Currie & Brown

Tunbridge Wells Borough Council

Energy Policy Viability Report

Final Report

September 2019

Executive summary

The UK has a legal commitment to reduce carbon emissions by 80% by 2050. This report considers different options for achieving carbon savings in new housing and non-domestic buildings within the borough of Tunbridge Wells and assesses their costs and other factors applicable to the development of relevant local planning policies.

A range of dwelling types were considered that are representative of new housing schemes within the borough. Detailed energy and cost modelling was undertaken for five house types investigating a wide range of energy efficiency, low carbon heating and renewable power generation strategies. Non-domestic buildings were considered through a review of the existing literature on the potential costs of achieving carbon reductions in new development.

The costs of a variety of policy options were considered in comparison to the current policy requirement of a 10% reduction in carbon emissions for new developments by using low and zero carbon (LZC) technologies (a Merton Rule requirement). Options included increasing percentage carbon saving from the use of LZC technologies, achieving minimum carbon savings through improved building fabric and ventilation standards (aka a ‘fabric first’ approach) and a combination of both fabric and LZC requirements.

Analysis was conducted using current regulatory compliance methods, i.e. modelling assumptions set out in the Standard Assessment Procedure (SAP) 2012. Because SAP2012 is now 7 years old, analysis also considered the carbon emission factors in the latest SAP version (SAP10), which although not yet adopted for regulatory compliance purposes, provides an indication of the factors that might be used in future building regulations (expected to be introduced in 2020).

The results of the analysis revealed that when using emission factors in the current SAP 2012, increasing the Merton Rule target of carbon savings through use of LZC to 15 or 20% is achievable at a relatively low cost of under £500 per home for most properties through the addition of more PV panels. These costs assume that they are for enlarging a smaller array that would have been installed to comply with existing policy requirements. Because many of the costs (i.e. access and wiring and connections) are fixed per installation and vary little with the installation size, the marginal cost of increasing the array is relatively small. Using SAP10 emission factors, the carbon savings from PV are reduced, nonetheless it should be possible to achieve savings of c.20% for under 1% additional cost.

Using SAP 2012 emission factors, it is possible to achieve a c.20% carbon reduction improvement through fabric and ventilation improvements at an additional 2-5% capital cost for homes. This is mainly achieved with a highly air-tight fabric supported by Mechanical Ventilation Heat Recovery systems. Increasing the Merton Rule LZC requirement to 20% can be achieved within the same overall cost uplift margin by using a combination of low carbon heat such as an Air Source Heat Pump (ASHP) and or with additional photovoltaic (PV) panels.

Using SAP10 emission factors the substantial potential carbon savings from the use of heat pump technologies becomes apparent with these systems delivering savings of 31-40% for the least efficient fabric standards or 16-26% for highly energy efficient (close to Passivhaus) homes. Using SAP10 emissions factors the savings from low carbon heat begin to outweigh those associated with energy efficiency in the absence of low carbon heat suggesting that these systems should be encouraged in the future.

The analysis shows that the potential carbon savings through fabric and ventilation measures are greatest for the least efficient dwelling forms (e.g. detached houses). As a result, although the models assessed in this study can all achieve a 20% emission saving through fabric and ventilation improvements alone, some designs may struggle to fully achieve these standards if they have a very efficient form factor. This includes mid-terrace properties and midfloor flats. When the heat loss elements such as external walls, floors and ceilings are limited, achieving a heating demand reduction by further upgrading these elements becomes challenging.

As modelling results indicated for small single aspect studio flats, fabric and only improvements similar to Passivhaus standards in naturally ventilated units would achieve a 10% DER/TER improvement (both using SAP2012 and SAP10), When MVHR units were used in the same models together with higher airtightness levels , even a small improvement over current fabric standards (thermal performance wise) led to a 10% DER/TER improvement in the case of SAP2012 carbon factors used and s 15% DER/TER improvement in the case of SAP10 carbon factors used (decarbonised electrical grid).

In such scenarios, of very efficient building forms, it is recommended that some accommodation is provided in terms of meeting an absolute DER/TER fabric first reduction target. Their absolute energy use and carbon emissions will be far lower than less efficient building forms even if they are not compliant with a 20% fabric first reduction requirement. For example, alternate technologies such as wastewater heat recovery systems can be used to deliver reductions in energy demand (hot water rather than heating) in these homes.

In term of non-domestic new buildings, a literature review analysis indicated that an uplift associated with achieving a 15% energy efficiency target would cost between £37 and £59 m^2. In many buildings this additional cost could be under 1% subject to its location, the base design and experience of the design and construction team. In general, lower uplift percentages will be seen in town centre buildings as these will have a higher base cost and levels of servicing. As noted in 2017, the average energy efficiency saving in non-domestic buildings in London was 19.2% beyond the requirements of building regulations making such options technically feasible in Tunbridge Wells[1].

Energy use in non-domestic buildings is highly variable by building type and design aspiration. The cost and potential for achieving savings beyond the requirements of Part L2013 will therefore depend on building type and design decisions. For example, the nature of demand heating, cooling and lighting energy demand will be influenced by the intended use, the extent and orientation of glazing and any associated shading, and plan depth. Substantial energy efficiency savings are typically achievable in office and retail buildings, but other building types such as schools and particularly hotels may find it more difficult to achieve energy efficiency savings because of the specific nature of their demand, e.g. the dominance of hot water supply as an energy source in hotels..

Government are in the process of reviewing the national building regulations (Part L) against which the TWBC planning requirements are set. This review may result in changes to the national minimum standard, compliance metrics and the assessment method (e.g. the adoption of SAP10 or a successor). These changes in the regulatory baseline and assessment method may come into force in 2020 and it is recommended that TWBC revalidate and if needed calibrate its standards against the new regulatory environment once this is known.

[1] The direct applicability of savings seen in London within Tunbridge Wells may vary in some instances as the form of non-domestic developments may differ, however analysis suggests that significant savings are possible through improved lighting and HVAC system and controls for a wide range of non-domestic buildings.

As with any planning policy, the effectiveness of carbon reduction standards is dependent on their effective delivery during design, construction and handover. The increasing use of newer building solutions such as ASHP and MVHR systems together with any requirement for highly energy efficient fabric standards will make it even more important that designs are robust and that technologies are integrated effectively. For example, ASHP systems should be designed to operate at lower temperatures, must be paired with sufficiently sized heat emitters (e.g., radiators or underfloor heating), and the external unit should also be located so as to avoid potential noise disturbance to neighbours. Similarly, MVHR systems should be designed so that they remain within the insulated envelope (or have insulated ducting) so that filters can be readily accessed and changed.

It is recommended that TWBC consider providing references to relevant existing guidance material to supplement their planning policies and consider whether planning officers should be given additional guidance / training to support them in evaluating future applications. A wide range of existing materials exists including that produced by Zero Carbon Hub, NHBC and CITB.

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Glossary

Actual

This term is used within the domestic energy modelling section of the report as a way to describe a new built property currently delivered within TWBC. In effect the PartL2013 compliant model was adjusted to reflect minor variations in terms of the fabric elemental performance, as extracted from new built planning applications within the TWBC, In all models it was noted that the 'Actual' had a similar (less than 1% improvement) fabric performance to the minimum PartL2013 requirements.

Airtightness

Airtightness is a general descriptive term for the resistance of the building envelope to infiltration with ventilators closed. The greater the airtightness at a given pressure difference across the envelope, the lower the infiltration.

Emission factor

Emission factors are the amount of carbon emitted to supply a given quantity (eg 1 kWh) of energy. Emission factors exist for a wide range of fuels and also for electricity. In recent years the emission factor for electricity has reduced considerably as a result of increased use of renewable energy and of lower carbon sources of power generation. Emission factors for fuels are largely unchanged. The reducing emission factor for electricity means it is becoming an increasingly low carbon source of energy, particularly when used within highly efficient technologies such as heat pumps.

Fabric First

A ‘fabric first’ approach to building design involves maximising the performance of the components and materials that make up the building fabric itself, before considering the use of mechanical or electrical building services systems. This can help reduce capital and operational costs, improve energy efficiency and reduce carbon emissions. A fabric first method can also reduce the need for maintenance during the building’s life[2].

Grid Space Heating Energy Demand

This refers to energy supply requirement from the gas and electricity grids It does not consider system’s efficiency and final delivered energy to the building.

Heat pumps

Heat pumps typically use electricity to compress and thereby increase the temperature of air or water and then extract the heat to provide space heating or domestic hot water. Common heat pumps are either air source (ASHP) that extract heat from the air or ground source (GSHP) where heat extracted from water that has absorbed heat from the ground. Because some of the heat suppled is already present in the air or water, the energy used by the heat pump is only a fraction of the useful heat supplied to the building. For example, an ASHP may output over three times more heat energy than it requires to in the form of electric power.

Home Space Heating Energy Demand

This refers to the delivered energy in the form of heat to the space in order to maintain favourable and compliant indoor thermal conditions

Infiltration

The uncontrollable air exchange between the inside and outside of a building through a wide range of air leakage paths in the building structure.

Kilowatt peak (kWp) capacity

In the context of photovoltaic panels, the peak capacity is the maximum theoretical output of the system under standardised test conditions. In practice, the output of a fixed PV array will vary throughout the day according to its orientation and incline, presence of oversharing, the position of the sun and weather conditions.

LEAN

London Plan Policy SI2 Minimising greenhouse gas emissions. Be lean: use less energy and manage demand during construction and operation.

Mechanical Ventilation & Heat Recovery (MVHR)

MVHR is a mechanism for providing ventilation that provides a controlled supply of outside air that has been warmed by recovering heat from the stale air being extracted from the property. In this way the unit provides the necessary ventilation with minimal loss of heat in the home. When external temperatures are higher, the MVHR is capable of operating in ‘bypass’ mode whereby there is no heating of the incoming air. The system uses electric fans and so has running costs and associated carbon emission but in a well-insulated and air-tight home the saving in heating energy use is greater than that required to operate the MVHR unit.

[2] https://www.designingbuildings.co.uk/wiki/Fabric_first

Merton Rule

The Merton Rule is a term used to describe planning requirements to incorporate a minimum level of renewable energy within development, the concept was first popularised by its introduction in, and advocacy by, the London Borough of Merton.

Notional Dwelling

A notional dwelling is a dwelling that is of the same size and shape as the actual dwelling (model) reviewed under the Standard Assessment Procedure (SAP) 2012. The performance of the modelled dwelling is compared against that of the notional dwelling (gas boiler based) in terms of carbon performance through the use of the Target Emission Rate (TER) (notional) and the Design Emission Rate (DER) (model). If the actual dwelling is constructed entirely to the notional dwelling specifications it will meet the CO2 and the fabric energy efficiency targets and the limiting values for individual fabric elements and buildings services[3].

Photovoltaics

Photovoltaics (PV) are renewable energy technologies that generate electricity from solar energy. There are a range of PV technologies ranging from thin film solutions that can be overlain on existing surfaces (e.g. glass) through to discrete panels made of a mono or polycrystalline silicon substrate. The electricity generated by a PV is direct current (DC) so it needs to pass through an inverter to be converted into the alternating current (AC) that can be used within a home.

Passivhaus

Passivhaus is an international energy standard that was originally developed for housing and is now applied to a range of building types. A building certified to the Passivhaus standard must meet stringent standards for energy consumption for heating (15kWh per m^2) and for overall energy demand. In addition, there are design requirements to control the quality of the internal environment for example by controlling internal surface temperatures and the risk of overheating to provide a comfortable living space.

Regulated energy

Energy use that is regulated by Part L of Building Regulations. This includes energy used for space heating, hot water and lighting together with directly associated pumps (for circulating water) and fans (eg for ventilation).

Standard Assessment Procedure (SAP)

SAP is a procedure by which the energy performance of a home is assessed, it is the typical method used for the purposes of assessing compliance with Building Regulations Part L1a. SAP calculates the energy use, cost of energy and carbon emissions of a home, the last of which (the Dwelling Emission Rate) must be lower than the calculated Target Emission Rate. The Target Emission Rate is calculated by modelling a home of the same form and size but built to the minimum standards required by Building Regulations. The version of SAP used to assess compliance for new homes is currently SAP 2012, a more recent SAP10 has been published by BRE on behalf of Government but this has not yet been adopted for use in assessing Part L1A compliance.

U-value

A u-value is a measure of the rate of heat transfer across a structure divided by the temperature difference (in Kelvin) across the structure. It is measured in watts per m^2 per Kelvin of

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[3] Approved document L1A, 2013 edition incorporating 2016 amendments – for use in England*

temperature difference or Wm^2K. Lower U values equate to better insulative properties and reduced heat loss. Part L of building regulations sets minimum standards for the U values of different building elements (e.g. floor, window, roof or external walls) but building to lower U values is one method that can help to reduce energy consumption.

Unregulated energy

Energy use that is not controlled by Part L of Building Regulations. In homes this includes energy use for cooking, white goods and small power (eg, TV's, kettles, toasters, IT, etc). The quantity of unregulated energy in a home is estimated in SAP2012 using information on the building area.

In non-domestic buildings unregulated energy also includes that used for vertical transportation (lifts and escalators) and process loads such as industrial activities or server rooms.

Ventilation

The removal of 'stale' indoor air from a building and its replacement with 'fresh' outside air.

Abbreviations

ASHP	Air Source Heat Pump
BRE	Building Research Establishment
BREEAM	Building Research Establishment Environmental Assessment
CITB	Construction Industry Training Board
COP	Coefficient of Performance
D	Detached House
DER	Compared Design Emissions Rate
DFEE	Design Fabric Energy Efficiency
DHW	Domestic Hot Water
F	Flat
F1 – F3	Fabric Improvement 1 - 3
FEES	Fabric Energy Efficiency Standard
G-SHED	Grid Space Heating Energy Demand
H-SHED	Home Space Heating Energy Demand
HQM	Home Quality Mark
LZC	Low and Zero Carbon
MEES	Minimum Energy Efficiency Standards
MHRV	Mechanical Heat Recovery Ventilation
MT	Mid Terrace House
MV	Mechanical Ventilation
NHBC	National House-Building Council
NPPF	National Planning Policy Framework
NV	Natural Ventilation
NV-F	Naturally Ventilated Fabric improvements
Part L	National building regulations
PV	Photovoltaic panels
RHI	Renewable Heat Incentive
SD	Semi-detached House
SAP	Standard Assessment Procedure
SBEM	Simplified Building Energy Model
SF	Studio Flat

SHMA	Strategic Housing Market Assessment
SPD	Supplementary Planning Document
SSSI	Sites of Special Scientific Interest
TER	Target Emission Rate
TFEE	Target Fabric Energy Efficiency
TWBC	Tunbridge Wells Borough Council

1. Introduction

1.1 Research Objectives

This report considers how planning policy can help reduce carbon emissions from new developments (both residential and non-residential) within Tunbridge Wells Borough.

The research was undertaken by Currie & Brown on behalf of the Tunbridge Wells Borough Council (TWBC) and was conducted during the period of 11th February 2019 to 1st April 2019.[4]

Currie & Brown evaluated the energy, carbon and cost implications of a range of potential new buildings' carbon standards improvements. Findings can be used to address the four key Tasks as described within the Tender Specification for the provision of "Energy Policy Viability Report" (Table 1).

Table 1 – Tasks within the tender Specification for the provision of "Energy Policy Viability Report"

Tender Task Number	Questions
TASK 1 (Merton Rule)	
Since 2011, Tunbridge Wells Borough Council (TWBC) has had a requirement in place to reduce carbon dioxide emissions by 10% through the use of Low and Zero Carbon (LZC) technologies[5]. This is set out in the Renewable Energy Supplementary Planning Document (SPD).	Is it technically feasible to construct buildings that go beyond the 2013 Building Regulation requirements of a Target Emission Rate (TER) by between 15 and 20% using LZC technology? What would the additional cost be for a developer if this target was strengthened to 15 and 20% against a 10% baseline cost?
TASK 2 (Fabric First Thresholds)	
TWBC would like to implement a policy that requires energy performance improvements of 19% better than Building Regs 2010 (as amended in 2013) for new development. A 'fabric first' policy of this type has never been implemented in the borough.	Is it technically feasible to construct buildings that go beyond the 2013 Building Regulation requirements of a Target Emission Rate (TER) by 15%, 19% and 25% using the fabric first approach? What would the additional cost be for a developer if this target was implemented and compare these costings for targets of 15% and 25%?

[4] The analysis is based on current regulatory requirements, it should be noted that national building regulations and associated assessment methods (e.g. SAP versions) are currently being reviewed by the Ministry of Housing, Communities and Local Government with the aim of setting new minimum performance requirements in 2020. While some consideration of the implications of changes in the carbon emission factors in SAP is considered in this study, other changes in the assessment methodology of national standard are not yet known. As a result, it would be prudent to re-validate and, if necessary, calibrate the findings of this research in light of the new assessment method and Part L standard once this is known.

[5] In this study LZC technologies include Air Source Heat Pumps (ASHP) and Photovoltaics (PV) both of which are broadly applicable to different development types and locations.

Tender Task Number	Questions
TASK 3 (Combined Policies)	
TWBC would like a report to recommend the best combination of fabric first and LZC targets to provide a balance between reducing emissions but ensuring development remains financially viable.	Is it technically feasible to implement a combination of the above described fabric first and Merton rule style policies? What are the indicative cost implications of implementing both these policies for developers? Which combination of policy targets are best suited to TWBC? For example: a) 19% fabric first and 15% Merton rule? b) 25% fabric first and 10% Merton rule? c) 15% fabric first and 20% Merton rule? Any other combination?

1.2 Research Methodology

A stepped research approach was followed in support of a better understanding of the TWBC local built environment, current state of construction (in terms of new buildings energy efficiency and carbon performance standards), current and future local housing needs and stakeholders' views on new buildings' energy efficiency and carbon performance targets.

Information collected was used to develop appropriate housing models and provide key recommendations in terms of new non-domestic buildings energy and carbon potential improvements and associated costs.

| Scoping Activity

A review of relevant existing policies and guidance documents was performed. This covered energy and sustainability, construction design, local population statistics and economic growth projections. Existing information was supplemented by TWBC planners and sustainability officers' expert knowledge and advice.

| Risks and Opportunities Survey

The research team designed and issued an online 'Risks and Opportunities' survey questionnaire designed to capture TWBC stakeholders' views in terms of new buildings current energy and carbon performance standards within the borough. Questions also considered the potential for uplifts in standards, new buildings construction quality and impact of energy and carbon standards on local design.

| Housing Design Archetypes

Typical construction designs for Tunbridge Wells Borough were selected based on Currie & Brown work undertaken for PartL2013, and confirmation of applicability through information collected during the scoping activity.

House design archetypes included the following five housing typologies: a detached, semi-detached and mid-terrace houses, a small and a large flat.

| Non-Domestic Performance Analysis and Cost uplift Review

Technical feasibility and potential cost implications of TWBC non-domestic buildings' energy and carbon performance standards uplifts was conducted through a literature review.

The wide variation in non-domestic development types (including form, shape, materials used, FM systems installed and type of use) meant that is was not practicable to undertake a bespoke modelling exercise.

There was a reasonable existing evidence base for tighter standards for the main forms of non-domestic development and this evidence is summarised in Section 6 of this report together with analysis of the implications for future planning requirements in TWBC.

| Housing SAP Models – Energy and Carbon Performance

Developed housing design archetypes were modified, in terms of fabric and services specifications used, to produce different energy and carbon performance improvement scenarios with more than 110 variations generated.

The DER/TER improvement was assessed[6] against minimum PartL1A 2013 compliant (notional building[7]) specifications and an 'Actual' model based on housing specifications currently used within TWBC planning applications, as advised by TWBC planning officers.

The 'Actual' fabric model, together with sufficient PV to current planning requirements for a 10% reduction in DER through LZC technologies, was used for estimating the resultant construction cost uplifts.

The different modelled scenarios reviewed targets to address the different Tasks. In summary, the model variations included:

- **A fabric first approach** achieving 15, 20 and 25% of DER/TER, using both natural ventilation and mechanical ventilation heat recovery (MVHR) solutions
- **Variations of heating services** which entailed the use of a low heat ASHP. Where applied, the carbon savings from the use of ASHP were considered as a contributor to meeting 'Merton Rule' requirements for reductions in the DER from the use of LZC technologies.
- **Assignment of Photovoltaics (PV)** as a proxy for additional on-site renewable energy generation to achieve 10, 15 and 20% reductions in the DER.

Figure 1 summarises the approach taken to assessing the impact of different systems in meeting planning policy requirements.

Housing Modelling Approach to Tender Tasks 1-3 Questions

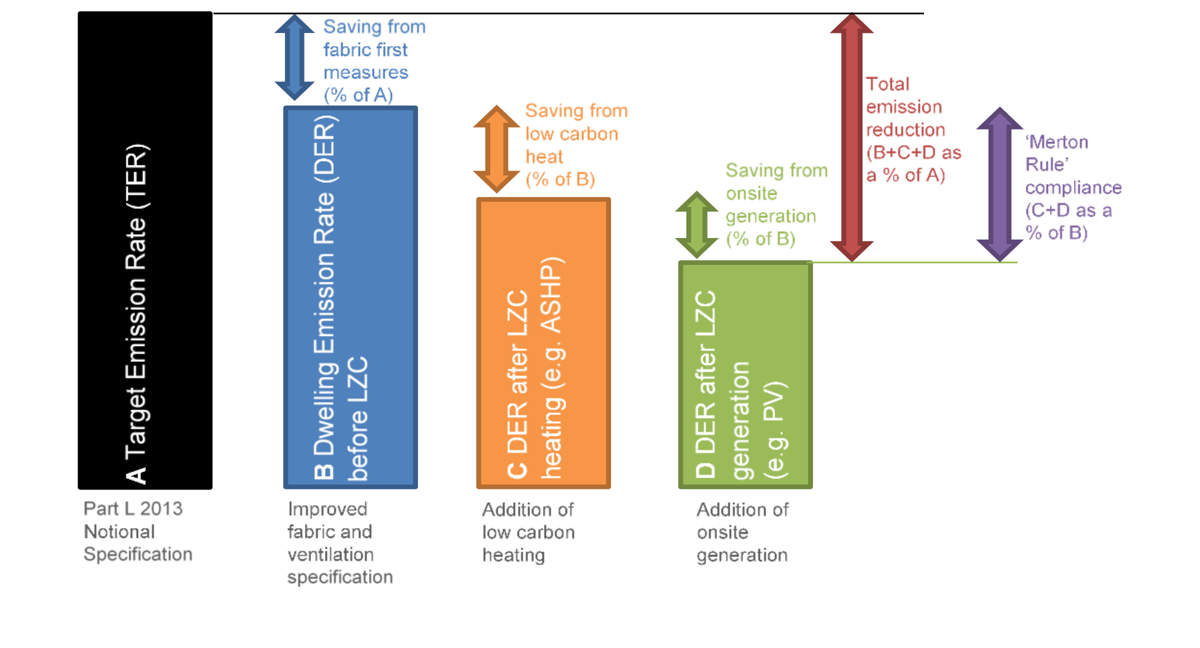

Figure 1 - Approach to assessing the contribution of fabric, services and renewable energy generation to planning requirements

[6] Calculated using the Elmhurst Energy Systems SAP2012 Calculator version 4.10r08 software
[7] The notional specification is a specification which, if followed, would achieve the requirements of Part L 2013. The specification higher than the minimum performance standard for each element specified in the regulations, a developer is not obligated to follow the notional specification and could build to a lower standard in some parts of the building and compensate by achieving a higher standard elsewhere.

The analysis was conducted in accordance with SAP 2012 modelling assumptions and associated emissions factor. A newer, but as yet unadopted, version of SAP exists known as SAP10. Among other changes, SAP10 contains substantially different fuel carbon emission factors for electricity. To test the validity of the results of this study against a possible future modelling method (i.e. SAP10) the implications of using SAP10 emission factors were included in this report.

It should be noted, however, that it is not yet clear how Part L2020 and the SAP10 method will change. This report cannot make firm proposals for performance standards under a future regulatory regime.

It is expected that modifications to the Part L method in 2020 or soon after will include the range of performance metrics, emissions and fuel factors together with other modelling assumptions and potentially alterations to the minimum performance requirements.

These changes will mean that current TER and DER assumptions will change, and it is recommended that TWBC energy and carbon policies are re-examined when more information becomes available to either validate their applicability or recalibrate them to reflect the new regulatory regime.

| Capital Cost Modelling

In-house Currie & Brown cost databases were used to analyse the cost implications (increase) over baseline costs of the advanced energy and carbon performance standards applied on the housing models.

Cost analysis considered the additional costs of implementing the specified carbon reduction measures in comparison to the costs of building the same home to a Part L 2013 compliance specification using ‘actual’[8] specifications and including a minimum 10% reduction in DER from the use of LZC technologies.

Costs were based on the professional experience of Currie & Brown’s residential quantity surveying team and are developed from detailed specifications of the full range of cost implications for each element.

The cost of building each home to varying standards and performance levels was estimated through the development of elemental cost models for each home as built to the actual Part L 2013 specification and then adapting these costs for each relevant building element to achieve a different standard.

In some cases, the alternate specification simply involves varying the thickness of an insulation layer while in others the implications are more wide ranging, for example in achieving higher levels of air tightness which would require the use of specific technologies together with close attention to detail on site.

[8] The actual models consist of the PartL1A notional specifications adapted to reflect elemental thermal performance variations currently used in Tunbridge Wells Borough new homes planning applications.

2. Scoping Activity

2.1 National Policy Context

Implementing successful energy and sustainability policies through a Local Plan is extremely important both for meeting local and national carbon emissions reduction targets, as well as for providing local communities with a healthy, energy efficient and sustainable environment addressing their various housing and employment needs.

The Committee on Climate Change's Reducing UK emissions – 2018 Progress Report to Parliament reported that direct and indirect emissions from buildings accounted for almost 30% of the total UK GHG emissions in 2017. Furthermore, in the same year buildings were responsible for 66% of the overall UK electricity consumption[9].

Similar trends had been observed in previous years. Buildings have a huge impact on the country's total calculated carbon emissions, making building improvements a UK priority for addressing climate change (and overall sustainability targets).

Local planning authorities are bound by the legal duty set out in Section 19 of the 2004 Planning and Compulsory Purchase Act[10], as amended by the 2008 Planning Act, to ensure that, taken as whole, plan policy contributes to the mitigation of, and adaptation to, climate change.

This powerful outcome-focused duty on local planning clearly signals the priority to be given to climate change in plan-making. In discharging this duty, local authorities should consider guidance provided within the National Planning Policy Framework (NPPF) and understand the economic, social and environmental aspects of their current and future Local Plan targets.

National Planning Policy Framework (Feb 2019) - Paragraphs 7 & 8
The purpose of the planning system is to contribute to the achievement of sustainable development. At a very high level, the objective of sustainable development can be summarised as meeting the needs of the present without compromising the ability of future generations to meet their own needs. *Achieving sustainable development means that the planning system has three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways (so that opportunities can be taken to secure net gains across each of the different objectives):* *a) an economic objective – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure;* *b) a social objective – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering a well-designed and safe built environment, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and* *c) an environmental objective – to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.*

Furthermore, Paragraph 129 of the revised NPPF (2018)[11] encourages local authorities to use assessment frameworks as tools for improving design quality while paragraph 149 of the NPPF

[9] https://www.theccc.org.uk/publication/reducing-uk-emissions-2018-progress-report-to-parliament/
[10] http://www.legislation.gov.uk/ukpga/2004/5/section/38

requests ensuring that policies and decisions are in line with the objectives and provisions of the Climate Change Act 2008.

The NPPF sets guidance that local authorities have to follow to demonstrate, through viability assessments, that higher sustainability standards will not affect housing delivery. Assessments need to be underpinned by a proportionate evidence base that reflects local circumstances.

The NPPF also says that plans should be prepared positively in a way that is aspirational but deliverable. This means that policies should be realistic, and the total cumulative cost of all relevant policies should not be of a scale that will make development unviable. Key points from the guidance are as follows.

'*Policy requirements, particularly for affordable housing, should be set at a level that allows for sites allocated in the plan to be delivered without the use of further viability assessment at the decision-making stage.*

Where proposals for development accord with all the relevant policies in an up-to-date development plan no viability assessment should be required to accompany the application. Plans should however set out circumstances in which viability assessment at the decision-making stage may be required.'

The Section 19 duty is much more powerful in decision-making than the status of the NPPF, which is guidance, not statute. Where local plan policy which complies with the duty is challenged by objectors or a planning inspector on the grounds, for example, of viability, they must make clear how the plan would comply with the duty if the policy were to be removed.

Technically feasible and cost-effective 'tighter energy and carbon performance requirements for new buildings' within a local plan is further supported by the Planning and Energy Act 2008[12], section 1:

A local planning authority in England may in their development plan documents, a strategic planning panel may in their strategic development plan, and a local planning authority in Wales may in their local development plan, include policies imposing reasonable requirements for—

(a) a proportion of energy used in development in their area to be energy from renewable sources in the locality of the development;

(b) a proportion of energy used in development in their area to be low carbon energy from sources in the locality of the development;

(c) development in their area to comply with energy efficiency standards that exceed the energy requirements of building regulations.

Renewable energy generation contributes positively to carbon emissions reductions through displacement of grid electricity, or by direct partial consumption at the point of generation. Such contributions support the gradual decarbonisation of the electricity grid and, combined with smart local supply/demand solutions and/or energy storage technologies, provide a robust approach towards more resilient energy strategies. In that respect it was important to consider PV generation within the research work. Renewable heat generation also has an important role to play reducing energy required for hot water generation.

Energy used for hot water generation becomes increasingly important when space heating demand requirements of buildings are significantly decreased. In that sense the use of low

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[11] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/779764/NPPF_Feb_2019_web.pdf
[12] https://www.legislation.gov.uk/ukpga/2008/21/section/1

carbon heat and the use of technologies such as heat pumps will contribute to further carbon emission reductions from buildings and enable achieving the Climate Change targets.

The importance of combining high fabric energy efficiency, low carbon heat and hot water generation solutions and renewable energy / zero and low carbon technologies in buildings has been recently restated by both the UK Government and the Committee on Climate Change (the independent, statutory body established under the Climate Change Act 2008).

Committee on Climate Change – UK Housing: Fit for the future? February 2019[13]
Immediate Government action is needed to ensure the new homes planned across the UK are fit for purpose, integrating the highest possible levels of emissions reduction with a package of design improvements to adapt to the changing climate. This will require an ambitious trajectory of standards, regulations and targets for new homes throughout the UK: ▪ By 2025 at the latest, no new homes should connect to the gas grid. Instead they should have low-carbon heating systems such as heat pumps and low-carbon heat networks. ▪ Make all new homes suitable for low-carbon heating at the earliest opportunity, through use of appropriately sized radiators and low-temperature compatible thermal stores. This can save £1,500 - £5,500 per home compared to later having to retrofit low-carbon heat from scratch. ▪ New homes should deliver ultra-high levels of energy efficiency as soon as possible and by 2025 at the latest, consistent with a space heat demand of 15-20 kWh/m2/yr. Designing in these features from the start is around one-fifth of the cost of retrofitting to the same quality and standard. When installed alongside heat pumps in a typical home, ultra-high levels of fabric efficiency can deliver average bill savings of around £85 per household per year, contribute to reducing annual and peak electricity demand alongside other measures, provide comfort and health benefits for occupants, and create an industrial opportunity for the UK to export innovation and expertise. ▪ Statutory requirements should be in place to reduce overheating risk in new-build homes. Evidence suggests that all new-build homes are at risk of overheating. Passive cooling measures should be adopted to reduce overheating risks before considering active measures such as air conditioning. ▪ Improve focus on reducing the whole-life carbon impact of new homes, including embodied and sequestered carbon. Using wood in construction to displace high-carbon materials such as cement and steel is one of the most effective ways to use limited biomass resources to mitigate climate change.
UK Government - Spring Statement March 2019[14]
From HM Treasury and The Rt Hon Philip Hammond MP, the Spring Statement builds on the Industrial Strategy, Clean Growth Strategy, and 25 Year Environment Plan as set out in the Budget 2018. In terms of buildings, energy and carbon the following are noted: ▪ to help meet climate targets, the government will advance the decarbonisation of gas supplies by increasing the proportion of green gas in the grid, helping to reduce dependence on burning natural gas in homes and businesses ▪ to help ensure consumer energy bills are low and homes are better for the environment, the government will introduce a Future Homes Standard by 2025, so that new build homes are future-proofed with low carbon heating and world-leading levels of energy efficiency

[13] https://www.theccc.org.uk/wp-content/uploads/2019/02/UK-housing-Fit-for-the-future-CCC-2019.pdf
[14] https://www.gov.uk/government/news/spring-statement-2019-what-you-need-to-know.

2.2 Local Policy Documents, Standards and relevant publications

A detailed review of relevant local planning and development publications was undertaken to inform the development of the research house types, development scenarios and improvement options. The review is described in Appendix A with key considerations described below.

Considerations relevant to the research

Population

- There is a notable difference in the prediction models, with Kent County Council projecting a 16% increase (18,600 people) by 2033 while ONS 2016-based data only project a 5% increase in population by 2033 (6,343 people)
- Population statistics indicate an increase in Tunbridge Well Borough population by the end date of the new Local Plan (2033) varying between 6,343 and 18,600 people. The size and age distribution of the population, as well as the population spatial distribution, will affect new housing, buildings and infrastructure requirements in the various borough areas.
- In 2033 both models indicate that people aged 65 and over will account for 23-25% of the total Tunbridge Wells Borough population. Compared to 2016 population statistics that would signify an almost 5% increase of that age group within the overall population. An increase in the number of people of older age (and that of young children), will influence new residential designs.

Housing solutions in the borough

- The range of measures reviewed within the evaluated housing models included both a fabric first approach as well as service technologies such as gas boilers and ASHP. Both options are both technically feasible and user friendly albeit care is required for the effective design and commissioning of ASHP systems. Advanced controls, smart systems and energy storage solutions have not been considered at this stage as are at an early stage of their application in housing and the evidence base on energy and carbon savings plus user response is currently limited.

Planning requirements for new homes

- The 2016 Renewable Energy SPD update acknowledges the importance of a fabric first approach as well as the introduction of new technologies as in the case of Air Source Heat Pumps which can be used to meet the Renewable Energy policy requirement.
- Negotiation requirements to be exempt from the policy are included, in terms of delivering high energy standards through different routes or by using a recognised standard such as the Home Quality Mark (HQM).
- The SPD does not quantify requirements for energy efficiency standards or HQM certification.

Non-domestic buildings

- New non-domestic buildings to be delivered within the borough will include a mix of uses and types and are not limited to specific design typologies as in the case of housing. Overall the level of non-domestic development will be substantially smaller than that for new homes.
- The shape, form, specification and layout of the new non-domestic buildings will vary greatly depending on the intended use, the operating schedules the construction type and standards used. Given the diversity of non-domestic building types, their use and

operating schedules simple and isolated indicative energy and carbon performance models would not be representative in terms of cost and performance

- A literature and evidence-based review of potential improvements in terms of carbon and energy performance of various non-domestic buildings typologies, BREEAM standard ratings achieved and potential indicative costs uplifts are more suitable than models.

3. Risks and Opportunities Survey

In order to capture stakeholders' views on potential energy and carbon performance standards uplifts of new buildings within the Tunbridge Wells Borough an online Risks and Opportunities Survey was designed and provided to TWBC for circulation.

The survey included twenty-five questions. The first four introductory questions collected information in terms of personal details, occupation and level of involvement of the responders with construction projects in the area, as well as their level of specialisation. Anonymised responses and overall findings are provided below.

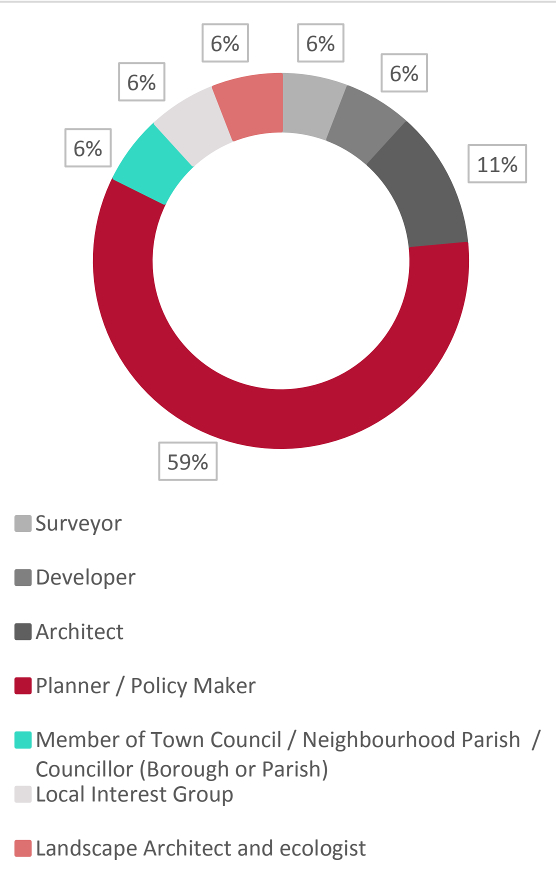
The survey was sent to the following parties:

- All Officers within the planning department of TWBC (including Development Management, Planning Policy and Building Control).
- All Counsellors
- All parish councils (with instructions to share with Neighbourhood Plan Groups)
- Developers that have worked in the Borough (see Appendix C for full list of developers)

3.1 General Findings

In total eighteen individual responses were collected. Not all responders addressed all questions.

Risks and opportunities responders background and level of involvement



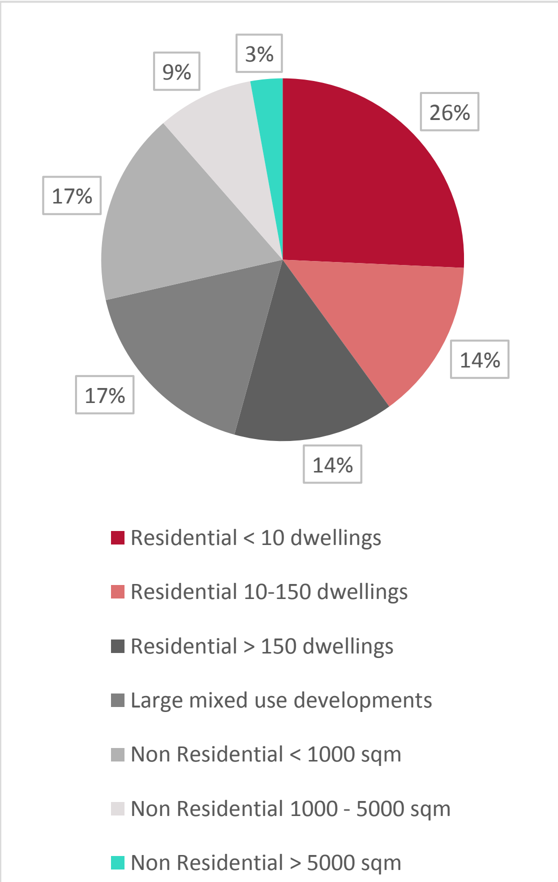


Figure 2 - Risks and Opportunities Survey Responders background and level of involvement

More than half of the responders worked for the TWBC and have a background in planning. Most of the responders were not currently working on an active construction project within the borough.

Main concerns and comments as summarised in Table 2.Views were supportive of a new policy introduction, especially consideration of a fabric first approach.

Table 2 - Risks and Opportunities Survey - Results and Comments

Risks and Opportunities Survey - Results and Comments	
Do you think current TWBC Energy & Carbon Building requirements are set at an appropriate level?	Seven out of twelve responders agreed with the statement
Do you think that the construction quality of new development in the borough meets user expectations for energy and carbon?	Eight out of twelve responders agreed with the statement
In your experience, is there a particular area of improvement that you would like to be seen as a priority when setting buildings energy & carbon requirements in the borough?	Seven out of eleven responders indicated that they would like to see improvements in terms of a fabric first approach, passive design measures, innovation, retrofit of properties and maximising the use of local materials
Do you think an uplift in the buildings' energy and carbon planning requirements for the borough will have an impact on costs?	Seven out of nine responders indicated that costs will increase on construction costs, but economies of scale can have a positive impact. A note was made on unintended consequences in terms indoor air quality and maintenance costs
Do you think an uplift in the buildings' energy and carbon planning requirements for the borough will support improvements in air quality and quality of living in the area?	Eight out of ten responders agreed with the statement with a note made in terms of emissions from traffic contributing to reduced air quality
Do you think an uplift in the buildings energy and carbon planning requirements for the borough will affect new buildings construction delivery rates in the borough?	Seven out of ten responders did not agree with the statement, with notes made in terms of sensitivity of developer profit margins and impact on affordability
It is important that carbon emissions from new buildings in the borough should be minimised	Nine out of eleven responders agreed with the statement, with notes made in terms of protecting affordability
It is important that energy consumption from new buildings in the borough should be minimised (aka operational energy)	Ten out of eleven responders agreed with the statement, with notes made in terms of achieving carbon neutrality
It is important for new houses to be inexpensive to run, with simple systems installed that require little maintenance.	Ten out of eleven responders agreed with the statement, with notes made in terms of affordability and fuel poverty
It is important that the new buildings in the borough retain a traditional style (even when affecting their energy and carbon performance).	Three out of eleven responders agreed with the statement, while five maintained a neutral position with notes made about respect of local environment and well-designed contemporary buildings
New highly energy and carbon efficient buildings should be given priority when considering planning permissions.	Five out of eleven responders agreed with the statement, while five maintained a neutral position with notes made about respect of local environment, no material harm and well-designed space standard affordable buildings
More new houses are required within the borough and there should be more focus on affordable housing	Nine out of eleven responders agreed with the statement, with notes made about a balanced approach and high-quality housing required
Modern methods of construction (e.g. offsite manufacturing), higher levels of insulation and better and more efficient building services should be promoted in new buildings designs planning applications assessments.	Nine out of eleven responders agreed with the statement, with notes made about good design
New buildings designs should be resilient and easy to adapt to future climate and user needs	Nine out of eleven responders agreed with the statement, with notes made about the practical aspects of flexible design
Future energy prices and building maintenance costs should be considered at the design stage of a new development within the borough	Eight out of eleven responders agreed with the statement, with notes made that this is not a consideration for planning
Any other comments	Notes made about land banking and measures adoption timelines as well as incentivising user behaviour

SECTION 1: DOMESTIC

4. Housing Models Design and Analysis Considerations

4.1 Housing Design Archetypes

As indicated through the Scoping Activity (Chapter 2), a diverse range of new home typologies is required to be delivered in order to address the Tunbridge Wells Borough population needs. The five main housing types noted included detached, semi-detached, terraced properties, small and large flats.

The different home types used as references in this study are shown in Table 3. These archetypes designs are compliant with the Technical housing standards including nationally described space standard (2015) requirements[15].

Table 3 - Reference House Design Archetypes

ID	Type	Floor Area (m^2)	Number of Bedrooms
D	Detached House	116.9	4
SD *	Semidetached House	84.2	3
MT	Mid Terrace House	84.2	3
SF	Studio Flat	42.9	1
F	Flat	70.1	2

* Same for End-Terrace

The floor areas of the modelled housing design archetypes above aligned well with new home designs granted planning approval within the Tunbridge Wells Borough (Developments A-D, Figure 3)[16].

Smaller floor areas used were reflective of smaller household sizes predicted, and representative of typologies that would face more challenges when addressing energy and carbon compliance in terms of kWh/m^2, CO_2kg/m^2 reductions.

[15] https://www.gov.uk/government/publications/technical-housing-standards-nationally-described-space-standard
[16] Data provided by TWBC

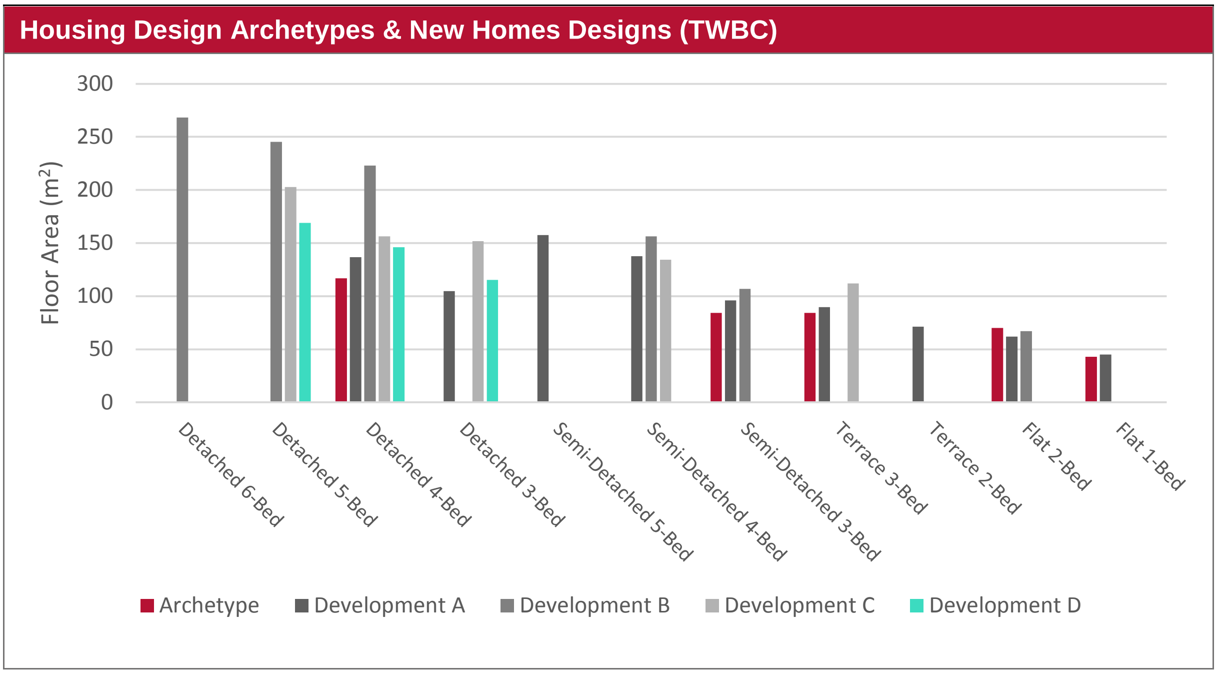


Figure 3 - Housing Design Archetypes & New Homes Designs (TWBC)

4.2 Addressing the Tender Task Requirements

The analysis considered four areas of interest:

- **Improved energy efficiency**
  - achieved through a combination of enhanced fabric standards and use of low carbon heating sources.
  - Energy efficiency standards ranged from the current Part L1A 2013 Notional[17] specification to a series of improved energy efficiency standards with reduced heating requirements
- **Impact on predicted carbon performance**
  - assessed impact of energy efficiency on predicted carbon emissions from different specification scenarios used.
  - Compared Design Emissions Rate (DER) to Target Emissions Rate (TER) of PartL1A 2013 Notional, noting Tender Task Requirement Targets, while considering SAP10 new fuel emission factors.
- **Generation of renewable energy onsite (Merton Rule)**
  - Air Source Heat Pumps (ASHP) and Photovoltaics (PV) were used as reference examples. This was because both technologies are widely applicable to new developments in a range of location types. An ASHP is a renewable and low carbon technology. They are all electric systems with the ability to achieve high levels of energy efficiency.
  -
- **Construction cost capital uplift**

[17] The notional specification is a specification which, if followed, would achieve the requirements of Part L 2013. The specification is higher than the minimum performance standard for each element specified in the regulations. A developer is not obligated to follow the notional specification and could build to a lower standard in some parts of the building and compensate by achieving a higher standard elsewhere.

- evaluation of different modelled scenarios cost implications using ‘Actual’ model construction cost as the baseline

Tender Task Requirements were reviewed and interpreted in support of developing the structure of the model outputs.

Task 1: Evaluation of cost uplift in strengthening the current 10% requirement to 15% and 20%.

Low and Zero Carbon technologies would mean that the Task 1 requirements can also be achieved by using an Air Source Heat Pump. Such scenarios were evaluated in addition to using just PV for compliance and are presented within the report.

Task 2: Refers to energy performance improvements of 19% better than Building Regs 2010 (as amended in 2013) for new development following a ‘fabric first approach’. The range of target levels of ‘fabric first improvements considered comprise 15%, 19% and 25% reductions in the Target Emission Rate (TER).

Within the current version of SAP, the fabric performance of homes is assessed using a separate metric called the Design Fabric Energy Efficiency (DFEE) which is reviewed against the Target Fabric Energy Efficiency (TFEE) of the PartL1A notional. The DFEE/TFEE performance of the housing models was evaluated in addition to DER/TER improvements with results provided within the report for reference purposes.

Task 3: Refers to combining the policies mentioned within Task 1 and Task 2 in ordered to set a two-tiered approach. For example:

a) 19% fabric first and 15% Merton rule
b) 25% fabric first and 10% Merton rule
c) 15% fabric first and 20% Merton rule

Housing models were reviewed and costed against several scenarios achieving the required levels of compliance following the two-tiered approach described above. The models included:

- Naturally ventilated housing models incorporating higher fabric performance specification and PV
- Mechanically ventilated air-tight housing models incorporating higher fabric performance specification and PV
- Naturally ventilated and MVHR supported housing model, incorporation low heat ASHP and PV

Model compliance was evaluated using both SAP2012 and SAP10 carbon emission factors to understand the impact on performance against each target.

5. Domestic Building Models Details and Summary of Results

5.1 Natural Ventilation – Fabric First Models

5.1.1 Fabric Improvement Model Scenarios

A set of three fabric specification variations was produced in terms of naturally ventilated housing models. The Naturally Ventilated Fabric improvements (NV-F models) follow a tiered approach, progressively tightening the standards used. It progresses from Fabric improvement 1 (F1) which provides a small improvement over current, to Fabric Improvement 3 (F3) which is a level of improvement commonly seen in PassivHaus projects (highest). The specification occupied within the models reflects specifications commonly seen in new housing construction projects and is thus technically feasible.

Table 4 - Naturally Ventilated Fabric First Housing models abbreviations

Abbreviations	Explanation
Actual	The PartL1A notional building model, adapted to common specs used within TWB
NV-F1	Natural Ventilation, Fabric Improvement 1
NV-F2	Natural Ventilation, Fabric Improvement 2
NV-F3	Natural Ventilation, Fabric Improvement 3

While the Passivhaus standards require specific levels of air-tightness to be achieved supported by mechanical ventilation systems, high fabric performance standards in naturally ventilated buildings will also lead to reduced space heating demand requirements.

'Actual' models were developed by altering the thermal performance (U-Values) of three key PartL1A notional elements to reflect standards used in new housing projects within the borough.

Table 5 - Variations of U-values (W/m^2K) within PartL1A models to reflect 'Actual' specifications used in projects within the borough of Tunbridge Wells

Element	U-values (W/m^2K)		
	Part L1A 2013 Compliant Actual	TWBC Data	Limiting Fabric Parameter[18] (PartL1A2013)[19]
Exposed Wall	0.18	0.21	0.30
Ground Floor	0.13	0.15	0.25
Exposed Roof	0.13	0.11	0.20

In terms of air-tightness levels, a threshold of >3 $m^3/m^3/h.m^2$ @50pa has been used in all models following a Natural Ventilation approach.

The details of the NV-F fabric specifications used within the models for the different Housing Design Archetypes are provided in Table 6.

[18] Limiting fabric standards are the minimum performance standards described within the Approved Document L1A of the Building Regulations
[19] Part L1A 2013 edition incorporating 2016 amendments

Table 6 - Fabric First Construction Specification details for Naturally Ventilated models

Archetype		Part L1A 2013		Modelled Scenarios		
D, SD, MT	Type/unit	Notional	Actual	NV-F1	NV-F2	NV-F3
Walls	Exposed (W/m2.K)	0.18	0.21	0.18	0.15	0.12
Floors	Ground Floor (W/m2.K)	0.13	0.15	0.15	0.13	0.11
Roofs	Exposed Roof (W/m².K)	0.13	0.11	0.11	0.09	0.09
	Bay Window Roof (W/m².K)	0.13	0.20	0.20	0.20	0.20
Doors	U-value (W/m².K)	1.20	1.20	1.20	1.10	1.00
Windows	U-value (W/m².K)	1.40	1.30	1.30	1.00	0.80
	g-value	0.63	0.63	0.63	0.50	0.50
Air-tightness	(m³/h.m² @50pa)	5.00	5.00	5	4	4
Thermal Bridging Detached	Y-value	0.048	0.050	0.045	0.040	0.035
Thermal Bridging Semi-Detached	Y-value	0.057	0.055	0.050	0.045	0.040
Thermal Bridging Mid-Terrace	Y-value	0.068	0.070	0.065	0.060	0.050
		Part L1A 2013		Modelled Scenarios		
SF	Type/unit	Notional	Actual	NV-F1	NV-F2	NV-F3
Walls	Exposed (W/m2.K)	0.18	0.21	0.18	0.15	0.12
	Wall to corridor (W/m2.K)	0.18	0.25	0.25	0.21	0.18
	Wall to lift (W/m2.K)	0.18	0.25	0.25	0.21	0.18
Doors	U-value (W/m².K)	1.00	1.31	1.31	1.10	1.00
Windows	U-value (W/m².K)	1.40	1.30	1.30	1.00	0.80
	g-value	0.63	0.63	0.63	0.50	0.50
Air-tightness	(m³/h.m² @50pa)	5.00	5.00	5	4	4
Thermal Bridging	Y-value	0.083	0.125	0.115	0.105	0.095
		Part L1A 2013		Modelled Scenarios		
F	Type/unit	Notional	Actual	NV-F1	NV-F2	NV-F3
Walls	Exposed (W/m2.K)	0.18	0.21	0.18	0.15	0.12
	Wall to corridor (W/m2.K)	0.18	0.25	0.25	0.21	0.18
Doors	U-value (W/m².K)	1.00	1.31	1.31	1.10	1.00
Windows	U-value (W/m².K)	1.40	1.30	1.30	1.00	0.80
	g-value	0.63	0.63	0.63	0.50	0.50
Air-tightness	(m³/h.m² @50pa)	5.00	5.00	5	4	4

Thermal Bridging	Y-value	0.087	0.150	0.150	0.125	0.100

5.1.2 Fabric Improvement Model Outcomes

The Design Fabric Energy Efficiency of the NV-F models were assessed for the different housing models. The SAP2012 Technical Manual Provides the following definition of FEE[20]:

‘*The Fabric Energy Efficiency is defined as the space heating and cooling requirements per square metre of floor area’*

Figure 4 summarises results obtained from when assessing the NV-F scenarios for the different housing types and the actual achieved performance is shown in Table 7

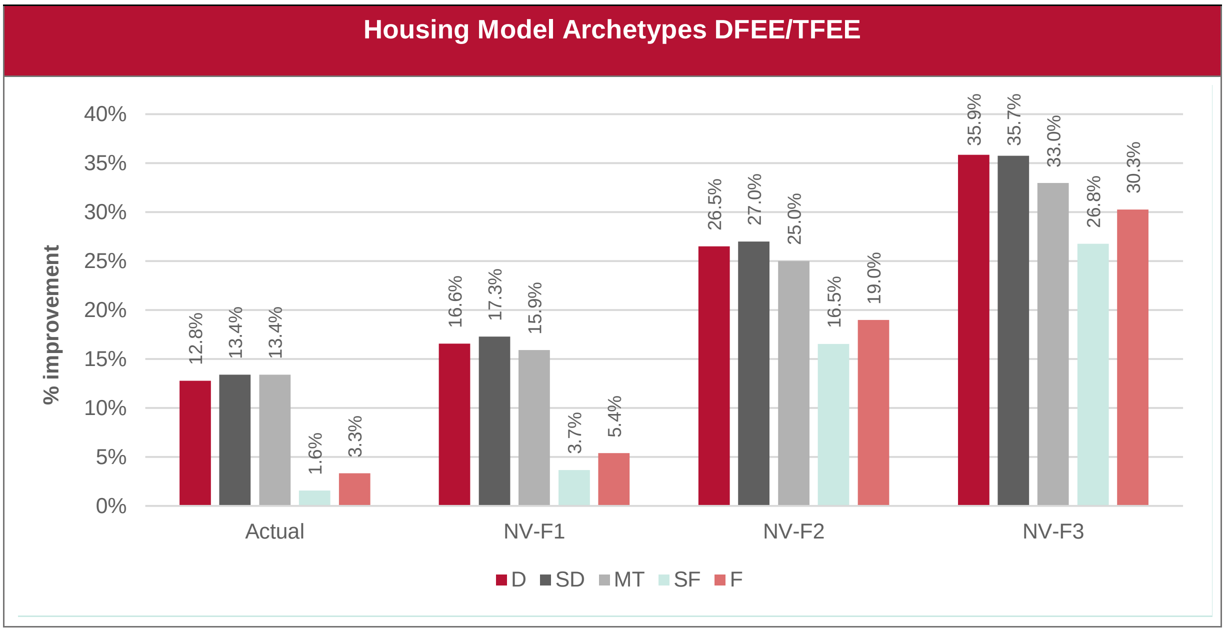


Figure 4 - DFEE/TFEE % of improvement of the NV-F models over PartL1A 2013 notional

Table 7 - Housing Models Fabric Energy Efficiency (*kWh/m²/year)*

		Part L1A 2013		Modelling Scenarios		
	Type/unit	Notional	Actual	NV-F1	NV-F2	NV-F3
Houses	Detached	55.5	48.4	46.3	40.8	35.6
	Semi-Detached	51.5	44.6	42.6	37.6	33.1
	Mid-Terrace	44.0	38.1	37.0	33.0	29.5
Flats	Studio Flat	38.1	37.5	36.7	31.8	27.9
	Flat	39.0	37.7	36.9	31.6	27.2

While it is not clear whether or not future versions of PartL1A will retain the Fabric Energy Efficiency SAP outputs, presenting this information in this research was considered as supportive of achieving a better understanding of metrics within SAP referring to evaluating a ‘fabric first’ approach.

For reference purposes, the now redundant Zero Carbon Homes definition used the following limiting fabric performance parameters for Zero Carbon Homes Compliance in terms of FEES:

[20] http://www.bre.co.uk/filelibrary/SAP/2012/SAP-2012_9-92.pdf

- 39 kWh/m^2/year for apartment blocks and mid-terrace homes
- 46kWh/m^2/year for Semi-detached (End-Terrace) and Detached

All improved models achieved a similar FEE to that of Zero Carbon Homes using the SAP DFEE methodology.

5.1.3 Impact on Energy Demand

The Design Emissions Rate (DER) includes the conversion of total energy demand to carbon emissions. This includes energy use for lighting, installed services pumps and fans, domestic hot water generation and space heating.

As a complication of that, assessing the impact of fabric improvements only in terms of DER performance becomes challenging. Future policies could include references to specific energy demand targets, in addition to carbon performance improvements.

Analysis of the impact of the advanced fabric specifications used in the models on space heating demand was conducted to showcase the levels of performance improvements achieved in terms of overall energy demand reduction.

Increasing the thermal performance of the fabric directly affects H-SHED. This is due to reduced heat losses during the colder months of the year when heating is required. G-SHED depends on the efficiency of the space heating technology used to supply the required space heating.

Results shown in Table 8 are of models using the same gas boiler system ().

Table 8 - H-SHED percentile reduction improvement over PartL1A baseline

		Modelling Scenarios		
	Type/unit	NV-F1	NV-F2	NV-F3
Houses	Detached	2%	14%	26%
	Semi-Detached	2%	14%	25%
	Mid-Terrace	1%	12%	22%
Flats	Studio Flat	N/A	2%	17%
	Flat	N/A	N/A	17%

| Key Outputs

- In the case of houses, NV-F2 and NV-F3 improvements led to substantial reductions in the space heating demand when compared to PartL1A notional specs.
- Due to the limited heat loss elements in the case of flats, a fabric performance improvement close to that of Passivhaus (NV-F3) was required to achieve the same levels of space heating demand reductions to that of NV-F2 specification in houses.
- When compared to overall energy demand, the NV-F3 specifications led to an energy demand reduction of almost 15% in houses and 7% in flats, while NV-F2 to almost 7% overall energy demand reductions in houses while in flats it had negligible effects.

5.1.4 Impact on Carbon Performance

The impact on the predicted DER of the advanced NV-F1 to NV-F3 fabric specifications was evaluated using both SAP2012 and SAP10 grid carbon emission factors. The following results were obtained (Table 9).

Table 9 - DER/TER percentage of improvement for NV-F1 to NV-F3 models using SAP2012 and SAP10 energy carbon factors

Type	SAP	Notional carbon emissions (kg CO2e m2)	Percentage improvement against notional (with gas boiler)			
Dwelling type	**Version**	**Part L 2013Notional**	**Part L 2013 Actual**	**NV-F1**	**NV-F2**	**NV-F3**
D	SAP2012	16.6	0%	3%	10%	17%
	SAP10	15.0	0%	3%	11%	18%
SD	SAP2012	18.1	1%	3%	9%	15%
	SAP10	16.1	1%	3%	10%	16%
MT	SAP2012	16.7	1%	2%	7%	12%
	SAP10	14.8	1%	3%	8%	13%
House Avg.	SAP2012	**17**	**1%**	**3%**	**9%**	**14%**
	SAP10	**15**	**1%**	**3%**	**9%**	**16%**
SF	SAP2012	18.6	N/A	N/A	4%	9%
	SAP10	16.3	N/A	N/A	4%	10%
LF	SAP2012	16.1	N/A	N/A	0%	7%
	SAP10	14.1	N/A	N/A	-1%	7%
Flat Avg.	SAP2012	**17.3**	**N/A**	**N/A**	**2%**	**8%**
	SAP10	**15.2**	**N/A**	**N/A**	**2%**	**8%**

5.1.5 Key Findings

- In terms of DFEE/TFEE the advanced fabric standards used in NV-F1, NV-F2 and NV-F3 achieved average the improvements shown in(Table 10). This was due to the reduced heat loss area which leads to reduced heating demand.

Table 10 – Average improvements achieved by advanced fabric standards

	Achieved average improvements		
	NV-F1	NV-F2	NV-F3
Houses	17%,	26%	35%
Flats	5%	18%	29%

- Overall energy demand reductions identified in all cases were attributed to the reduction of space heating energy demand, while the fabric first approach used did not affect energy required for the generation of domestic hot water (DHW), or electricity requirements of installed services and lighting.

- DER/TER improvements were not significantly affected by the change in the gas carbon fuel factors between SAP2012 and SAP10 due to fact that the properties used gas for space heating and DHW generation.

- In the case of houses, the NV-F2 scenario led to almost a 9% DER/TER reduction while the advance NV-F3 fabric specifications led to and almost 14% improvement. Flats achieved an average of 8% DER/TER using the advanced NV-F3 fabric specification in both instances.

5.2 Mechanical Heat Recovery Ventilation – Fabric First Models

Following a fabric first approach, the NV-F models were adapted to higher air-tightness levels (<3 m3/h.m2 at 50 Pa) to address requirements for the MHRV technology to work efficiently. Thresholds set were in accordance with guidance provided within the Approved Document F of the 2010 Building Regulations for mechanically ventilated houses.

The MVHR housing models' abbreviations are shown in Table 11.

Table 11 – MVHR supported Fabric First Housing models abbreviations

Acronym	Explanation
Actual	The PartL1A notional building model, adapted to TWBC common specs
MV-F1	MVHR, Fabric Improvement 1 (Airtight) (smallest improvement)
MV-F2	MVHR, Fabric Improvement 2 (Airtight)
MV-F3	MVHR, Fabric Improvement 2 (Airtight) (greatest improvement)

The level of air-tightness used within the models is shown in Table 12. The elemental fabric performance was retained between the NV-F and MV-F model sets (NV-F1 to MV-F1, NV-F2 to MV-F2 and NV-F3 to MV-F3) and was as specified in Table 6.

Table 12 - MV-F models air-tightness levels assessed in SAP2012

Type/unit	Part L1A 2013		Modelling Scenarios		
	Notional	Actual	MV-F1	MV-F2	MV-F3
Air-tightness ($m^3/h.m^2$ @50pa)	5.00	5.00	3	3	1

The MVHR efficiency across all MV-F model variations was kept constant at 88%.

5.2.1 Fabric Improvement and MHVR Model Outcomes

Figure 5 summarises results obtained from when assessing the MV-F scenarios for the different housing types.

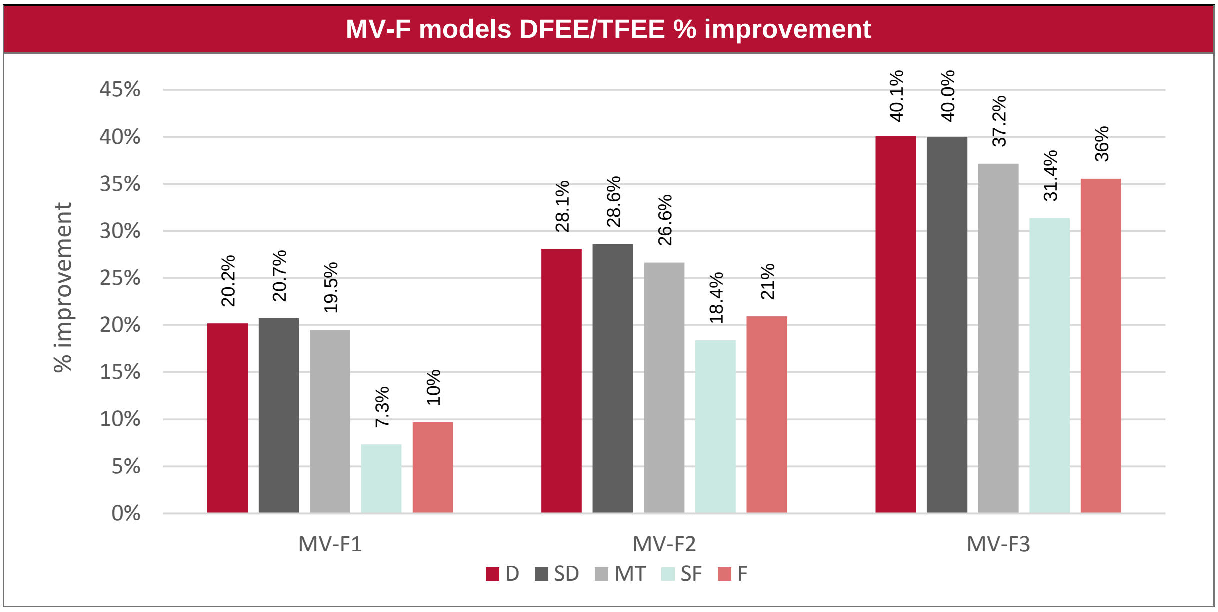


Figure 5 - DFEE/TFEE % of improvement of the NV-F models over PartL1A 2013 notional

As shown the increased air-tightness had a positive impact on the fabric energy efficiency in all cases. This was due to reduced heat losses through infiltration.

Table 13 - Housing Models Fabric Energy Efficiency (kWh/m^2/year)

Type/unit		Part L1A 2013		Modelling Scenarios		
		Notional	Actual	MV-F1	MV-F2	MV-F3
Houses	Detached	55.5	48.4	44.29	39.9	33.26
	Semi-Detached	51.5	44.6	40.83	36.77	30.90
	Mid-Terrace	44.0	38.1	35.43	32.28	27.65
Flats	Studio Flat	38.1	37.5	35.31	31.1	26.15
	Flat	39.0	37.7	35.22	30.84	25.13

5.2.2 Impact on Energy Demand

The following G-SHED energy demand reductions were noted between the naturally ventilated and MVHR supported models (Table 14). Absolute amounts of G-SHED per year are noted in

Figure 6.

Table 14 – Impact of combination of MVHR and higher airtightness levels on G-SHED, Gas Boiler 89.5% average across housing design archetypes

Type	Improvement G-SHED (%)		
	NV-F1 to MV-F1	NV-F2 to MV-F2	NV-F3 to MV-F3
Houses (D, SD, MT)	36%	46%	70%

Flats (SF, LF)	46%	59%	83%
Type	**Improvement Grid Energy Demand (%)**		
Average	17%	22%	35%

Total G-SHED energy requirements per year of NV-F and MV-F models

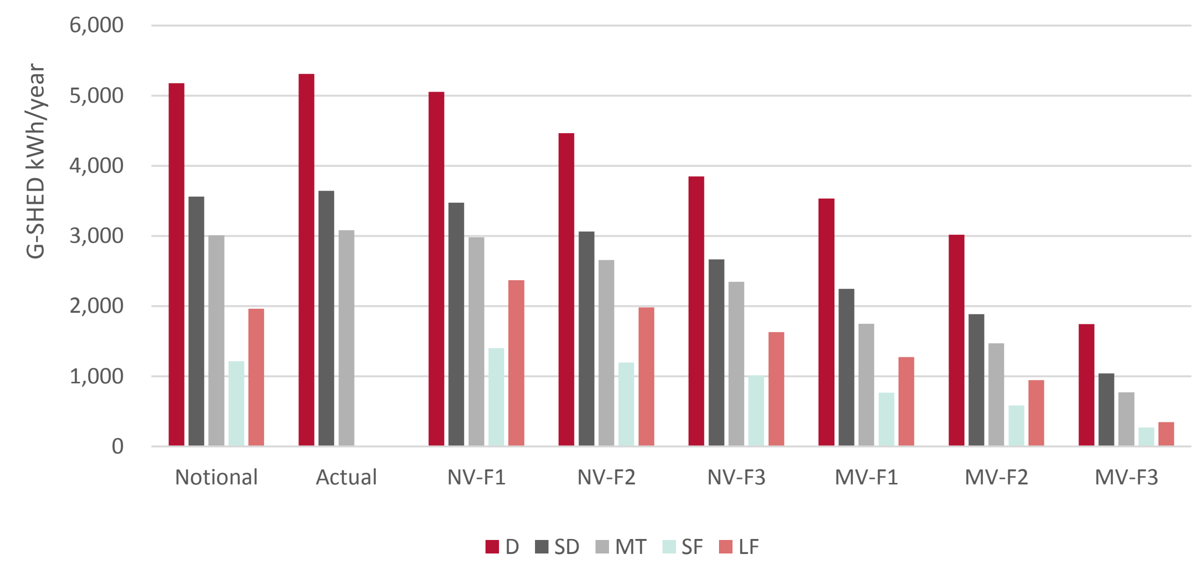


Figure 6 – Total G-SHED energy requirements per year of NV-F and MV-F models across housing design archetypes

5.2.3 Impact on Carbon Performance

The naturally ventilated and mechanically ventilated models DER improvements over the notional TER targets have been analysed and are summarised in Table 15.

Table 15 - Fabric First models DER/TER (%) improvement using SAP2012 and SAP10 factors

Type	SAP	TER	DER Improvement over TER					
	Version	($kgCO_2/m^2$/year)	NV-F1	NV-F2	NV-F3	MV-F1	MV-F2	MV-F3
D	SAP2012	17	3%	10%	17%	10%	15%	29%
	SAP10	15	3%	11%	18%	16%	23%	38%
SD	SAP2012	18	3%	9%	15%	13%	18%	30%
	SAP10	16	3%	10%	16%	18%	24%	37%
MT	SAP2012	16.7	2%	7%	12%	13%	17%	28%
	SAP10	14.8	3%	8%	13%	19%	24%	36%
SF	SAP2012	19	N/A	N/A	9%	10%	15%	24%

	SAP10	16	N/A	N/A	10%	14%	20%	29%
LF	SAP2012	16	N/A	N/A	7%	7%	13%	25%
	SAP10	14	N/A	N/A	7%	11%	18%	30%

5.2.4 Key Findings

- In terms of DFEE/TFEE, the advanced fabric standards used in MV-F1, MV-F2 and MV-F3 achieved average improvements on 20%, 28% and 39% in the case of houses while the percentage of DFEE/TFEE in the case of flats was smaller 9%, 20% and 30% respectively. This was due to the reduced heat loss areas which leads to reduced heating demand.

- Overall energy demand reductions identified in all cases were attributed to the reduction of space heating energy demand, while the fabric first approach used did not affect energy required for the generation of domestic hot water, or electricity requirements of installed services and lighting.

- G-SHED SAP2012 predicted reductions in the MV modelled scenarios (using the lowest F1 fabric improvement option) surpassed the highly fabric efficient NV-F3 model achieving an average of 37% G-SHED reduction compared to PartL1A 2013 notional baseline. Whereas, NV-F3 models achieved an average of 24% reduction across all models. Higher G-SHED reductions were achieved using the MV-F3 (similar to Passivhaus specification standard) which achieved an average of a 70% G-SHED reduction.

- In the case of DER/TER, the benefit of reduced carbon emission factors in SAP10 became apparent in the MVHR supported models when compare to SAP2012 carbon performance predictions. This was expected as a significant reduction in the case of grid electricity carbon emission factors of almost 55% was introduced in the new version of the Standard Assessment procedure signifying the decarbonisation of the electricity grid

- The average DER/TER improvement using the SAP2012 carbon factors was 10% using the MV-F1 scenario 16% using the MV-F2 scenario and 27% using the MV-F3 scenario. Using the SAP10 electricity carbon emission factors, almost 6% improvement was added (for example achieving as an average 16% DER/TER improvement in the case of MV-F1 using the SAP10 factors)

5.3 Low and Zero Carbon Energy Generation

The previous modelling scenarios described in sections 5.1 and 5.2 investigated the performance of the housing archetypes when improved fabric standards were used.

Such improvements would lead to reductions in space heating energy requirements, but further improvements can be achieved by increasing the efficiency of the space heating supply service.

In the case of Air Source Heat Pumps (low temperature heating), efficiencies of up to 300% can be achieved[21] leading to significant reductions in energy demand from the grid. For this type of

[21] Efficiencies of above 100% can be achieved because the heat pump draws energy from the environment. This environmental sourced energy is deemed a renewable source and enables the heat pump to deliver substantially more heating or hot water energy and it consumes in electrical energy. A gas boiler by contrast consumes more gas energy than it outputs as useable heat.

heating (supply temperatures 35-55° C compared to 75-85°C) larger radiators would have to be used that could increase capital construction costs.

Nevertheless, for homes that have particularly low levels of space heating demand, i.e. houses with heating demand of 25kWh per m^2 or below, there are potential cost savings associated with a reduction in the extent of the internal heating distribution system. These could be realised both in terms of fewer radiators and by moving the radiators towards the core of the building and thereby reducing the length of pipe runs. There is evidence for these savings from Passivhaus projects which typically involve substantially reduced heating distribution systems[22].

The research analysis included a review of models where the existing gas boiler (89.5% efficient) was replaced by low temperature heating using an ASHP with an efficiency of 250% to cover the supply heating requirements. In the case of flats, the ASHP was considered as a centralised communal system.

The use of heat pumps in high rise apartments could involve centralised systems with heat interface units for individual units, or in the case of ground source systems, could include localised pumps connected to a water circuit. Depending on whether the system supplies one or multiple homes, ASHP systems could quality for either domestic or non-domestic Renewable Incentive (RHI) funding[23]. Similarly, the use of photovoltaics could allow for Smart Export Guarantee (SEG)[24] support. Such incentive payments would result in operational cost reductions and have not been considered within the analysis.

New and better performing better solutions offer the opportunity of reducing G-SHED, DHW energy consumption or the electricity used by installed services and lighting (for example various boiler pumps and fans systems).

Table 16 summarises the different LZC Technologies considered in the cost and performance analysis of the housing models.

Table 16 – Primary Heating System and LZC Technologies used in the cost models

	Efficiency	Comments
Gas Boiler	89.5%	Same As PartL1A notional
ASHP COP2.5	250%	Low Temperature / Carbon Heat
Photovoltaics	Orientated to the south at an incline of 30^o	0.5, 0.75,1 and 1.25 kWp modelled

The results of the combined fabric, low carbon heat (ASHP) and PV scenarios are shown, together with the associated cost implications, in Section 5.4 .

5.4 Cost Analysis – Domestic

5.4.1 Capital Cost Modelling

5.4.1.1 Model Overview

Cost analysis considers the additional costs of implementing the specified carbon reduction measures in comparison to the costs of building the same home to the Part L 2013 Actual

[22] https://www.theccc.org.uk/publication/the-costs-and-benefits-of-tighter-standards-for-new-buildings-currie-brown-and-aecom/
[23] https://www.ofgem.gov.uk/publications-and-updates/non-domestic-rhi-tariff-table
[24] BEIS initiative from 1 January 2020, https://www.ofgem.gov.uk/publications-and-updates/smart-export-guarantee-seg

specification. Costs are based on Currie & Brown's professional experience of project costs and are developed from detailed specifications of the full range of cost implications for each element.

Four Housing Design Archetypes cost uplifts were reviewed: detached, semi-detached, mid-terrace houses and small flats. The uplifts associated with the construction of the large flats in traditional masonry construction would be similar to that of the smaller flats therefore the studio flat and flat archetypes previously described were not considered individually. No high-rise options were costed, which could require reinforced concrete and steel frame construction detailing.

Putting Cost Estimates In Context

The costs presented in this report are for a medium sized developer, building several hundred to a thousand homes per year.

It is important to remember that the costs of developing new homes can vary very widely for a range of factors, not least: location, ground conditions, site constraints, access, topography, quality of finishes, design complexity, supply chain and management.

Construction costs can also be subject to sudden and significant change because of market or economic factors. For example, varying exchange rates, skills or materials shortages and interest rates. In the 12 months from May 2017 to May 2018 average housing materials costs increased by around 5%. However, this number is likely to conceal larger variations in specific items.

These extensive factors mean that a benchmark cost analysis is only indicative of overall cost implications of different policy options and their relative significance.

5.4.1.2 Potential for Cost Reductions

Cost analysis is based on rates as of late-2018. An indication of how these costs may change in the future is estimated based on published cost projection data for key solutions such as photovoltaics, ASHP and achieving higher standards of airtightness.

Some of the technologies and materials used in energy efficient homes are well established, while others are relatively new (e.g. mechanical ventilation with heat recovery systems) or rarely achieved (e.g. very high air tightness).

Analysis of the potential for reduced costs associated with achieving higher standards of energy efficiency suggest that the cost premium associated with the most energy efficient standards may fall by around 20-30% between 2020 and 2030 as project teams become more familiar with achieving high levels of air tightness and the markets for new technologies become more established. In addition, it is likely that there will be further reductions in the costs of PV with costs falling by a further 35% on 2020 levels by 2030.

These cost trajectories mean that it is likely to become less expensive to build to lower carbon standards over time. However, the scale and speed of changes in costs associated with different technologies is relatively small and slow in comparison to other factors such as the changes to the modelling method.

For example, the most recent update to the SAP methodology (SAP10) proposes a 55% reduction in the emission factor for electricity. This, or a similar change, together with other methodological amendments, could immediately come in to effect when a new version of SAP is adopted for compliance purposes.

Government projections are that by 2030 the emission factor for electricity will have reduced further to approximately 0.1 kgCO_2e per kWh. This equates to a reduction of approximately 50%

on the SAP 10 figure and a reduction of over 75% on the SAP 2012 factor. These changes will have a very material impact on the total estimated carbon emissions of new homes and the effectiveness of different options for their reduction. They will act to favour the use of heat pumps for heating and will reduce the carbon savings delivered by PV arrays.

The costs of meeting a specific standard will change markedly when modelling methods and emission factors are changed. These changes, which may be introduced within the next two years, are likely to have a more material effect on the costs of meeting a target than changes in the capital costs of specific solutions.

5.4.2 Capital Cost Uplift and DER/TER improvement – Informing Policy Options

Detailed results of housing models' capital cost uplifts and the achieved DER/TER level of improvement are provided within the graphs shown in Figure 7 -

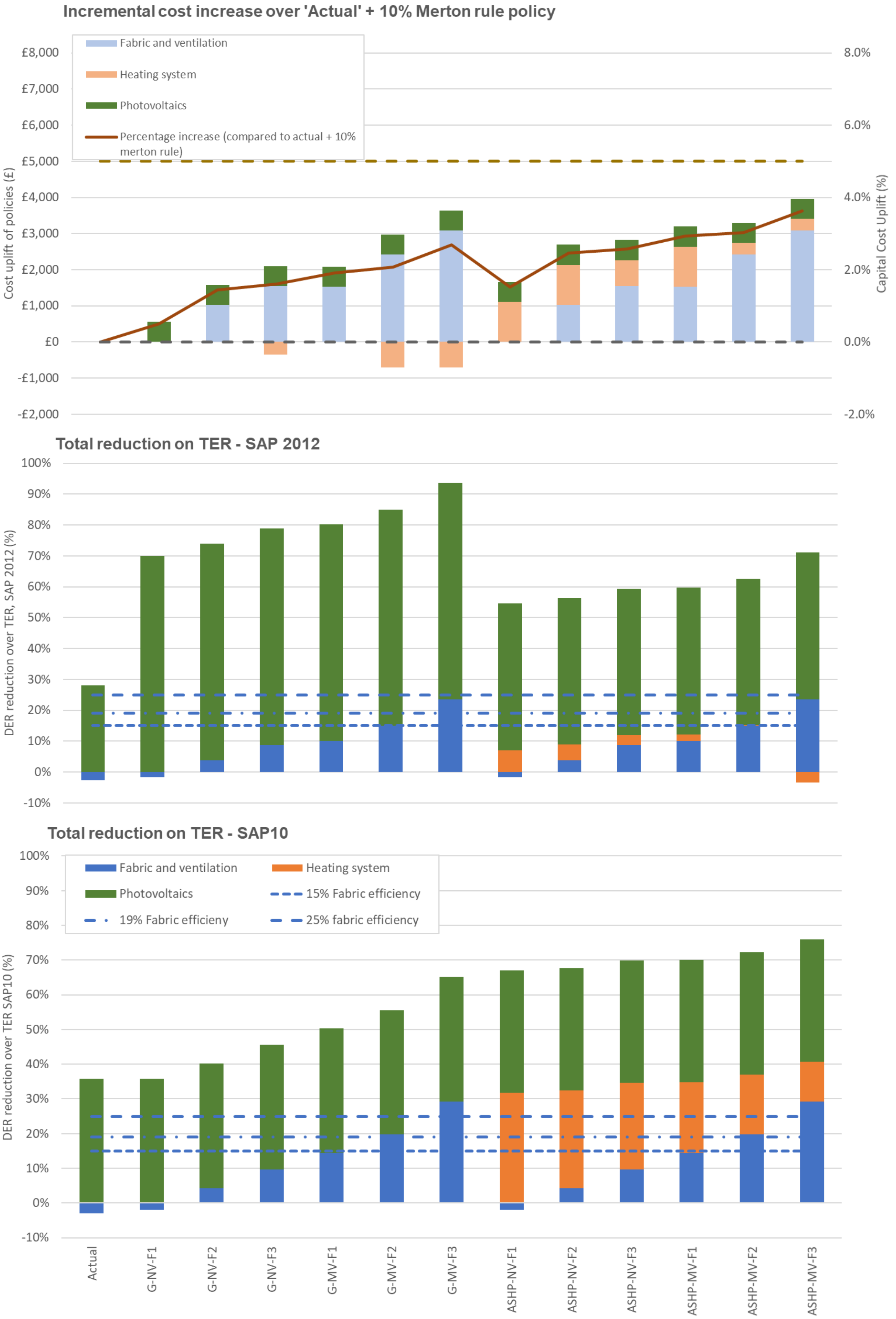

Incremental cost increase over 'Actual' + 10% Merton rule policy
Fabric and ventilation
Heating system
Photovoltaics
Percentage increase (compared to actual + 10% merton rule)
Cost uplift of policies (£)
Capital Cost Uplift (%)
£8,000
£7,000
£6,000
£5,000
£4,000
£3,000
£2,000
£1,000
£0
-£1,000
-£2,000
8.0%
6.0%
4.0%
2.0%
0.0%
-2.0%
Total reduction on TER - SAP 2012
DER reduction over TER, SAP 2012 (%)
Total reduction on TER - SAP10
DER reduction over TER SAP10 (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
-10%
Fabric and ventilation
Heating system
Photovoltaics
15% Fabric efficiency
19% Fabric efficieny
25% fabric efficiency
Actual
G-NV-F1
G-NV-F2
G-NV-F3
G-MV-F1
G-MV-F2
G-MV-F3
ASHP-NV-F1
ASHP-NV-F2
ASHP-NV-F3
ASHP-MV-F1
ASHP-MV-F2
ASHP-MV-F3

Figure 10.

Models considered all fabric first solutions developed within the naturally ventilated and MVHR supported scenarios (NV-F1/F3 and MV-F1/2), supported by either a gas boiler (models starting with G- as shown in the graphs) or an ASHP of a COP2.5.

5.4.2.1 Cost Modelling Assumptions

In the case of photovoltaics, the initial installation was costed at £1470 for 0.5kWp installed on the Actual model specification in order to achieve the 10% DER/TER carbon performance improvement baseline.

This cost was embedded within the baseline cost of the 'Actual' specification with an incremental cost of £185 per additional 0.25kWhp PV required added to the model.

The relationship between PV output and surface area will vary between different PV technologies. An average of $7m^2$ /kWh was assumed in the research. The maximum PV specified (1.25 kWp) compared to the floor area of the different design archetypes is estimated in the Table 21 below.

Table 17 - PV capacity to floor area of housing models

Design Archetypes	PV Capacity (kWhp)	PV to Floor Area Ratio (%)
Detached	1.25 kWp	7%
Semi-detached		10%
Mid-Terrace		10%
Small Flat		20%

Previous work on setting the Carbon Compliance levels undertaken by the Zero Carbon Hub[25] demonstrated a PV to floor area ratio of 40% as limit for coverage of the roof after which additional PV installations increase the technical risk of the project (space limitation, access, layouts and design). In that sense and considering the limited floor space of the small flats it needs to be noted that a maximum of 0.75 kWp could be used if the flats were part of a 3-storey building. While the cost-models show the carbon saving and cost impact of higher percentages of PV in flats, this is provided for reference purposes and it is accepted that limitations exist to the use of the technology especially on high-rise buildings.

Associated heating systems sundries costs were reduced in the case of models with lower than $25kWh/m^2$/year space heating demand following the rules described in Table 18. Explain why.

Table 18 – Heating system sundries cost reductions associated with reduced space heating demand

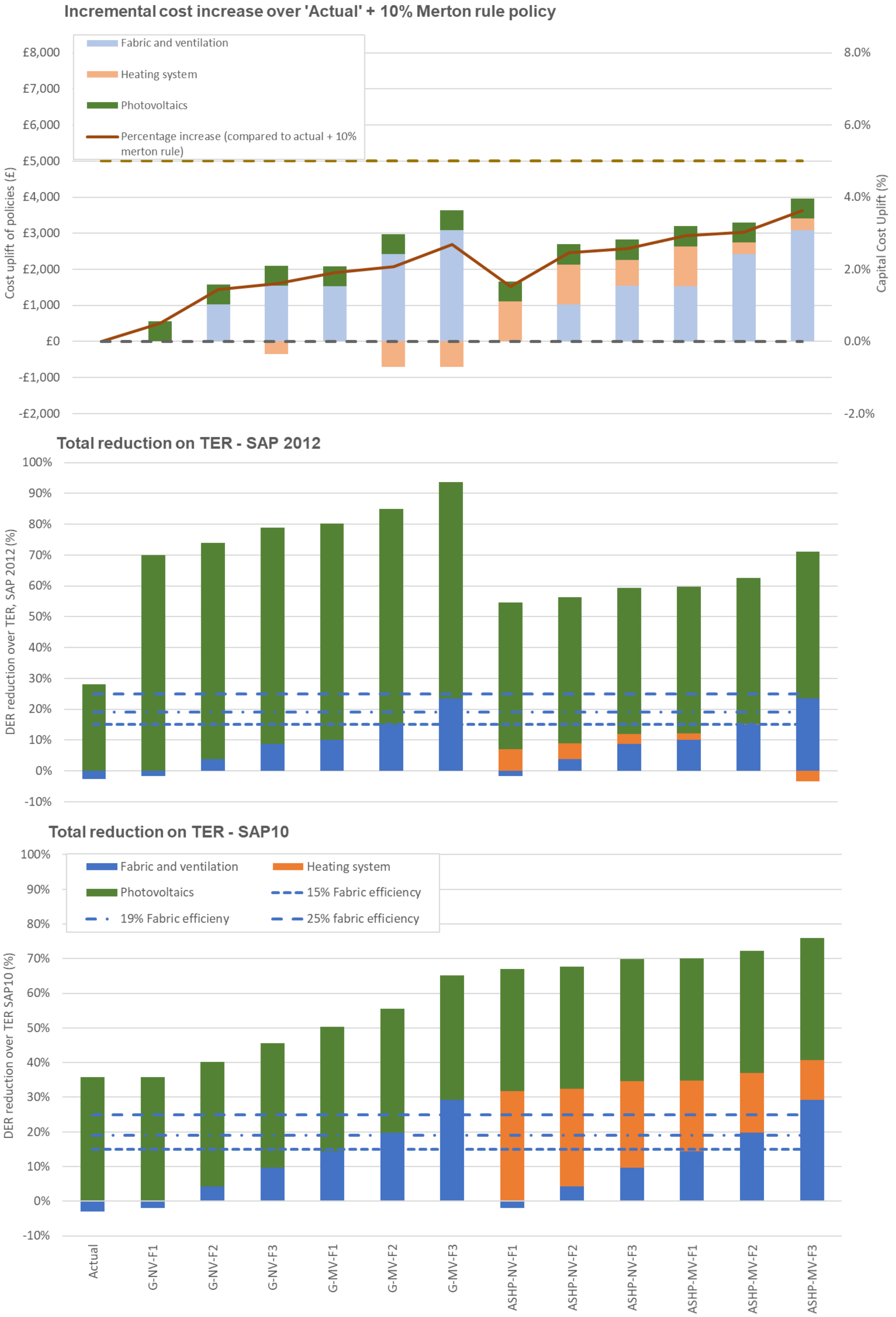
Space Heating Demand (H-SHED) (kWh/m2/year)	Reduction in Heating Systems radiators and distribution pipework cost (%)
< 25	25
< 20	50
< 15	75[26]

[25] http://www.zerocarbonhub.org/sites/default/files/resources/reports/Carbon_Compliance_What_is_the_Appropriate_Level_for_2016.pdf

[26] Not applied to small flats due to an already reduced internal space heating network and small number of radiators required. For flats a maximum reduction of 50% was considered.

5.4.2.2 Cost Modelling Results

In response to the policy questions detailed in Section 1.1, the following information has been extracted from the detailed model cost analysis. To review exact model performances please refer to Figure 7 -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£6,000
£5,000
£4,000
£3,000
£2,000
£1,000
£0
-£1,000
-£2,000
Cost uplift of policies (£)
8.0%
6.0%
4.0%
2.0%
0.0%
-2.0%
Capital Cost Uplift (%)
Total reduction on TER - SAP 2012
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
-10%
DER reduction over TER, SAP 2012 (%)
Total reduction on TER - SAP10
Fabric and ventilation
Heating system
Photovoltaics
15% Fabric efficiency
19% Fabric efficieny
25% fabric efficiency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
-10%
DER reduction over TER SAP10 (%)
Actual
G-NV-F1
G-NV-F2
G-NV-F3
G-MV-F1
G-MV-F2
G-MV-F3
ASHP-NV-F1
ASHP-NV-F2
ASHP-NV-F3
ASHP-MV-F1
ASHP-MV-F2
ASHP-MV-F3

Figure **10**.

Table 19 - Summary of findings addressing main policy questions

Policy Questions
Task 1 - Merton Rule
Is it technically feasible to construct buildings that go beyond the 2013 Building Regulation requirements of a Target Emission Rate (TER) by between 15 and 20% using LZC technology? What would the additional cost be for a developer if this target was strengthened to 15 and 20% against a 10% baseline cost?
Houses ▪ SAP2012: Almost all 'Actual' specification models were able to meet the baseline 10% current target by using a 0.5kWp PV. SAP10: The same models were unable to meet the required 10% baseline target when tested against the SAP10 performance standards. In such cases, additional PV (0.25kWp) would have to be installed increasing the baseline cost slightly by £185. Small Flats ▪ SAP2012: All the 'Actual' specification models were able to meet the baseline 10% current target by using a 0.5kWp PV (27% improvement). SAP10: All the 'Actual' specification models met the 10% policy requirement without additional PV required (14% improvement). ▪ SAP2012: The 15% and 20% DER/TER improvements were satisfied in all models with use of the 0.5kWp PV specified. SAP10: Fabric first models required additional PV to meet the 15% and 20% targets due to the reduced electricity carbon emission factor (offset) with a slight additional cost of £185. For naturally ventilated solutions, the impact of advanced fabric specification on carbon emissions reduces in line with the space heating demand reductions in each home archetype i.e. the most energy efficient forms such as the flat and mid terrace houses show smaller carbon savings from improved fabric and ventilation specifications than the detached house. Using SAP10 emission factors, the largest impact on carbon emissions is seen for all homes arises from replacing the gas boiler with an ASHP. Housing models with ASHP meet and exceed the highest Merton Rule targets.

Policy Question 2
Fabric First Thresholds
Is it technically feasible to construct buildings that go beyond the 2013 Building Regulation requirements of a Target Emission Rate (TER) by 15%, 19% and 25% using the fabric first approach?

What would the additional cost be for a developer if this target was implemented and compare these costings for targets of 15% and 25%?

- Model series NV-F1/3 and MV-F1/3 followed a tiered fabric first approach. The solutions used within these models include various levels of increased fabric performance and air-tightness levels as detailed in Section 5.1.
- An capital cost uplift of approximately 2.5 to 5% was recorded in the majority of models using the highest fabric performance specifications (-F3).
- The (MV-F3) ‘Passivhaus type’ fabric upgrade was estimated to result in an absolute fabric capital cost uplift of £3,084 (Small Flat) to £7,902 (Detached House).
- The (MV-F2) fabric upgrade was estimated to result in an absolute fabric capital cost uplift of £2,422 (Small Flat) to £5,318(Detached House).
- The (MV-F1) fabric upgrade was estimated to result in an absolute fabric capital cost uplift of £1,526 (Small Flat) to £2,621 (Detached House).
- The (NV-F3) ‘Passivhaus type’ fabric upgrade was estimated to result in an absolute fabric capital cost uplift of £1,545 (Small Flat) to £5,423 (Detached House).
- The (NV-F2) fabric upgrade was estimated to result in an absolute fabric capital cost uplift of £1,023 (Small Flat) to £3,296 (Detached House).
- The (NV-F1) fabric upgrade was estimated to result in an absolute fabric capital cost uplift of £0 (Small Flat) to £288 (Detached House).
- The transitions from the SAP2012 to SAP10 carbon fuel factors positively impact the carbon savings from the mechanically ventilated (MV) models due to the lower carbon emissions generated by the electrical consumption of the MVHR units.

SAP 2012 and SAP 10

- SAP2012: The (MV-F3) ‘Passivhaus type’ fabric upgrade was estimated to result in an average 29% carbon improvement (over TER) in houses and 24% in the small flat
- The (MV-F2) fabric upgrade was estimated to result in an average 17% carbon improvement (over TER) in houses and 15% in the small flat
- The (MV-F1) fabric upgrade was estimated to result in an average 12% carbon improvement (over TER) in houses and 10% in the small flat
- The (NV-F3) ‘Passivhaus type’ fabric upgrade was estimated to result in an average 14.5% carbon improvement (over TER) in houses and 9% in the small flat
- The (NV-F2) fabric upgrade was estimated to result in an average 10% carbon improvement (over TER) in houses and 4% in the small flat

- The (NV-F1) fabric upgrade was estimated to result in an average 3% carbon improvement (over TER) in houses and 0% in the small flat

SAP 10:

- The (MV-F3) 'Passivhaus type' fabric upgrade was estimated to result in an average 37% carbon improvement (over TER) in houses and 29% in the small flat

- The (MV-F2) fabric upgrade was estimated to result in an average 24% carbon improvement (over TER) in houses and 20% in the small flat

- The (MV-F1) fabric upgrade was estimated to result in an average 18% carbon improvement (over TER) in houses and 14% in the small flat

- The naturally ventilated fabric options performed in a similar manner, as in the case of SAP2012. This was due to the added benefit and carbon improvements, in the case of the SAP10 mechanically ventilated models was the new electricity carbon factors (MVHR units use electricity for their operation affecting the estimated carbon performance of the property.

Policy Question 3

Combined Policies

Is it technically feasible to implement a combination of the above described fabric first and Merton rule style policies?

What are the indicative cost implications of implementing both these policies for developers?

Which combination of policy targets are best suited to TWBC? For example:

a) 19% fabric first and 15% Merton rule?
b) 25% fabric first and 10% Merton rule?
c) 15% fabric first and 20% Merton rule?

Any other combination?

- Cost and energy models show that in the case of houses an average of a 20% improvement on TER can be achieved using increased levels of airtightness and an MVHR units. Small flats might require the highest fabric spec to achieve similar levels of performance in SAP2012. No cost-uplift exceeded 5%.

- For naturally ventilated houses a 15% improvement on TER is possible using fabric specifications close to the Passivhaus standard indicating a cost-uplift of 5%. Due to reduced heat loss elements using the advanced F3 fabric specification naturally ventilated flats led to a 3% cost uplift. The flat F3 fabric specification improvement was approximately 10%.

- With SAP10 emission factors the use of ASHP results in the homes meeting all of all Merton Rule targets (15-25%) in all house cases with no additional PV.

- For models using a gas boiler, the PV capacity increase needed to meet the 15% Merton Rule requirement under SAP2012 carbon emission factor translated to a cost increase of £185 for additional capacity installation. This is deemed insignificant in comparison to the cost of building a new home.

- Using SAP10 emission factors reduces the carbon savings from the use of PV and so additional PV is required to meet the relevant Merton rule standards. The costs of achieving carbon savings through PV are approximately double those associated with SAP2012 emission factors (although still deemed relatively insignificant). Nonetheless, with a maximum cost uplift of 5%, it is still possible to achieve both c.20% emission reductions from fabric and ventilation and then 20-25% Merton Rule reductions while retaining a gas boiler and using SAP10 emission factors.

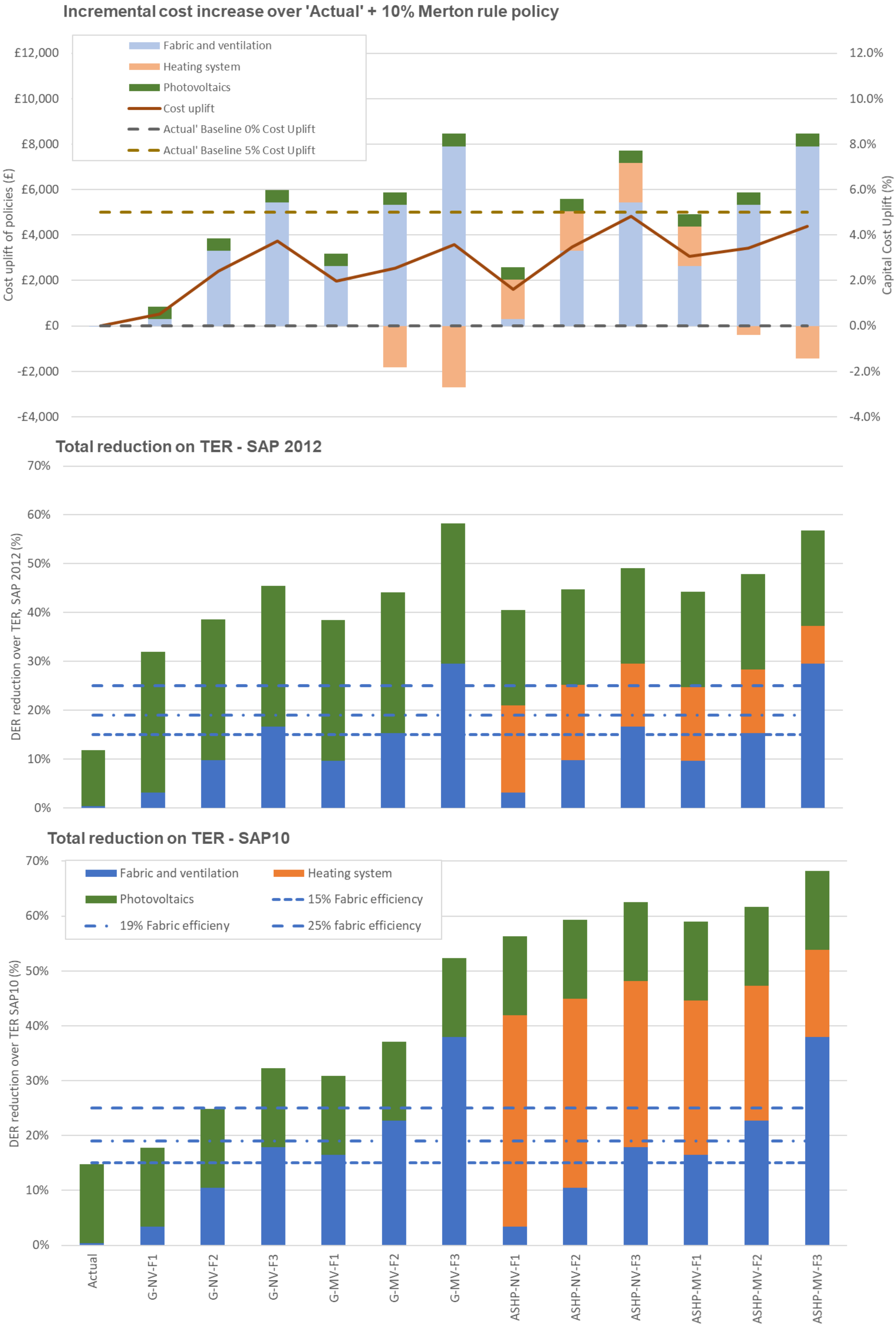


Figure 7 - Detached House Models Cost Uplift and DER/TER performance (SAP2012 and SAP10)

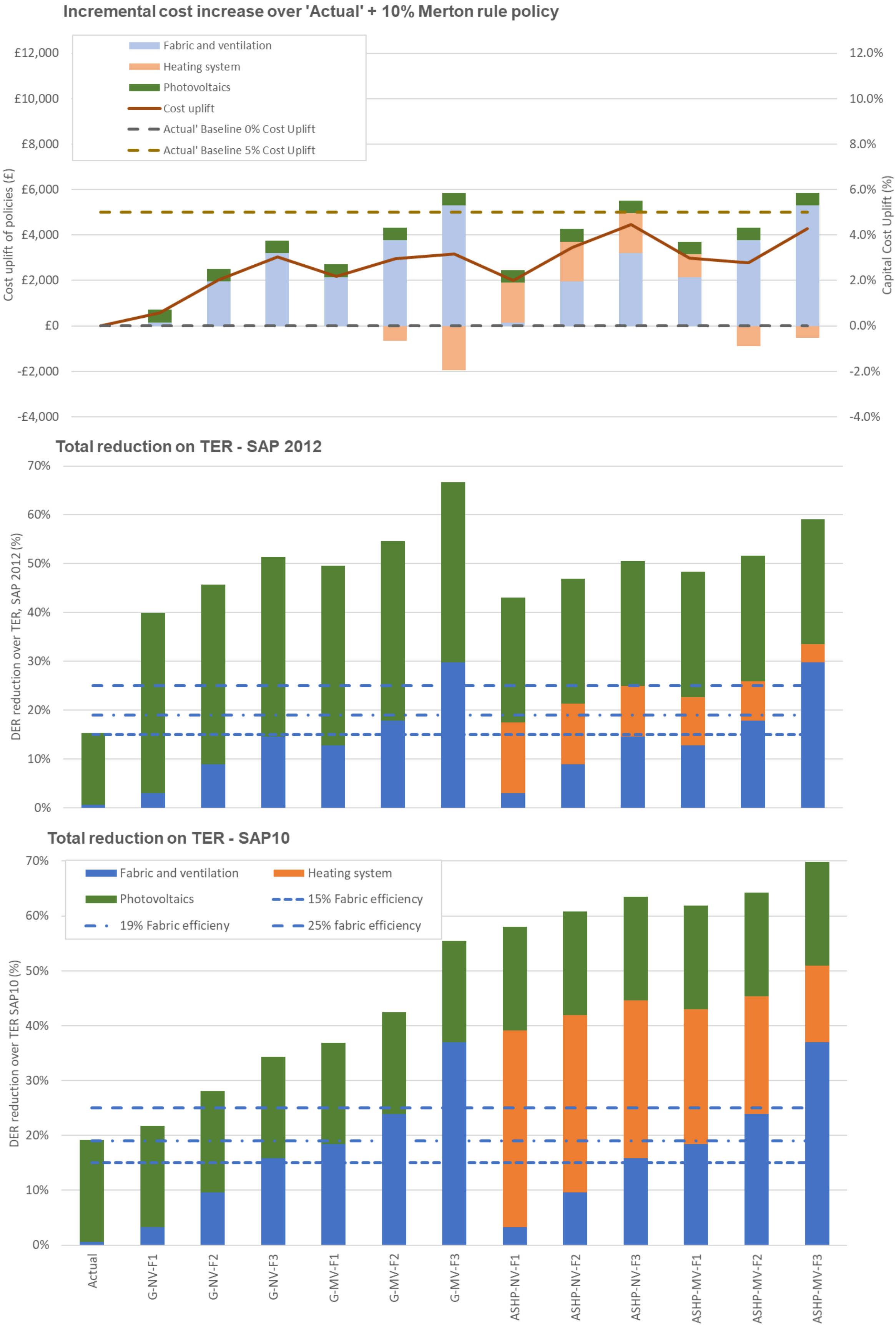


Figure 8- Semi-Detached House Models Cost Uplift and DER/TER performance (SAP2012 and SAP10)

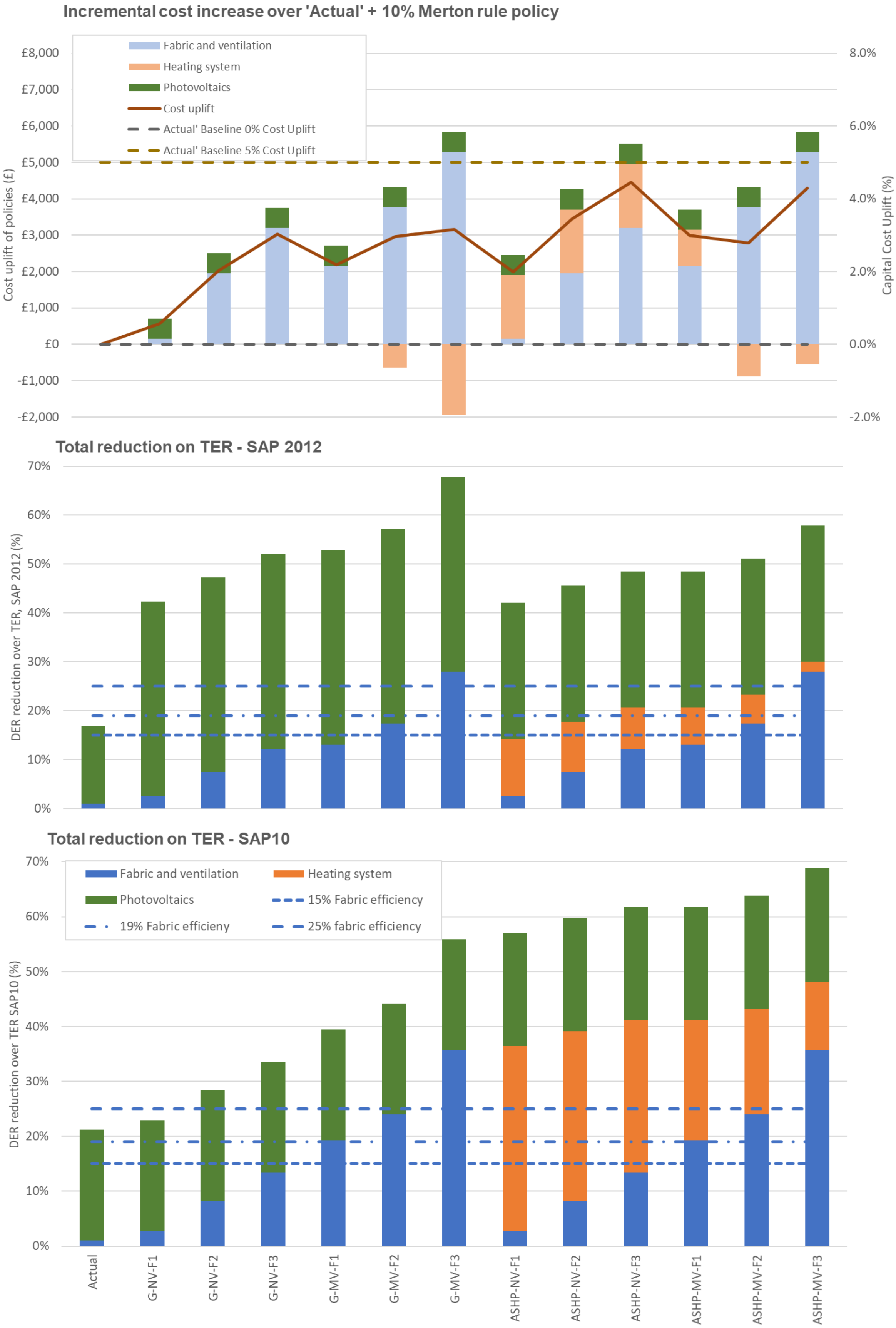


Figure 9 – Mid-Terrace House Models Cost Uplift and DER/TER performance (SAP2012 and SAP10)

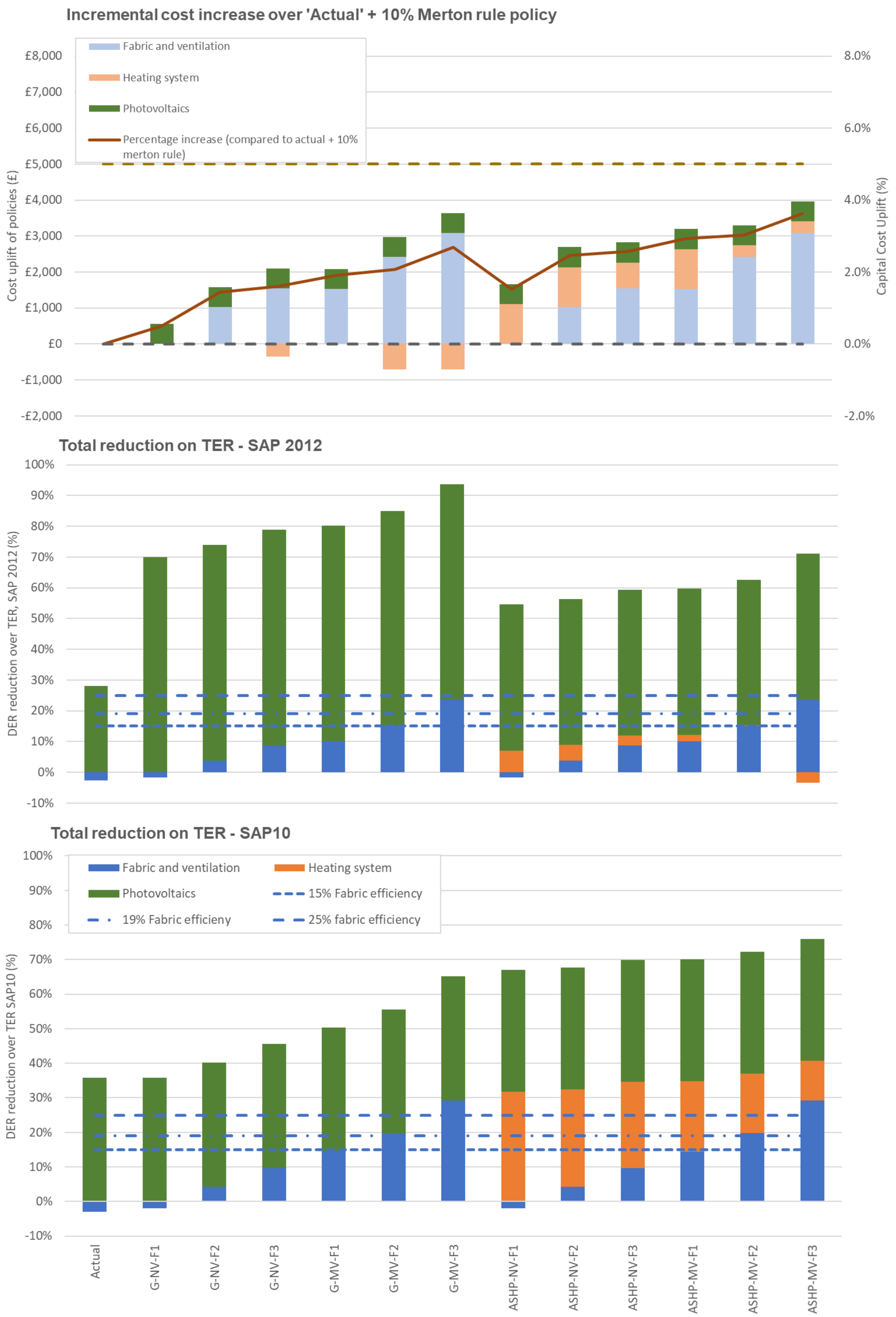


Figure 10 - Small Midfloor Flat Models Cost Uplift and DER/TER performance (SAP2012 and SAP10)

SECTION 2: NON-DOMESTIC

6. Non-domestic buildings

Potential standards that might be applied to non-domestic buildings have been assessed by a review of recent literature on the subject considering both the potential and costs for reducing energy use and carbon emissions and the implications of setting BREEAM ratings encompassing a wider range of sustainable buildings topics.

The policy option considered is for a 15% reduction in carbon emissions from energy efficiency. The analysis assumes the current emission factors for electricity used within the Simplified Building Energy Model (SBEM) method, same range of issues relating to changing emissions factors and their implications for future performance apply to SBEM as to SAP.

6.1 Energy Efficiency

Recent studies by Buro Happold[27] and AECOM[28] (both supported by Currie & Brown) for the Greater London Authority considered the potential and associated costs from achieving carbon reductions in non-domestic buildings. These studies considered the implications of setting tighter energy efficiency standards for non-domestic buildings as part of the formulation of the draft new London plan. In addition, work by Buro Happold (with Currie & Brown) for the Old Oak Park Royal Development Corporation specifically considered how energy and carbon savings can be achieved in higher rise and mixed-use developments[29].

Key findings from these studies include:

- The correlation between energy efficiency / carbon performance (excluding PV and heat networks) and capital cost is weak[27] or absent[29] with a range of factors influencing both cost and performance including:
  - building form,
  - glazing ratio
  - ‘good passive design’ that balances glazing area and energy demands
- Energy use in non-domestic buildings is highly variable by building type and design aspiration. The cost and potential for achieving savings beyond the requirements of Part L2013 will therefore depend on building type and design decisions. For example, the nature of demand heating, cooling and lighting energy demand will be influenced by the intended use, the extent and orientation of glazing and any associated shading, and plan depth. Substantial energy efficiency savings are typically achievable in office and retail buildings, but other building types such as schools and particularly hotels may find it more difficult to achieve energy efficiency savings because of the specific nature of their demand, e.g. the dominance of hot water supply as an energy source in hotels[28]
- Efficient lighting and control systems are a major contributor to energy efficiency in office and retail spaces with the potential to deliver substantial savings in lighting energy demand compared to the that required by Part L 2013. Substantial energy efficiency savings can be achieved purely with highly efficient lighting (i.e. LED) and controls, in some situations these could be sufficient to achieve savings of 10-15% or more on the requirements of Part L 2013[30] . More efficient lights and controls are still more expensive than traditional systems (approximately a further £20m^2 depending on design) but are becoming standard in new buildings as developers and occupiers realise their significant performance benefits and reduced maintenance and energy costs.
- Cost uplift associated with energy efficiency measures varies considerably because of differing building designs. The Part L Notional specification was set at £0 but in practice

[27] Buro Happold, 2017. Driving Energy Efficiency savings through the London Plan - Data Analysis. www.london.gov.uk
[28] AECOM, 2017a. GLA energy efficiency target – development case studies. www.london.gov.uk
[29] Buro Happold, 2018. Energy, daylight and overheating study in tall buildings. www.london.gov.uk

there is a substantial variation in the costs of building to this specification depending on design considerations. The uplift associated with achieving a 15% energy efficiency target was between £37 and £59 m^2 which when compared with overall development costs of between £2,000 and £3,000 m^2 is under 2% of the capital cost.

- Nearly 60% of non-domestic developments in London achieve a 10% energy efficiency saving with a little under half achieving a saving of 15% in comparison to Part L 2013[27].

In 2017, the average energy efficiency saving in non-domestic buildings in London was 19.2% beyond the requirements of building regulations[30], this suggests that while certain buildings may not be able to achieve a 15% requirement it is widely achievable in new non-domestic buildings.

Policy Consideration: Energy efficiency
Most existing buildings can achieve 10-15% energy efficiency improvements on current regulations, but there are some buildings that might find this standard more difficult due to the energy associated with their type and operational demand, for example hotels.

Evidence suggests that 15% is widely achievable on new buildings.

6.2 BREEAM Rating

Currie & Brown's research with BRE[31,32], together with previous studies for the British Constructional Steelwork Institute show that, if delivered efficiently by experienced design and construction teams the additional costs of meeting the 2011 BREEAM Excellent ratings are in the order of a 1-2% of capital costs for most buildings but can be higher, in the order of 3-5% for some buildings (such as healthcare buildings) and locations.

The most significant costs associated with achieving higher BREEAM ratings are often associated with meeting minimum energy requirements. This means that where a planning requirement also exists for carbon / energy efficiency measures beyond the requirements of building regulations then the net impact of an additional BREEAM requirement would be reduced.

Where a contractor is inexperienced in delivering BREEAM then it is possible for additional costs to be incurred in setting up processes to ensure that their site management and supply chain activities are BREEAM compliant. Similarly, for very small projects the costs of assessment and certification, which do not scale linearly with project size, may result in disproportionately higher costs. For example, assessment costs might be 0.1% or less of the cost of a 10,000m^2 office but around 1% of the costs of a 1,000m^2 retail unit.

BRE have recently introduced the BREEAM 2018 standard which includes a range of new or amended requirements. Some of these new criteria are deemed to be cost-free albeit they may require additional consultant's input and considerations at early design stage. BREEAM 2018 is a recently introduced standard and evidence of sufficient data on it implications is not yet available for a substantial cost analysis.

However, Currie & Brown's initial review suggests that whilst the 2018 standard requires more time input from the project team, its implications for capital costs are relatively small.

[30] GLA, 2018. Energy Monitoring Report: Monitoring the implementation of London Plan energy policies in 2017. www.london.gov.uk
[31] BRE, 2014. Delivering Sustainable Buildings: Savings and Payback.
[32] BRE, 2017. Briefing Paper Delivering Sustainable Buildings: Savings and Payback - Office Case Study for BREEAM UK New Construction 2014

Policy consideration: BREEAM
While the costs of BREEAM ratings are typically in the range of a few percent of capital cost, the implications for specific buildings, development locations (e.g. greenfield sites, away from transport links and amenities) may be higher and the costs of the certification itself become considerable for smaller developments. A size threshold may help to reduce costs for smaller projects.

6.3 Summary

There is a huge variation in the form and use of non-domestic buildings and this results in a wide range of energy demands and varying potential for efficiencies. If higher standards were set at a level that could be definitively achieved by all non-domestic buildings, it is likely that the standards would be too lax for most circumstances. Therefore, it is sensible to set standards at a level that are challenging to most projects but to be flexible for other projects which can demonstrate that through their best endeavours the necessary standards cannot be achieved.

Table 20 summarises the cost uplifts of the potential standards to reduce carbon emissions. As stated previously there will inevitably be variation around these levels depending on the type and design of non-domestic building being proposed so these uplifts should be taken as indicative of scale only.

Table 20 - Indicative cost uplifts of the potential standards to reduce carbon emissions

Standards	Target	Percentage of construction cost
Energy Efficiency	Minimum carbon reduction of 15%	<2%
BREEAM	BREEAM Excellent rating	1-2%
Total		<2%-4%

The additional cost of BREEAM Excellent certification may be a 1-2% for measures not associated with delivering energy requirements. In many buildings this additional cost could be under 1% subject to its location, the base design and experience of the design and construction team.

7. Conclusions and Policy Considerations

The analysis considered current and predicted domestic and non-domestic building energy demand within the Tunbridge Wells Borough, local limitations and needs, and current energy and design policies.

It was identified that a variety of housing typologies and non-domestic buildings will be required by the end of the new Local Plan with an estimate need of 648 new homes a year, and a much smaller number of non-domestic buildings to be delivered based on local needs.

In terms of key considerations in terms of housing these included predicted increase in population of 65 years old and over, an increase in one-persons households, smaller predicted households, affordability and fuel-poverty.

The importance of affordability, fuel poverty and delivery of good quality new buildings design were noted in the responses of stakeholders surveyed as part of this study.

As far as Climate Change prevention and environmental protection is concerned, Tunbridge Wells borough have already in place a set of requirements referring to 10% predicted carbon emissions reductions using LZC technologies for both domestic and non-domestic new developments.

Improving and setting higher carbon emissions performance standards has formed part of the Local Plan review. This is in line with government policy and targets promoting increased buildings energy efficiency and energy demand supply from renewable energy sources.

A review of different housing models adapted to reflect local needs indicated that it is possible for energy and carbon performance standards of housing within the Tunbridge Wells Borough to be improved with a maximum capital cost uplift of 5%. The higher – similar to Passivhaus – standards MVHR and low carbon heating (via ASHP) models meet the 25% fabric improvement threshold and a 20% Merton Rule and remained within the cost uplift threshold (5%) in all cases using both SAP2012 and SAP10 factors.

While cost uplifts did not exceed the 5%, it should be noted that advancing the targets to such high standards would lead to the exclusion of a lot of the traditional, naturally ventilated solutions currently used in new housing construction. The fabric first approach in addition needs to be considered against the house typology, with highly efficient forms as in the case of the small mid-floor flat facing some additional challenges in terms of improvements on TER (%) thresholds set for a fabric first approach. This is due to the already reduced space heating requirements of such building forms compared to the PartL1A notional with main carbon savings achieved using efficient and low carbon domestic hot water generation systems.

In that sense the models indicated that a 20% carbon savings on TER using fabric first measures would be appropriate to accommodate more efficient housing forms. Homes could achieve this by using MVHR systems together with advanced airtightness standards. In naturally ventilated buildings an average of 15% for houses and 10% for the small flats was the maximum achieved even for very energy efficient fabric standards that are similar to Passivhaus standards.

Other findings that are relevant to the interpretation of the results of this analysis include:

- Importance of the SAP version used - Assumptions in the currently operational SAP method (SAP2012) are now several years old and do not reflect current understanding of the carbon emissions associated with the supply of electricity. Revised emission factors were published in the SAP10 methodology and these have a substantial impact on the estimated carbon emissions and impact of new development. As well as much lower carbon emission factors for electricity, SAP10 includes a wide range of other methodological changes which mean that assessment of a home's performance under a future regulatory regime may be considerably different to the results from a SAP2012 assessment.

- ASHP efficiencies - Default efficiencies for ASHP within SAP2012 are lower than those believed to be achieved in practice and so assessments of the performance of these technologies could be based on higher assumed levels of heating efficiency of up to 300%. However, to achieve the default SAP efficiencies used in this study it is vitally important that the whole heating system (including radiators / underfloor heating etc) is appropriately specified, installed and commissioned. TWBC should therefore consider how it will ensure that designs are appropriate and that the adoption of these and other new technologies does not present risks to housing quality, cost or carbon savings.

- Photovoltaics costs - The costs used in this study assume that some PV is installed as part of meeting current policies. As a result, the marginal cost of installation is much lower than would be the case if all the 'fixed' costs (i.e. access, wiring, connections, inverters, etc) were included.

- Non-domestic buildings – there is a high degree of variation in the energy use and potential for carbon savings in non-domestic buildings nonetheless there is evidence from recent studies that savings of 10-15% are achievable in existing buildings and in London the average level of energy efficiency saving achieved in new non-domestic buildings was 19.2% beyond the requirements of Part L 2013.

- Variations in costs – construction costs vary for a wide range of factors. The proportionate impact of the considered policy options may not vary considerably but there may be a variation in absolute costs based on the size of development and developer. It is also the case that the targeted development plots and offered housing products will vary and so land values and sales prices will also vary between development locations and scales.

Appendices

Appendix A - Review of local planning and development context

Twenty-five documents were identified as relevant by the researchers (see Appendix B). The list was issued to TWBC for review and included commentary on the level of detail that can be extracted from each document, relevance to the topic and date of issue. Feedback received included notes on relevance, current status and advice on potential changes.

It needs to be noted that a draft unpublished version of the new Local Plan consultation document, along with new supplementary documents were issued to the researchers in confidence and for reference by TWBC. Information extracted was only used to identify potential updates in terms of documents reviewed.

7.1.1 Local Environment

The following information was extracted from the TWBC official website and the TWBC Development Constraints Study (2016).

Development constraints exist both in the terms of new development spatial distribution, as well as in the case of actual development capacity (strongly links to environmental capacity).

It needs to be noted that TWBC includes a number of unique sites relating to Areas of Outstanding Natural Beating (almost 68% of the borough), 10 sites of Special Scientific Interest (SSSI), and 22% of the borough is designated as Green Belt.'

In terms of transportation links, and as noted within the Development constraints report, some capacity issues are noted which could affect the spatial distribution of new development while air quality considerations relevant to traffic are raised as well.

| Considerations relevant to the research

- New construction densities and location will affect the viability of specific technological solution such as in the case of district heating networks. Limitations may exist in terms of impact on habitats, numbers of potential connections and extent of network required. Overall infrastructure costs, along with potential costs transferred indirectly to the consumer will need to be considered on a case by case basis.
- Traditional architectural features and design specifications should be assessed against the opportunity to use passive design solutions and new construction materials. Passive design solutions include as key elements the location of the building, the site orientation, the site layout, the specific design of windows (solar gains and lighting strategy), levels of insulation use and ventilation strategies. While this current research uses generic housing design archetypes models modified to reflect some local fabric specifications performance variations, local architectural limitations and opportunities can affect the design strategy occupied to deliver the required energy and carbon performance targets and associated costs (increase or decrease, location specific).
- Minimising air pollutants from buildings that are generated by fossil fuel combustion can unlock new development opportunities and enhance the experience of the Tunbridge Wells Borough residents.

7.1.2 Population

Information on current and future TWBC population data was reviewed using two reference points:

- The Kent County Council interactive population forecast toolkit[33] (Oct'2018) and the
- ONS 2016-based Subnational Population Projections for England[34]

Results are shown in **Error! Reference source not found.**

Table 21 - 2033 Tunbridge Wells Borough Population Projections

	Kent County Council interactive population forecast toolkit		ONS 2016-based Subnational population projections[35]	
Year	All Ages	65 and Over	All Ages	65 and Over
2016	117,400	22,000	117,357	23,153
2033	136,000	32,000	123,700	30,600

Considerations relevant to the research

- There is a notable difference in the prediction models, with Kent County Council projecting a 16% increase (18,600 people) by 2033 while ONS 2016-based data only project a 5% increase in population by 2033 (6,343 people)
- Examining the ONS 2012-based Subnational Population Projections it was identified that the 2033 predictions accounted for a total population of 135,000 people not dissimilar to the Kent County Council interactive population forecast toolkit. This appears to have been modified in the ONS 2016-based data.
- Population statistics indicate an increase in Tunbridge Well Borough population by the end date of the new Local Plan (2033) varying between 6,343 and 18,600 people. The size and age distribution of the population, as well as the population spatial distribution, will affect new housing, buildings and infrastructure requirements in the various borough areas.
- In 2033 both models indicate that people aged 65 and over will account for 23-25% of the total Tunbridge Wells Borough population. Compared to 2016 population statistics that would signify an almost 5% increase of that age group within the overall population. An increase in the number of people of older age (and that of young children), will influence new residential designs.
- Variations in housing type requirements should not affect energy and carbon performance cost uplifts. Nevertheless, it is advised that in the case of home designs that accommodate vulnerable groups consideration is given to servicing strategies in terms of meeting high energy efficiency and carbon emissions performance to ensure that solutions are cost-effective and user-friendly.
- It was not within the scope of this research to specify preferred approaches in terms of technological solutions meeting the carbon performance requirement uplifts, but it was considered important to note that lifecycle cost and carbon performance assessments could be undertaken to demonstrate robustness of solutions suggested in such schemes.

[33] https://www.kent.gov.uk/about-the-council/information-and-data/Facts-and-figures-about-Kent/population-and-census#tab-3
[34] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/subnationalpopulationprojectionsforengland/2016based
[35] TWBC Housing Needs study 2018 is using the ONS 2012-based Subnational Population Projections

- The range of measures reviewed within the evaluated housing models included both a fabric first approach as well as service technologies such as gas boilers and ASHP. Both options are both technically feasible and user friendly albeit care is required for the effective design and commissioning of ASHP systems. Advanced controls, smart systems and energy storage solutions have not been considered at this stage as are at an early stage of their application in housing and the evidence base on energy and carbon savings plus user response is currently limited.

7.1.3 The Local Plans

Relevant to the research background scoping activity aspects of the Local Plan 2006 and the new working draft Local Plan Consultation document (not published) have been extracted. Establishing the links between the two documents was considered important in order to identify critical changes in policy direction and potential historic commitments.

Local Plan 2006

Summarised extracted content is shown below:

- Priority is given to the re-use of previously developed land, including the conversion, redevelopment and sub-division of existing buildings, with a target of 90% of new housing development to be generated from previously-used sites during the Plan period.
- The most sustainable location for housing is within, or close to, the existing town and neighbourhood centres of Royal Tunbridge Wells and Southborough.
- As the number of one-person households rises, it is important to respond to an increasing demand for smaller properties.
- The Plan also recognises the need for an adequate supply of affordable housing and accommodation for key workers.
- Some 80% of the growth in the total number of households nationally over the next 15 years is expected to be due to the increase in one-person households. A similar pattern will apply to the Plan area, with single person households accounting for over 70% of the increase in households to 2011 and this trend is expected to continue and intensify thereafter.
- At the 1991 Census, the average household size in the Plan area was 2.5 persons per household, falling to 2.37 at 2001, and is expected to be 2.26 at 2011. Projections (2005 based) indicate that the average household size will continue to fall until at least 2021.

New working draft Local Plan Consultation document (2019)

Summarised extracted content is shown below:

- References are provided for the Sevenoaks & Tunbridge Wells Strategic Housing Market Assessment (SHMA)[36]. Evidence is used to underline notable affordability pressures, in terms of market houses purchases.
- Affordability, an ageing population and the increase in the rented property market segment were all indicative of the need to provide a mix of housing types and tenures addressing the various needs.

[36] http://www.tunbridgewells.gov.uk/__data/assets/pdf_file/0007/98521/SHMA-final-September-2015.pdf

- In terms of the natural environment and sustainability standards, the draft consultation document addresses new development sensitivities. The surrounding environment, both natural and the build environment, of a new development will need to be considered. Furthermore, the natural environment should be preserved or enhanced.
- The Climate Change Act 1998 is also recognised, in two concepts: as a motivator to reduce energy and carbon consumption of new building in the area, and as an informant of climate change and more particularly the requirement for resilient, future proofed and adaptable design.
- While there is a positive economic growth expected in the area, a number of new non-domestic buildings will be required. This includes amongst others retail, leisure, accommodation and SMEs premises.

7.1.4 Current Renewable Energy Supplementary Planning Documents

The Renewable Energy SPD Update (2016) provides an update to the Renewable Energy Supplementary Planning Document, adopted in 2007[37] in order to assess current energy requirements imposed to new developments within the borough. The main points are summarised in **Error! Reference source not found.**.

Table 22 - Renewable Energy SPD Update

Renewable Energy SPD Update: An update to the Renewable Energy Supplementary Planning Document, issued in 2016
▪ Developers must incorporate renewable technology on-site to reduce predicted CO2 emissions by 10% for all residential developments greater than 10 dwellings (or 0.5 ha and greater if outline) and all non-residential developments greater than 1 ha. ▪ The council accepts that a fabric first approach is important and that the 10% requirement should not be calculated until energy efficiency measures have first been implemented to achieve a minimum of current building regulation requirements ▪ The 10% requirement can be negotiated if a developer is able to prove that they will achieve energy standards significantly beyond current building regulation requirement or were choosing to build to a recognised standard such as the energy requirements of BRE's Home Quality Mark ▪ Air Source Heat is now a recognised renewable technology and is classified as such in the Renewable Energy Directive (2009). If this technology is included in new development, it can contribute towards the requirements for the Tunbridge Wells Renewable Energy SPD.

| Considerations relevant to the research

- The 2016 Renewable Energy SPD update acknowledges the importance of a fabric first approach as well as the introduction of new technologies as in the case of Air Source Heat Pumps which can be used to meet the Renewable Energy policy requirement.
- Negotiation requirements to be exempt from the policy are included, in terms of delivering high energy standards through different routes or by using a recognised standard such as the Home Quality Mark (HQM).
- Both references in terms of high energy standard and HQM certification are not quantified.

[37] http://www.tunbridgewells.gov.uk/residents/planning/planning-policy/supplementary-planning-documents

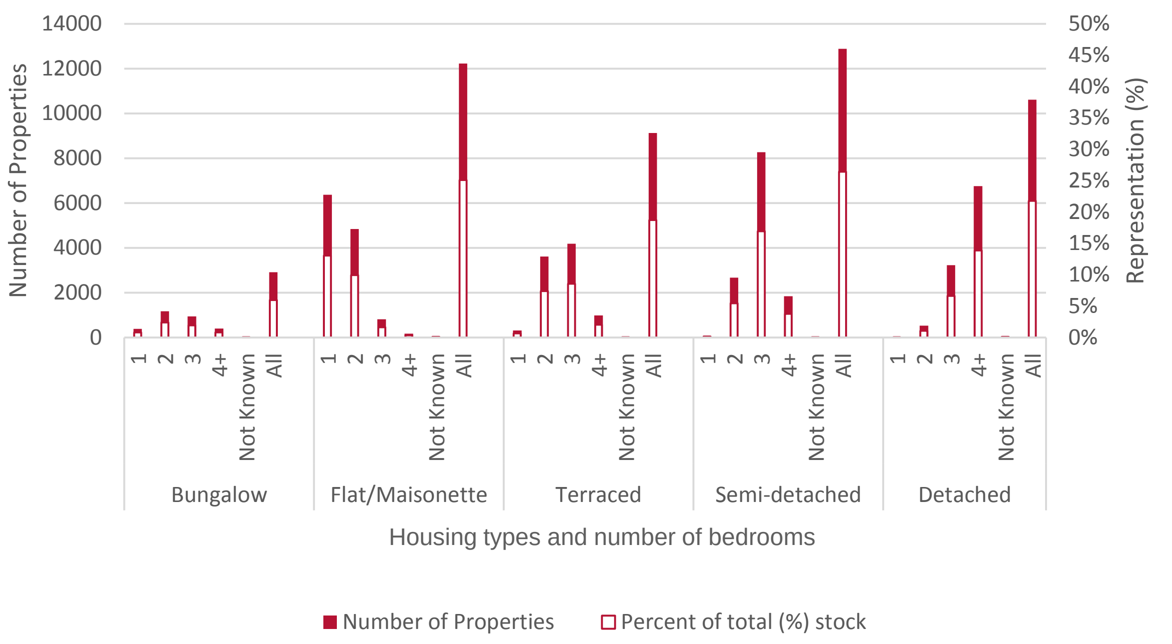
7.1.5 Housing Stock

Government data from the Council Tax: stock of properties 2017[38] was used to evaluate the existing distribution of housing types and size of properties, in terms of number of bedrooms, within the Tunbridge Wells Borough (**Error! Reference source not found.**).

The majority of properties included terraced, semi-detached and detached houses of three bedrooms and more. This information was supportive of the housing design archetypes models developed for the research.

Table 23 - Tunbridge Wells Borough Housing Types Representation

Tunbridge Wells Borough – Housing Statistics (2017)



West Kent Housing & Homelessness Strategy 2016–2021[39]

The West Kent Housing and Homelessness Strategy 2016-2021 in relationship to affordability indicated that:

- The need for affordable housing is currently estimated at 341 homes per year in Tunbridge Wells.
- None of the West Kent local authorities retain ownership of housing with Tunbridge Wells having transferred their housing stock to Town & Country Housing Group.
- The percentage of households in fuel poverty (2014/15) Tunbridge Wells was 9.8%

In terms of New Housing Delivery targets, it needs to be noted than the new working Draft Local Plan document indicated a need for 648 homes per year (12,960 over 20 years).

[38] https://www.gov.uk/government/statistics/council-tax-stock-of-properties-2017
[39] http://www.tunbridgewells.gov.uk/__data/assets/pdf_file/0010/227098/79074C40686724F2E0531401A8C0CDFC_Joint_Housing__Homeless_Strategy_TW1374_V4_Final.pdf

As noted, energy efficiency and fuel poverty remain key challenges across all tenures, and particularly impact lower income households.

Table 24 - TWBC Housing Needs Study 2018 Key Data

TWBC Housing Needs Study 2018 Data	
House prices	Median house prices in the Borough of Tunbridge Wells have been consistently higher than those of the South East region, which have in turn tracked higher than those of England as a whole. During 2016, median prices across the Borough of Tunbridge Wells were £327,000 and lower quartile prices were £250,000.
Dwelling stock	The vast majority (71.8%) of properties are houses (of which 26.6% are detached, 29.2% are semi-detached and 16.0% are terraced/town houses), 22.7% are flats/apartments and maisonettes. In terms of number of bedrooms 14.7% have one bedroom/studio, 24.9% have two bedrooms, 31.3% have three bedrooms and 29.1% have four or more bedrooms. 30.9% of properties were built before 1919, a further 11.3% were built between 1919 and 1944, 16.7% between 1945 and 1964, 19.4% between 1965 and 1984, 13.4% between 1985 and 2004 and 8.2% (3981) have been built since 2005 (average 300 per year).
Economic drivers	63.1% of Household Reference People are economically active and a further 26.4% are retired from work. 40.7% of Households received less than £26000 per year gross (16% less than £13000).
Affordable housing	Overall gross need for affordable housing is 662 dwellings each year. From which 45.4% smaller one- and two-bedroom general needs, 45.4% three or more-bedroom general needs, 7.0% one-bedroom older person dwellings and 2.2% two or more-bedroom older person dwellings. The Council does not have an affordable housing stock of its own so there is a reliance on Registered Providers, (RP's), to build new rented and shared ownership housing in the Borough. There are 7,934 households who live in an affordable (social rented or intermediate tenure) property across the Borough of Tunbridge Wells, accounting for 16.1% of all occupied dwellings. 46.4% of Household Reference People living in affordable housing are in employment.
Market demand	74.7% expect to move to a house, 4.6% to a bungalow, 16.5% a flat and 4.2% to other property types. 70.0% of households would like three or more bedrooms. 55.7% of households would like a detached house. There is a strong desire for owner occupation, with around 82.0% of households planning to move stating a preference.
Rent	The private rented sector accommodates around 18.3% (9,054) of households across the Borough of Tunbridge Wells Median (£945 pcm) and lower quartile (£750 pcm) rental prices are higher in the Tunbridge Wells Borough than in the county (Kent) The 2017 Household Survey found that most private rented properties (47.8%) are houses (of which 21.1% are semi-detached, 15.4% are terraced, and 11.3% are detached); a further 46.9% are flats/maisonettes and 3.8% are bungalows
New Housing	Over the 11 years, 2006/07 to 2016/17 there has been an average of 299 completions per year across the Borough of Tunbridge Wells. This compares with an annualised

Delivery	target over the period of 427 dwelling completions.

7.1.6 Non-Domestic Buildings

In order to identify the potential future requirements in terms of non-domestic buildings within the Tunbridge Wells Borough, the scoping activity extracted key information from three different key reports, which are summarised below:

Town Centre Office Market Review – Tunbridge Wells February 2018

- Of the office space existing at May 2013, 22% has been lost through change of use to residential via Permitted Development rights and a further 22% is at risk. An additional 11% of space has been created.
- Of the remaining current office space, very little is likely to be available to new occupiers because either it is let to single occupiers on a long term basis, the buildings are non-purpose built or more than 20 years old and have inadequate facilities, and/or the buildings do not or will not meet Minimum Energy Efficiency Standards (MEES) legislation requirements: whilst demand has remained constant, local completed lettings by Darlings are down by 50% from June 2017 to December 2017 as a result of shortage of stock[40].

As indicated within the Sevenoaks and Tunbridge Wells Economic Needs Study Final Report for Tunbridge Wells Borough August 2016[41] office space could be constrained by supply factors, such as a lack of new build office activity in the borough. Allocation of additional buildings and floor space suitable for office and warehouse use is recommended.

Tunbridge Wells Hotel Capacity Study 2017

Information extracted from the Tunbridge Wells Hotel Capacity Study 2017[42], refer to additional requirements in terms of visitor accommodation facilities with recommendation 7.4 noting:

'*Based on a steady increase in domestic tourism across the UK and within the region, there is scope to upgrade and expand existing visitor accommodation across the Borough to facilitate more rooms and provide new and/or improved amenities such as spa facilities and packages*.'

Tunbridge Wells Borough Site Allocations Local Plan adopted in July 2016

The report indicates that a diverse mix of non-domestic new buildings is required in different locations, with detailed master plans required in the case of larger allocations.

Tunbridge Wells Borough Site Allocations Local Plan adopted in July 2016[43]
▪ Traditionally, employment land has been considered as B1 (Business), B2 (General Industry) and B8 (Storage and Distribution) uses, some of which has been lost through conversions and redevelopments, particularly from office to residential. ▪ However, it is accepted that employment has been created through a much wider range of uses, including retail, leisure, the service industry and the health sector. Core Policy 7 encourages the retention of existing floorspace and the encouragement of new floorspace

[40] http://www.tunbridgewells.gov.uk/__data/assets/pdf_file/0016/180115/TWBC_Office_Market_Review_8.5.18.pdf
[41] http://www.tunbridgewells.gov.uk/__data/assets/pdf_file/0003/134238/Economic-Needs-Study_Final-Report-with-appendices-min2.pdf
[42] http://www.tunbridgewells.gov.uk/__data/assets/pdf_file/0004/141817/Tunbridge-Wells-Hotel-Capacity-Study.pdf
[43] http://tunbridgewells.gov.uk/__data/assets/pdf_file/0016/130066/01_Site-Allocations-Local-Plan_July-2016.pdf

in the Key Employment Areas, which are designated within the Core Strategy.'

- The mix of uses set out in some site allocations is quite general, including, for example, a mix of retail, hotel, office, leisure and residential uses. It is, however, the intention with the larger allocations that the requirement for the preparation of a masterplan will provide more detailed information about the quantum, range and mix of uses, taking into account a thorough assessment of issues such as design, viability and deliverability.

Considerations relevant to the research

- New non-domestic buildings to be delivered within the borough will include a mix of uses and types and are not limited to specific design typologies as in the case of housing. Overall the level of non-domestic development will be substantially smaller than that for new homes.
- The shape, form, specification and layout of the new non-domestic buildings will vary greatly depending on the intended use, the operating schedules the construction type and standards used. Given the diversity of non-domestic building types, their use and operating schedules simple and isolated indicative energy and carbon performance models would not be representative in terms of cost and performance
- A literature and evidence-based review of potential improvements in terms of carbon and energy performance of various non-domestic buildings typologies, BREEAM standard ratings achieved and potential indicative costs uplifts are more suitable than models.

Appendix B - Local Policy Documents, Standards and relevant publications

	Document Title	Date of Issue
1	Local Plan 2006	2006
2	Renewable Energy Supplementary Planning Document	2007
3	Renewable Energy Supplementary Planning Document Update	2016
4	Kent Design Guide	2006
5	Kent Environment Strategy	2017
6	Tunbridge Wells Borough Housing Needs Study 2018	2018
7	Tunbridge Wells Borough Energy Efficiency and Historic Buildings	2019
8	Tunbridge Wells Borough The five-year plan 2017-2022	2017
9	Kent Government, 2016-Based Subnational Population Projections	2018
10	Sevenoaks and Tunbridge Wells Economic Needs Study	2016
11	Sevenoaks & Tunbridge Wells Strategic Housing Market Assessment	2015
12	Tunbridge Wells Borough Local Plan Issues & Options consultation	2017
13	Tunbridge Wells Borough Local Development Scheme	2018
14	Tunbridge Wells Borough Sustainability Appraisal Issues and Options Report	2017
15	Tunbridge Wells Borough Site Allocations Local Plan	2016
16	Tunbridge Wells Borough lls Hotel Capacity Study	2017
17	Tunbridge Wells SHMA Update Implications of 2014-based SubNational Population Projections and Household Projections	2017
18	Tunbridge Wells Borough Town Centre Office Market Review	2018
19	Tunbridge Wells Borough LP Settlement Role and Function Study	2017
20	Tunbridge Wells Housing Strategy 2012 - 2017	2012
22	Kent Government Housing Stock by age of property in Kent Local Authorities 2014	2015
23	Tunbridge Wells Borough LP Development Constraints study	2016
24	Tunbridge Wells Borough Draft new Local Plan	N/A
25	West Kent HOUSING & HOMELESSNESS Strategy 2016–2021	2017

Appendix C - Developers that have worked in the borough

- KLW
- Pellings
- Bloomfields
- SJM Planning
- Chris Anderson Architects
- DHA Planning
- Coleman Anderson
- DGJP Architecture Ltd
- John Bullock Design
- Kent Design Studio
- Lambert and Foster
- Tad Planning
- DMP LLP
- Patrick Durr
- Vernacular Homes
- AHP Architects & Surveyors
- Broadlands Planning
- Douglas Moat Practice LLP
- Evisions
- Hazle McCormack Young LLP
- Iceni Projects
- JP Architect
- LT Drawing Services Ltd
- The Rural Planning Practice
- Batchellor Monkhouse
- Berkeley
- Bracketts
- Dandara
- GL Hearn
- Parkerdann
- Crest Nicholson
- Persimmon
- McCarthy & Stone
- Rydon

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