizing)	11	96.8	1,042	1	100,865.60	96,830.98	92.93	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	60	1,042	1	62,520.00	60,019.20	57.60	1
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1
5.8.5	Local electricity generation systems (SPONS M&E 2020 - median cost)	11	1,518.75	7	1	10,631.25	10,206.00	1.40	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost) - specialist PV mounting	11	379.7	7	1	2,657.81	2,551.50	364.50	1
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2020 - cost models)	11	22	1,042	1	22,924.00	22,007.04	21.12	1
Project cost							1,915,471.55	1,838.26	



15. SYSTEM 3, SIMULATION 1

Guildford Project		System V3 - Simulation 1.0 - Part L2A compliant asset									
ID	Description	Code	Rate	Quantity	Weight	Base cost £	Cost £	Cost £ / FU	TPI		
6.1.1	Complete buildings (SPONS A&B 2020 - median cost - accommodation for the elderly)	11	1,262.50	1,042	0.82	1,078,730.50	1,035,581.28	993.84	1		
5	Services (BES) (typically based on apartment fit out (private)	11	0	0	1	0.00	0.00	0.00	1		
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1		
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1		
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1		
5.5	Heat source (HS) gas fired CHP via a heat network and site wide energy centre	11	75.9	1,042	1	79,087.80	75,924.29	72.86	1		
5.6	Space heating (SPONS M&E 2020 - upper end cost to account for radiator sizing)	11	96.8	1,042	1	100,865.60	96,830.98	92.93	1		
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	20	1,042	1	20,840.00	20,006.40	19.20	1		
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1		
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1		
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1		
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1		
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1		
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1		
Project cost							1,812,453.50	1,739.40			



16. SYSTEM 3, SIMULATION 3

Guildford Project System V3 - 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 - accommodation for the elderly)	11	1,262.50	1,042	0.82	1,078,730.50	1,035,581.28	993.84	1
5	Services (BES) (typically based on apartment fit out (private)	11	0	0	1	0.00	0.00	0.00	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1
5.5	Heat source (HS) gas fired CHP via a heat network and site wide energy centre	11	75.9	1,042	1	79,087.80	75,924.29	72.86	1
5.6	Space heating (SPONS M&E 2020 - upper end cost to account for radiator sizing)	11	96.8	1,042	1	100,865.60	96,830.98	92.93	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	20	1,042	1	20,840.00	20,006.40	19.20	1
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1
5.8.5	Local electricity generation systems	11	1,518.75	11	1	16,706.25	16,038.00	1.40	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2017 - cost models)	11	22	1,042	1	22,924.00	22,007.04	21.12	1
Project cost							1,850,498.54	1,775.91	



17. SYSTEM 3, SIMULATION 4

Guildford Project		System V3 - 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 - accommodation for the elderly)	11	1,262.50	1,042	0.82	1,078,730.50	1,035,581.28	993.84	1	
5	Services (BES) (typically based on apartment fit out (private)	11	0	0	1	0.00	0.00	0.00	1	
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1	
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1	
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1	
5.5	Heat source (HS) gas fired CHP via a heat network and site wide energy centre	11	75.9	1,042	1	79,087.80	75,924.29	72.86	1	
5.6	Space heating (SPONS M&E 2020 - upper end cost to account for radiator sizing)	11	96.8	1,042	1	100,865.60	96,830.98	92.93	1	
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	20	1,042	1	20,840.00	20,006.40	19.20	1	
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1	
5.8.5	Local electricity generation systems	11	1,518.75	15	1	22,781.25	21,870.00	1.40	1	
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1	
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1	
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1	
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1	
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1	
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2017 - cost models)	11	22	1,042	1	22,924.00	22,007.04	21.12	1	
Project cost							1,856,330.54	1,781.51		



18. SYSTEM 3, SIMULATION 6

Guildford Project System V3 - 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 - accommodation for the elderly)	11	1,342.50	1,042	0.82	1,147,085.70	1,101,202.27	1,056.82	1
5	Services (BES) (typically based on apartment fit out (private)	11	0	0	1	0.00	0.00	0.00	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1
5.5	Heat source (HS) gas fired CHP via a heat network and site wide energy centre	11	75.9	1,042	1	79,087.80	75,924.29	72.86	1
5.6	Space heating (SPONS M&E 2020 - upper end cost to account for radiator sizing)	11	96.8	1,042	1	100,865.60	96,830.98	92.93	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	20	1,042	1	20,840.00	20,006.40	19.20	1
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1
5.8.5	Local electricity generation systems	11	1,518.75	17	1	25,818.75	24,786.00	1.40	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2017 - cost models)	11	22	1,042	1	22,924.00	22,007.04	21.12	1
Project cost							1,924,867.54	1,847.28	

19. SYSTEM 3, SIMULATION 7

Guildford Project System V3 - 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 - accommodation for the elderly)	11	1,342.50	1,042	0.82	1,147,085.70	1,101,202.27	1,056.82	1
5	Services (BES) (typically based on apartment fit out (private))	11	0	0	1	0.00	0.00	0.00	1
5.1	Sanitary installations (SA) (SPONS M&E 2020 - median cost)	11	110	1,042	1	114,620.00	110,035.20	105.60	1
5.3	Disposal installation (DI) (SPONS M&E 2020 - median cost)	11	26.95	1,042	1	28,081.90	26,958.62	25.87	1
5.4	Water installations (WI) (SPONS M&E 2020 - median cost)	11	59.95	1,042	1	62,467.90	59,969.18	57.55	1
5.5	Heat source (HS) gas fired CHP via a heat network and site wide energy centre	11	75.9	1,042	1	79,087.80	75,924.29	72.86	1
5.6	Space heating (SPONS M&E 2020 - upper end cost to account for radiator sizing)	11	96.8	1,042	1	100,865.60	96,830.98	92.93	1
5.7	Ventilation systems (VS) (SPONS M&E 2020 - median cost)	11	60	1,042	1	62,520.00	60,019.20	57.60	1
5.8	Electrical installations (EI) (SPONS M&E 2020 - median cost)	11	123.75	1,042	1	128,947.50	123,789.60	118.80	1
5.8.5	Local electricity generation systems	11	1,518.75	17	1	25,818.75	24,786.00	1.40	1
5.9	Fuel installations / systems (FI) (SPONS M&E 2020 - median cost)	11	17.05	1,042	1	17,766.10	17,055.46	16.37	1
5.10.1	Lifts and enclosed hoists (SPONS M&E 2020 - 8 person lift)	1	72,600.00	1	1	72,600.00	69,696.00	66.89	1
5.11	Fire and lightning protection (FLP) (SPONS M&E 2020 - median cost)	11	31.9	1,042	1	33,239.80	31,910.21	30.62	1
5.12	Communication, security and control systems (CSC) (SPONS M&E 2020 - median cost)	11	110.55	1,042	1	115,193.10	110,585.38	106.13	1
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost) - specialist PV mounting	11	397.7	17	1	6,760.90	6,490.46	381.79	1
5.13	Special installations / Systems (SI) (SPONS M&E 2020 - median cost)	11	34.1	1,042	1	35,532.20	34,110.91	32.74	1
2.3.1	Roof (ROO) - additional roof reinforcement for PV only (SPONS A&B 2017 - cost models)	11	22	1,042	1	22,924.00	22,007.04	21.12	1
Project cost							1,971,370.80	1,891.91	



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