Assessment of the Viability of Carbon Emission Targets for New Builds – Main Report

FEBRUARY 2020

Author: Andrew Cooper, Director **|** **Reviewed**: Neil Dady, Director **|** **Issue Status: V1.0**

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1. INTRODUCTION TO THE PROJECT

In 2017 Guildford Borough Council (GBC) commissioned EVORA EDGE to determine what the additional cost would be for a developer to reduce carbon dioxide (CO_2) emissions if the target detailed in Action 4 of its Sustainable Design and Construction Supplementary Planning Document (SPD) was strengthened from 10% to 15% or 20%. Following this study GBC has set this target at 20% with the exception of retail in the town centre. GBC has now asked EVORA EDGE to extend its study to include increased targets of 25%, 30% and 35%. It has also asked EVORA EDGE to consider the possible effect of mandating the BRE Home Quality Mark (HQM) on new residential developments.

GBC is not alone in its ambitions to reduce CO_2 emissions. As of June 2019, the UK Government amended the Climate Change Act[1] committing the UK to zero carbon emissions by 2050 while the London Plan's Policy 5.2 already mandates zero carbon construction for residential properties.

The purpose of this extension report 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 (the extra over costs) for meeting the proposed revised targets now under consideration by GBC.

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

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

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?

This report summarises the findings of four separate reports covering domestic (flats and houses) and non-domestic (offices, residential care homes and retail).

2. EXECUTIVE SUMMARY

Set out below is a summary of the answers to the three questions raised in Section 1. *Introduction to The Project*. Additional information and greater detail on our findings are provided in the reports covering non-domestic and domestic constructions.

2.1. Question 1: Is it technically feasible to construct buildings that go beyond the requirements of a Target Emission Rate (TER) by between 25% and 35%?

Yes. Our simulations covering non-domestic and domestic properties found that in all scenarios we have been able to meet the maximum target rate of 35% (meaning that the Built Emission Rate (BER) or Dwelling Emission Rate (DER) is at least 35% lower than the Target Emission Rate (TER). Refer to Section 4 for and explanation of BER, DER and TER).

We were able to meet these targets through a 'fabric first' approach and through the use of energy efficient but typical building services. 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 or Zero Carbon (LZC) technologies which were incorporated to augment or replace conventional non-LZC technologies.

In order to meet the upper target rates of 30% and 35% it was necessary across some simulations to improve the efficiency of the building fabric such as the U value of floors, walls, roofs and windows, and it was also necessary to reduce glazing solar gain values (g values).

Of importance to the study are Standard Assessment Procedure (SAP) emissions factors. These are the factors that determine the level of CO_2 emissions generated by each kWh of energy used. Building Regulations (and EPCs) as at the date of this report are based around emission factors that are set out in SAP 2012. BRE, authors of the SAP methodology, have released revised SAP10.1 'SAP 10'. It is not known exactly when SAP 10 will come into effect, but the new methodology will supersede SAP 2012 when the Building Regulations Conservation of fuel and power: Approved Document L, is next updated, which is expected to be in 2020.

This is of relevance since the emissions factor of electricity will change considerably. SAP 2012 sets a value of 0.216 kg CO_2 per kWh for mains gas, and 0.519 kg CO_2 per kWh for electricity. SAP 10 changes this to 0.210 kg CO_2 per kWh for mains gas, and 0.136 CO_2 per kWh for electricity.

The moment this happens then developer's costs are likely to increase if they use conventional gas systems (such as condensing boilers) to meets Part L + targets. This is because they will likely have to improve fabric and fenestration and research has shown that this can increase costs. Therefore, it is likely that the most cost-effective way to meet any targets in the immediate future would be through electrical systems such as heat pumps, or district heating systems.

GBC may be interested in the approach that has been adopted by the Greater London Authority (GLA). In October 2018, the GLA published updated Energy Assessment Guidance which applies from January 2019 and directly impacts on developers. All new planning submissions in London are now 'encouraged' to use the new emissions factors detailed in the government's latest Standard Assessment Procedure for Building Regulations (i.e. SAP 10) alongside PART L 2013 (i.e. SAP 12). For more information on this please refer to our report on domestic properties.

We recommend that GBC considers adopting a similar approach to the GLA over what is now essentially a transitional period since SAP 2012 no longer represents grid emissions.

2.2. Question 2: What are the indicative cost implications of this type of enhanced policy for developers?

The tables in sections 2.2.1, 2.2.2, 2.2.3 and 2.2.4 provide a summary of the extra over costs to a developer against the base build case. For example, the extra over cost to a developer for constructing an office building that complies with a proposed target rate of 25% ranges from 2.13% to 2.55% if the base construction complies with Part L.

2.2.1. OFFICES

Base build case	Extra over costs as a percentage of the base build cost to reach a target of 25%	Extra over costs as a percentage of the base build cost to reach a target of 30%	Extra over costs as a percentage of the base build cost to reach a target of 35%
A building that complies with Part L	2.13% to 2.55%	4.75% to 5.70%	7.26% to 8.72%
A building that complies with the existing target of 20% (B/DER ≤ TER)	0.54% to 0.65%	3.13% to 3.75%	5.60% to 6.72%

2.2.2. RESIDENTIAL CARE HOMES

Base build case	Extra over costs as a percentage of the base build cost to reach a target of 25%	Extra over costs as a percentage of the base build cost to reach a target of 30%	Extra over costs as a percentage of the base build cost to reach a target of 35%
A building that complies with Part L	1.37% to 1.65%	3.47% to 4.16%	7.27% to 8.72%
A building that complies with the existing target of 20% (B/DER ≤ TER)	0.49% to 0.59%	2.56% to 3.08%	6.33% to 7.60%

2.2.3. RETAIL

Base build case	Extra over costs as a percentage of the base build cost to reach a target of 25%	Extra over costs as a percentage of the base build cost to reach a target of 30%	Extra over costs as a percentage of the base build cost to reach a target of 35%
A building that complies with Part L	2.29% to 2.75%	2.80% to 3.35%	3.42% to 4.11%
A building that complies with the existing target of 20% (B/DER ≤ TER)	1.15% to 1.37%	1.64% to 1.97%	2.27% to 2.72%

2.2.4. RESIDENTIAL

Base build case	Extra over costs as a percentage of the base build cost to reach a target of 25%	Extra over costs as a percentage of the base build cost to reach a target of 30%	Extra over costs as a percentage of the base build cost to reach a target of 35%
A building that complies with Part L	3.76% to 4.51%	4.65% to 5.58%	7.46% to 9.3%
A building that complies with the existing target of 20% (B/DER ≤ TER)	0.91% to 1.09%	1.77% to 2.13%	4.50% to 5.6%

2.3. *Question 3: What will be the impact of mandating the BRE HQM on residential developments?*

Through research we have concluded that to-date take up of the scheme is low in comparison to the Code for Sustainable Homes (CfSH). The relevance of this is that while there was previous evidence of the effect of CfSH on the costs of construction, there is no evidence that we are aware of showing the effect of BRE HQM on the costs of construction. Further, while previous studies by DCLG showed a clear link between Code levels and DER target rates, BRE HQM is opaque around this. For example, Table 1.2 of DCLG Code for Sustainable Homes Technical Guide 2010 (see below) shows that typically a Level 4 property is required to meet the first revised target rate of 25%, but no equivalent information is available in respect of BRE HQM without undertaking a BRE HQM assessment. The targets under the previous EVORA EDGE study and the existing GBC targets can be reached with a code Level 2 to 3 equivalent property with additional LZC as/when required.

…Levels for Mandatory Minimum Standards in CO_2 Emissions (Ene 1)

…e Level	Minimum Percentage Improvement in Dwelling Emission Rate ov… Target Emission Rate
Level 1 (★)	0% (Compliance with Part L 2010 only is required)
Level 2 (★★)	0% (Compliance with Part L 2010 only is required)
Level 3 (★★★)	0% (Compliance with Part L 2010 only is required)
…evel 4 (★★★★)	25%
…(★★★★★)	100%
…)	Net Zero CO_2 Emissions

It is therefore not possible to directly link BRE HQM to this study since energy only forms one element of a HQM (and any BREEAM) assessment, but with our experience of dealing with other BREEAM (commercial) schemes it is our view that if GBC mandates Very Good + for BRE HQM, then this will affect the cost of accreditation and the cost of construction. A practical example would be the inclusion of refrigeration leak detection to achieve a POL 1 credit which could add tens of thousands of pounds on to a large heat pump installation.

In our cost models we have therefore sought to draw an equivalence in terms of BRE HQM and CfSH with a Code Level 4 building used as the revised benchmark for having to achieve targets of between 25% and 35%. In other words, the cost models for the targets over 25% apply equally to our estimate on costs of adopting BRE HQM.

3. REPORT STRUCTURE

Our reporting structure incorporates four asset specific sub-reports as an appendices. These sub-reports provide a review and analysis of asset specific simulations and asset specific costs. For reasons of practicality and project costs the list of both assets and systems modelled is not exhaustive – however, assets have been selected to ensure that a suitably diverse range of system types and system complexities is represented. The results of these sub-reports have been reviewed, analysed and summarised as part of this overarching summary report. The asset specific reports cover the following asset types:

1. Domestic property (houses and flats)
2. Domestic/Non-domestic property (care homes and retirement homes with commercial systems)
3. Non-domestic property (large offices)
4. Non-domestic property (retail units)

Finally, a series of Building Information Models or BIMS have been created recording energy simulations and cost studies. Separately to the BIMs are a number of SAP[2] models since domestic SAP and non-domestic NCM[3] compliant software are not yet compatible. These BIMs and SAP files will be included in an evidence pack. Access to IES VE[4] and IES IMPACT will be required to review the BIMs and access to the STROMA SAP software[5] is required for the SAP files. For more information on our use of BIM etc. see Section 7.0 Project M*ethodology*.

4. THE TARGET EMISSION RATE (TER) IN PLANNING POLICY AND BUILDING REGULATIONS

In England, building standards - otherwise known as regulations, are mandated to provide protection to consumers and to ensure that government policy is implemented. Approved Documents L1A and L2A (ADL1A and ADL2A) of Building Regulations 2010 require that reasonable provision shall be made for the conservation of fuel and power in buildings by:

a. Limiting heat gains and losses-
    I. Through thermal elements and other parts of the building fabric; and
    II. From pipes, ducts and vessels used for space heating, space cooling and hot water services;
b. Providing fixed building services which-
    I. Are energy efficient

[2] The Standard Assessment Procedure (SAP) is the methodology used to assess and compare the energy and environmental performance of dwellings
[3] The National Calculation Method (NCM) is the procedure for demonstrating compliance with the Building Regulations for buildings other than dwellings
[4] https://www.iesve.com/
[5] https://www.stroma.com/software/sap-software-fsap

II. Have effective controls; and

III. Are commissioned by testing and adjusting as necessary to ensure they use no more fuel and power than is reasonable in the circumstances.

Both ADL1A and ADL2A mandate minimum energy performance standards known as the Target Emission Rate (TER) under what is known as Criterion 1. In addition, ADL1A has a further minimum standard known as a Target Fabric Efficiency Rate (TFEE).

These minimum performance standards are in turn used as a benchmark by Local Planning Authorities as a basis for defining and ensuring sustainable development. Where this is the case, as part of planning processes, an energy statement or strategy is necessary to demonstrate how a development will comply with local policy. Using the TER as the primary benchmark for energy efficiency and carbon dioxide emissions is therefore both logical and efficient, as it aligns planning policy with building regulations. A summary of the five criterion is included below:

Table 1: The Criterions of ADL1A and ADL2A of Building Regulations

CRITERION	DESCRIPTION	SUMMARY
1	Achieving the TER	The regulations state that where a building is erected it shall not exceed the TER for the building that was approved
2	Limits on design flexibility	This subjects any new development to limiting parameters for both building fabric and building services
3	Limiting the effects of heat gains in the summer	This requires a demonstration to show the building has appropriate passive control measures to limit solar gains
4	The building performance is consistent with the BER or DER	Buildings should be constructed and equipped to show that performance is consistent with the calculated BER or DER
5	Provisions for the energy efficient operation of the building	The owner of the building should be provided with sufficient information about the building so that the building can be operated in an efficient manner

CRITERION	DESCRIPTION	SUMMARY
EPBD (Recast requirement)[6]	Consideration of alternative energy systems	Alternative energy systems should be considered as part of the design process

5. CURRENT POLICY

Since 2011, Guildford Borough Council has had a requirement in place to reduce carbon dioxide emissions by 10% through the use of Low and Zero Carbon technologies. This is set out in Action 4 of its Sustainable Design and Construction Supplementary Planning Document (SPD). Following EVORA EDGE's report of 2017 policy was amended and currently the BER/DER must be at least 20% better than TER through any mix of fabric or energy, though the policy steers designs towards fabric first by hooking in the principle of the energy hierarchy.

The minimum 20% carbon reduction does not apply to retail only units within the town centre boundary. Retail units elsewhere still have to meet the carbon reduction. Where a mixed-use building of retail and other uses comes forward in the town centre, the other uses would still have to comply with the 20% reduction.

[6] As part of the latest version of ADL1A and ADL2A (effective 6th April 2014) the person who is to carry out the development must analyse and take into account the technical, environmental and economic feasibility of using high-efficiency alternative systems in the construction to include, if available-

1. Decentralised energy supply systems based on energy from renewable sources such as PV, solar or wind
2. Cogeneration, such as combined heat and power
3. District or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources
4. Heat pumps, including air source and ground source

6. ADVISORY NOTE ON SAP AND THE GREATER LONDON AUTHORITY

Building Regulations (and EPCs) as at the date of this report are based around emission factors that are set out in SAP 2012. BRE, authors of the SAP methodology, have released revised SAP10.1 'SAP 10'. It is not known when SAP 10 will come into effect. The new methodology will only supersede SAP 2012 when the Building Regulations Conservation of fuel and power: Approved Document L, is next updated, which is expected to be in 2020.

This is of relevance since the emissions factor of electricity will change considerably. SAP 2012 sets a value of 0.216 kg CO_2 per kWh for mains gas, and 0.519 kg CO_2 per kWh for electricity. SAP 10 changes this to 0.210 kg CO_2 per kWh for mains gas, and 0.136 CO_2 per kWh for electricity. This means that it will be very unlikely that a developer will be able to meet the upper end of the proposed targets when using fossil fuel systems (such as natural gas) without looking at increased LZC and increased (improved) fabric which is likely to increase costs.

GBC may be interested in the approach that has been adopted by the Greater London Authority (GLA). In October 2018, the GLA published updated Energy Assessment Guidance which applies from January 2019 and directly impacts on developers. All new planning submissions in London are now 'encouraged' to use the new emissions factors detailed in the government's latest Standard Assessment Procedure for Building Regulations (i.e. SAP 10) alongside PART L 2013 (i.e. SAP 12).

This is a highly unusual step for GLA to have taken, given SAP 10 has yet to be incorporated into official Building Regulations. However, the GLA guidance states that any energy assessments which do not use SAP10 will be expected to provide a justification as to why not and presumably this will be a consideration in planning approval.

The reason behind this policy change is England's rapid decarbonisation of the National Grid which has seen the amount of electricity sourced from wind and solar technologies increase year on year, while at the same time there is a move away from coal fired generation to gas fired generation.

The GLA believe the new SAP 10 factors more accurately reflect actual carbon emissions as the electricity emissions factor in SAP 10 is now 55% lower than that specified in PART L 2013. In practical terms, any PART L 2013 compliance should be accompanied by a separate spreadsheet document, supplied by the Greater London Authority (GLA), that translates energy consumption to SAP 10 carbon emissions.

The changes, detailed in the GLA's Energy Assessment Guidance, affect both residential and non-residential applications referred to the Mayor of London from January this year including:

- Developments of 150 residential units or more
- Development over 30 metres in height (outside the City of London)
- Development on Green Belt or Metropolitan Open Land

Applications for commercial developments also need to show at least a further 35% reduction in carbon emissions on top of those specified in PART L of Building Regulations 2013. However, the Mayor has already said that he intends to introduce zero carbon emissions for commercial developments in the final version of the London Plan.

Domestic / residential developments are already required to achieve zero carbon emissions. However, if this is not feasible or viable then developers must show how they will reduce emissions on-site by a minimum of 35% on top of those specified in Part L 2013. The remainder of the target needs to be met via carbon-offsetting either elsewhere in London (for example photovoltaic panels on a local school) or by contributing a carbon offset payment.

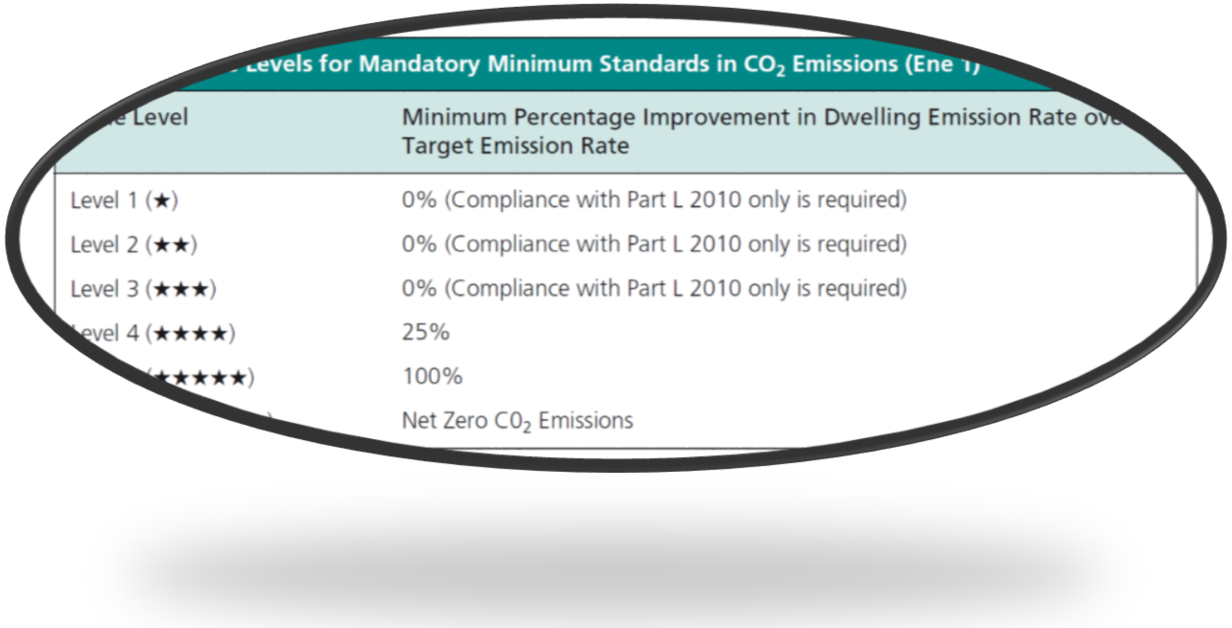
7. BRE HOME QUALITY MARK (HQM) – AND CODE FOR SUSTAINABLE HOMES (CFSH)

In 2015 the Government announced the conclusion to the Housing Standards Review. This review aimed to simplify government regulations and standards into one key set, driven by Building Regulations. As part of this review the Government also clarified the future of the Code for Sustainable Homes (CfSH) – a Government owned standard for sustainable house building. The written ministerial statement withdrew the Code (in England) so Local Authorities should no longer require it as a planning condition for new approvals.

Following this announcement BRE announced (also in 2015) that it was developing a Home Quality Mark (HQM) which would be a voluntary standard and accreditation scheme designed as a natural replacement for CfSH to maintain sustainability-driven house building standards. As part of this study GBC has asked EVORA EDGE to consider the effect of BRE HQM on CO_2 targets and in turn potential impact to developer's costs of construction.

EVORA EDGE has undertaken some research into the popularity of BRE HQM which included consulting with BRE HQM experts Encon Associates[7], and we have concluded that to-date take up of the scheme is low in comparison to CfSH. The relevance of this is that while there was previous evidence of the effect of CfSH on the costs of construction, there is no evidence that we are aware of showing the effect of BRE HQM on the costs of construction. Further, while previous studies by DCLG showed a clear link between Code levels and DER target rates, BRE HQM is opaque around this. For example, Table 1.2 of DCLG Code for Sustainable Homes Technical Guide 2010 (see below) shows that typically a Level 4 property is required to meet the first revised target rate of 25%, but no equivalent information is available in respect of BRE HQM without undertaking a BRE HQM assessment. The targets under the previous EVORA EDGE study and the existing GBC targets can be reached with a code Level 2 to 3 equivalent property with additional LZC as/when required.

[7] https://www.enconassociates.com/



Levels for Mandatory Minimum Standards in CO_2 Emissions (Ene 1)	
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Level 2 (★★)	0% (Compliance with Part L 2010 only is required)
Level 3 (★★★)	0% (Compliance with Part L 2010 only is required)
evel 4 (★★★★)	25%
★★★★★)	100%
)	Net Zero CO_2 Emissions

Indeed, BRE itself on its website states “It is difficult to draw comparisons between Code for sustainable homes (CfSH) and Home Quality Mark (HQM) schemes as it is not a like for like comparison. Although in principle CfSH and HQM seem similar in terms of some of the technical areas they consider, fundamentally their approaches and structures are very different. For example, specific technical content is very different and HQM is much more flexible as a scheme with only one mandatory requirement, which is important as a voluntary scheme. The outputs are also very different with any star rating considered as ‘better’ than minimum standards. The indicator scores within HQM also allow value to be drawn out from dwellings to a deeper level, while using a language that is consumer friendly”.

It is therefore not possible to directly link BRE HQM to this study since energy only forms one element of a HQM (and any BREEAM) assessment, but with our experience of dealing with other BREEAM (commercial) schemes it is our view that if GBC mandates Very Good + for BRE HQM, then this will affect the cost of accreditation and the cost of construction. A practical example would be the inclusion of refrigeration leak detection to achieve a POL 1 credit which could add tens of thousands of pounds on to a large commercial heat pump installation.

In our cost models we have therefore sought to draw an equivalence in terms of BRE HQM and CfSH with a Code Level 4 building used as the revised benchmark for having to achieve targets of between 25% and 35%.

8. REPORT SOURCES / REFERENCES

The following resources have informed this study:

- DCLG, Cost for Sustainable Homes, cost review, July 2011
- DCLG, Cost of building to the Code for Sustainable Homes, Updated cost review, August 2011
- Passivhaus Trust, PassivHaus Construction Costs, October 2019
- SPONS, Architects and Builders Price Book, 2020
- SPONS, Mechanical and Electrical Services Price Book, 2020

9. PROJECT METHODOLOGY

9.1. The simulations

Part L 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[8]. For a building to pass the exacting requirements of Part L it must be designed and constructed to a standard that meets or betters the TER of a Notional Building (BER / DER ≤ TER). A building that is constructed to the limiting parameters of Part L1/2A will fail Criterion 1, which is the Criterion that requires the BER / DER ≤ TER.

Each model simulated is identical in every respect other than its building services, which may or may not include renewable energy systems. To ensure that the model is capable of passing Part L the building fabric and thermal bridging is based upon the requirements of a Notional Building, and unless indicated to the contrary these remain unchanged throughout the various iterations of the model(s).

System 1 starts with the least number of LZC technologies possible for a typical services solution, and as the targets become more challenging, then more efficient conventional systems and/or LZC technologies are incorporated into the model(s) to augment or replace less efficient and/or non LZC technologies. Systems 2 to 4 on the other hand, start with LZC technologies, for example primary fossil fuel heating is typically replaced with heat pumps or district heating.

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

The main key difference between this and the 2017 study are the target rates of 25%, 30% and 35% and the fact that it was necessary for some simulations to improve building fabric.

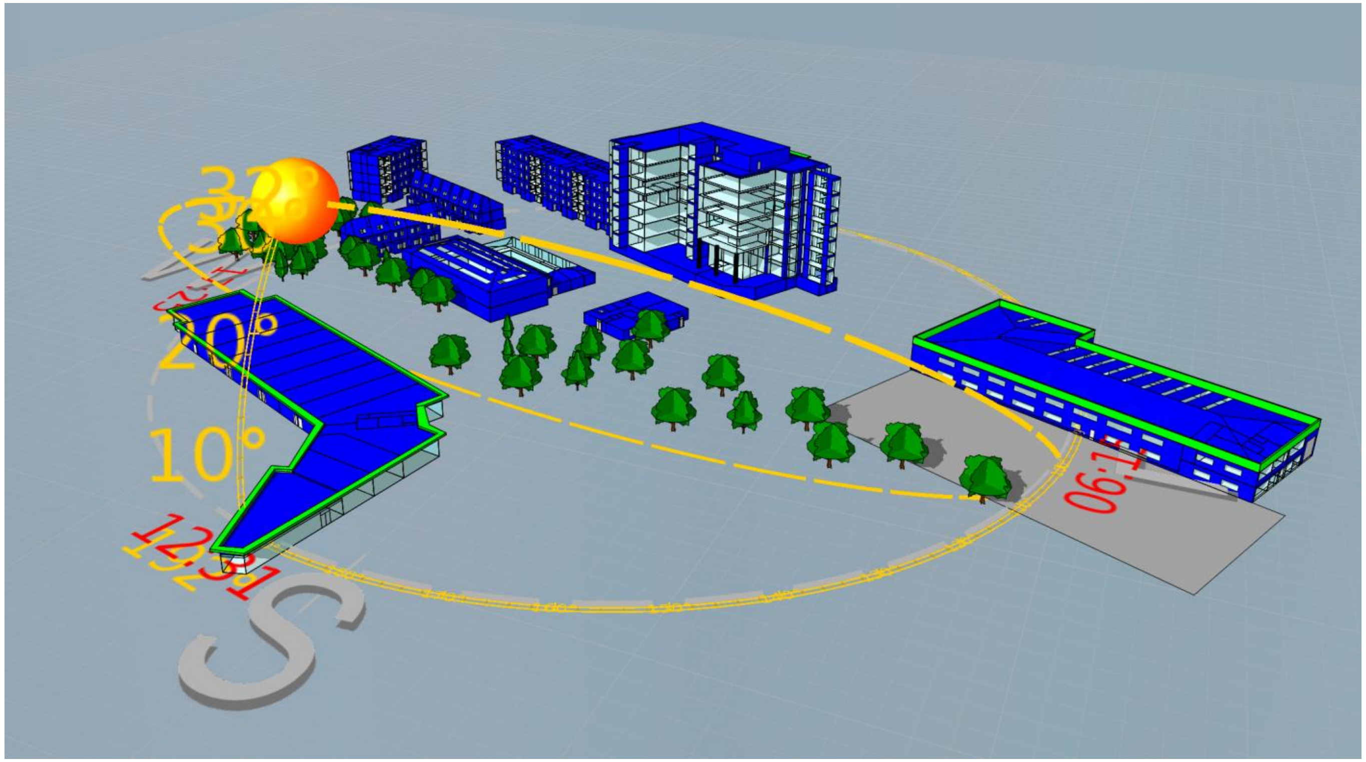
9.2. Building information model (BIM)

To prepare this report we have used building information models or BIMs created in IES engineering software - the Virtual Environment or VE and SAP. 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 or global BIM which was shared between two principal energy modellers.

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

A representation of the federated/global BIM is shown below. Those persons wishing to inspect these models must have access to appropriate SAP and 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/global BIM of a mixed-use scheme



9.3. Disclaimers

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 four benchmarks using the geometry and construction type of buildings which either already exist, or 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 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 L, or the Energy Technology List (ETL)[9], or other reputable or market sources.

[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.

Costs are indicative and for benchmarking purposes only. They exclude VAT and fees associated with design, professional services and project management. They do however include for preliminaries, profit and overheads for the services contractor. Build costs have typically been taken at the median of a range of costs detailed in SPONS 2020 unless indicated otherwise. Greater detail and information on our costing methodology has been provided in the sub-reports.

10. THE LZC TECHNOLOGIES MODELLED AND EXCLUDED FROM OUR RESEARCH

Table 3: LZC technologies reviewed by the study

ITEM	TECHNOLOGY	MODELLED	EXCLUDED
1	Heat pumps	Yes – we modelled air source heat pump (ASHP), air-to-air and air-to-water systems and we modelled ground source heat pump (GSHP) to water systems. These were typically found to be viable technologies[10] although we noted that some of the results in SAP were counter-intuitive in respect of GSHP.	No
2	Photovoltaics	Yes – we modelled solar PV. These were typically found to be viable technologies	No
3	Solar Heat	Yes – we modelled solar heat. These were typically found to be viable technologies for domestic dwellings.	No
4	CHP	Yes – we modelled both building sited gas fired CHP and district gas fired CHP (i.e. heat networks where the primary source of heat and power is through CHP)	No

[10] Viability is determined by the ability to reduce CO_2 emissions by a target rate and not on simple payback, discounted cash flow/IRR, or life cycle costs.

ITEM	TECHNOLOGY	MODELLED	EXCLUDED
		These technologies were typically found to be viable when properly applied[11] - however gas fired CHP may be less effective once SAP 10 comes into force (See Section 6)	
5	Wind	No	The British Wind Energy Association (BWEA) suggests that turbines become feasible where there is an average annual wind speed of 7 m/s and that most small/micro wind turbines start to generate electricity in wind speeds of approximately 3–4 m/s. Most turbines achieve their maximum rated output at a wind speed of 10–12 m/s. The NOABL wind map indicates that the wind speeds in Guildford are less than most turbines would require to make them feasible. For this reason, we have not run simulations on wind turbines.
6	Biomass	No	We excluded biomass due to the location of the mixed use site upon which our development was based. However due to the low emission factor in SAP, which is also used in NCM modelling, biomass systems such as biomass CHP (or energy from waste) perform well against the TER. Biomass systems need careful consideration. Storage of fuel is an issue, and in built up locations pollutants

[11] To be viable CHP needs a year round heat load, typically resulting in >4,500 hours runtime. This means that so-called micro-CHP is often unsuitable for individual dwellings or buildings. Exceptions would be domestic properties with swimming pools etc. which require heating in summer months.

ITEM	TECHNOLOGY	MODELLED	EXCLUDED
			such as NOx and noise may render these technologies unsuitable, or there may be a requirement for additional expenditure to mitigate the effect of the pollutants reducing the economic case for their use.

11. PROJECT FINDINGS

Detailed below in Table 1 is a summary of our cost models showing costs of construction and the percentage difference between the base build case and the extra over costs that a developer may have to pay to meet the proposed targets for non-domestic and domestic properties. As an example, the extra over costs as a percentage of the base build case for a target policy of 35% (the DER is 35% less than the TER) for residential costs is between 7.46% and 9.30% - if the base build case is taken as a Part L only compliant property. It is between 0.91 and 1.09% if the base case is a property that complies with the existing 20% target.

Table 1: Project results (costs)

	Part L	Extant Policy (20%)	Policy 25%	Policy 30%	Policy 35%	Base build case	Policy 25%	Adjustment to create a range of costs	Policy 30%	Adjustment to create a range of costs	Policy 35%	Adjustment to create a range of costs
Residential (flats & houses)												
System 1	£2,279.72	£2,436.02	£2,480.02	£2,483.21	£2,639.81							
System 2	£2,312.98	£2,312.98	£2,312.98	£2,312.98	£2,340.50							
System 3	£2,407.37	£2,516.48	£2,560.48	£2,640.37	£2,720.27	**Residential**	**Scenario 1**					
System 4	£2,393.83	£2,393.83	£2,393.83	£2,393.83	£2,393.83		**Policy 25% min**	**Policy 25% max**	**Policy 30% min**	**Policy 30% max**	**Policy 35% min**	**Policy 35% max**
Sub total(s)	£9,393.91	£9,659.32	£9,747.31	£9,830.40	£10,094.40	**Part L**	3.76	4.51	4.65	5.58	7.46	9.3
						Policy 20%	0.91	1.09	1.77	2.13	4.50	5.6
Office Buildings												
System 1	£2,212.98	£2,258.44	£2,269.53	£2,282.73	£2,384.97	**Offices**						

	Part L	Extant Policy (20%)	Policy 25%	Policy 30%	Policy 35%	Base build case	Policy 25%	Adjustment to create a range of costs	Policy 30%	Adjustment to create a range of costs	Policy 35%	Adjustment to create a range of costs
System 2	£2,185.41	£2,209.30	£2,222.50	£2,324.74	£2,332.88		**Policy 25% min**	**Policy 25% max**	**Policy 30% min**	**Policy 30% max**	**Policy 35% min**	**Policy 35% max**
Sub total(s)	£4,398.40	£4,467.74	£4,492.03	£4,607.47	£4,717.85	**Part L**	2.13	2.55	4.75	5.70	7.26	8.72
Sub total average	£2,199.20	£2,233.87	£2,246.01	£2,303.73	£2,358.92	**Policy 20%**	0.54	0.65	3.13	3.75	5.60	6.72
Care Homes for the elderly/nursing homes												
System 1	£1,671.50	£1,705.21	£1,712.21	£1,780.78	£1,819.18							
System 2	£1,703.53	£1,734.44	£1,744.23	£1,747.03	£1,838.26	**Care Homes**						
System 3	£1,739.40	£1,775.91	£1,781.51	£1,847.28	£1,891.91		**Policy 25% min**	**Policy 25% max**	**Policy 30% min**	**Policy 30% max**	**Policy 35% min**	**Policy 35% max**
Sub total(s)	£5,114.42	£3,439.65	£3,456.44	£3,527.81	£3,657.44	**Part L**	1.37	1.65	3.47	4.16	7.27	8.72
Sub total average	£1,704.81	£1,719.83	£1,728.22	£1,763.91	£1,828.72	**Policy 20%**	0.49	0.59	2.56	3.08	6.33	7.60
Retail units												
System 1	£1,579.67	£1,616.22	£1,624.34	£1,634.49	£1,644.65	**Retail**						
System 2	£1,645.89	£1,645.89	£1,675.14	£1,681.23	£1,691.38		**Policy 25% min**	**Policy 25% max**	**Policy 30% min**	**Policy 30% max**	**Policy 35% min**	**Policy 35% max**
Sub total(s)	£3,225.56	£3,262.11	£3,299.48	£3,315.72	£3,336.03	**Part L**	2.29	2.75	2.80	3.35	3.42	4.11
Sub total average	£1,612.78	£1,631.06	£1,649.74	£1,657.86	£1,668.01	**Policy 20%**	1.15	1.37	1.64	1.97	2.27	2.72
Totals		£20,584.04	£20,668.88	£20,878.33	£21,172.56							
Average(s)		**£3,430.67**	**£3,444.81**	**£3,479.72**	**£3,528.76**							

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