Examination of the Tunbridge Wells Borough Local Plan

Tunbridge Wells Borough Council

Hearing Statement

Matter 14: Sustainable Design and Heritage and Conservation (Policies STR2, STR4, STR7, EN1, EN2, EN3, EN4, EN5 and EN7)

Issue 2: Climate Change Mitigation and Adaptation

Document Reference: TWLP/075

.

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Inspector's Question 1: [re. soundness of Policy EN 2 - Sustainable Design Standards]

Is Policy EN2 justified, effective and consistent with national planning policy?

TWBC response to Question 1

Introduction

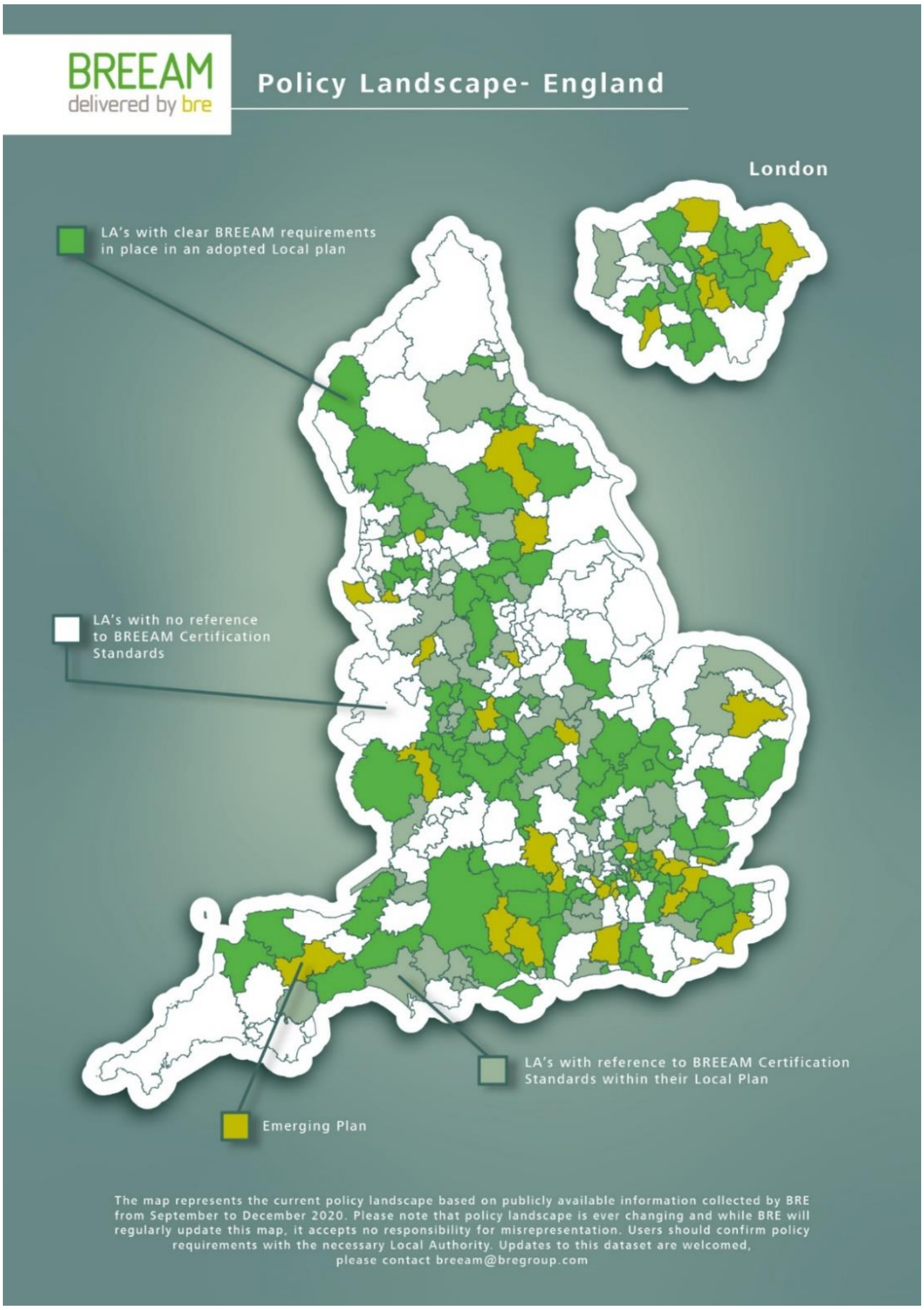
1. Yes, Policy EN2 (Sustainable Design Standards) is justified, effective and consistent with national planning policy, with each of these aspects considered in turn below.

Justification

2. Sustainable design standards are a helpful way to drive up standards in development. They provide an efficient method for tackling a broad range of sustainable development issues, including capturing environmental issues such as resource efficiency and the embodied energy of materials, which are not considered in detail elsewhere in the Local Plan. They also consider the full development process from conception and design through to construction and finally operation, helping to address the performance gap between what is agreed at planning application stage and what is achieved on site.

3. In the case of residential development, sustainable design standards provide reassurance to home buyers that dwellings have been built to high standards and they also give a reputational boost to developers.

4. Whilst the policy makes provision for alternative equivalent standards, the BREEAM family of sustainable design standards are explicitly mentioned in the policy as they are the most well known nationally and internationally. This is exemplified in the map below which shows the high proportion of local authorities in England and Wales that either reference BREEAM in their Local Plan, include explicit BREEAM policy or are developing a BREEAM policy in their emerging Local Plan.



5. As can be seen, BREEAM is referred to in the local plans of 193 authorities across the UK and is considered a tried and tested metric to deliver sustainability in the non-residential sector. Of these, 48 make reference to BREEAM Excellent (25%).

6. The choice of minimum BREEAM score, timescale for implementation and size of development for which sustainable design standards are required varies between authorities and, to determine the most appropriate approach for the borough, the Council has taken into account viability technical advice from both consultants [CD 3.99] and liaised with BRE when preparing the policy.

7. In line with numerous other Local Planning Authorities, the Council has chosen to require BREEAM Excellent for larger non-residential development. Examples of authorities that have already adopted this approach include Bristol, Wiltshire, Swindon, Lambeth, North Somerset, South Somerset, Purbeck, Reading, Poole, Exeter, Camden, Oxford and Sutton. Also, Solihull and Cornwall which are currently at Examination.

8. In order to justify this policy, the Council commissioned a literature and evidence-based review of BREEAM ratings as this was felt to be more suitable than models. This evidence is presented in the Energy Policy Viability Report [CD 3.99] and includes an evaluation of indicative cost uplifts.

Effectiveness

9. Sustainable Design Standards are considered an effective way for developers to demonstrate commitment to tackling environmental issues. All standards allow some flexibility in how the credit requirements are met thus ensuring that site characteristics and development size is taken into account.

10. The standards in Policy EN2 begin at a relatively achievable level to allow developers time to adjust. The expectations are then gradually increased throughout the timescale of the Local Plan, in order to drive up standards. This progression is consistent with the Government's approach of producing more rigorous carbon budgets over time.

11. The supporting text also confirms that should a developer's chosen design standard undergoes a nationwide uplift in expectations at a similar time to the Council's uplift described above, allowances will be made.

12. Once the Local Plan is adopted, the Council will consider whether it would be appropriate to prepare further guidance which advises on how developers could approach BREEAM (or alternative equivalent standards) for various types of typical planning application and differing site conditions.

Consistency with national planning policy

13. In Paragraph 133, the NPPF (July 2021) advocates the use of assessment frameworks such as sustainability standards specifically:

> *"Local planning authorities should ensure that they have access to, and make appropriate use of, tools and processes for assessing and improving the design of development. These include … assessment frameworks such as Building for a Healthy Life."*

14. BREEAM is perhaps the most well-known example of a Sustainable Design Assessment Framework both nationally and internationally and covers a broad range of environmental topics such as waste, energy and pollution. It offers a science-based sustainability framework for the verification and certification of new development. Indeed, the environmental characteristics outlined in the National Design Guide can be met by implementing the BREEAM family of assessment schemes which also have the benefit of providing a robust way of monitoring implementation.

15. Government's National Technical Standards are referenced in footnote 49 on page 39 of the NPPF in relation to planning policies for housing that relate to access and space, but they equally apply to policies for sustainable design standards as is demonstrated in paragraph 154 which states "*Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards*".

16. It is clear from legal advice set out in the Energy Topic Paper [CD 3.107 – Appendix 2] that Local Planning Authorities are no longer permitted to include planning policies that require specific sustainable design standards for residential development. However, planning policy for non-residential development is permitted. For this reason, the policy has been worded such that sustainable design standards such as BREEAM or the Home Quality Mark are required for non-residential developments but only "*strongly encouraged*" for residential developments. See Question 2 below for more detail.

17. In Paragraph 135, the NPPF (July 2021) directs planning authorities to ensure that the quality of approved development is not materially diminished between permission and completion as a result of changes being made to the permitted scheme (see 'performance gap' mentioned in paragraph 2 above).

18. Finally, and arguably most importantly, the policy is in line with national legislation in that Local Planning Authorities across the whole of the UK have a responsibility to secure progress against national targets to reduce emissions, in line with the 2008 Climate Change Act. They also have a duty to adhere to S19(1A) of the 2004 Planning and Compulsory Purchase Act, which specifies that planning policy must contribute to the mitigation of, and adaptation to, climate change. BREEAM was first developed in the wake of the energy crisis in 1990, and thus has a strong, head-on approach to tackling environmental issues such as climate change.

19. This is further referenced in paragraph 153 of the NPPF which states:

> *"Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures (in line with the objectives and provisions of the Climate Change Act 2008)."*

20. Policy EN2 ensures that all the issues mentioned in NPPF Paragraph 153 are addressed to a high standard.

Inspector's Question 2: [re. clarity of Policy EN 2 - Sustainable Design Standards]

Is it clear to decision-makers, developers and local communities what standards are required as part of residential development proposals?

TWBC response to Question 2

21. Policy EN 2 differentiates between requirements for non-residential and residential development by stating the following:

    "The following minimum designs standards must be achieved for all major non-residential developments in the timescales shown. For residential development, achieving the following minimum design standards will be strongly encouraged until national policy allows otherwise".

22. This sentence is then followed by a table which clearly describes the requirements for both residential and non-residential developments of various size thresholds and over varying timescales.

23. The policy is worded such that the requirements for non-residential development *must* be achieved, whereas the requirements for residential development are *strongly encouraged*. This is to reflect the fact that Government's Optional Technical Standards prevent Local Planning Authorities from enforcing developments meet additional standards for housing beyond space, access, water and energy.

24. The Council has sought legal advice on this issue which is set out in the Energy Topic Paper [CD 3.107 – Appendix 2] and confirms that Local Planning Authorities are no longer permitted to include planning policies that require specific sustainable design standards for residential development. Similarly, the legal advice has confirmed that planning policy for non-residential development is allowable.

25. The requirements for residential development are clearly laid out in a table within the policy on page 332 of the Submission Local Plan [CD 3.128] and background information is provided within the supporting text. This includes a link to the Home Quality Mark website in paragraph 6.27. The website provides detailed information on the requirements of this standard.

Inspector's Question 3: [re. consistency of Policy EN 3 with the 2015 WMS]

The PPG[1] refers to the Written Ministerial Statement on Plan Making dated 25 March 2015. It clarified the use of policies on energy performance standards for new housing developments. The Statement sets out the Government's expectation that such policies should not be used to set conditions on planning permissions with requirements above the equivalent of the energy requirement of Level 4 of the Code for Sustainable Homes (this is approximately 20% above current Building Regulations across the build mix). Is Policy EN3 consistent with this approach?

TWBC response to Question 3

26. Policy EN 3 is consistent with national legislation and policy. Chapter 2 of the Energy Topic Paper [CD 3.107] provides a detailed explanation of the current policy expectations in relation to energy performance standards.

27. In summary, the Planning and Energy Act 2008 allows local authorities to enforce energy standards in new development as follows:

"*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."

[1] Paragraph: 012 Reference ID: 6-012-20190315

28. In line with Section 1 (1c) of the Planning and Energy Act 2008, part 1 of Policy EN3 includes a requirement for operational CO_2 emissions (synonymous with energy) to be reduced by at least 10% below the Target Emissions Rate (TER) in 2013 Building Regulations. This is well below the 19% limit described in the Climate Change PPG at paragraph 012.

29. The additional requirement within Policy EN3 part 2 of the Submission Local Plan for a reduction of operational CO_2 emissions by 15% using renewable energy generating technology relates to Section 1 (1a) of the Planning and Energy Act 2008 which was unaffected by the 2015 Written Ministerial Statement. Alongside viability evidence, the Council has taken legal advice to ensure this approach is consistent with the WMS and this advice is contained in Appendix 2 of the Energy Topic Paper [CD 3.107].

30. However, it is pertinent to note that since submission of the Local Plan, an uplift to Part L of Building Regulations was implemented on 15th December 2021 (coming into effect on 25th June 2022) which is intended to pave the way towards the new Future Homes/Buildings Standards which Government currently intends to introduce in 2025 (Consultation Response, Dec 2021).

31. The 2021 Part L Building Regulation uplift equates to a 31% reduction in carbon and is an interim measure before the Future Homes Standard is introduced, which is proposed to equate to a reduction of 75-80% compared to 2013 Building Regulations. Both these approaches supersede the combined approach in Policy EN3 (which equates to a 25% total reduction in carbon emissions) and thus this element of Policy EN3 now requires a review.

32. Consideration of the implications of these national changes for Policy EN 3 are set out in the response to Question 4 below.

Inspector's Question 4: [re. soundness of Policy EN 3]

Is Policy EN3 justified, effective and consistent with national planning policy?

TWBC response to Question 4

Introduction

33. Policy EN3 as drafted in the SLP is intended to tackle aspects of climate change that are not considered elsewhere in the Submission Local Plan. In the face of a nationally declared Climate Emergency, the ethos behind the policy is critical. The policy is also an essential part in ensuring that the Local Plan is compliant with the requirements of Section 19(1a) of the Planning and Compulsory Purchase Act 2004 and paragraphs 152 and 153 of the NPPF [CD_1.4].

34. Two topics are considered within the policy:

- Energy Reduction in New Buildings, and
- Climate Change Adaptation.

35. Policy measures in relation to Climate Change Adaptation are considered to be justified, effective and consistent with national planning policy and further detail on this is provided below. However, as of 15th June 2022, the Local Planning Authority (LPA) acknowledges that those relating Energy Reduction in New Buildings can no longer be considered fit for purpose in the light of the recently revised Building Regulations. This is discussed further below, with a proposal for a Main Modification.

Energy Reduction in New Buildings

36. Following the publication of Consultation Response by Government on 15th December 2021 which introduced an uplift in Part L of Building Regulations equating to a 31% improvement beyond 2013 Building Regulations), the Council commissioned work to determine how Policy EN3 should be updated to reflect the changing policy landscape. This intention was noted in in paragraph 64 of the Council's Hearing Statement for Matter 1 Issue 4 ([TWLP/004], February 2022).

37. Policy EN3 was first drafted in 2019 with only subsequent minor alterations following consultation. Since this time, national legislation has moved forward rapidly with the Climate Change Act 2008 being amended to include an expectation for net zero emissions by 2050 and, similar to most councils across the country, TWBC declared a Climate Emergency (see Full Council 17 July 2019, Item FC29/19 [CD 3.122]).

38. During this time, numerous Councils have successful adopted energy reduction policies that require large reductions in emissions (see paragraph 51a). Hence, it is clear that Councils have an important role to play in driving up standards for energy reduction and meeting climate change targets.

39. A strong local approach is particularly pertinent when national policy changes are under consideration. Removal of the previous Zero Carbon Homes strategy (and accompanying changes indicated by Written Ministerial Statement (WMS) in 2015 - see Question 3 above) triggered many authorities to stop implementing targets for energy reduction in new development.

40. The Future Homes and Buildings Standard (at present planned for implementation in 2025) intends to implement higher standards nationally but may be subject to change. For this reason, it is critical that Local Planning Authorities (LPAs) continue to implement ambitious but viable local targets. Indeed, it is noted in the MHCLG Consultation on Part L 2020 and the Future Homes Standard (MHCLG, October 2019) that "*While most of these adhere to the 19% level set in the 2015 Written Ministerial Statement, some go further*."

41. Justification for a local approach is abundant and can be summarised as follows:

- The latest IPCC report has reconfirmed that climate change is rapid, widespread and intensifying (IPCC 6th Assessment Report, 2022). Impacts will be felt by all life, with the poorest countries being disproportionally affected, and will be irreversible for many centuries. Time for action is running out and UK is already on a path to miss the national carbon budget set when targets were less onerous (Business, Energy & Industrial Strategy Select Committee, Energy efficiency: building towards net zero, Twenty-First Report of Session 2017-19). It is widely accepted that we have approximately 10 years to make significant impact – this decade will fall well within the Plan period.

- In the UK, homes – both new and existing – account for 20% of our greenhouse gas emissions (Climate Change Committee, UK housing: fit for the future?, 2019). In the borough, energy consumption from domestic sector is closer to 50% (see Energy Topic Paper [CD 3.107]). It is counterproductive to build new homes that require retrofitting in the future. Low carbon homes should be built to minimise the need for future retrofitting, reduce fuel bills and help address fuel poverty. This is particularly pertinent in a borough that has one of the highest house price/earnings ratios in the country.

- The Borough Council has implemented an approach requiring higher standards for many years. This began with a SPD in 2007 which has been updated several times since (Renewable Energy SPD). Developers choosing to submit planning applications in the borough are aware that standards beyond Building Regulation expectations are required.

42. Further advice was sought from consultants to inform the way forward, their report is set out at Appendix 1.

43. Any new targets should be in line with the uplift to Part L and Government's direction of travel for energy, which is to encourage developers to build without fossil fuel heating, favouring air source heat pumps, and also to encourage an approach which includes the installation of photovoltaics.

44. The Planning and Energy Act makes it clear in Section 5 that: *"Policies included in development plan documents by virtue of subsection (1) must not be inconsistent with relevant national policies for England."*

45. Undoubtedly, the most relevant national policy on this topic is the NPPF which calls for *radical* reductions in carbon emissions in paragraph 153 [CD_1.4].

46. Further national policy that could be considered relevant in this context are:

    - Standard Assessment Procedure (SAP) / Simplified Building Energy Model (SBEM)

      SAP and SBEM calculations are the government-required method for calculating whether Building Regulation compliance has been achieved. Any new policy would need to be compatible with this methodology.

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- The Written Ministerial Statement from 2015

  Given that the notional dwelling described within Building Regulations would require 11% fabric energy reductions beyond 2013 Building Regulations, a maximum additional requirement for up to 8% would still be within the 19% limit set by the WMS and confirmed with paragraph 012 of the Climate Change PPG (see Question 3 for more detail)

- Future Homes/Buildings Standard

  It is important to remember that if Government's plans for Future Homes/Buildings Standard is realised, industry will need to reduce energy from 31% beyond Part L 2013 in 2022, to 75-80% beyond Part L 2013 in 2025. This is a large step-change within a short time period and thus, against this backdrop, encouraging an additional expectation would be in line with Government's policy commitment to ramp up standards rapidly. The point at which Government commits to legislate for these new standards would clearly constitute 'national policies or guidance' as specified in the Act (see paragraph 44 above).

Proposed revised policy approach

47. In the light of available advice and evidence, the Council looks to propose modifications to the '**Energy reduction in new buildings**' element of Policy EN3, as set out below.

Part 1 - Fabric Efficiency

48. Part 1 of this section of the policy, as currently drafted, has been superseded by new Building Regulations. It contains a requirement for at least a 10% improvement in fabric efficiencies beyond Part L 2013, whereas the notional dwelling for Part L 2021 includes fabric efficiencies and other demand reduction methods of approximately 11% beyond Part L 2013.

49. A new target is recommended that equates to a minimum improvement over the Part L 2021 notional building Target Emission Rate (TER) of 5%, achieved through fabric efficiencies. If paired with on-site generation as per the Part L 2021 notional building, this equates to approximately 16% above the notional dwelling in Part L 2013. It therefore provides a good basis for delivering high performance homes which will be needed in preparation for the Future Homes/Buildings Standard (whilst remaining

compliant with the 19% limit set by the Written Ministerial Statement of 2015 – see Question 3).

50. This approach is in line with the '*Be Lean*' element of the energy hierarchy (see Appendix 2) which has been a focus for energy policy at the Council for many years. Put simply, optimising the efficiency of the building fabric is the starting point for the whole net zero journey. It is not sustainable to be designing and building homes that will need retrofitting in the future. Likewise, this approach is particularly pertinent for decarbonisation trajectories involving heat pumps, as effective use of the technology will require highly insulated and draught-proofed buildings to operate efficiently. This approach is similar to planning policy already adopted at other Local Planning Authorities for example Greater Manchester (19%), GLA (10 - 15%), Milton Keynes (19%), Oxford (15%), Reading (19%).

51. In terms of viability, when comparing these fabric efficiency targets to those originally allowed for in the 2019 Local Plan Stage 1 Viability Assessment Report [CD 3.54a], it can be seen on page 41 in paragraph 2.8.17 that an allowance for fabric improvements up to 19% was made (equivalent to Code for Sustainable Homes Level 4). This exceeds the new target of 5% beyond 2021 Part L (equivalent to 16% beyond 2013 Part L) and thus is within the allowance already made.

52. The amended energy reduction target through a 'fabric first' approach described above is incorporated in the draft revised policy put forward proposed as a Modification at Appendix 3.

Part 2 - Renewable Energy

53. Part 2 is no longer necessary. It currently contains a requirement for 15% of carbon savings to come from renewable energy generating technology installed on site. However, the new 2021 Building Regulations have assumed that a notional building will make savings of approximately 20% using PV. Whilst it is possible for developers to choose to veer away from the notional building in their design by installing less PV, to remain compliant with Building Regulations, they would need to make up the shortfall with fabric efficiencies that go beyond the 11% expectation which is a more costly process. For this reason, the provision within Building Regulations 2021 will be sufficient in driving forward installation of renewable energy generating technology.

54. Therefore, Part 2 is recommended for deletion.

Consideration of an alternative overall saving target

55. The review in Appendix 1 suggests that the proposed target in Part 1 of the policy be combined with an overall carbon saving of at least 35% more than the notional building.

56. This approach would essentially seek the installation of low carbon and fossil fuel free heating such as heat pumps and be more useful in tackling climate change than that of the renewable energy target currently in Part 2 of the policy (commonly known as a 'Merton Rule') because it draws greater focus to the avoidance of fossil fuel consumption and, thus, better implements the 'Be Lean' element of the energy hierarchy, which should take priority over the 'Be Green' element (see Appendix 2).

57. While this may well be viable for some developments, subject to other development and policy costs, it would exceed the costs allowed for in the whole plan viability assessment (of 4% above overall build costs under the 2013 Building Regulations) for the most common dwelling types. Therefore, it would not be appropriate to put forward a policy requirement along these lines. However, given the contribution such greater energy reductions would mean, as a move towards the proposed forthcoming national Future Homes Standard, it regarded as appropriate to *strongly encourage* its adoption.

58. An alternative unit of target may also be supported, that allows a move away from a percentage reduction target and towards a consumption-based target to achieve a low or zero carbon development (see the Green Building Council's New Homes Policy Playbook, 2021, RIBA Climate Challenge 2021 v2 and Sustainable Outcomes Guide 2019, TCPA/RTPI Climate Crisis Guide for Local Authorities, 2021, LETI Climate Emergency Design Guide). This is because the least efficient dwelling types with the highest energy consumption (detached houses) are required to achieve relatively less stringent targets than the most efficient dwelling types that have the lowest energy demands (flats). Indeed, Government is following this approach within the 2021 Building Regulations by ensuring PV provision is also based on floor area. There are two consumption-based targets available for use: the Space Heating Demand Standard and the Energy Use Intensity (EUI). It is suggested that both of these standards are referred to as options that developers are strongly encouraged to meet.

59. The above proposals are incorporated in the draft revised policy put forward proposed as a Modification at Appendix 3.

Climate Change Adaptation

60. Section 19 of the Planning and Compulsory Purchase Act 2004, as amended by the Planning Act 2008, includes the duty on plan-making to ensure that, taken as whole, plan policy contributes to the mitigation ***and adaptation*** of climate change (emphasis added). Likewise, Paragraph 153 of the NPPF is clear that climate change adaptation must be considered.

61. The related element of Policy EN3 provides a detailed overview of aspects not considered in detail elsewhere in the Local Plan, drawing together relevant themes ideas and providing focus for developers.

62. The policy allows for flexibility in order to consider different types of development and provides reference to important guidance documents to assist developers.

63. The justification for the Climate Change Adaptation component of the policy is set out in the Energy Topic Paper [CD 3.107]) and no amendments are proposed.

Conclusion

64. In conclusion, a new approach for the Energy Reduction in New Buildings part of Policy EN3 is proposed that will ensure the Local Plan contains an up to date, future-proofed climate change policy that is effective, justified and consistent with national policy.

65. A proposed new wording for Policy EN3 is included in Appendix 3 and it is expected that there will be consequential changes to the supporting text to the policy, such as the incorporation of details of how to comply with, or support, the policy. As noted above, aspects relating to Climate Change Adaptation remain unchanged.

Appendices

Appendix 1: Energy and Sustainability Policy Viability Report (May 2022 update)

Currie & Brown

Tunbridge Wells Borough Council

Energy and Sustainability Policy Viability Report - May 2022 Update

Final Report

6 May 2022

1. 2022 Update to findings

1.1 Summary of key changes in regulatory environment since 2019

1.1.1 Since the publication of the Energy and Sustainability Policy Viability Report in 2019 there have been significant changes in climate and buildings policy, regulations, and assessment methods. Key changes include:

- Changes to Part L of Building Regulations (Part L2021) which come into force in June 2022. These changes raise standards for both domestic and non-domestic buildings with an approximate 31% improvement in the carbon performance of new homes in comparison to existing regulations
- In line with changes from Part L 2021 a new version of the Standard Assessment Procedure for measuring building performance is being launched known as SAP 10.2. This standard introduces several changes to the assessment method for homes, most significantly a substantial reduction in the carbon intensity of electricity from 0.519 kg per kWh to 0.136 kg per kWh[1].
- Confirmation of plans to introduce a Future Homes Standard (FHS) in 2025 which will include a further tightening of performance standards to include both higher levels of fabric insulation and the use of low carbon heating systems (i.e., not natural gas based). The specific form of the FHS is still to be determined but the Government have published their current assumptions about the notional building specification which provides an indication as to the level of performance expected.

1.1.2 In addition to the above changes there have been ongoing variations in construction costs arising from the COVID-19 pandemic and other factors together with technology cost changes driven by ongoing technical efficiencies the production and supply of maturing technologies such as photovoltaic (PV) panels.

1.2 Updates to the analysis

1.2.1 Three Tasks were specified in the update to the 2019 analysis. As follows:

- Task 1
  - Is it still technically feasible to construct buildings that go beyond the 2013 Building Regulation requirements of a Target Emission Rate (TER) by 20-25% using LZC technology?
  - What are the indicative cost implications of this type of enhanced policy for developers?

  Additionally

  - Is a higher percentage of 30% or more now technically feasible and what would be the cost implications?
  - What is the % reduction in operational CO_2 emissions in relation to the new 2021 Buildings Regulations?

[1] This change is more significant than the options modelled in the April 2019 study which used SAP2013 and SAP10 factors only. The change reflects reality that electricity has become a significantly lower carbon source of energy than gas, particularly when used to run a heat pump which can deliver efficiencies of 250% or more in comparison to the 89-93% efficiency achieved by gas boilers.

  - What will be the likely implications for TWBC's new climate change mitigation policy requirement when the Future Homes/Buildings Standards are enacted?

- Task 2

  - Is it still technically feasible to construct buildings that go beyond the 2013 Building Regulation requirements of a Target Emission Rate (TER) by 20% using only the fabric first approach?
  - What are the indicative cost implications of this type of policy for developers?

  Additionally:

  - What is the equivalent % reduction in operational CO2 emissions in relation to the new 2021 Buildings Regulations?
  - What will be the likely implications for TWBC's new policy requirement when the Future Homes/Buildings Standards are enacted?

- Task 3

  - Is it technically feasible to implement a combination of the above-described fabric first and LZC style policies?
  - What are the indicative cost implications of implementing both these policies for developers?
  - Advice on which combination of policy targets are best suited to TWBC? For example: 20% fabric first and 25% LZC?

1.3 Approach to updating the analysis

1.3.1 To consider the above questions the modelling originally undertaken in 2019 has been updated in the following ways:

- Modelling outputs have been updated to reflect the emissions factors that will be used in SAP10.2 (note that all other aspects of modelling are in line with SAP2013 as the new SAP software is still to be released).
- Performance improvements are also shown relative to the Part L 2021 standard (with gas heating) and without a 'fuel factor' which was used in the previous building regulations to increase (make worse) the performance target for homes heated with electricity.
- Costs were reviewed and updated to include most recent cost information on various products and technologies as per Q1 2022.
- Additional cost and performance information from published work to support the development of Part L 2021 has been used to provide analysis of the impacts of Part L 2021 and the FHS.

1.4 Updated results

Task 1a - Is it still technically feasible to construct buildings that go beyond the 2013 Building Regulation requirements of a Target Emission Rate (TER) by 20-25% using LZC technology?

1.4.1 Since the conclusion of the original study in 2019, the Government have formalised their requirements for Part L 2021, this revised standard will deliver a 31% reduction in carbon emissions as modelled by SAP10.2 and approximately 20% of the savings achieved in the notional building are through the introduction of large PV arrays of around 3.6kWp for detached homes and 2.6kWp for semi and mid terrace homes and

0.8kWp for the small flat. The additional 11% savings is achieved through energy efficiency measures such as enhanced window and roof performance and the introduction of wastewater heat recovery (WWHR) systems. An alternative approach to compliance would be with an air source heat pump which would deliver savings in the order of 70% in comparison to Part L 2013.

1.4.2 While savings of 20% are achievable, savings significantly beyond 20% - eg 25% or more through the use of PV alone could be technically challenging for some homes (depending on orientation and number of storeys) without resort to mono-pitch roofs or other design features to increase the available areas for installation of PV panels.

Task 1b - What are the indicative cost implications of this type of enhanced policy for developers?

1.4.3 Our analysis of the costs associated with meeting this standard is based on that used for the revision to building regulations using the following fixed and variable costs:

- Fixed costs (cost per installation) - £1,100
- Variable costs (cost per kWp installed) - £650

1.4.4 The resulting total costs for meeting the LZC requirements for each home types are shown in Table U.1 below.

Table U.1 Costs of achieving c.20% carbon savings using PV

Home type	kWp PV required	Fixed cost	Variable cost	Total cost
Detached	3.6	£1,100	£2,340	£3,440
Semi / Mid terrace	2.6	£1,100	£1,690	£2,790
Flat (in block of 32)	0.8	n/a as array is shared	£550	£550

Task 1c Is a higher percentage of 30% or more now technically feasible and what would be the cost implications?

1.4.5 Whilst a higher standard of 30% could be achieved with PV for some homes it could be technically challenging for others (eg those with a N/S roof orientation and dormer windows). If an ASHP were used as the LZC technology, then a 30% improvement would be readily achieved.

Task 1d What is the % reduction in operational CO2 emissions in relation to the new 2021 Buildings Regulations?

1.4.6 The above PV areas and costs would not be sufficient to meet the requirements of Part L 2021 as this would require additional investments in either a low carbon heating system (ASHP) or additional fabric improvements and WWHR. The use of PV alone (in the above quantities) would result in performance approximately 10% worse than the new Part L 2021 standard.

Task 1e What will be the likely implications for TWBC's new climate change mitigation policy requirement when the Future Homes/Buildings Standards are enacted?

1.4.7 The current specification for the FHS does not require the use of PV, it is possible that this may change before the final requirements are determined. The FHS currently prescribes the use of a high level of fabric performance and low carbon heating systems (an ASHP), this specification would deliver a very substantial reduction in carbon emissions compared to Part L2013 in the order of 70-75%, most of which would be related to the LZC technology. An approach the prioritise fabric efficiency and energy reduction (eg including hot water) together with the use of low carbon heating systems is therefore well aligned to the planned direction of national policy.

~~1.4.8 If TWBC were to include ASHP within the list of available LZC technologies, then a standard of +20% achieved through LZC (in comparison to Part L2013) will help to drive the update of ASHP's prior to their widespread adoption in 2025.~~

1.4.9 If TWBC wish for additional carbon savings to be delivered exclusively through onsite generation then savings of 20% for low / medium rise flats and over 20% for houses would be possible through the installation of PV. The absolute carbon reductions achieved using PV once the FHSs is introduced would be relatively small because homes built to FHS would have very low lifetime carbon emissions, however there would be a significant potential benefit to households in the form of lower running costs with each kWp installed generating savings and export revenue of c.£150 per year[2] or around £500 for a detached house. Surplus energy exported to the grid would help reduce the overall carbon intensity of grid supplied electricity for all users (albeit all the benefit is assigned to the home where the energy is generated).

1.4.10 This analysis is consistent with that undertaken in 2019 with respect to quantity of onsite generation that could be installed, however the changes encompassed in the Part L2021 standard mean that these requirements are now included within the regulatory minimum for new homes.

~~Please add sentence on how this compares to 2019 findings?~~

Non-domestic buildings

1.4.11 The 2021 update to Part L for new non-domestic buildings delivers and average carbon reduction on the 2013 standard of 27%. The notional building specification includes a PV array equivalent to 20% of the foundation area of the building (40% for warehouses). The impact of this PV on overall energy consumption varies significantly depending on nature of the building (e.g., air-conditioned offices vs naturally ventilated healthcare buildings) and the number of stores. The impact of this PV in the notional building is estimated at a reduction of between 5% and 12% in comparison to the 2013 notional building.

1.4.12 Because of the significant variability in the percentage contribution overall of onsite generation to the building's energy use a minimum percentage improvement achieved through LZC is likely to be too easy for some projects and too difficult for others.

1.4.13 An alternative approach would be to follow the methods used in specifying the notional building for Part L 2021 and to specify a requirement relative to the foundation area. This might be done in the form of a minimum level of electricity generation per m2 foundation area. A target of 25kWh per m^2 would be equivalent to 20% of foundation area with a target of 37kWh m2 roughly equivalent to 30% of foundation area being used for PV. For some building types it will be possible to go beyond this standard without significant technical difficulty (e.g., warehouses) whereas for others the need to utilise roof space for biodiversity / amenity purposes or to for building services could minimise the ability to achieve these standards.

1.4.14 One solution that would enable PV to be installed without prejudicing other beneficial uses of roof space would be to subtract any areas of beneficial green roof from the building footprint used to determine the area over which PV should be installed. For

[2] Based on 70% self-consumption in an electrically heated home and energy tariffs of 21p per kWp for imported energy and 5.5p per kWp for exported energy.

example, a 1000m2 building with 200m2 of green roof would need to meet a 37kWh m2 target only for the 800m2 of roof that is not devoted to biodiversity / amenity space.

1.4.15 The costs of requiring PV on non-domestic buildings are likely to be in the order of £30-£50 per m2 of eligible floor area. The significance of this cost will vary according to the number of storeys in the building, for a two storey naturally ventilated office building with a construction cost of c.£2,500 m2 the impact of a renewable energy requirement would be less than 1% of construction cost, for buildings of more than 2 storey's the cost would be lower.

Task 2a - Is it still technically feasible to construct buildings that go beyond the 2013 Building Regulation requirements of a Target Emission Rate (TER) by 20% using only the fabric first approach?

1.4.16 Figures U.1 to U.4 show the updated performance of each of the homes modelled using SAP 10.2 emission factors.

Figure U.1 Performance of Detached home using SAP 10.2 emission factors

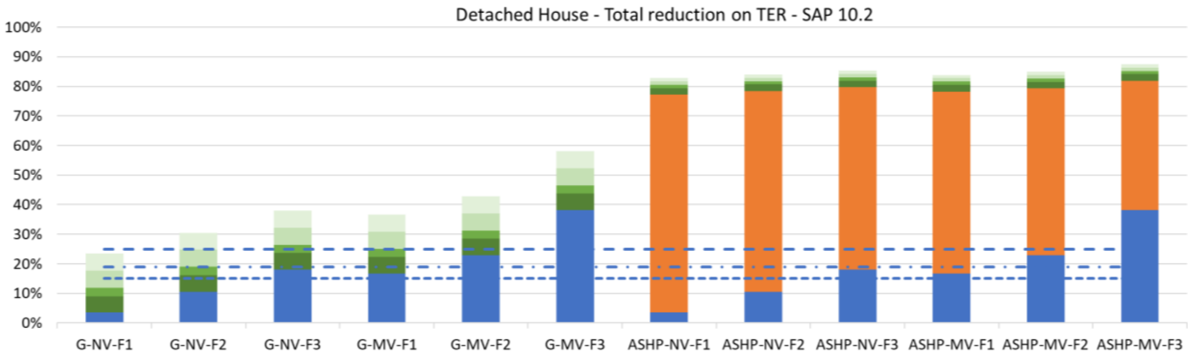


Figure U.2 Performance of Semi-detached home using SAP 10.2 emission factors

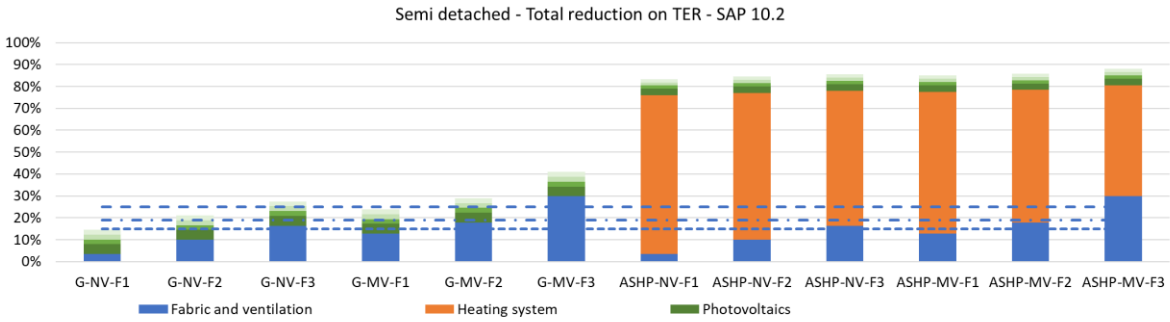


Figure U.3 Performance of Mid-terrace home using SAP 10.2 emission factors

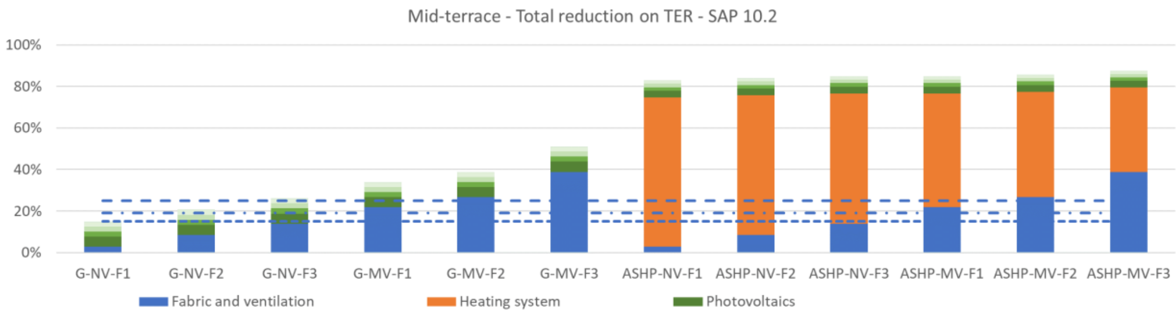
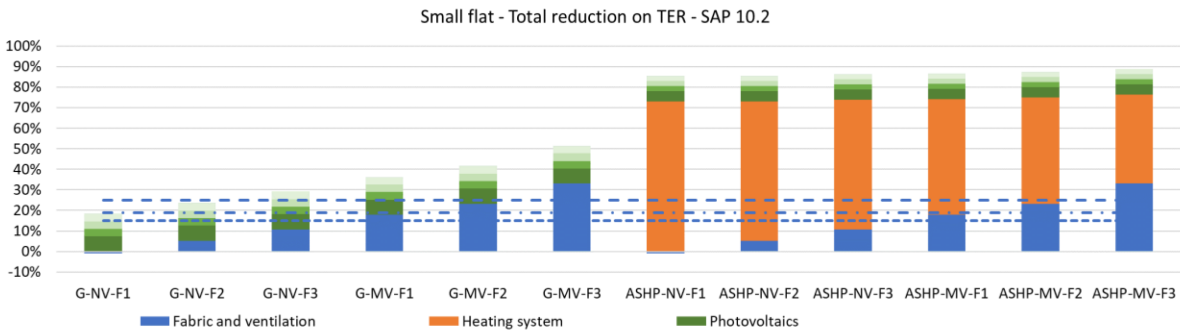


Figure U.4 Performance of Small flat using SAP 10.2 emission factors



1.4.17 These show that it is still possible to achieve a 20% efficiency saving through fabric and ventilation measures but that this would require the use of MVHR systems for all homes except the detached house.

1.4.18 As per the 2019 study, a standard of 10% savings through energy efficiency is achievable in all home types using natural ventilation methods.

~~How does this compare to conclusions from 2019? It is now more or less achievable?~~

Task 2b - What are the indicative cost implications of this type of policy for developers?

1.4.19 Achieving this policy standard requires the use of higher performance insulation, glazing and for flats, improved airtightness and thermal bridging and installation of MVHR systems. Indicative costs are as follows:

- Detached £5,400
- Semi-detached £3,200
- Mid-terrace £2,600
- Small flat £3,100

1.4.20 Around £2,000 of the costs for flats relate to the use of MVHR systems with the balance being expended on fabric enhancements. Costs are highest for detached houses because these are both larger and have a higher external area relative to internal area than other home types.

Task 2c - What is the equivalent % reduction in operational CO_2 emissions in relation to the new 2021 Buildings Regulations?

1.4.21 Only the highest level of energy efficiency and ventilation measures would meet the 2021 building regulations through fabric improvements alone. For the highest fabric specification together with MVHR the % saving over the Part L2021 standard is 10-15% for houses, but only 3% for the flat. It must be remembered that the notional Part L2021 compliance standard includes for the significant use of photovoltaics and only a relatively modest improvement in fabric standards in comparison to Part L 2013. As a result, achieving this standard without the use of LZC is challenging.

Task 2d - What will be the likely implications for TWBC's new policy requirement when the Future Homes/Buildings Standards are enacted?

1.4.22 As stated previously the specific details of the FHS are still to be determined but the most recent proposals presented by Government would be approximately between NV-F2 and NV-F3 or MV-F1. This would broadly equate to a 10-15% saving for the houses and around 8% for the small flat. A 20% efficiency saving would therefore be a more ambitious standard than the currently published FHS proposals.

1.4.23 A more ambitious approach would be to set a minimum standard based on space heating demand for example a standard of 15-20kWh m^2 would be broadly in line with specification MV-F3 with the following associated costs:

- Detached £7,900
- Semi-detached £5,300
- Mid-terrace £4,700
- Small flat £3,100

1.4.24 A space heat demand standard is more in line with current performance standards developed by the UK GBC, RIBA and LETI and is an absolute and energy based standard and so is not subject to the impacts of changes in carbon factors or building standards. When paired with a high efficiency heat-pump based heating system a space heat demand of 15-20kWhm^2 should result in an overall annual energy use intensity of 35-50kWhm^2

Non-domestic buildings

1.4.25 As identified in 2019 it is possible to achieve significant efficiency savings in new non-domestic buildings relative to the 2013 Part L standard. The 2021 version of Part L includes an average saving of 27% for non-domestic building types albeit with significant variation between different types as shown in Figure U.5.

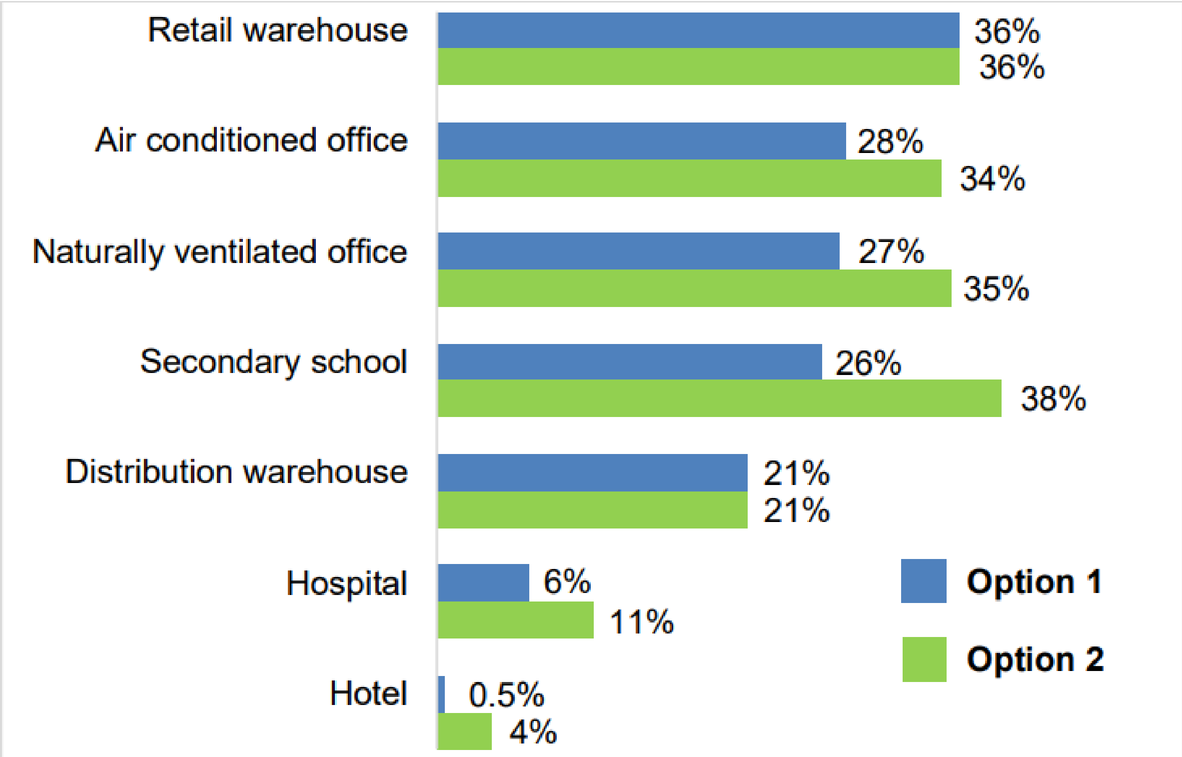


Figure U.5 Percentage improvement in carbon performance for new buildings associated with the 2021 change in Part L (Option 2)

1.4.26 On average the minimum performance of non-domestic buildings will be c.27% better than that assumed when the 2019 study was undertaken. A further tightening of the minimum requirement could be achieved through the use of low carbon heating systems for heating and / or hot water in new buildings and with further efficiencies in services and fabric standards. However, the relative impact of implementing these measures will vary between building type. Additional savings over Part L2021 are likely to be more significant for naturally ventilated buildings than for air-conditioned buildings where much of the heating / cooling load is already met by electricity. Additional savings of c.10% should be achievable in all building types using heat pumps, high performance lighting and other efficiency measures. However further savings may be challenging for some building types such as hotels where relatively high levels of simultaneous hot water demand make the use of heat pump systems more complex and expensive than would be the case in other buildings.

1.4.27 The cost implication of implementing low carbon heating systems in non-domestic buildings are difficult to define in detail given the diversity of the types of buildings to which they apply. However, studies for the Committee on Climate Change by Currie &

Brown suggested that for naturally ventilated and air-conditioned offices the costs of installing heat pumps had less than a 2% impact on the capital cost of construction.

Task 3a Is it technically feasible to implement a combination of the above-described fabric first and LZC style policies?

1.4.28 It is possible to implement a combination of fabric first and LZC policies relative to Part L 2013. Figures U.1-U.4 show the carbon implications of different combinations of measures in SAP10.2.

1.4.29 A further factor to consider is that the Part L2021 notional building standard is based on a combination of energy efficiency and LZC measures, with the later making a major contribution to the eventual performance achieved. Figures U.5-U.8 show the % improvements of each specification in comparison to an estimated Part L 2021 (a 31% improvement on the 2013 notional building) baseline position and show that many of the gas heated options to not meet the 2021 requirement without the introduction of PV, in many cases more than the amounts considered in this study.

1.4.30 As a result, it is not possible to meeting Building Regulation requirements using a percentage improvement standard that is purely linked to an energy efficiency unless TWBC wishes to effectively require the highest performance standard (MV-F3) for all new developments or where there is a requirement to use electric heating in the form of a heat pump.

Figure U.5 Performance of Detached home options against Part L2021 using SAP 10.2 emission factors

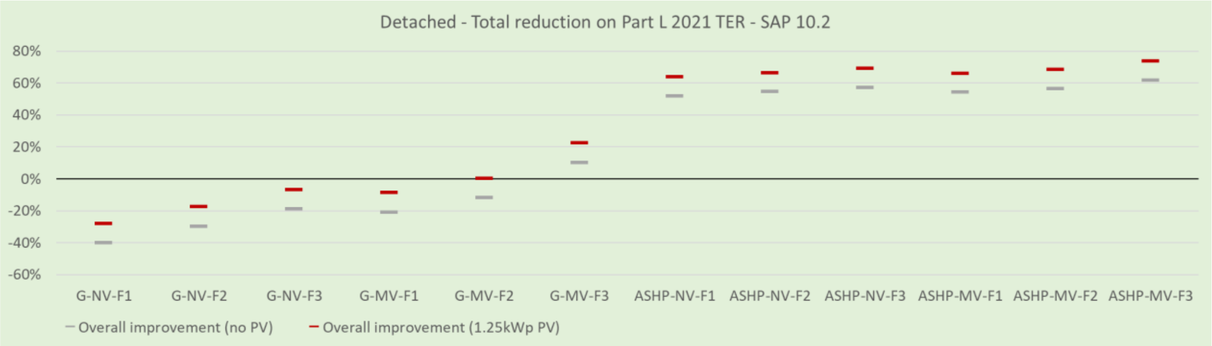


Figure U.6 Performance of Semi-detached home options against Part L2021 using SAP 10.2 emission factors

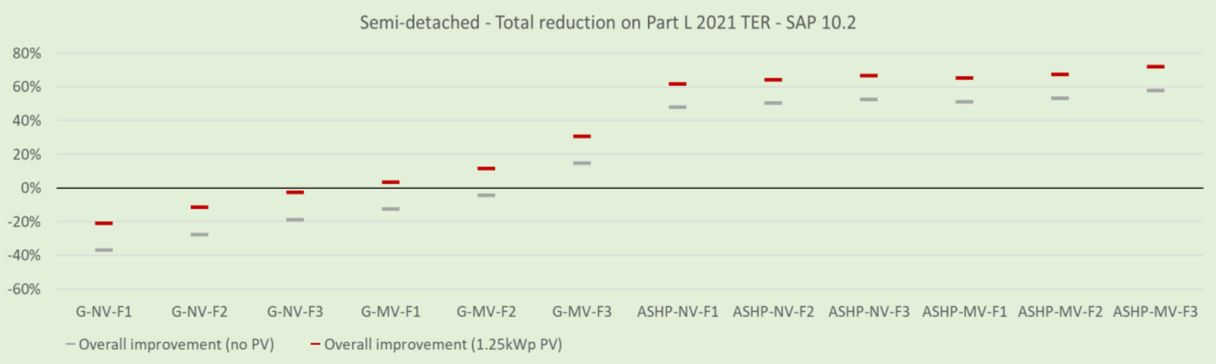


Figure U.7 Performance of Mid-terrace home options against Part L2021 using SAP 10.2 emission factors

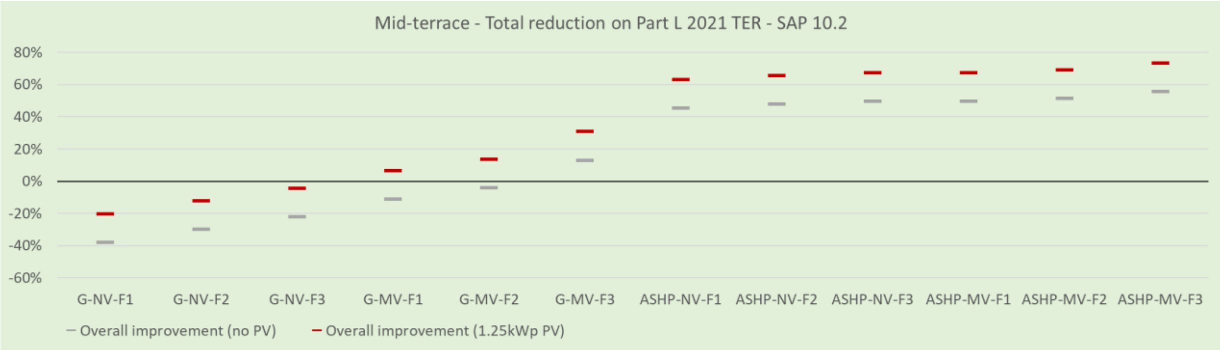
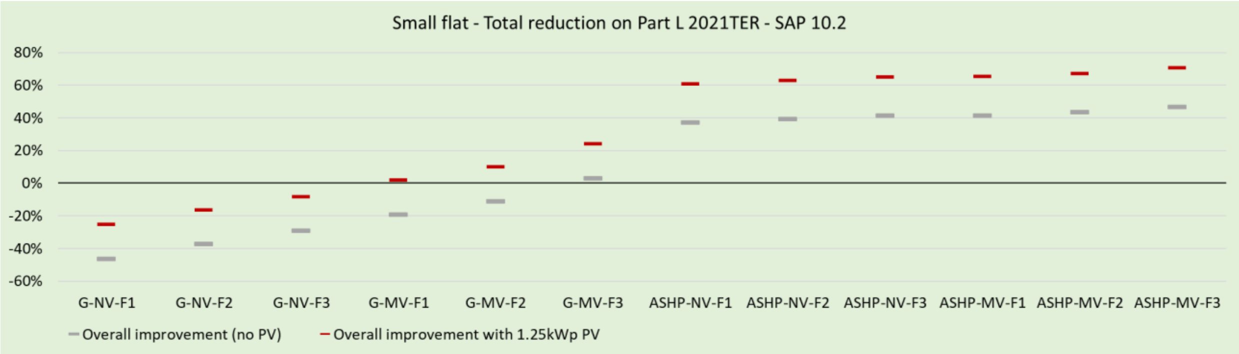


Figure U.8 Performance of Small flat options against Part L2021 using SAP 10.2 emission factors



1.4.31 The most suitable approach for long term carbon reductions is to combine a high level of energy efficiency with low carbon heating systems (ASHP or alternative) as these will deliver the greatest long term carbon savings. The use of PV in lieu of low carbon heating will deliver far less long-term carbon savings for homeowners/tenants and gas consumption will be locked in for around 15 years. Over time the relative carbon benefit of PV will diminish significantly due to grid decarbonisation, i.e. each unit of grid energy displaced has less carbon with the expectation being that by 2035 grid supplied electricity has little or no associated carbon and so the net carbon benefit of onsite generation from PV will be limited after this time. It is therefore worth considering policy options in this context and assessing the most suitable means for achieving both energy efficiency and low carbon heating outcomes.

1.4.32 As stated above, for homes with a gas boiler it is challenging to define a percentage improvement over Part L2021 in fabric terms only as the standard implicitly includes LZC of some form. Therefore, the introduction of a minimum improvement on Part L 2021 through fabric measures alone would strongly encourage the use of an electric heating system. Albeit the highest fabric (MV-F3) standard and a large PV array (equivalent to 40% of building footprint) could comply.

1.4.33 For homes with a heat pump, the % improvement in performance from the basic (NV-F1) to most advanced (MV-F3) systems are in the order of 10% for each house type and would require the use of MVHR systems. This is a smaller variation than that seen with gas heating because the efficiency and lower carbon intensity of the heat pump means that fabric efficiency has a smaller impact on the homes' overall energy demand. Requiring a fabric improvement in the order of 5% could be achieved by either the use of MVHR or through a high level of fabric efficiency and natural ventilation together. This option also provides additional flexibility as a developer could also use a WWHR system to reduce energy consumption thereby providing additional flexibility in terms of fabric specifications.

1.4.34 An overall improvement target (fabric and LZC) of 35% compared to Part L would require the developer to either use the highest fabric standard + MVHR and a large amount of PV or to use an ASHP together with an ambitious fabric standard (NV-F2/3 or above) with natural ventilation. Both approaches are challenging but achievable and provide a basis for delivering high performance homes which will aid in preparation for the FHS.

Task 3b What are the indicative cost implications of implementing both these policies for developers?

1.4.35 The estimated costs of compliance with Part L2021 for each house type are shown below. These include for PV, some fabric improvements and WWHR systems.

- Detached £4,900
- Semi-detached £3,800
- Mid-terrace £3,800
- Small flat £2,100

1.4.36 The additional costs of a policy requiring a further 5% saving through energy efficiency measures and a 35% saving overall are shown below. These include for fabric improvements to the level of NV-F3 (but with natural ventilation) and an ASHP instead of gas for heating and hot water. There is no provision of PV in this scenario (beyond that which is already required by Building Regulations).

- Detached £3,256
- Semi-detached[3] £3,226
- Mid-terrace[3] £1,899
- Small flat[4] £148

Task 3c Advice on which combination of policy targets are best suited to TWBC? For example: 20% fabric first and 25% LZC?

1.4.37 Based on the changes to building regulations and associated assessment methodologies this updated analysis suggests that it would be better to reform the proposed policy targets to reflect the incoming regulations which incorporate both energy efficiency and onsite generation components. New policy requirements should be framed in relation to the incoming standard as this will be regulatory compliance test that all new development will need to meet. **The new targets should require a minimum improvement over the Part L2021 notional building TER of 5% achieved through energy efficiency measures alone together with a requirement for an overall carbon saving of at least 35% more than the notional building.** Such an

[3] The additional costs are around £800 higher than those estimated previously in 2019 due to use of updated cost data and a change in assumption about the presence of a hot water cylinder in the semi-detached and mid-terrace homes.
[4] These additional costs are based on the assumption that the baseline flat has a communal gas heating system, should the base case be for individual combi boilers (i.e. a low rise flat of 4 or fewer stories) then the additional costs would be higher, and would be of a similar order to those for the mid-terrace house.

approach would address the key climate mitigation challenges facing new housing, namely, to encourage a high-performance building fabric and the use of low carbon heating systems. If such an approach is followed it would not require the use of MVHR systems in new homes. The approach provides flexibility because it would also be possible to achieve compliance with gas heating through building to very high fabric standards with MVHR and PV. This approach is typically more expensive solution but might be preferable in some situations where the developer is loathe to move to fully electric heating systems. Any homes built with gas heating would be of a standard where subsequent conversion to use a heat pump would be relatively straight forward. As new buildings move increasingly to low carbon sources of heating, measuring carbon relative to Part L standards will become a less useful way of assessing the overall effectiveness of a climate mitigation strategy. Measuring absolute energy use intensity per m2 of floor area, together with minimum standards for space heat demand ensure that new homes are playing a full part in helping contribute to the UK's climate change targets by minimising demand for energy as well as by utilising low carbon energy sources. Further, the introduction of absolute targets would help to drive higher standards for those home types (eg detached houses and bungalows) with the highest emissions per m2 of floor area, thereby focusing effort on the least efficient homes.

Tasks 3a-3d – need perspective of non-residential buildings and Future Buildings Standard too

Non-domestic buildings

1.4.38 Non-domestic buildings are much more diverse in their nature and in the associated energy consumption and operational carbon emissions. Part L 2021 provides a substantial average improvement in energy performance, but this is not equally distributed between different types of non-domestic building. It is likely that most non-domestic buildings could achieve a minimum of a further 10% improvement in carbon performance beyond Part L2021 through a combination of efficiency measures or from the use of low carbon heating, the costs of this would represent a construction cost increase of less than 2%. The council may need to provide some flexibility in the application of this policy for certain building types, such as hotels where hot water demands are not ideally suited to supply from heat pump technologies, nonetheless it is likely that savings of 10% could be achieved via other means such as the use of heat pumps for space heating and through introduction of high-performance light systems.

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.

The development of specific policy options will reflect local priorities, viability and other considerations but the information on costs and other relevant policy considerations is intended to help inform these decisions in developing effective policies that deliver carbon savings whilst protecting housing supply and household costs.

A range of dwellings 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 and 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 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 it has not been 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).

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 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 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 building 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. In this scenario it is recommended that some accommodation is provided because their absolute energy use and carbon emissions will be far lower than less efficient building forms even if they are compliant with a 20% reduction requirement.

In term of non-domestic new buildings, a literature review analysis indicated that an uplift associated with achieving a 15% energy efficiency target was 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. 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.

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.

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 and must be paired with sufficiently sized heat emitters (e.g., radiators or underfloor heating), 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 envelop (or have insulated ducting) and 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. As wide range of existing materials exists including that produced by Zero Carbon Hub, NHBC and CITB.

Contents

Appendices

Glossary

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.

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).

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.

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 extracting 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.

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.

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.

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.

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.

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.

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.

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 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.

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.

Ventilation

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

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.

2. Introduction

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

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.[5]

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 and Sustainability Policy Viability Report" (Table 1).

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

Tender Task Number	Questions
TASK 1	
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[6]. This is set out in the Renewable Energy Supplementary Planning Document (SPD).	What the additional cost would be for a developer if this target was strengthened to 15 and 20% against a 10% baseline cost. 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 are the indicative cost implications of this type of enhanced policy for developers?
TASK 2	
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. TWBC would like to determine what the additional cost would be for a developer if this target was implemented and compare these costings for targets of 15% and 25%. 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 are the indicative cost implications of this type of policy for developers?

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

Tender Task Number	Questions
TASK 3	
TWBC would like the report 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?
TASK 4	
TWBC would like to implement a policy that requires developers to meet design standards such as the Home Quality Mark or BREEAM.	TWBC would like the report above to also provide an analysis of the viability implications of implementing such a policy (alongside the chosen combination of policies in Task 3).

2.1 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 rapid review of relevant existing policies and guidance documents was performed. These covered amongst other 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 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 is a reasonable existing evidence base for tighter standards for the main forms of non-domestic development and this evidence is summarised in Section 7 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 (more than 110 variations generated).

The DER/TER improvement was assessed[7] against minimum PartL1A 2013 compliant (notional building[8]) 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, is used for estimating the resultant construction cost uplifts.

The different modelled scenarios reviewed targeted 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

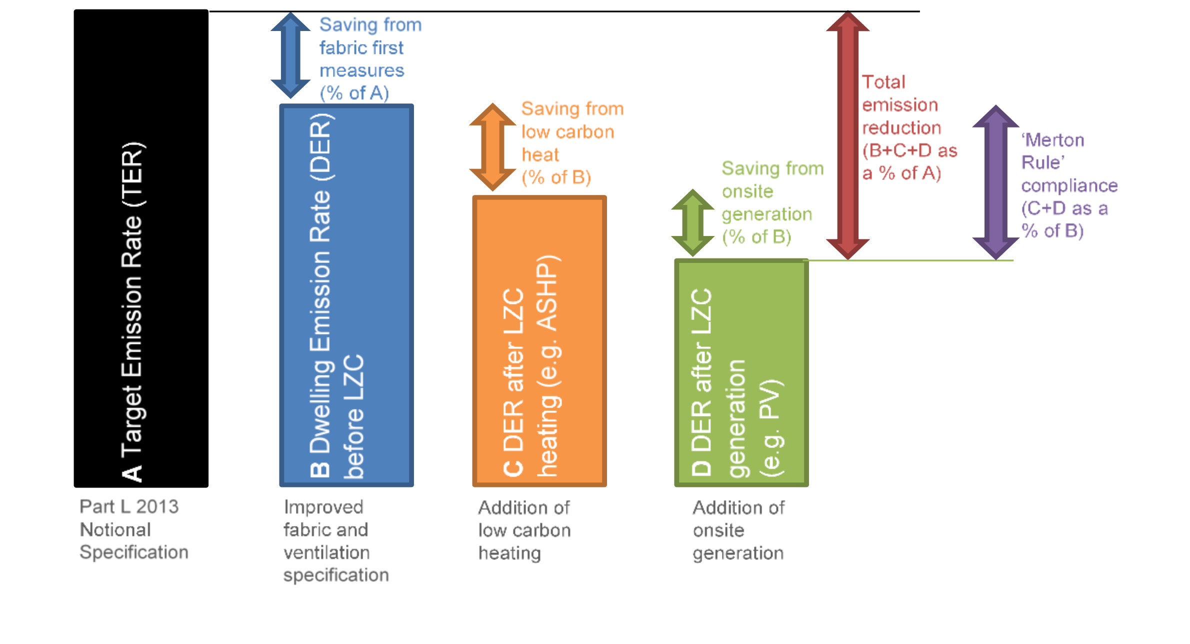


Figure 1 - Approach to assessing the contribution of fabric, services and renewable energy generation to planning requirements

[7] Calculated using the Elmhurst Energy Systems SAP2012 Calculator version 4.10r08 software
[8] 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 is 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 are 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 considers 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’[9] specifications and including a minimum 10% reduction in DER from the use of LZC technologies.

Costs are 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.

[9] 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.

3. Scoping Activity

3.1 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[10].

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[11], 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)[12] encourages local authorities to use assessment frameworks as tools for improving design quality while paragraph 149 of the NPPF

[10] https://www.theccc.org.uk/publication/reducing-uk-emissions-2018-progress-report-to-parliament/

[11] 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[13], 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

[12]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/779764/NPPF_Feb_2019_web.pdf
[13] 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[14]
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[15]
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 FHS by 2025, so that new build homes are future-proofed with low carbon heating and world-leading levels of energy efficiency

[14] https://www.theccc.org.uk/wp-content/uploads/2019/02/UK-housing-Fit-for-the-future-CCC-2019.pdf

[15] https://www.gov.uk/government/news/spring-statement-2019-what-you-need-to-know.

3.2 Local Policy Documents, Standards and relevant publications

Twenty-five documents were identified as relevant by the researchers (Appendix A -). 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 the TWBC. Information extracted was only used to identify potential updates in terms of documents reviewed.

3.2.1 Local Environment

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

'The borough of Tunbridge Wells is one of 12 local authority areas in the county of Kent. The borough borders four Kent authorities (Ashford, Maidstone, Sevenoaks and Tonbridge & Malling) and two within East Sussex (Rother and Wealden).

The borough encompasses the communities of Royal Tunbridge Wells, Cranbrook, Paddock Wood and Southborough as well as a number of rural villages.

The borough is made up of 20 ward areas (administrative units) which are represented by your local ward members (Borough Councillors). Eight of these wards are located within the main urban area of Royal Tunbridge Wells.

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 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 extend 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 scenario.
- 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 (fossil fuel combustion building services by-products) can unlock new development opportunities and enhance the experience of the Tunbridge Wells Borough residents.

3.2.2 Population

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

- The Kent Council interactive population forecast toolkit[16] (Oct'2018) and the
- ONS 2016-based Subnational Population Projections for England[17]

Results are shown in Table 2

Table 2 - 2033 Tunbridge Wells Borough Population Projections

	Kent Council interactive population forecast toolkit		ONS 2016-based Subnational population projections[18]	
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 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 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.

[16] https://www.kent.gov.uk/about-the-council/information-and-data/Facts-and-figures-about-Kent/population-and-census#tab-3

[17] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/subnationalpopulationprojectionsforengland/2016based

[18] TWBC Housing Needs study 2018 is using the ONS 2012-based Subnational Population Projections

- 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 as important to note that lifecycle cost and carbon performance assessments could be occupied to demonstrate robustness of solutions suggested in such schemes.
- The range of measures reviewed within the housing models within the evaluated research include 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 we 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.

3.2.3 The Local Plans

Relevant to the research background scoping activity aspects of the Local Plan 2006 and the new 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 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)[19]. 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.
- 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, 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.

3.2.4 Current Renewable Energy Supplementary Planning Documents

The Renewable Energy SPD Update (2016) an update to the Renewable Energy Supplementary Planning Document, adopted in 2007[20] was reviewed in order to assess current energy requirements imposed to new developments within the borough. Main points are summarised in Table 3.

Table 3 - 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

[19] http://www.tunbridgewells.gov.uk/__data/assets/pdf_file/0007/98521/SHMA-final-September-2015.pdf
[20] http://www.tunbridgewells.gov.uk/residents/planning/planning-policy/supplementary-planning-documents

- 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.

The research study provides additional information on the association of CO2 emissions and energy demand and clarifications were required on sensitivities in terms of metrics selected. A separate discussion piece on HQM requirements is also provided.

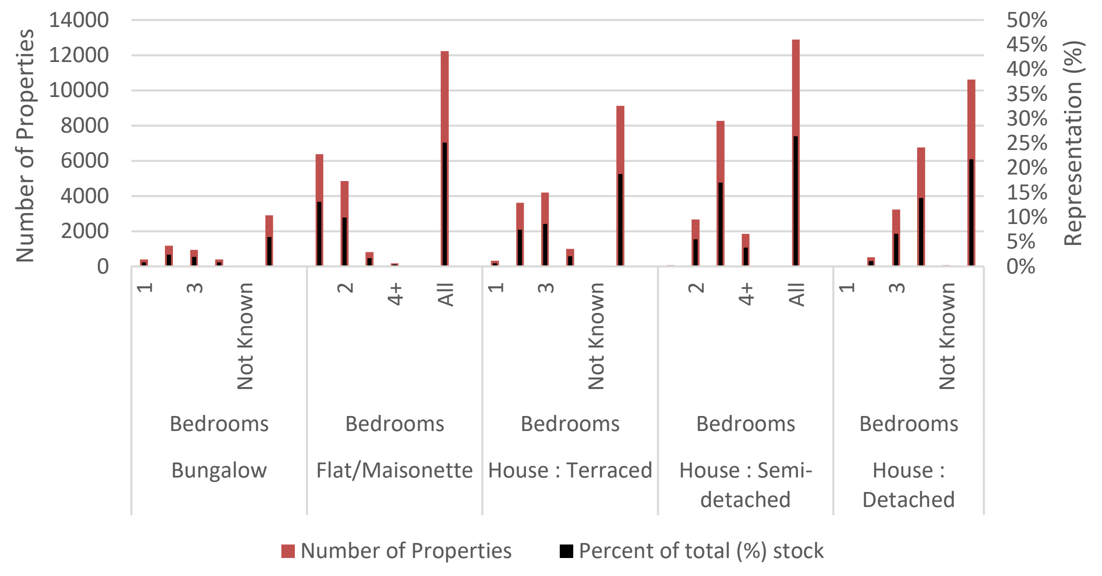
3.2.5 Housing Stock

Government data from the Council Tax: stock of properties 2017[21] 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 (Table 4).

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 4 - Tunbridge Wells Borough Housing Types Representation

Tunbridge Wells Borough – Housing Statistics (2017)



West Kent Housing & Homelessness Strategy 2016–2021[22]

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

[21] https://www.gov.uk/government/statistics/council-tax-stock-of-properties-2017

[22] http://www.tunbridgewells.gov.uk/__data/assets/pdf_file/0010/227098/79074C40686724F2E0531401A8C0CDFC_Joint_Housing__Homeless_Strategy_TW1374_V4_Final.pdf

- 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 Draft Local Plan document indicated a need for 648 homes per year (12,960 over 20 years).

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

Table 5 - 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 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 Delivery	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 target over the period of 427 dwelling completions.

3.2.6 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[23].

As indicated within the Sevenoaks and Tunbridge Wells Economic Needs Study Final Report for Tunbridge Wells Borough August 2016[24] 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[25], 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[26]
▪ 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 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

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

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.

4. 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 (25) questions. The first four (4) 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.

4.1 General Findings

In total eighteen (18) individual responses were collected. No all responders addressed all questions.

Risks and opportunities responders background and level of involvement

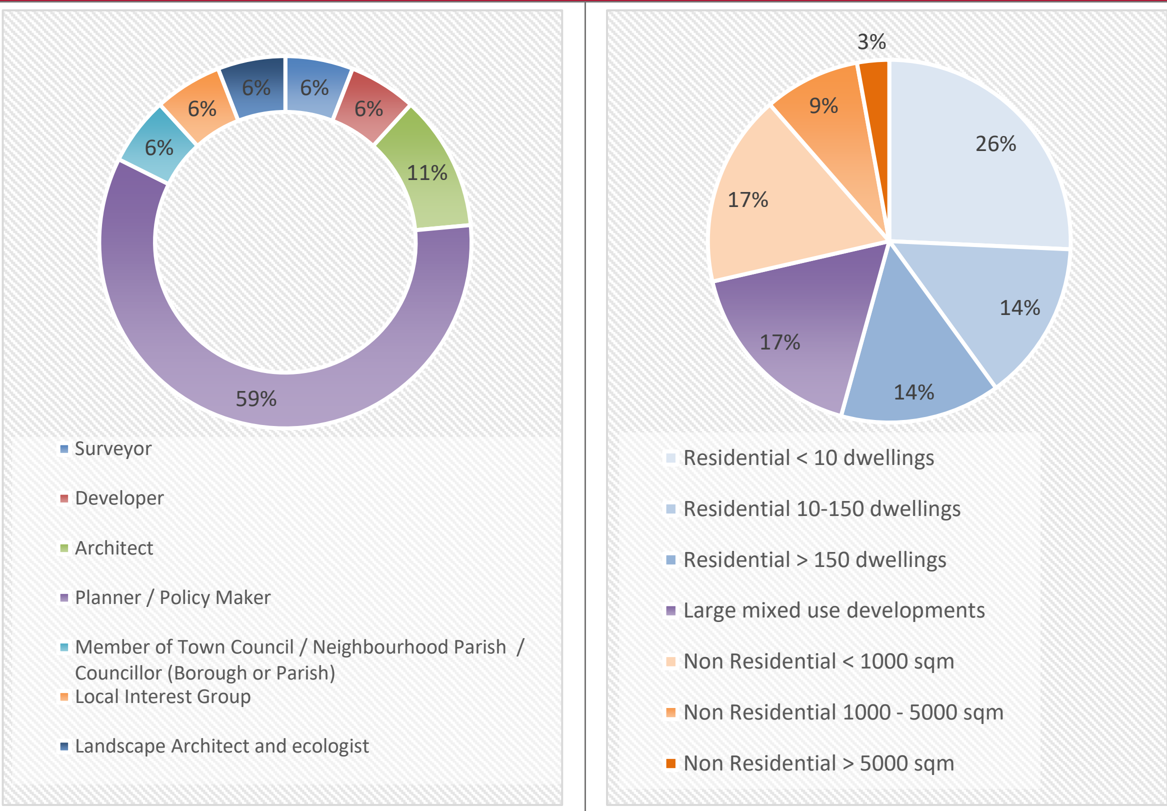


Figure 2 - Risks and Opportunities Survey Responders background and level of involvement

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 at summarised in Table 6 .Views were supportive of a new policy introduction, especially considering of a fabric first approach.

Some concerns raised related to affordability and fuel poverty. Contemporary design and Moderns Method of Construction were supported while current Energy and Carbon requirements were also considered as set at an appropriate level.

Table 6 - 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

5. Housing Models Design and Analysis Considerations

5.1 Housing Design Archetypes

As indicated through the Scoping Activity 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 7. These archetypes designs are compliant with the Technical housing standards – nationally described space standard (2015) requirements[27].

Table 7 - 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 housing design archetypes aligned well with new homes designs submitted for planning approval in different developments within the Tunbridge Wells Borough (Developments A-D, Figure 3)[28].

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

Housing Design Archetypes & New Homes Designs (TWBC)

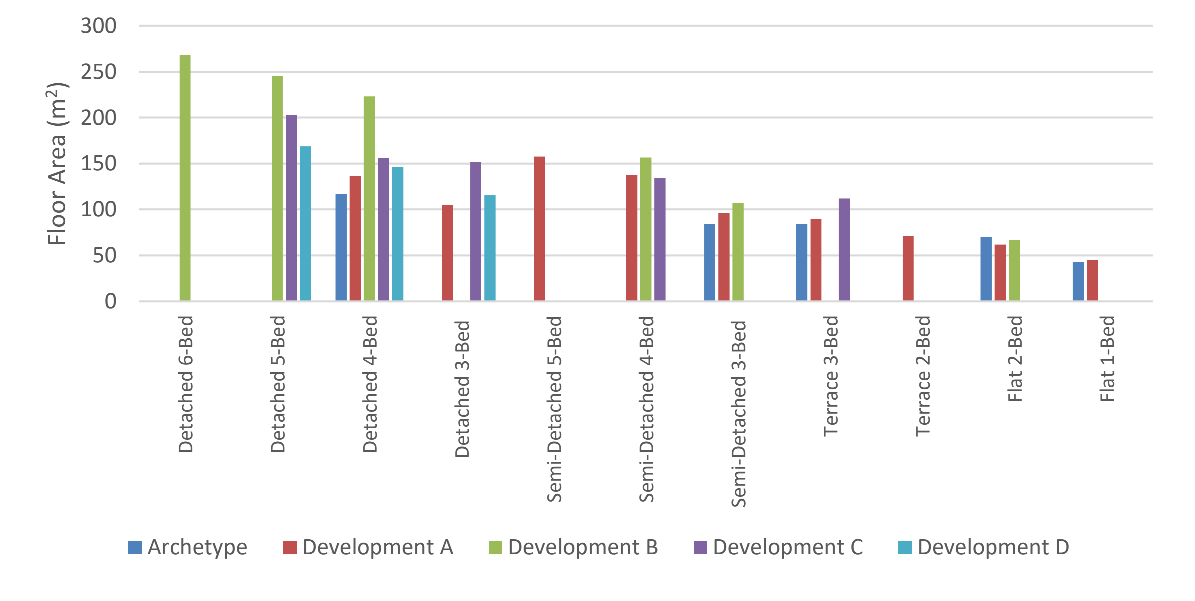


Figure 3 - Housing Design Archetypes & New Homes Designs (TWBC)

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

5.2 Addressing the Tender Task Requirements through modelling scenarios

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[29] 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 and Photovoltaics (PV) were used as reference examples.
- **Construction Cost Capital uplift** – 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 a fabric first approach and 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.

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[29] 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.

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

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 which included:

- Naturally ventilated housing models incorporating higher fabric performance specification and PV (fabric first)
- Mechanically ventilated air-tight housing models incorporating higher fabric performance specification and PV (fabric first)
- Fabric first (naturally ventilated and MVHR supported housing model), 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.

Task 4: Refers to implementing a policy that requires developers to meet design standards such as the Home Quality Mark or BREEAM.

The policy refers to using non-regulatory sustainability and environmental assessment standards for domestic and non-domestic properties. Both standards can be used to achieve high construction quality, address environmental impact, assess overall construction impact on sustainability and report on the predicted energy and carbon performance of new buildings.

It needs to be noted that such standards are based on scoring systems with final scores calculated by acknowledging a range of sustainability criteria. Energy and Carbon performance metrics therefor consist part of the assessment process, and methodologies used can be different when compared with the methodology used within the building regulations.

In that sense, unless explicitly specified it won’t be clear at which level the energy and carbon emissions ambition is set at and how these elements were evaluated.

The cost of undertaking such assessments, as a contributor to capital construction costs uplift (service) will vary depending on the type of building evaluated, number of units and the standards used.

Considering these limitations, such costs and scoring criteria were not assessed as part of this research.

6. Domestic Building Models Details and Summary of Results

6.1 Natural Ventilation – Fabric First models

6.1.1 Fabric Improvement 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. Specification occupied within the models reflect specifications commonly seen in new housing construction projects (technically feasible).

Table 8 - Naturally Ventilated Fabric First Housing models abbreviations

Acronym	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

'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 9 - Variations of PartL1A models to reflect 'Actual' specifications used in projects within the borough of Tunbridge Wells

Housing Modelling Design Archetypes elemental performance adaptation base on TWBC data U-values (W/m2K)			
Element	Part L1A 2013 Compliant	Actual TWBC Data	Limiting Fabric Parameter (PartL1A2013)[30]
Exposed Wall	0.18	0.21	0.30
Ground Floor	0.13	0.15	0.25
Exposed Roof	0.13	0.11	0.20

It needs to be noted that the Fabric Improvement Option 3 (F3) refers to elemental fabric thermal performance standards commonly seen in PassivHaus projects.

While the PassivHaus standards requires 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.

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 10.

[30] Part L1A 2013 edition incorporating 2016 amendments

Table 10 -Fabric First Construction Specification details for Naturally Ventilated models

Archetype		**Part L1A 2013**		**Modelling 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		Modelling 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		Modelling 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

6.1.2 Design Fabric Energy Efficiency Levels of models

The Design Fabric Energy Efficiency of the NV-F models was assessed for the different housing models. The SAP2012 Technical Manual Provides the following definition of FEE[31]:

'*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.

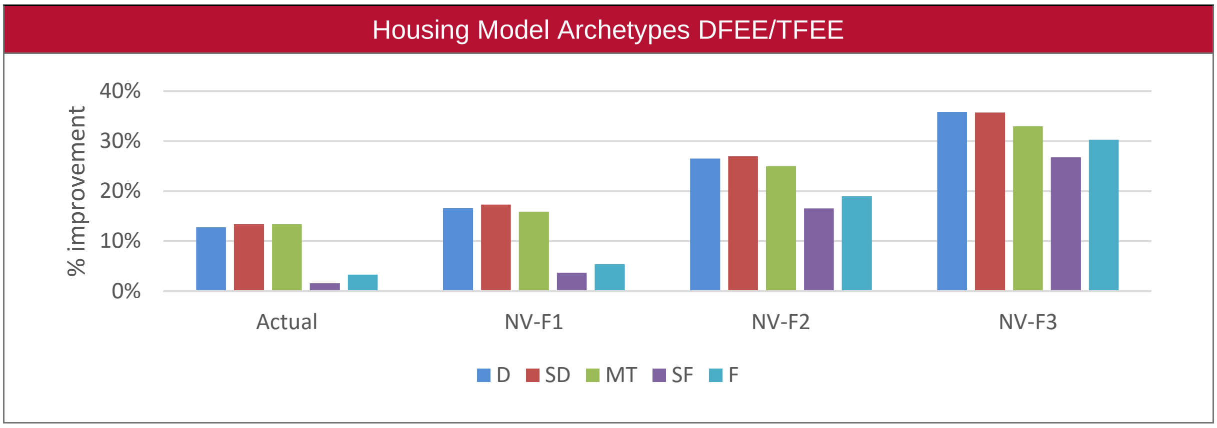

Figure 4 - DFEE/TFEE % of improvement of the NV-F models over PartL1A 2013 notional

Actual achieved performance is shown in Table 11.

Table 11 - 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	SF	38.1	37.5	36.7	31.8	27.9
	F	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:

- 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.

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

6.1.3 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 and 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 in terms of space heating demand was conducted to showcase levels of performance improvements achieved in terms of overall energy demand reduction.

For Clarification purposes the following abbreviations[32] are used within this report (Table 12).

Table 12 - Naturally Ventilated Fabric First Housing models abbreviations

Energy Demand – G-SHED / H-SHED explanation	
Grid Space Heating Energy Demand (G-SHED)	Referring to energy supply requirement from the gas and electricity grids
Home Space Heating Energy Demand (H-SHED)	Referring to the delivered energy in the form of heat to the space in order to maintain favourable and compliant indoor thermal conditions

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 13 are of models using the same Gas boiler system (89.5% efficiency).

Table 13 - H-SHED percentile improvement over PartL1A baseline (reduction)

		Part L1A 2013	Modelling Scenarios		
	Type/unit	Notional	NV-F1	NV-F2	NV-F3
Houses	Detached	Baseline	2%	14%	26%
	Semi-Detached	Baseline	2%	14%	25%
	Mid-Terrace	Baseline	1%	12%	22%
Flats	SF	Baseline	N/A	2%	17%
	F	Baseline	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 in order to achieve the same levels of space heating demand reductions to that of NV-F2 specification in houses a fabric performance improvement close to that of Passivhaus (NV-F3) was required.

[32] H-SHED and G-SHED abbreviations used are specific to this report

- 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,

6.1.4 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 14).

Table 14 - DER/TER percentage of improvement for NV-F1 to NV-F3 models using SAP2012 and SAP10 energy carbon factors

Type	SAP2012 Carbon Factors					SAP10 Carbon factors				
	PartL2013		NV-F1	NV-F2	NV-F3	PartL2013		NV-F1	NV-F2	NV-F3
	Notional	Actual	Gas Boiler 89.5%			Notional	Actual	Gas Boiler 89.5%		
D	16.6	0%	3%	10%	17%	15.0	0%	3%	11%	18%
SD	18.1	1%	3%	9%	15%	16.1	1%	3%	10%	16%
MT	16.7	1%	2%	7%	12%	14.8	1%	3%	8%	13%
Avg	17	1%	3%	9%	14%	15%	1%	3%	9%	16%
SF	18.6	N/A	N/A	4%	9%	16.3	N/A	N/A	4%	10%
LF	16.1	N/A	N/A	0%	7%	14.10	N/A	N/A	-1%	7%
Avg	17.3	N/A	N/A	2%	8%	15.2	N/A	N/A	2%	8%

| Key Outputs

- In terms of DFEE/TFEE the advanced fabric standards used in NV-F1, NV-F2 and NV-F3 achieved average improvements on 17%,26% and 35% in the case of houses while the percentage of DFEE/TFEE in the case of flats was smaller 5%, 18% and 29% 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.

- 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 15% improvement. Flats achieved an average of 8% DER/TER using the advanced NV-F3 fabric specification in both instances

6.2 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 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 15.

Table 15 – 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)
MV-F2	MVHR, Fabric Improvement 2 (Airtight)
MV-F3	MVHR, Fabric Improvement 2 (Airtight)

The levels of air-tightness used within the models is shown in Table 16, while 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 10.

Table 16 - MV-F models air-tightness levels assessed in SAP2012

		Part L1A 2013		Modelling Scenarios		
	Type/unit	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 to 88%.

6.2.1 Design Fabric Energy Efficiency Levels Achieved

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

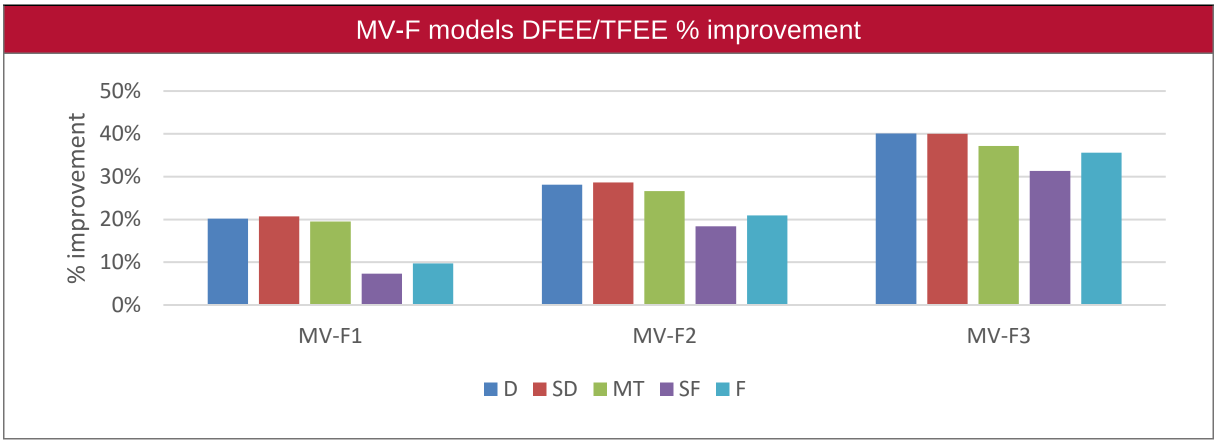

Figure 5 - DFEE/TFEE % of improvement of the NV-F models over PartL1A 2013 notional

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 17 - Housing Models Fabric Energy Efficiency (kWh/m²/year)

		Part L1A 2013		Modelling Scenarios		
	Type/unit	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	SF	38.1	37.5	35.31	31.1	26.15
	F	39.0	37.7	35.22	30.84	25.13

6.2.2 Impact on energy demand

The following G-SHED energy demand reductions were noted between the naturally ventilated and MVHR supported models (Table 18). Absolute amounts of G-SHED per year are noted in Figure 6.

Table 18 – 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 (%)		
	NV-F1 to MV-F1	NV-F2 to MV-F2	NV-F3 to MV-F3
Average	17%	22%	35%

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

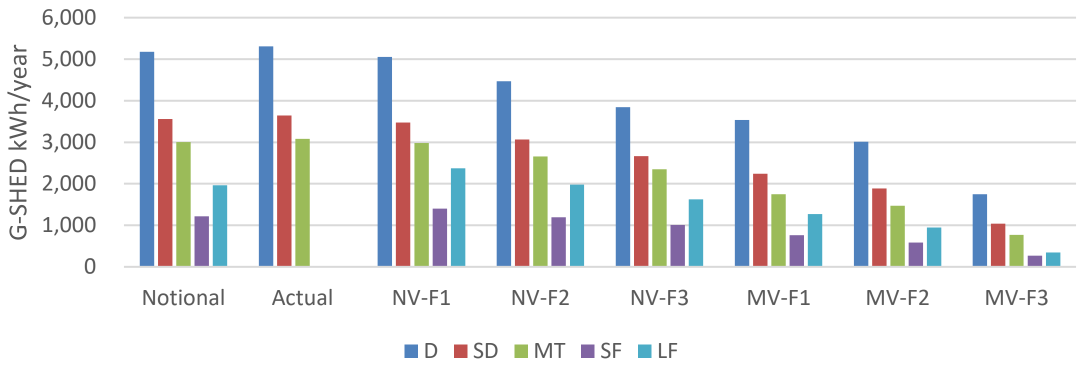

Figure 6 – Total G-SHED energy requirements per year of NV-F and MV-F models across housing design archetypes

6.2.3 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 19.

Table 19 - Fabric First models DER/TER (%) improvement using SAP2012 and SAP10 factors

Type	SAP	TER	DER Improvement over TER					
	Version	(kgCO2/m2/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%

6.2.4 Key Outputs

- 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 indicated on average a 37% G-SHED reduction compared to PartL1A 2013 notional baseline with NV-F3 models achieving on average a 24% reduction across all models. Higher G-SHED reductions were achieved using the MV-F3 (similar to Passivhaus specification standard) which achieved on 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 MV-F1 scenario was 10%, using the MV-F2 scenario 16% and using the MV-F3 scenario 27% using the SAP2012 carbon factors. Using the SAP10 electricity carbon emission factors and additional of almost 6% improvement added to the one achieved using the SAP2012 factors was demonstrated (for example achieving as an average 16% DER/TER improvement in the case of MV-F1 using the SAP10 factors)

6.3 Air Source Heat Pumps and PV energy generation

Previous modelling scenarios developed investigated the performance of the housing archetypes when improved fabric standards were used.

Such improvements would lead to reductions of the 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 high efficiencies of up to 300% (low temperature heating) can be achieved leading to significant reductions in energy demand from the grid. In the case of low temperature heating (supply temperatures 35-55 ^{o}C compared to 75-85 ^{o}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, e.g. houses with heating demand of 25kWh per m^2 or below, then there are potential cost savings associated with a reduction in the extent of the internal heating distribution system. This 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.

The research analysis included the review of models where the Gas Boiler (89.5%) was replaced by low temperature heating using an ASHP of 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 the size of the system ASHP systems could quality for either domestic or non-domestic Renewable Incentive (RHI) funding. Similarly, the use of Photovoltaics could allow for Feed-in Tariff support. Such cost reductions would refer to operational cost reductions and have not been considered within the analysis.

Given the scale of a typical high-rise block (or development of multiple blocks) it would be proportionate to expect an energy strategy that explicitly demonstrates how relevant area specific energy policies are being achieved and that these should include a requirement to ensure that representative current (or future weighted) emission factors are used as the basis for selecting the proposed solution.

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

Table 20 – 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		0.5, 0.75,1 and 1.25 kWp modelled

The results of the combined fabric, gas/low carbon heat (ASHP) and PV scenarios are shown, together with the associated cost implications, in Section 6.4 .

6.4 Cost Analysis – Homes

6.4.1 Capital cost modelling

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 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.

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 Part L 2013 Actual specification and then adapting these costs for each relevant building element to achieve a different standard.

Four Housing Design Archetypes cost uplifts were reviewed which included the detached, semidetached, mid-terrace houses and the small flats. Costs uplifts associated with the construction of the large flats in traditional masonry construction would be similar to that of the smaller flats. 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 a 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.

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 are 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 should 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 around 0.1 $kgCO_2e$ per kWh a further 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.

6.4.2 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 - 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 and ASHP of a COP2.5.

6.4.2.1 Cost modelling assumptions

In the case of Photovoltaics, the initial installation was costed at £1470 for the initial 0.5kWhp 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. Maximum of PV specified (1.25 kWp) compared to the floor area the different design archetypes is estimated in the Table 21 below.

Table 21 - PV capacity to floor area of housing models

	PV Capacity (kWhp)	PV to Floor Area (%)
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 demonstrated ta PV to floor area ration of 40% as the threshold. 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 22.

Table 22 – 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 kWh/m^2/year	25%
< 20 kWh/m^2/year	50%
< 15 kWh/m^2/year	75%[33]

[33] 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.

6.4.2.2 Cost Analysis Results of housing design archetypes using fabric first, LZC technologies and Merton Rule Policies Thresholds

In response to the policy questions the following information has been extracted from the detailed model cost analysis. To review exact model performances please refer to Figure 7 - Figure 10.

Table 23 - Summary of findings addressing main policy questions

Policy Questions 1
Merton Rule
What the additional cost would be for a developer if this target was strengthened to 15 and 20% against a 10% baseline cost. *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 are the indicative cost implications of this type of enhanced policy for developers?*
Houses ▪ SAP2012: Most 'Actual' specification models were able to meet the baseline 10% current target by using a 0.5kWhp PV. SAP10: the same models were unable to meet the required 10% baseline target when tested against the SAP10 performance standards. In such case additional PV (0.25kWhp) would have to be installed at increasing the baseline cost by £185. Flats ▪ SAP2012: The 'Actual' specification models were able to meet the baseline 10% current target by using a 0.5kWhp PV (27% improvement). SAP10: The 'Actual' specification model 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 the used the 0.5kWhp 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 an additional cost of £186. 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

A 'fabric first' policy of this type has never been implemented in the borough. TWBC would like to determine what the additional cost would be for a developer if this target was implemented and compare these costings for targets of 15% and 25%.

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 are the indicative cost implications of this type of policy for developers?

- 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 earlier in the report.
- An average capital cost uplift of around 5% was recorded in the majority of models using the highest fabric performance specifications (-F3). The (-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 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 predicted due to the electrical consumption of the MVHR units.

Houses

- SAP2012: The average carbon savings of naturally ventilated models was 15% using the most advanced F3 fabric spec. Using MVHR systems and increasing the levels of air-tightness almost 20% reductions on the TER in most MV models using MV-F2 and in all cases with MV-F3 specs

  SAP10: Naturally ventilated buildings are not affected by the carbon factor changes. Levels of performance remain similar to SAP2012. MVHR models with Fabric specs F2 (2-3% cost uplift) achieved a 24% improvement on the TER.

Flats

- SAP2012: The small flat fabric first NV-F3 higher spec achieves a 9% improvement on TER at a 1-2% cost uplift. The MVHR supported models managed to achieve a 15% improvement in the case of MV-F2 specification and 24% in the case of MV-F3 specification at a 2-3% cost uplift.

  SAP10: Naturally ventilated buildings were not affected by the carbon factor changes. Levels of performance remained similar to SAP2012. MVHR models with Fabric specs F2 achieved a 20% improvement on TER with the F3 specification achieving at least a 25% improvement and in some cases, a saving of over 35%.

Policy Question 3
Fabric, LZC Technologies and the Merton rule
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 an average of a 20% improvement on TER can be achieved using increased levels of airtightness and an MVHR units in the case of houses. 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 standard for the naturally ventilated flats led to a 3% cost uplift. Nevertheless, the small flat fabric first F3 the improvement is limited to c.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. ▪ Using SAP10 emission factors reduces the carbon savings from through the use of PV and so additional PV is required to meeting the relevant Merton rule standards. The costs of achieving carbon savings through PV are approximately double those associated with SAP2012 emission factors. Nonetheless is its still possible to achieve both c.20% emission reductions from fabric and ventilation and then 20-25% Merton Rule reductions while retaining gas boiler and using SAP10 emission factors.

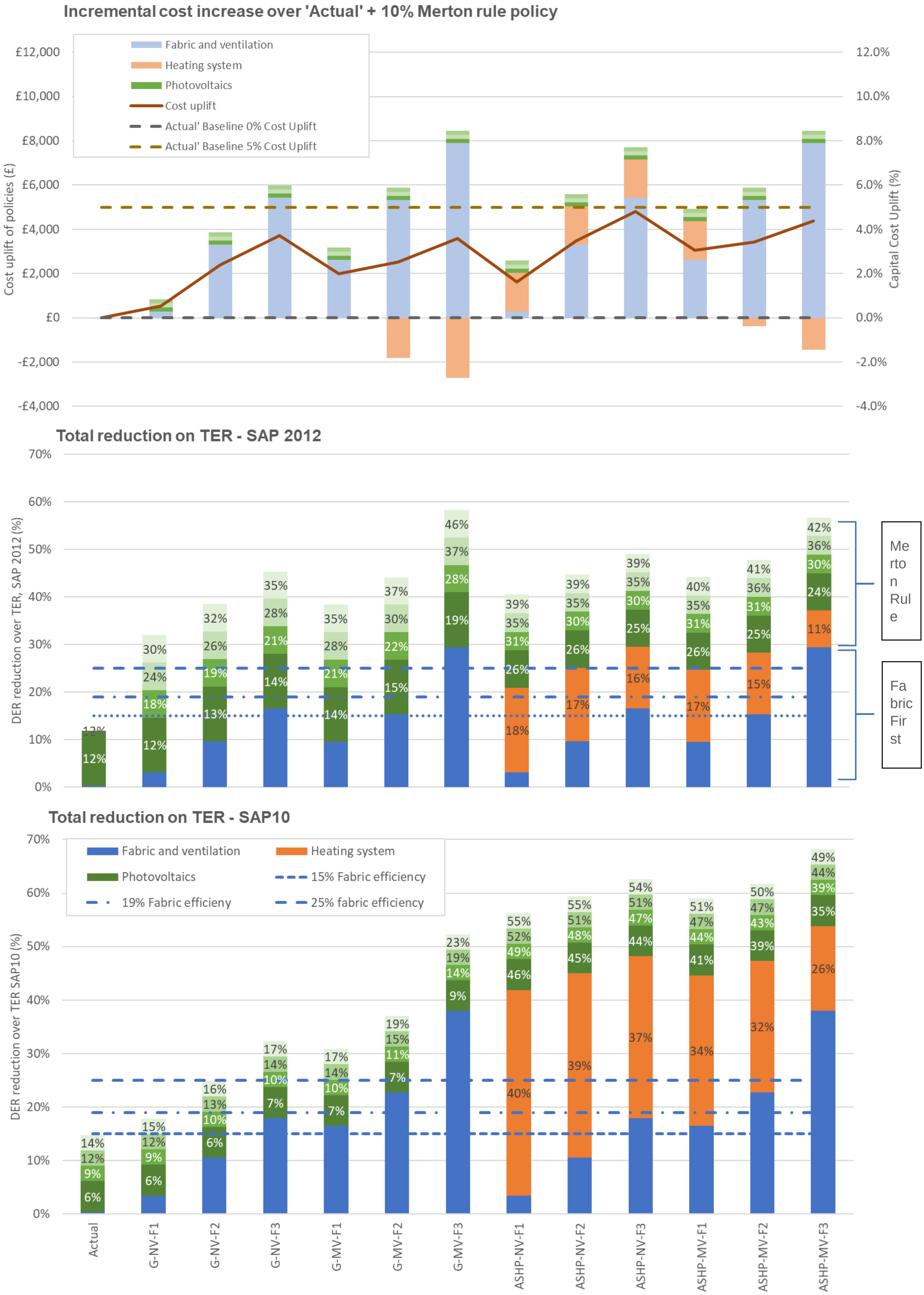

Figure 7 - Detached House Models Cost Uplift and DER/TER performance (SAP2012 and SAP10)

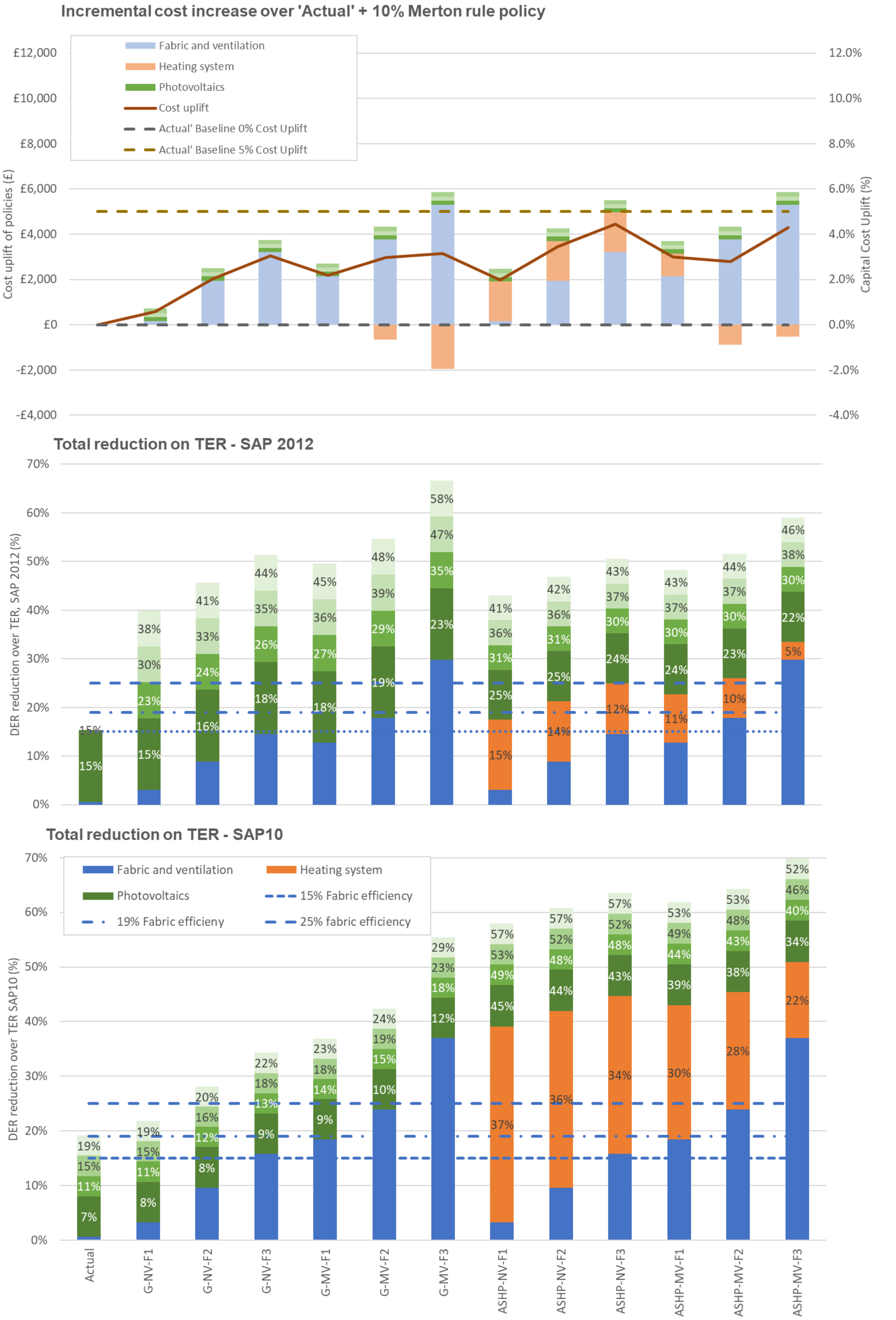

Figure 8- Semi-Detached House Models Cost Uplift and DER/TER performance (SAP2012 and SAP10)

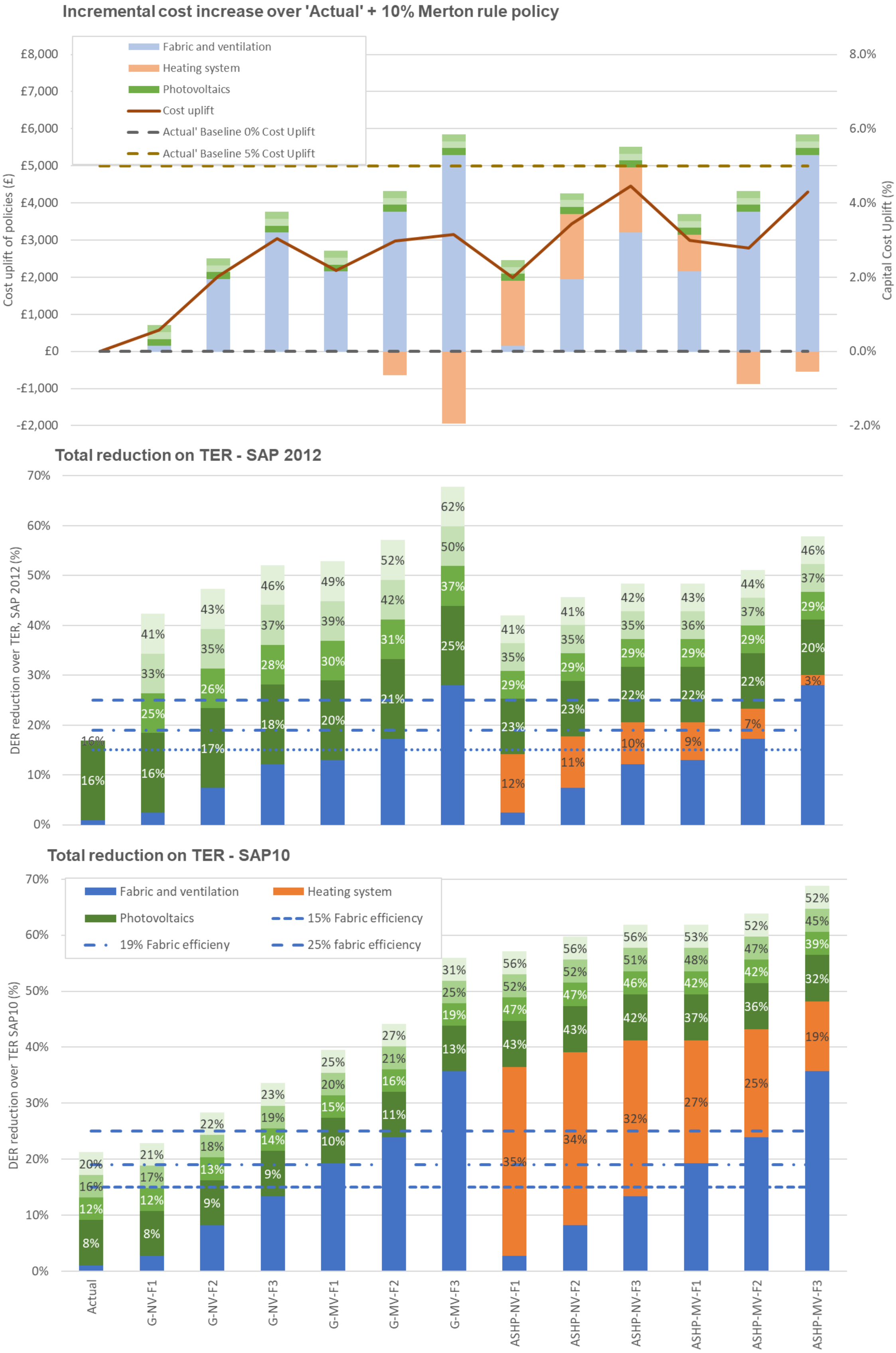

Figure 9 – Mid-Terrace House Models Cost Uplift and DER/TER performance (SAP2012 and SAP10)

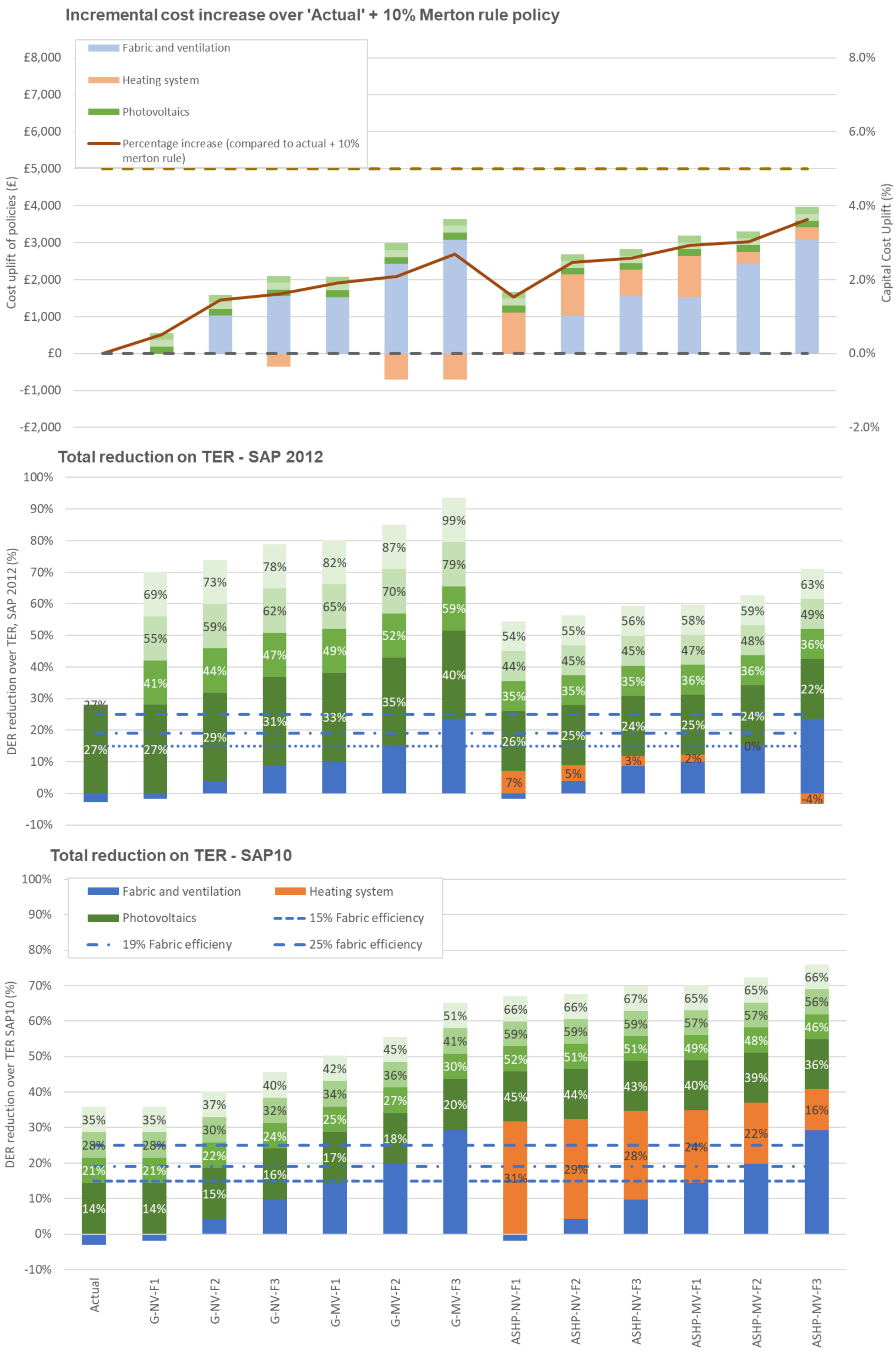

Figure 10 - Small Midfloor Flat Models Cost Uplift and DER/TER performance (SAP2012 and SAP10)

Policy Question 4 – Residential
HQM Discussion
TWBC would like to implement a policy that requires developers to meet design standards such as the Home Quality Mark or BREEAM.

The HQM assessment refers to a holistic approach taken to Sustainability. For reference purposes additional information in terms of the energy and carbon evaluations methods used within the HQM are shown in Table 24.

The cost implications of adopting such an optional standard were not assessed due to the limited evidence base in terms of its application. It is advised that specific requirements within the HQM in terms of energy and carbon performance are reviewed and aligned with TWBC energy and sustainability policies in order to identify potential overlap or conflicts in methodology used.

Table 24 - Home Quality Mark

Home Quality Mark and BREEAM energy and carbon supported information as extracted from relevant guidance
The Home Quality Mark is set up to take a holistic view of the sustainability of residential development. As such it covers a broad range of categories aimed at improving the sustainability and quality of housing, as well as ensuring that key processes and procedures are put in place to support responsible construction practices and address the performance gap. There are a number of minimum requirements and early stage mandatory items which need to be picked up to progress the assessment, however the scheme is designed to allow a high degree of flexibility and a low entry point, with just 18% of the available credits enabling 1.5-star certification and 30% for 3 stars. The 'Energy' category includes the most available points of an individual issue within HQM, accounting for 83 of the available 500 credits (circa 17%). There is no minimum standard at any level of the assessment, however the significant emphasis means that targeting the highest levels of HQM is likely to require good performance within this issue. The Home Energy Performance Ratio is a key aspect of the assessment and adopts a 'triple metric' approach, considering heating and cooling demand, CO_2 emissions and the primary energy demand of a dwelling. In contrast to the current version of SAP, the HQM assessment includes a more specific calculation of hot water usage based on shower flow rates and bath capacities. Whilst highly occupant-specific, the HQM approach to assessing the demand based on the actual fittings takes the place of the standardised assessment within SAP 2012 and should allow a more accurate reflection of the likely hot water usage of a dwelling. Unregulated energy demand for appliances and cooking is also included within the assessment, and therefore the specification of efficient equipment is incentivised - where these will be provided by the developer. A more accurate assessment of lighting is additionally included, with HQM assuming that a reasonable level of internal illumination is provided and requiring the efficacy and lumen output of lighting to be included in the calculation. The approach within HQM (vs Building Regulations) therefore enables a broader view of the overall energy performance of a dwelling, taking into account the majority of energy consumption over which a developer can have control. As the assessment combines the performance against the 'triple metric' into a single overall score, it can however be more difficult to disentangle these to focus on the most cost-effective strategies to achieve a high score. The overall CO_2 emissions for a dwelling based on the

assessment is not separated out from the energy demand and costs, and therefore comparison of credits scored against simple carbon reduction targets for example is not as straightforward as other assessment methodologies.

Likewise, for a homeowner, it may be difficult to assess how much their actions would affect a high-scoring dwelling and whether this score is down to very efficient appliances and water fixtures which will depend on their usage patterns, or a highly thermally efficient building fabric which is less user-sensitive.

The energy assessment within HQM can therefore be used as a useful supplement to the current SAP/Part L approach to assess energy demand and CO2 emissions, and enables a broader view of overall impact. When applied in conjunction with more specific targets governing regulated energy use and CO2 emissions, HQM would enable a more comprehensive assessment of the sustainability of housing to be undertaken.

SECTION 2: NON-DOMESTIC

7. 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.

7.1 Energy efficiency

Recent studies by Buro Happold[34] and AECOM[35] (both supported by Currie & Brown) for the Greater London Authority consider the potential and associated costs associated with 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 considers specifically how energy and carbon savings can be achieved in higher rise and mixed-use developments[36].

Key findings from these studies include:

- The correlation between 'energy efficiency / carbon performance (excluding PV and heat networks) and capital cost is weak[34] or absent[36] 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[35]
- 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[37] . 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.

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

- 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 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 for 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 (LEAN) saving with a little under half achieving a saving of 15% in comparison to Part L 2013[34].

In 2017, the average energy efficiency saving in non-domestic buildings in London was 19.2% beyond the requirements of building regulations[37], 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 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.

7.2 BREEAM rating

Currie & Brown's research with BRE[38,39], 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 BREEAM (the 2011 standard) 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.

he 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.

[37] GLA, 2018. Energy Monitoring Report: Monitoring the implementation of London Plan energy policies in 2017. www.london.gov.uk
[38] BRE, 2014. Delivering Sustainable Buildings: Savings and Payback.
[39] 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 (eg 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.

7.3 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 25 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 25 - 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%

The additional cost of BREEAM Excellent certification may be a further 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.

8. Conclusions and policy considerations

The analysis considered current and predicted domestic and non-domestic buildings 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 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.

The stakeholders survey indicated that while the current threshold was considered as set at the right level, additional improvements would be supported. This should not come at a cost to affordability or have negative knock-on effects.

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 capital cost uplift of almost 5%. The higher – similar to Passivhaus – standards MVHR and low carbon heating (via ASHP) models did meet the 25% fabric 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. In addition, the cost implications to the used in terms of the higher cost of electricity (MVHR, ASHP all electric systems) and potential maintenance costs.

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 even 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 in any event 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 and in London the average level of energy efficiency saving achieved in 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 - 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

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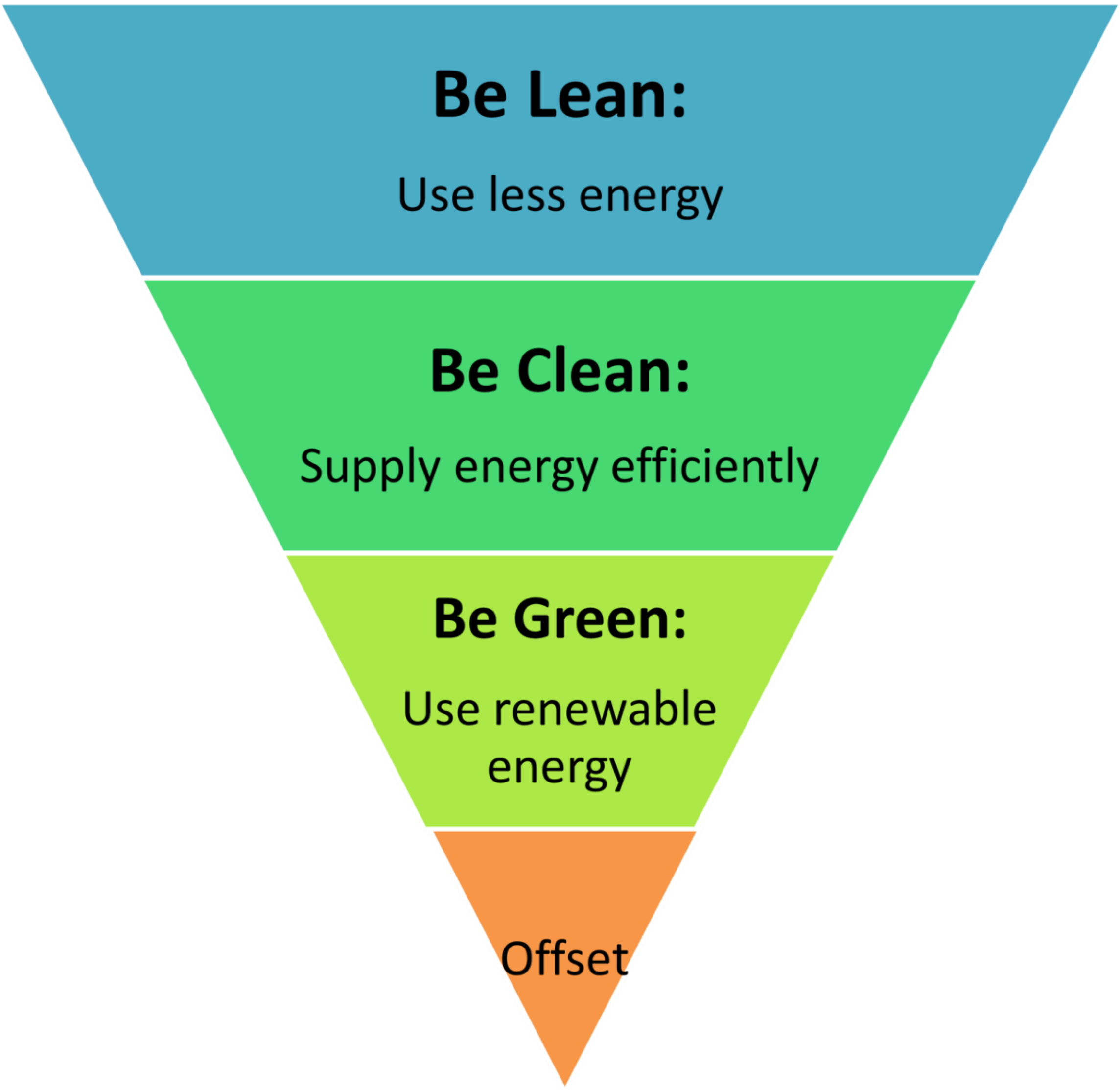
Appendix 2: Energy Hierarchy



It is noted that the London Plan 2021 adds a further element to the energy hierarchy known as ‘Be Seen’, covering all stages of the hierarchy and intended to help address the performance gap between design and operation through rigorous monitoring.

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Appendix 3: Proposed new wording for Policy EN3

Policy EN 3

Climate Change Mitigation and Adaptation

Subject to all other material considerations, proposals for zero carbon and low emission development, as well as development that allows communities, infrastructure, businesses, and the natural environment to adapt to the impacts of climate change, will be strongly supported.

Energy reduction in new buildings

Proposals for the construction of new buildings are required to incorporate design features that help deliver radical reductions in greenhouse gas emissions, particularly CO_2 emissions, and thus help mitigate climate change impacts. This will be achieved ~~using the measures set out below~~, unless superseded by national policy or legislation, by applying a 'Fabric first' approach***** in which all development comprising the construction of new buildings is required to reduce operational CO_2 emissions by at least ~~10%~~ 5% below the Target Emission Rate (TER) as set out in Building Regulations Part L (~~2013~~2021)

~~Requirement for major development comprising the construction of new buildings to reduce operational CO_2 emissions by 15% using renewable energy-generating technology to be installed on site. The 15% reduction will be calculated only after the 'fabric first' approach has been applied.~~

[*The 'fabric first' approach should be based upon a consideration of U-values, thermal bridging, air permeability, and thermal mass, and also features that affect lighting and solar gains, such as building orientation and layout.]

~~Renewable energy-generating technology includes photovoltaics, solar hot water, air/ground source heat pumps, wind turbines, hydropower, and biomass boilers*. Low carbon technology presented as an alternative to renewable energy-generating technology, such as Combined Heat and Power (CHP), will be considered on a case-by-case basis, as will emerging new technology. The choice of technology to be installed will have consideration for~~

~~site constraints such as shading, local air quality, and sensitive features such as the landscape and historic environment.~~

In addition to the above policy requirement, developers are strongly encouraged to be proactive ahead of the introduction of the forthcoming ‘Future Homes Standard’ and seek an overall carbon reduction target of 35% more than that set out in Building Regulations Part L (2021) or a simliar consumption target.

~~* using locally sourced fuel and outside of urban areas only. See Policy EN 23: Biomass Technology.~~

Climate change adaptation

[*No change to policy wording proposed*]