Report for Essex Climate Action Commission

NET ZERO CARBON VIABILITY AND TOOLKIT STUDY

Report of findings August 2022

Three Dragons
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Use of this report	This report discusses the findings from the research undertaken to meet Essex Climate Action Commission's project objectives. It includes a high-level assessment of the viability of different development types. No responsibility whatsoever is accepted to any third party who may seek to rely on the content of the report unless previously agreed.

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EXECUTIVE SUMMARY

Study objectives and research undertaken

1. In May 2019, Parliament declared a climate emergency in the UK. This followed the Climate Change Act 2008 which requires the UK to achieve net zero carbon emissions by 2050. In response, the Essex Climate Action Commission (ECAC) has been established, to provide expert advice and up-to-date recommendations to move Essex to net zero by 2050.

2. In its 2021 report, Net zero: Making Essex Carbon Neutral[1], the Commission put forward a number of recommendations for all new buildings, including that:

   - New schools commissioned to be net zero carbon by 2022 and carbon positive by 2030;
   - New homes and all new commercial buildings granted planning permissions to be net zero carbon by 2025 and carbon positive by 2030;
   - The Essex employment, training, skills, procurement and business operations should be reviewed to support delivery of the ambitions of the ECAC;

3. ECAC subsequently commissioned a net zero Carbon Viability and Toolkit Study as reported here. The core aim of the study is to assess the cost and viability of achieving net zero carbon development; with options for doing so identified and evaluated against a series of economic, social, and environmental criteria, including the capital costs for developers. Building on this, the research has considered how best to support local authority planners in seeking higher environmental standards that will help to meet net zero targets.

4. The research undertaken for the study included a literature review and interviews with local authority planning officers and representatives of the local development industry and a high-level review of the impact on scheme viability of different carbon reduction targets.

Definitions of net zero

5. While there is no single agreed UK definition of net zero, the established principles are that emissions of greenhouse gases for a period are balanced by the amount of that gas that is removed.

6. For new homes, it is important to consider i) embodied carbon - used in the building's product and construction stages ii) operational carbon – carbon emissions associated with the building's operational energy and include regulated and unregulated energy and iii) whole life carbon - the carbon emissions associated with the construction, use and disposal of a building. This study was asked to focus on (regulated) operational carbon but also makes comment on the other carbon types.

[1] See https://www.essexclimate.org.uk/sites/default/files/DS21_7178%20ECAC_Commission_Report-Final.pdf

Government targets for net zero

7. The Building Regulations (Part L and Part F) were updated in December 2021 (coming into force in June 2022) with new standards intended to deliver a 31% saving in carbon emissions in new residential development against the 2013 Building Regulations – applying to regulated operational carbon only. From 2025, the Building Regulations set out that 'fossil-fuel heating systems' in any domestic new build properties are not permitted.

8. Government requirements are also changing. In its Future Homes Standard publication, the government sets out its intention that in 2025 there is a further reduction in CO_2 emissions (75% in total). Thereafter, government is relying on grid decarbonisation to achieve net zero operational carbon in all new homes by 2050. At the time of writing further, information is awaited about the measures that will be put in place to achieve the 2025 standard.

Local authority powers

9. The government has confirmed that local authorities retain the power, under the Planning and Energy Act 2008, to set local energy efficiency standards for new homes in their area. To confirm the position and provide confidence to local authorities to set strong net zero policies, one of the recommendations made in this report is for the local planning authorities to seek legal advice on this matter.

Essex policy approach and development industry charter

10. ECAC has set out its objectives for achieving net zero carbon in Essex as illustrated below:

11. The ECAC targets mirror those of the UK government but seek to achieve net zero at a much faster pace with all new buildings net zero carbon in 2025 - some 25 years earlier than the national target. In support of the ECAC targets, the Essex Developers Group (EDG) has signed up to a Developers Climate Action Charter. The Charter has been adopted by the EDG as well as Homes England, the South East Local Enterprise Partnership and the Essex Planning Officers Association (representing the 15 councils of Essex). The Charter restates the ECAC targets and, while it is acknowledged that the Charter cannot legally bind its signatories, it is an important statement of intent between the development industry and local planning authorities.

12. Planning policies effective in Essex (in the councils' local plans) have a variety of adoption dates – including four local plans adopted before 2012. As would be expected, newer plans are more likely

to have a stronger focus on policies that address climate change. In general they offer broad guidance and/or are supportive of measures to reduce carbon emissions. The importance of keeping policies up to date, in a fast-moving policy agenda, was apparent through the interviews undertaken for this research.

13. While neither Building Regulations nor other government guidance include targets for space heating demand and/or total energy use in buildings, emerging in local plans prepared elsewhere are policies that set such standards expressing these in terms of the total energy usage, referencing a metric such as kWh/m^2/year. These measures are being promoted to deliver a more accurate measure of operational net zero as they cover both regulated and unregulated energy use. At the same time, they more directly measure consumer costs, maintaining comfort levels for residents. These alternative approaches and are currently being tested at planning examination.

14. There is a considerable weight of guidance available both for the development industry and for planning authorities. These resources are generally freely available and it is likely that there will be further guides produced as more examples are built out and information becomes available. Given the wealth of general guidance already available, there is not a clear case for developing general guidance specifically for Essex.

Development industry perspectives

15. There are changing attitudes in the development industry to the energy performance of buildings with support for higher standards. Although there is said to be pressure from consumers for higher energy standards in new residential development this has not readily translated into higher market values with consumers expecting that new housing will be achieving higher standards as a matter of course. However, with the current significant increases in energy costs, consumer demand for lower energy housing seems to have the potential to lead to increased demand for increasingly energy efficient housing.

16. The development industry representatives interviewed also stressed the importance of having common standards across Essex (and beyond) and raised concerns about skills and capacity issues, in the short term at least.

Fabric first approach

17. A key principle of a low energy building is the efficiency of the thermal envelope i.e. the separation between the internal and external elements of a building. Improving the efficiency of the thermal envelope minimises heat losses through the fabric (step 1) before meeting the remaining energy demand through energy efficient systems (step 2) and renewables (step 3).

18. The epitome of a fabric first approach is Passivhaus - developed in Germany over 30 years ago, as a comfort and building performance standard using five design principles:

- High levels of thermal insulation;
- High performance windows;
- Mechanical ventilation that recovers heat;
- High levels of airtightness;

- Thermal bridge free design.

19. Passivhaus has three recognised levels of performance:

    - Passivhaus Classic –the essential high efficiency energy requirements that apply to the overall fabric, comfort and quality standards; its usage of regulated and unregulated energy must not exceed 15kwh/m2/year;
    - Passivhaus Plus – adds renewable energy such as photovoltaics to meet the normal regulated and unregulated energy demands required for the operational needs of the building;
    - Passivhaus Premium – where renewable generation exceeds the regulated and unregulated energy demands of the building.

Performance of options for carbon reduction

20. Five different approaches to reducing carbon emissions in new development were modelled including the move away from fossil fuels to assess their performance and the impact on occupiers – the modelling used a series of dwelling archetypes including apartments, terrace and detached housing. The options modelled were:

    - **Base Case: 2013** Part L Building Regulations;
    - **2021 Part L** Building Regulations - in place from June 2022;
    - **2025 Future Homes Standard** (using a best estimate of the likely standard);
    - "net zero Ready" standard based on the **Passivhaus Classic (this is the PH Classic but as it is generic rather than location specific we can only say it is based on the PH standard)**;
    - "net zero Carbon" Standard which closely aligns with the **Passivhaus Plus** standard. The net zero carbon standard was closely aligned with the requirements of the Passivhaus Classic standard but the local specific factors of climate, orientation etc have their part to play to make a building wholly conform with the PH standard. The Passivhaus standard takes into account both regulated and unregulated energy demands.

21. The modelling found that a fabric first approach, using a 'classic' Passivhaus will usually deliver housing at net zero. With the addition of photovoltaics, at an equivalent level to the Future Homes standard, new housing can become carbon positive. The Future Homes Standard has a formula for calculating how much PV is required to satisfy Building Regulations as enshrined in the current Building Regulations. The formula differs depending on whether a house or a flat. For example in the case of a house the PV renewable energy requirement measured in kWp (kilowatt peak) is 40% of the ground floor area, including unheated spaces, divided by 6.5.

22. Levels of comfort for occupiers increases and space heating demand reduces as the higher standards are introduced. However, it is only with a fabric first, Passivhaus, approach that there is a significant reduction in space heating demand (and consequently in household costs, with positive benefits for comfort and health.)

23. Other options for reducing carbon emissions such as heat networks and carbon off-setting can also have a role in reducing carbon emissions in new developments. Carbon offsetting should only be

considered as an option in exceptional circumstances when all other ways of delivering have been exhausted.

Impact on development viability

24. Using best available estimates of costs and values, three different standards of development were assessed to identify their impact on the viability of a series of 10 development typologies, ranging from 1 dwelling through to a strategic site of 5,000 new homes. The development typologies were tested in four notional value areas representing different housing market prices across Essex.

25. The three standards tested were:

- Building Regulations 2021;
- The government's 2025 Future Homes standard;
- ECAC's target for buildings to be net zero carbon by 2025.

26. With the majority of residential development. there is sufficient viability headroom to absorb the costs of net zero carbon. Moving from meeting the potential Future Homes Standard 2025, as set out in the government consultation documents, to net zero carbon, the additional costs average about £2,500 per unit for houses and £3,000 for flats.

27. Viability is weaker in the lower value area(s) and for a very limited number of development types. Where the costs of meeting net zero carbon mean that residential development becomes unviable, there may need to be an adjustment to land values and/or a balance of policy considerations, unless other measures can be taken to improve viability.

28. The costs of moving to net zero carbon for different types of non-residential uses (schools, offices and warehouse and industrial space were considered) vary significantly between schemes. The very high-level estimates identified for this report showed an additional 8%-12% costs for schools and 17%-20% for offices for achieving net zero carbon over current standards. However, these capital costs may be mitigated by significant operational cost savings. In any case, much non-residential development will be undertaken on a design and build basis, with the key determinants of whether schemes proceed related to the commercial (or educational) benefits to the occupiers.

Options evaluation

29. The final stage of the study addresses the core study requirement of evaluating the options identified to achieve net zero, against a series of economic, social, and environmental criteria.

30. The analysis showed that following Building Regulations alone (including Future Homes in due course) will make slow progress in reducing carbon. Although Future Homes will provide significant carbon reductions and some fuel poverty benefits, it does not address embodied carbon and unregulated operational energy and there are potentially sizeable impacts on the electricity grid capacity.

31. Unregulated energy use and the resultant carbon is not dealt with effectively by any of the Building Regulations and Future Homes housing development standards reviewed here. While the government standards are moving towards net zero in terms of regulated energy use only, it is

when the specifications and standards are tightened, as in the Passivhaus Classic with PV, that the government's CO_2 emissions targets are capable of confidently being achieved.

Conclusions and recommendations

32. It is recognised that tackling the climate emergency is a very fast paced agenda. The study, though, has reached the clear conclusion that a 'fabric first' approach should be the preferred method of achieving net zero and that we would strongly recommend that the Passivhaus Classic with photovoltaics (at 2021 Building Regulations levels which are based on a simple formula calculation related to floor areas and building type) is put forward as the standard to be adopted. This approach requires a series of performance indicators that will help achieve net zero and provide cost savings and comfort for occupiers. It will also require acceptance at any planning examination of the policy (typically in a local plan or equivalent).

33. Building on the above, the study has gone on to make a series of 15 recommendations

- **Recommendation 1**: Recognising that issues around energy use and carbon emissions is a fast changing area of policy development, it is critical that ECAC and the Essex planning authorities, keep under review approaches emerging elsewhere, particularly those backed at public examination.
- **Recommendation 2:** Within the context of the above recommendation, and as far as is practicable, the objectives for new development in Essex expressed through planning policy, should adopt the following performance indicators for both residential and non residential developments.

Building Type	Space Heating/Cooling Demand in kWh/m^2_{GIA}/year	Total Energy Consumption in kWh/m^2_{GIA}/year	Solar Electricity Generation in kWh/m^2_{GIA}/year
Residential	<15	<35	>35 on site for small scale; 70% of roof area for medium to large scale resi.
Schools	<15 - 20	<65	Exceeds metered energy use on site
Hotels	<30	<55	>120
Offices	<15	<55	>120
Light Industrial	<15 - 30	<55	>180

- **Recommendation 3:** A fabric first approach, that meets Passivhaus standards, should be the priority.
- **Recommendation 4**: Off-setting carbon reductions should be seen as the last resort and only allowed in exceptional circumstances. ECAC should review and provide further guidance on the types of circumstance in which off-setting might be considered acceptable.

- **Recommendation 5**: The use of PHPP software to account for unregulated energy and for transparency of targets is recommended. The key outputs to be demonstrated by the use of the PHPP software are:

Space Heating/Cooling Demand in $kWh/m^2_{GIA}/year$	Total Energy Consumption in $kWh/m^2_{GIA}/year$	Solar Electricity Generation in $kWh/m^2_{GIA}/year$

- **Recommendation 6**: The assessment of embodied carbon reductions and targets is evolving and its understanding is developing. Consequently, it is recommended that embodied carbon reduction targets are explored by ECAC and practical methodologies assessed - with industry involvement.
- **Recommendation 7:** A web based publication is produced by ECAC that provides information about specific aspects of planning for net zero – including available options and associated costs and occupier benefits. The publication will need strictly to be kept up to date.
- **Recommendation 8**: ECAC organises a 'planning policy summit' for the local planning authorities, with lead policy officers and their political portfolio holders invited. The summit would provide information about the policy options open to LPAs.
- **Recommendation 9**: ECAC (facilitated by ECC) organises and pump primes the funding of a pan-Essex group of expert advisers who can, on a call down basis, assist local authorities (officers and members) and developers in assessing planning applications.
- **Recommendation 10**: As already identified by ECAC, ECC and the district/unitary authorities should work together to put in place a monitoring process to ensure buildings meet the necessary standards and the potential 'performance gap' is tackled.
- **Recommendation 11**: Local plan policies will require back-up to describe, for the development industry and the wider public, how policies to reduce carbon emissions in new development are to be achieved and what is required. This can best be achieved through an Energy and Carbon Reduction SPD or alternatively, as an additional section to the existing Essex Design Guide already in place. ECAC should lead on the production of the SPD or equivalent.
- **Recommendation 12:** ECAC seeks a legal opinion on the role of local plans in setting standards beyond Building Regulations. This advice is then shared with the local planning authorities.
- **Recommendation 13**: As already recognised, the development industry workforce will require adapted and widened skills and enhanced delivery of factory produced products. ECAC should take these forward to ensure implementation of the ECAC Report Green Skills in Essex and to commission the necessary research to identify the best means of accelerated delivery of factory produced products.
- **Recommendation 14**: ECC and other public sector land owners across Essex should play a direct role in supporting development to the higher standards set out in this report. Interventions can include:
    - in their capacity as estate and asset owner by adopting the standards set out in this report;

- undertaking energy reviews when disposing assets and implementing retrofit measures;

ECAC to seek to encourage all partner and public anchor organisations to do the same.

- **Recommendation 15:** A monitoring and reporting regime needs to be identified and put in place and it is recommended that ECAC commissions a feasibility study that examines how this can best be achieved and how it would be funded.

Chapter 1 Study objectives and context

The Climate Emergency and the Essex Response

1.1 In May 2019, Parliament declared a climate emergency in the UK. This followed the Climate Change Act 2008 (as amended in 2019) which requires the UK to achieve net zero carbon emissions by 2050 – that is at least 100% lower than the 1990 baseline. Net zero carbon is referred to as 'zero carbon' across this report.

1.2 As a step in meeting this target, the 2021 Building Regulations (that came into force in June of this year) are intended to reduce carbon emissions in newbuild development by 31%. This reduction applies to operational carbon emissions from regulated energy use only. Emissions from embodied carbon and unregulated energy use are not covered in the Building Regulations. These are discussed later in the report but, in short, embodied carbon refers to emissions emitted producing a building's materials, their transport and installation on site as well as their disposal at end of life while unregulated carbon relates to the energy used by occupants in their day to day lives - for example, in cooking and use of appliances.

1.3 In response to the climate emergency, the Essex Climate Action Commission (ECAC) has been established. ECAC is an independent, voluntary and cross-party body, whose aim is to promote and guide climate action in the county. The Commission is to provide expert advice and up-to-date recommendations to move Essex to net zero by 2050.

1.4 In its 2021 report, Net zero: Making Essex Carbon Neutral[2], the Commission put forward a number of recommendations for all new buildings. Those of most direct relevance to this study are, in summary, that:

- All new schools commissioned to be net zero carbon by 2022 and carbon positive by 2030;
- All new homes and all new commercial buildings granted planning permissions to be net zero carbon by 2025;
- All new homes and non-domestic buildings granted planning permission to be carbon positive by 2030;
- Support local planning officers, by providing training and building expertise;
- Review of the Essex employment, training, skills, procurement, and business operations to deliver the ambitions of the ECAC and partners in relation to innovative and green construction for a carbon neutral or net zero future;
- Essex should bring forward net zero developments urgently to showcase these new approaches, with a major scheme under construction by 2023;

[2] See https://www.essexclimate.org.uk/sites/default/files/DS21_7178%20ECAC_Commission_Report-Final.pdf

- The Essex Developers Group should establish a Climate Change Charter and 'demonstrator' projects.

Research objectives

1.5 The core aim of the research reported here, is to assess the cost and viability of achieving net zero carbon development across a range of building types. Options for achieving net zero carbon development have been identified and evaluated against a series of economic, social, and environmental criteria, including the capital costs for developers. Building on this, the research has considered how best to support local authority planners to enable them to require higher environmental standards that will help to meet net zero targets.

1.6 It was intended that this study should lead to a toolkit to support the work of planners, but the study specification clarified that its details and implementation will be the subject of a separate commission. The relevance of this to the study recommendations is picked up in the study conclusions.

1.7 The remainder of the report is structured around the following key themes:

- Chapter 2 – is a review of the research undertaken to meet the study objectives;
- Chapter 3 – explores the alternative ways that net zero is defined, including operational, embodied and unregulated energy. The chapter sets out a working definitions(s) that underpins the remainder of the report;
- Chapter 4 – sets out the national legislation and policy context of net zero;
- Chapter 5 - reviews the role of the Essex Climate Action Commission (ECAC) and the implications of its work for spatial planning;
- Chapter 6 – assesses the approaches being taken by the district councils within Essex and the two unitary authorities of Southend on Sea Borough Council and Thurrock Council;
- Chapter 7 – complements chapter 6 with a commentary on the views of the development industry currently active in Essex – in delivering market and affordable housing;
- Chapter 8 – reviews the guidance already available for achieving net zero development and comments on the benefits of producing further guidance;
- Chapter 9 - sets out different options for achieving net zero for a series of residential and non residential development typologies and estimates their relative development costs;
- Chapter 10 – assesses the impact on development viability of the different options in achieving net zero;
- Chapter 11 – brings together the findings of the previous chapters to evaluate the different options against a series of criteria defined through the earlier work;
- Chapter 12 – provides a synopsis of the main study conclusions and makes recommendations to Essex Climate Action Commission about how it can build on this study

to strengthen the delivery of net zero development across Essex, providing evidence for policy and development management planners and for developers.

1.8 At the end of the report there is a glossary. There is also a separate Technical Report that sets out the information drawn on for the study, including a review of literature sources that are referenced.

Chapter 2 Research undertaken

Background knowledge

2.1 The study team has drawn on its background knowledge of the climate change agenda and approaches to reducing operational, embodied and unregulated carbon in new development. Qoda contributes to the team specialist knowledge of options available for reducing carbon in developments including Passivhaus and other fabric first approaches, while Ward Williams and Associates has been able to draw on a growing evidence base of real-world costs associated with different scheme types and development situations. The team, as a whole, has also contributed experience of the approach to reducing carbon emissions in other of the UK jurisdictions.

Literature review

2.2 An important element of the research undertaken for the study has been a review of the published literature. The library of literature is wide-ranging and we have necessarily been selective in the documents included in the review. The table in Appendix 1of the Technical Report sets out the key documents and their focus. There are other publications we have drawn on for specific elements of our report e.g. Planning Practice Guidance for guidance on the viability testing we have undertaken. These are referenced in the relevant chapters.

2.3 The key points from the literature review are that:

- Much of the literature referenced has been published in the last two years. Understanding is evolving about both the impact of climate change and what can be done to tackle it. Action plans and other interventions that ECAC and the Essex local authorities can undertake therefore will need to be flexible and carefully monitored so that new issues and activities can be quickly responded to and incorporated into future plans;
- The recently published Intergovernmental Panel on Climate Change (IPCC) report[3] makes for sombre reading and argues that climate change has already caused substantial damage and that some impacts are now irreversible, including impacts on human health and food production. The report concludes that, "*Near-term actions that limit global warming to close to 1.5°C would substantially reduce projected losses and damages related to climate change in human systems and ecosystems compared to higher warming levels, but cannot eliminate them all*"

  and that,

[3] https://www.ipcc.ch/report/ar6/wg2/

"*Climate change impacts and risks are becoming increasingly complex and more difficult to manage.*"

The clear implication of the IPCC report is that the importance of tackling climate change at (inter)national and local level is greater than previously anticipated;

- Reducing carbon emissions should not be at the expense of fuel poverty and improvements to building standards need to tackle both e.g. see the Essex Climate Action Commission (ECAC) report, "net zero: Making Essex Carbon Neutral"[4];
- The government has set out national targets (in The Future Homes Standard Consultation from 2019) for reducing carbon with new build homes having low carbon heating and increased levels of energy efficiency. The government has committed to introducing the Future Homes Standard in 2025 with the expectation that an average home built to it will have 75-80% less carbon emissions than one built to 'current' standards (Building Regulations 2013). The expectation is that this will be achieved through very high fabric standards and a low carbon heating system. By 2050 the target is to reduce greenhouse gas emissions across the economy to reach net zero. This is to be achieved through a combination of the Future Homes Standard operational by 2025 and subsequent decarbonisation of the national electricity grid through to 2050;
- ECAC has set targets ahead of those identified by the government. One of the recommendations of the commission was to vastly improve the energy efficiency of new homes, making them net zero by 2025 and carbon positive by 2030. This is something on which ECAC can lead the way, through pilot projects as a result of its ownership of Essex Housing Development LLP (e.g. at Hargrave House in Chelmsford which is to be net zero in construction and net zero in use). We understand that the Council is also setting up a new climate action planning team. This is to provide specialist expertise and work with and support the district councils to bring forward climate change planning policies and support planning officers with planning applications and planning appeals that relate to climate change..

[4] [4] See https://www.essexclimate.org.uk/sites/default/files/DS21_7178%20ECAC_Commission_Report-Final.pdf

Local authority consultation

2.4 All 12 Essex district, borough and city councils and the two unitary councils of Thurrock and Southend on Sea were invited to be interviewed and to contribute to the study. 11 agreed to take part. The interviews were undertaken by a member of the consultant team, usually with one or two officers from the authority's planning department. Interviews were conducted by phone or video conference and were typically 30 – 45 minutes long.

2.5 Prior to each interview, interviewers undertook a web based search of current and emerging planning policies for that authority (including the three authorities that did not take up the option of being interviewed). The interviews themselves were guided by a discussion agenda (see the Technical Report) and were undertaken on a confidential basis and results only shared within the research team, with an overview brought together for this report.

2.6 Topics covered in the interviews were:

- Confirmation of relevant planning policies and progress, where relevant, of newly emerging policies;
- The authority's approach to achieving net zero carbon emissions and relative importance attached to this against other objectives of the authority;
- Awareness and use made of the ECAC's work and reports;
- Awareness and use made of various guidance documents including the Essex Design Guide;
- Perceived approaches of the development industry in their area;
- Potential usefulness of an Essex toolkit (and what this could contain);
- Any local initiatives and pilot projects that offered useful learning for the research.

Development industry consultation

2.7 It has been important for this study to understand the views of the development industry active in Essex – including both businesses providing market and those providing affordable housing (or both). Views were sought in two ways.

2.8 The **first** was a workshop held on 20 January 2022. Excluding Essex County Council, 14 organisations were invited and 12 attended. Attendees were from across the development industry and included national, regional and local housebuilders and Registered Providers (RPs) of affordable housing. Following the workshop, a note of the workshop was circulated for any comment – none was received. See the Technical Report for a copy of the workshop note as circulated.

2.9 The workshop covered the following topics:

- Background to the work of the ECAC and the purpose and scope of this study;

- A review of progress towards net zero development by the development industry as a whole;
- Powers of local authorities to plan for decarbonisation standards beyond Building Regulations;
- Government and ECAC targets compared;
- Performance of different standards (including the 2021 Building Regulations, Future Homes and Passivhaus) against a series of criteria e.g. fuel poverty, carbon emissions, embodied carbon);
- Progress towards zero carbon development of the development industry – what actions companies are taking, key issues raised and examples of good practice/pilot projects being pursued;
- A description of the high-level viability testing to be undertaken and the opportunity for attendees to comment on the draft assumptions proposed by Three Dragons. The note included further details of the assumptions to be used in the viability testing;
- A review of guidance from elsewhere on delivering development at a reduced level of carbon.

2.10 The **second** was a series of depth interviews (held in late January and throughout February) with a selection of developers and other stakeholders who either the County Council and/or the research team thought could provide further knowledge about reducing carbon emissions in new development and/or were involved in specific exemplar projects. 17 organisations were initially contacted by the County Council. The research team followed up this initial contact and secured eight interviews and a joint meeting with one further developer (nine in total). Those interviewed included five housebuilders, two developing RPs, a contractor for residential and non-residential schemes, and an arms-length local authority housing delivery company. Again, interviews were conducted on a confidential basis, by video conference and following a discussion agenda. The discussion agenda is set out in the Technical Report. Interviews lasted between 20 minutes and an hour.

2.11 The topics covered were:

- Background to the organisation – types of scheme involved with and area of operation;
- Progress towards achieving government targets and net zero carbon development;
- Issues involved in this and implications for costs and values in new developments;
- Any implications for skill requirements.

Testing scheme viability

2.12 Achieving different standards of carbon reduction in new development can potentially have an impact on both the costs and values of development and therefore on the viability, and hence deliverability, of new housing. The scale of the impact has been explored across different strands of the research undertaken. With this information, and drawing on published viability

studies from across Essex, the team has undertaken a programme of high-level viability testing for alternative carbon reduction targets.

Chapter 3 Definitions of net zero

Internationally recognised definitions

3.1 To tackle climate change and its negative impacts, world leaders at the United Nations Climate Change Conference (COP21) in Paris reached a breakthrough on 12th December 2015.[5]The Paris Agreement is a legally binding international treaty between 193 parties. The Agreement underlines the need for net zero carbon, *requiring* states to 'achieve a balance between anthropogenic[6] emissions by sources and removals by sinks of greenhouse gases.[7] Sinks in this context refers to the idea of absorbing emissions in forests and tree planting schemes for example or using carbon capture technologies. Other removals might be through renewables or low carbon technologies.

3.2 The UN describes the Paris Agreement in the following terms:[8]

[5] The Paris Agreement | United Nations
[6] Anthropogenic definition: (chiefly in relation to pollution or environmental change)'originating in human activity'.
[7] https://netzeroclimate.org/what-is-net zero/
[8] https://www.un.org/en/climatechange/paris-agreement

Figure 3.1 UN description of the Paris Agreement

The Agreement sets long-term goals to guide all nations:

- substantially reduce global greenhouse gas emissions to limit the global temperature increase in this century to 2 degrees Celsius while pursuing efforts to limit the increase even further to 1.5 degrees;
- review countries' commitments every five years;
- provide financing to developing countries to mitigate climate change, strengthen resilience and enhance abilities to adapt to climate impacts.

The Agreement is a legally binding international treaty. It entered into force on 4 November 2016. Today, 193 Parties (192 countries plus the European Union) have joined the Paris Agreement.

The Agreement includes commitments from all countries to reduce their emissions and work together to adapt to the impacts of climate change, and calls on countries to strengthen their commitments over time. The Agreement provides a pathway for developed nations to assist developing nations in their climate mitigation and adaptation efforts while creating a framework for the transparent monitoring and reporting of countries' climate goals.

The Paris Agreement provides a durable framework guiding the global effort for decades to come. It marks the beginning of a shift towards a net-zero emissions world. Implementation of the Agreement is also essential for the achievement of the Sustainable Development Goals.

3.3 The IPCC uses a definition almost identical to that used by the UN i.e. **"***Net zero carbon dioxide (CO2) emissions are achieved when anthropogenic CO2 emissions are balanced globally by anthropogenic CO2 removals over a specified period.*" [9]

UK Statutory definitions

3.4 There is no single agreed UK statutory definition of net zero. The Climate Change Act 2008 (section 29) refers to UK emissions and removals in relation to a greenhouse gas. "*Net UK emissions" means the amount of UK emissions of that gas for a period, less the amount of that gas that is removed. i.e. "from the atmosphere due to land-use, land-use change or forestry activities in the United Kingdom.*" This approach can be open to wide interpretation to allow for innovative as well as practical solutions.

3.5 The closest there is to a government approved definition is from The Office for National Statistics (ONS) which defines Net Zero as follows[10]: "*Net zero means that the UK's total greenhouse gas (GHG) emissions would be equal to or less than the emissions the UK removed*

[9] The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change. Their 2022 report, Climate Change 2022, Impacts, Adaptations and Vulnerability, can be found at https://www.ipcc.ch/report/ar6/wg2/

[10] https://www.ons.gov.uk/economy/environmentalaccounts/articles/netzeroandthedifferentofficialmeasuresoftheuksgreenhousegasemissions/2019-07-24

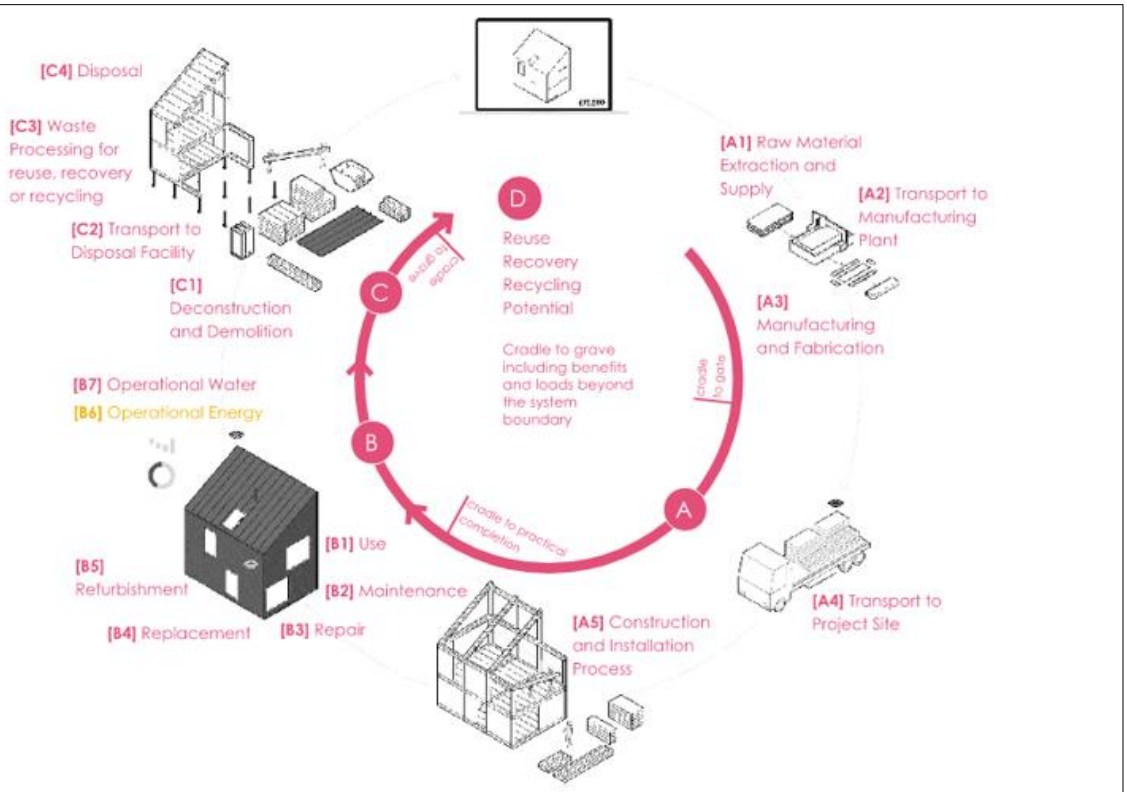
from the environment". This is on a territorial basis as covered by the UK's current reporting obligations under the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

Other definitions of net zero carbon used in the UK

3.6 The UK Green Building Council (UKGBC) has published a document entitled 'net zero Carbon Buildings: A Framework Definition'[11] which is an attempt at developing consistent approaches for the measurement, reporting and mitigation of in-use energy performance and whole-life carbon emissions. The framework, born from industry consensus, will initially act as guidance and a way to demonstrate how net zero can be achieved for a building. The UKGBC refers to 3 possible definitions to describe the scope of net zero: these perspectives are illustrated in the Life Cycle Assessment Diagram below[12]:

[11] Net-Zero-Carbon-Buildings-A-framework-definition.pdf (ukgbc.org)
[12] The LETI Climate Emergency Design Guide page 57.

Figure 3.2 Building life Cycle Assessment



net zero Carbon – Construction – Stage A in illustration – "Upfront Carbon"

"When the amount of carbon emissions associated with a building's product and construction stages up to practical completion is zero or negative , through the use of offsets or the net export of on-site renewable energy."

net zero Carbon – Operational Energy – Stage B in illustration – "Operational Carbon"

"When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset."

net zero Carbon – Whole Life – Stages A to D in illustration – "Circular Economy Carbon"

"When the amount of carbon emissions associated with a building's embodied and operational impacts over the life of the building, including its disposal, are zero or negative." An aspect of the scope is to consider the masterplan development in this context to ensure carbon

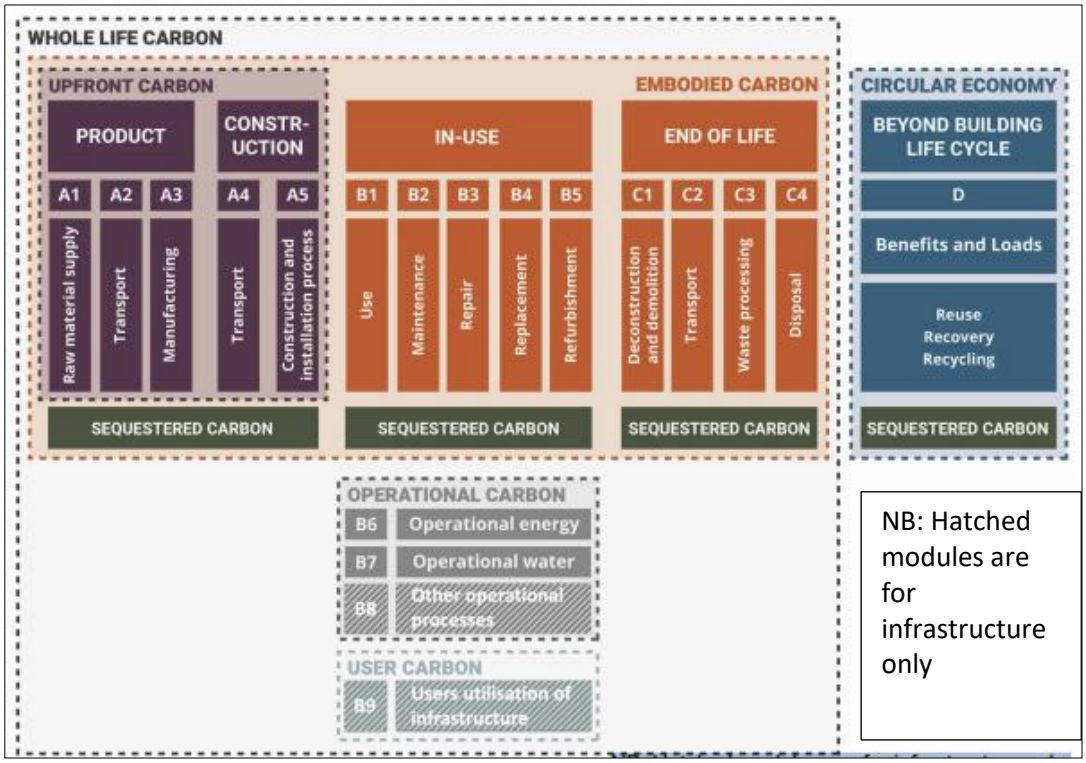
reductions are achieved even before any building work and take advantage of easy wins at an early stage. A useful case study for low carbon residential developments published in February 2022 is available online.[13]

3.7 The Whole Life Carbon Network (WLCN) is also currently developing definitions of Net Zero in collaboration with London Energy Transformation Initiative (LETI) and the Royal Institute of British Architects (RIBA).[14]

"The 'net zero carbon' definitions set out below are based on the 'Paris Proof' approach which dictates that the Built Environment Industry should only use the limited amount of carbon – including energy and material resources – apportioned to it, in order for the UK economy as a whole to reach net zero emissions by 2050 and ensure best efforts to limit global warming to 1.5 degrees Celsius. This requires reducing built environment emissions in line with a science-based trajectory (i.e. 50% reductions by 2030) as a priority measure, and a decreasing reliance on offsets over time to achieve a net zero carbon balance. These Definitions apply to new build, retrofit and infrastructure."

[13] https://ukgbc.s3.eu-west-2.amazonaws.com/wp-content/uploads/2022/02/23075804/08737-Masterplan-v12.pdf
[14] https://www.leti.london/_files/ugd/252d09_879cb72cebea4587aa860b05e187a32a.pdf

Figure 3.3 Life Cycle Modules adapted from BS EN 15978 and PAS2080 (for Infrastructure).



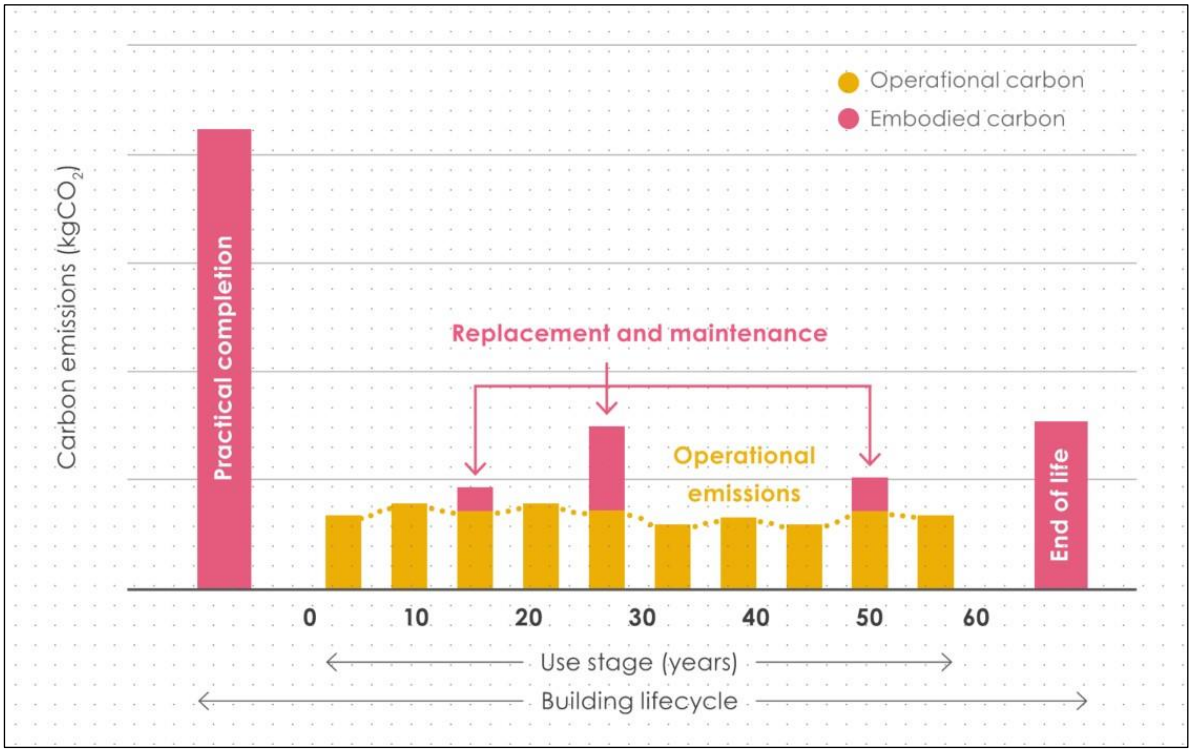
3.8 The above diagram shows the modules used in assessing all carbon emissions over an asset's entire lifecycle and the various terms that are used.

3.9 The work of the WLCN has been further developed with the Chartered Institution of Building Services Engineers (CIBSE) and LETI to produce a work in progress entitled 'Net Zero FAQs: What does Net Zero mean?' published in April 2022 and supported by the The Building Research Establishment (BRE), the Institute of Structural Engineers, RIBA, the Royal Institution of Chartered Surveyors (RICS) and The Good Homes Alliance.[15] The conclusions of the above report are broadly in line with our findings.

3.10 The whole life concept of carbon is illustrated in the following diagram – taken from the LETI guide.

[15] https://www.leti.london/_files/ugd/252d09_d824a0289c1e40d39cbe62514a285e10.pdf

Figure 3.4 Interaction of operational and embodied carbon over the whole life of a building[16]



3.11 The UKGBC approach to net zero has been adopted in effect by the Government Property Agency (GPA) since August 2020 in a document entitled 'net zero and Sustainability Design Guide – net zero Annex'.[17] While focused on new or retrofitted government offices, the guide sets out mandatory targets to aid the achievement of net zero for both the construction and operational stages, while encouraging steps towards whole life embodied energy assessments which the GPA envisage will be incorporated in their specifications within the next five years.

3.12 Specific to Essex, the ECAC Built Environment Technical Annex provides Glossary definitions of net zero carbon following the ones set out by the UKGBC as below:[18]

[16] Climate Emergency Design Guide | LETI. page 57

[17] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/925231/Net_Zero_and_Sustainability_Annex__August_2020_.pdf

[18] https://www.essexclimate.org.uk/sites/default/files/ECAC%20Built%20Environment%20Technical%20Annex_0.pdf

Figure 3.5 The ECAC definitions of net zero carbon

Net zero carbon: The state where there is a balance between the amount of greenhouse gases released into the atmosphere by a human activity, and the amount which is removed. A commitment to net zero carbon is associated with a commitment to reduce greenhouse gas emissions in order to achieve this balance. It can be defined with respect to three components as set out by the UK Green Building Council:

Net zero carbon (in construction): Defined as: "When the amount of carbon emissions associated with a building's product and construction stages up to practical completion is zero or negative , through the use of offsets or the net export of on site renewable energy." A whole life carbon assessment should be undertaken to determine the building's carbon impact, in line with the RICS Professional Statement 'Whole life carbon assessment for the built environment'.

Net zero carbon: operational energy: Is defined as: "When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on site and/or off site renewable energy sources, with any remaining carbon balance offset." The energy used in the operation of existing buildings represents the most significant carbon impact from the built environment contributing 30% of the UK's total emissions in 2017.It covers energy used for heating and cooling, cooking, lighting and plug loads, but excludes commercial process loads and transport (electric vehicle charging).

Net zero carbon (whole life): Defined as: "When the amount of carbon emissions associated with a building's embodied and operational impacts over the life of the building, including its disposal, are zero or negative." In order to achieve a net zero carbon economy, the UK must account for and offset all carbon impacts from the built environment. This will require moving towards a net zero whole life carbon approach for all buildings which will need to be developed in detail over the next five years."

Net zero further clarified

3.13 Within the broad definitions of net zero discussed above, more detailed descriptions are provided by LETI (London Energy Transformation Initiative – Climate Emergency Design Guide)[19] or the GLA (Greater London Authority - London net zero 2030[20]). These descriptions have found considerable support amongst experts and many leading organisations within the built environment industry[21].

[19] https://www.leti.london/cedg

[20] https://www.london.gov.uk/sites/default/files/london_net_zero_2030_-_an_updated_pathway_-_gla_response_1.pdf

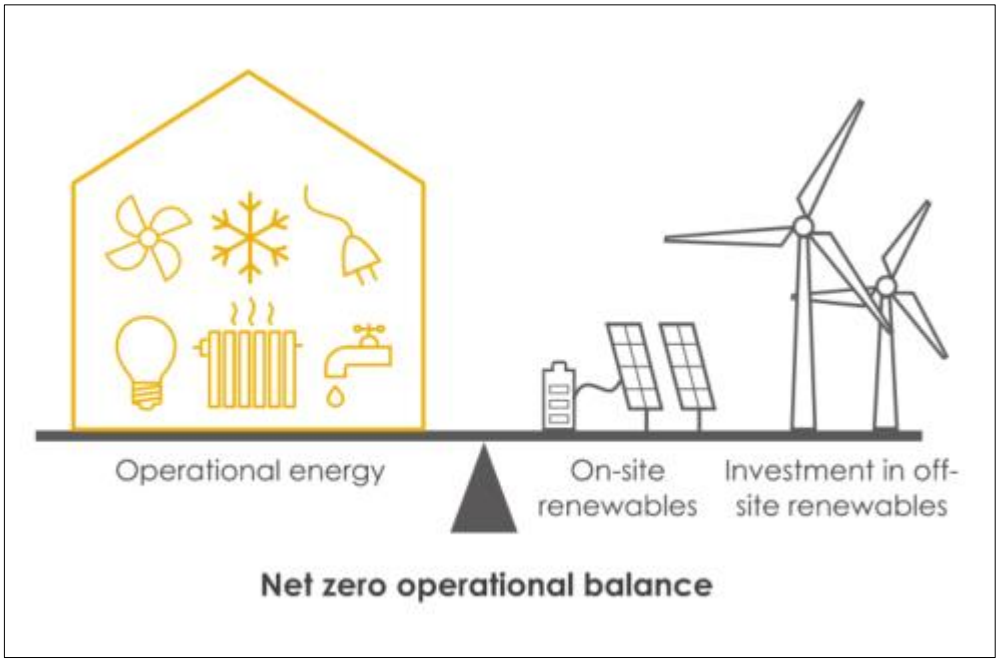
[21] For example: LETI, RIBA, CIBSE, BBP (Better Buildings Partnership), GHA and UKGBC.

A new building with net zero operational carbon

- Does not burn fossil fuels
- Is 100% powered by renewable energy
- And achieves a level of energy performance in use in line with our national climate change targets
- Building Fabric for all building types must achieve a space heating demand of less than 15kWh/m^2/year
- No carbon offsets can be used to achieve this balance.

3.14 It should be noted that some tall buildings or high density developments may not have enough on-site space to provide sufficient renewable energy to achieve the net zero operational balance and in this case investment in off-site renewable energy will be required: this is known as 'additionality' where additional renewable energy capacity (perhaps from a neighbouring roof of PV panels or from wind turbines) is provided from off site and is not considered to be an 'offset'. In the built environment 'offsetting' should be avoided. A green tariff is not sufficiently robust to guarantee 'additional' renewables. The illustration below is from the LETI Climate Emergency Design Guide.[22]

Figure 3.6 Net zero operational balance



[22] https://www.leti.london/cedg

3.15 In order to investigate the robustness of the net zero operational balance of a number of building standards we have developed a series of options and specifications on the journey to Net Zero. The standards are set out below for reference. Chapter 9 then describes the process we have used to test them (using both the Standard Assessment Procedure (SAP) and the Passivhaus Planning Package (PHPP) software tools) and the results of that testing.

1.	The most recent Building Regulations: Part L 2013 to provide a base case that is familiar.
2.	The current Building Regulations : Part L 2021 that came into force on 15th June 2022
3.	The notional Future Homes Standard (FHS) that is the government's preferred vehicle for steering towards Net Zero and due to be introduced in 2025
4.	The Passivhaus (PH) Classic Standard – a low energy fabric first approach to building
5.	The PH Classic standard with photovoltaic (PV) panels added in line with the current building regulations formula that will also be used in the FHS
6.	The Passivhaus Plus standard – that uses the PH classic standard approach and adds sufficient solar PV to balance the overall energy demand

3.16 The industry organisations set out energy targets, u-values and specifications but without prescribing how these are to be achieved, allowing for flexibility to reflect considerations such as local supply chains, context, building orientation, local skills. Consequently, we are proposing a set of net zero specifications that have considered Building Regulations approaches but improved upon the requirements to ensure operational net zero for all new buildings and further recommended embodied carbon reduction strategies as well as encouraging long term off-setting high level best practice policies as additional benefits for the Essex community. The specifications and embodied carbon reduction strategy recommendations can be found in the Technical Report.[23] These include a step by step document of standards and fabric improvement measures, charting changes from the recent (2013) Building Regulations to the current 2021 Part L that came in to force in June 2022, followed by the published proposals for the Future Homes Standard for 2025 compared with the net zero recommendations we are making in this report.

[23] See Technical Appendix 5.

As the National Grid decarbonises and the industry reduces its embodied energy by more judicious use of materials and transport, it will be important to shift attention away from carbon reductions and towards total energy reductions. Currently the UK legislation and the UN Paris agreement relate to carbon reduction as the key measure but there are signs that this focus may move towards different metrics over time and the ECC are advised to keep a watching brief on these trends.

3.17 For this report, we have taken the targets set out in national policy and by ECAC (and in some of the up to date local plans in Essex) which focus on operational carbon and do not encompass embodied or unregulated use of carbon. It is acknowledged that a small number of local authorities (e.g Cornwall and the Greater Cambridge councils) are developing planning policies that consider both carbon emissions and the use of energy within buildings. This approach, further described in the next chapters 4 and 5, is intended to tackle both the need to reduce carbon emissions and minimise energy costs for occupiers. As yet, none of these emerging policies have been tested at a planning examination and it is too early to recommend that Essex follows suit. However, it is acknowledged that this is a fast changing area of analysis and policy development and that ECC and ECAC should keep these new initiatives under review. However, for the purposes of this report, the main focus is on operational carbon but with consideration of other aspects of the 'energy debate' where relevant.

Embodied carbon

3.18 The understanding of embodied carbon is in its early days, so at this stage small steps in this direction are encouraged. The adoption of the LETI Embodied Carbon Primer[24] as a reference guide would be a good start. Initially reporting embodied carbon figures could be required in order to prepare the ground for a new mindset around tackling the issues of carbon emissions created by transport, distribution and materials. No targets need be set at this stage until a deeper understanding has been developed within the industry and among planners. Comparisons, benchmarks and targets can be developed in the future based on practical realities and understanding. Further consultations with industry groups are evolving rapidly and summaries of Embodied Carbon and Whole Life Carbon concepts are regularly published on the LETI website.[25]

[24] https://www.leti.london/ecp
[25] https://www.leti.london/carbonalignment

3.19 To ensure carbon reductions are achieved from the earliest stages of a new development it is important to take into account a range of other factors pre-design, including:

1. Is the location favourable? – transport networks, energy supplies, site topography, existing infrastructure;
2. Orientation – are the buildings optimised for solar gains?
3. Form factor – is the shape of the building optimised for efficient energy usage?
4. Glazing ratios – is the amount of glazing suitable for good daylight levels but at the same time has it taken account of overheating risk and energy efficiency as windows tend to be the weakest element of the wall or roof fabric?

Renewable energy

3.20 In the Energy Section of the ECAC report 'Net Zero: Making Essex Carbon Neutral'[26] there is a recommendation that Essex produce enough renewable energy within the county to meet its own needs by 2040. This approach supports the UK net zero objective in its transition to a zero carbon electricity grid and the default position would be that all buildings maximise solar PV where possible to help to minimise the amount of greenfield stand alone renewables needed. However, while it makes sense to maximise solar PV for new, well-insulated buildings and would support ECAC and the ECC's initiative in this direction already, we would more cautiously recommend that any new building should consider renewable energy generation **afte**r the fabric elements have been optimised for the site. Site constraints of orientation or overshading can mean that PV is not always suitable or consistent so alternative sources like wind or water power may need considering. Ultimately the priority has to be to incorporate robust insulation, airtightness and an efficient ventilation system in to the building itself for the Built Environment to contribute meaningfully towards the net zero carbon agenda.

The performance gap

3.21 Also important is attention to detail with the so-called, 'performance gap', something which reliance on Building Regulations alone does not deal with. Here, the performance ambition of a project at design stage gets undermined by poor detailing, poor or no inspection regimes, poor workmanship, cost cutting exercises and a myriad of other factors that mean that the building designed is **not** what is built. Without robust quantifiable targets it is very difficult to prove that there is a building failure especially when occupancy levels and habits can be so variable. This implies the need for a fifth factor to add to the above list – that is Supervision. Is there appropriate supervision from trained site managers who understand for example the benefits of airtightness as a measure of quality and durability? Site supervision from an 'airtightness champion', whilst being perceived perhaps as an additional expense, can also be seen as an opportunity to excel,

[26] Document.ashx (essex.gov.uk) page 25.

with improved quality, pride of workmanship, reduced performance gap and reduced costs of snagging.

3.22 One way of checking the quality of build is to carry out airtightness checks. These are required at the completion stages of a new building for building regulations purposes and the mandated target is 5 air changes per hour. This target has generally been achieved in recent years in the building industry without undue difficulty. However, a more robust air tightness target would be 1.5 air changes per hour[27] as recommended by the AECB[28] in their building standard which seeks to reflect realistic building practices of good quality for low energy homes.[29]

Regulated and unregulated energy

3.23 In any debate about zero net carbon, it is also necessary to take into account unregulated energy i.e. energy used by occupants in their day to day lives. Regulated energy (regulated by Part L of the Building Regulations) covers areas such as space heating, lighting and hot water. But cooking and appliances are not regulated by Part L and fall within the category of 'un-regulated energy use'. The graphic to the left illustrates the types of energy uses that are Regulated and those that are Unregulated. A fuller explanation can be found in the LETI Climate Design Guide[30] with more detailed information on the Performance Gap in their Appendix A1.2.

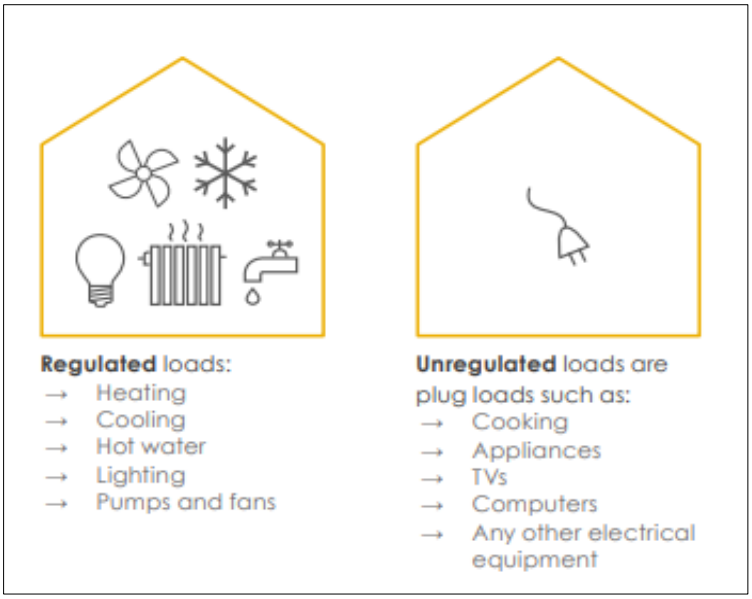


Figure 3.8 Regulated and unregulated energy

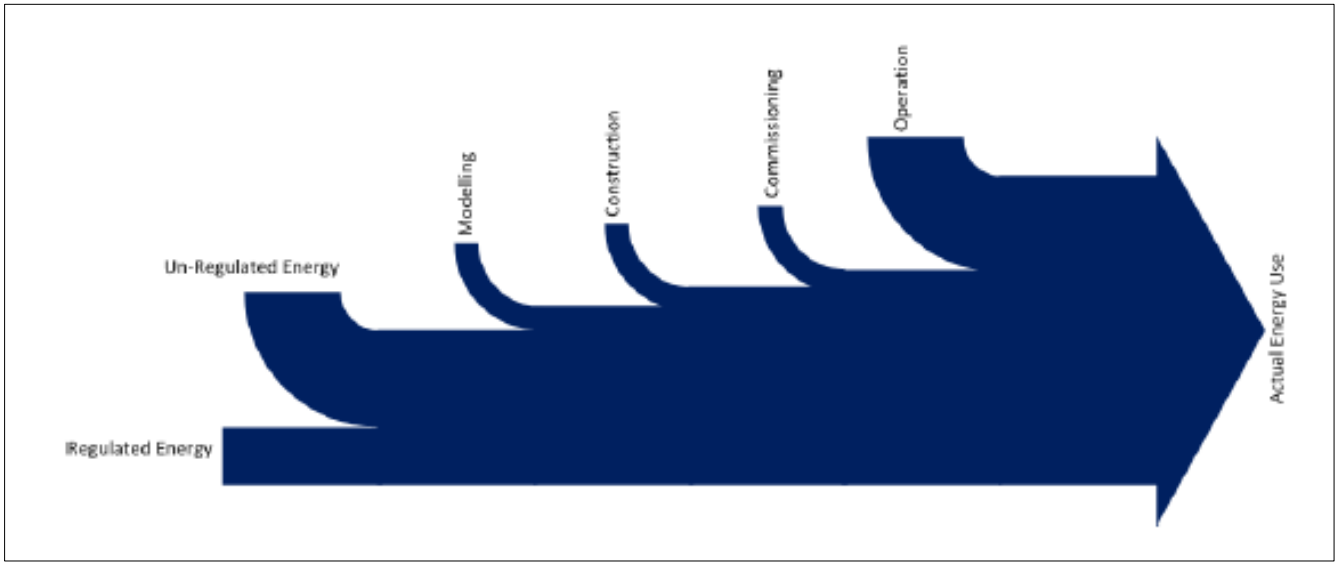
3.24 The importance of unregulated energy becomes apparent when considering the implementation of the Building Regulations. Building Regulations use a Standard Assessment Procedure (SAP) or a Simplified Building Energy Model (SBEM) for calculating the heat gains and losses in a building. SAP and SBEM take into account many of the heat losses and gains in the normal operation of a

[27] Design Guidance AECB Building Standard - AECB
[28] The AECB (Association for Environment Conscious Building) is a network of individuals and companies with a common aim of **promoting sustainable building**. Running since the 1980's the AECB are the largest and oldest network for sustainable building. www.aecb.net
[29] AECB Building Standard & Certification - AECB
[30] Climate Emergency Design Guide | LETI see pages 40 and 122

building but perhaps, surprisingly, there is often a large performance gap between the predicted, designed energy use of a building and the actual energy used once occupied. The Building Research Establishment (BRE) has developed many of the energy assessment methods but they rely on SAP which does not include unregulated energy in its calculations. By contrast the development of the Passivhaus Planning Package (PHPP) has a history of detailed data that includes unregulated energy and its results have been tested in use for reliability since the early 1990's. SAP is not a suitable alternative at present to PHPP for assessing the true performance of buildings although certain evidential requirements introduced in SAP10.2 (the latest iteration of this methodology) may help reduce the performance gap in construction. The UK Building Regulations at the moment do not achieve the level of quality assurance that is inherent in the Passivhaus approach.

3.25 The Building Regulations approach emphasises CO_2 reduction as a primary target. However, if the aim is to achieve the Future Homes Standards and beyond for 2050, which uses the **SAP** method of calculating emissions, even 100% carbon reduction **will not achieve zero carbon** as it does not include unregulated energy. According to the LETI Climate Emergency Design Guide 'unregulated energy can form up to 50% of total operational energy.'[31]

Figure 3.9 The Performance Gap growth from Design to Operation [32]



3.26 The performance gap is not only a result of splitting energy into regulated as well as unregulated, further errors creep in during design stage modelling, during construction, at commissioning stage, through misunderstandings of how to operate systems and occupant

[31] LETI Climate Emergency Design Guide p.40. Illustrations from LETI.

[32] Bernadette Bowden: Building Standards Scholarship 2015/16 Building Control influence on the energy performance gap of buildings. Southend-on-Sea Borough Council, January 2016.

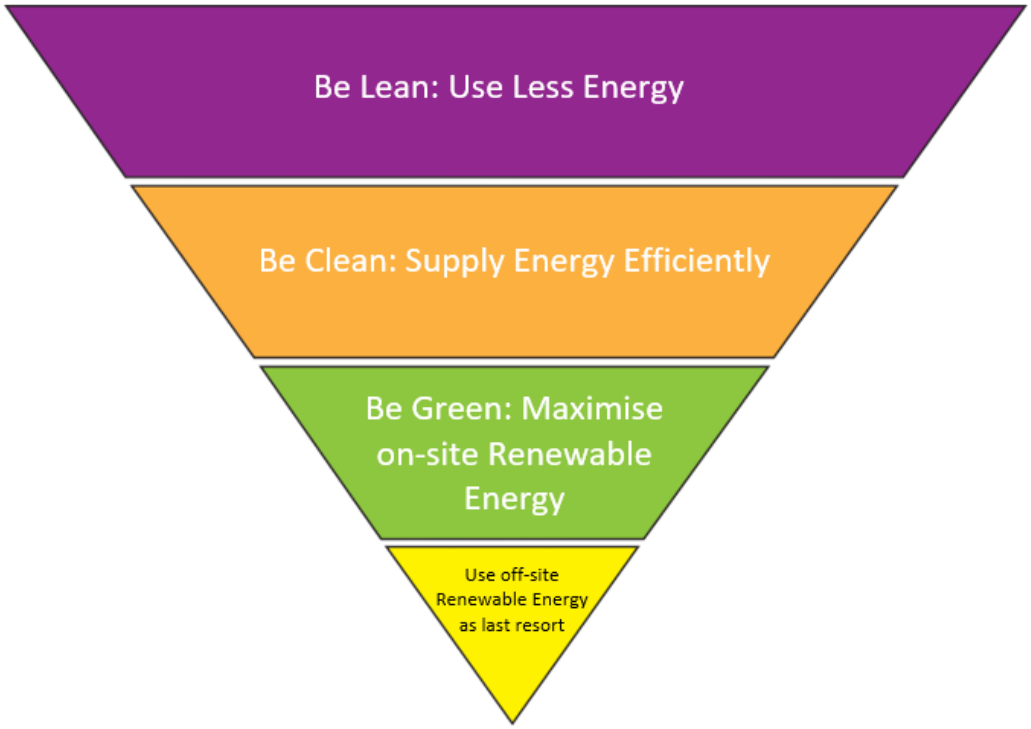
behaviour patterns. See figure 3.9 above illustrating how regulated energy only accounts for some of the actual energy use.

Link to fabric first approach

3.27 Human behaviour can account for some of the performance gap illustrated above but often there is a variance in predicted and actual operational performance of the fabric of the building which goes back to the point made earlier that supervision during construction is needed to address potential performance gaps.

3.28 It is accepted building physics that **to effectively achieve net zero carbon emissions in buildings** (with greater certainty as to performance), **we must start with reducing the energy required** as shown in the energy hierarchy below[33].

Figure 3.10 The Energy Hierarchy : Fabric First Approach



3.29 Once energy demand is minimised, then the design of efficient heating and hot water systems can take place, on-site renewable technologies installed and finally, as a last resort, investment in off-site renewable energy technologies explored where achieving net zero is excessively challenging. The latter may not be required if the energy demand can be sufficiently reduced on-site by

[33] Policy S12 https://www.london.gov.uk/what-we-do/planning/london-plan/new-london-plan/draft-new-london-plan/chapter-9-sustainable-infrastructure/policy-si2-minimising

designing well insulated, thermal bridge free and airtight homes which is implicit in the Passivhaus design process (see below in section 3.32). This is known as the fabric first approach.

3.30 In current Building Regulations for new domestic properties (Part L1A)[34], 'Fabric First' has been recognised by introducing a fabric energy efficiency target known as the TFEE (Target Fabric Energy Efficiency) as well as the overall target carbon dioxide (CO_2) emissions rate known as the TER (Target Emissions Rate). However, the TFEE has not been introduced for new non-domestic buildings which must only achieve a TER (Part L2A)[35]. This means that the focus under the current building regulations is still largely on carbon emissions and will be the most familiar metric for most of the UK building industry as well as for planning departments.

3.31 An example of tackling carbon reduction while using building regulations as a base line can be found in the Greater London Authority (GLA) requirements. The GLA imposes a further 35% on-site carbon reduction over and above Building Regulations

The Passivhaus[36] approach – fabric first

3.32 The first step in designing a low energy building is to optimise the efficiency of the thermal envelope. A useful introduction to Passivhaus can be found in video form on the internet with the title "Passive House explained in 90 seconds"[37] or in a slide or video format with the title "Passivhaus Easi Guide" from the UK Passivhaus Trust.[38]

3.33 The thermal envelope of a building is the physical separation between the internal and external elements of a building. The thermal envelope's performance determines the heat losses occurring through a building's fabric, and therefore the energy required to heat the house to compensate for heat losses. Improving the efficiency of the thermal envelope allows the minimisation of the heat losses through the fabric (step 1) before meeting the remaining energy demand through energy efficient systems (step 2) and potentially renewables (step 3).

3.34 A high performance building fabric is achieved through thermally efficient elements (insulated walls, floor and roof, high performance windows) to reduce fabric heat losses; and an airtight envelope to reduce infiltration (i.e. warm air escaping from the house).

3.35 Passivhaus was developed in Germany over 30 years ago by a physicist, Dr Wolfgang Feist, as a comfort and building performance standard. It adopts the 'fabric first' approach. The

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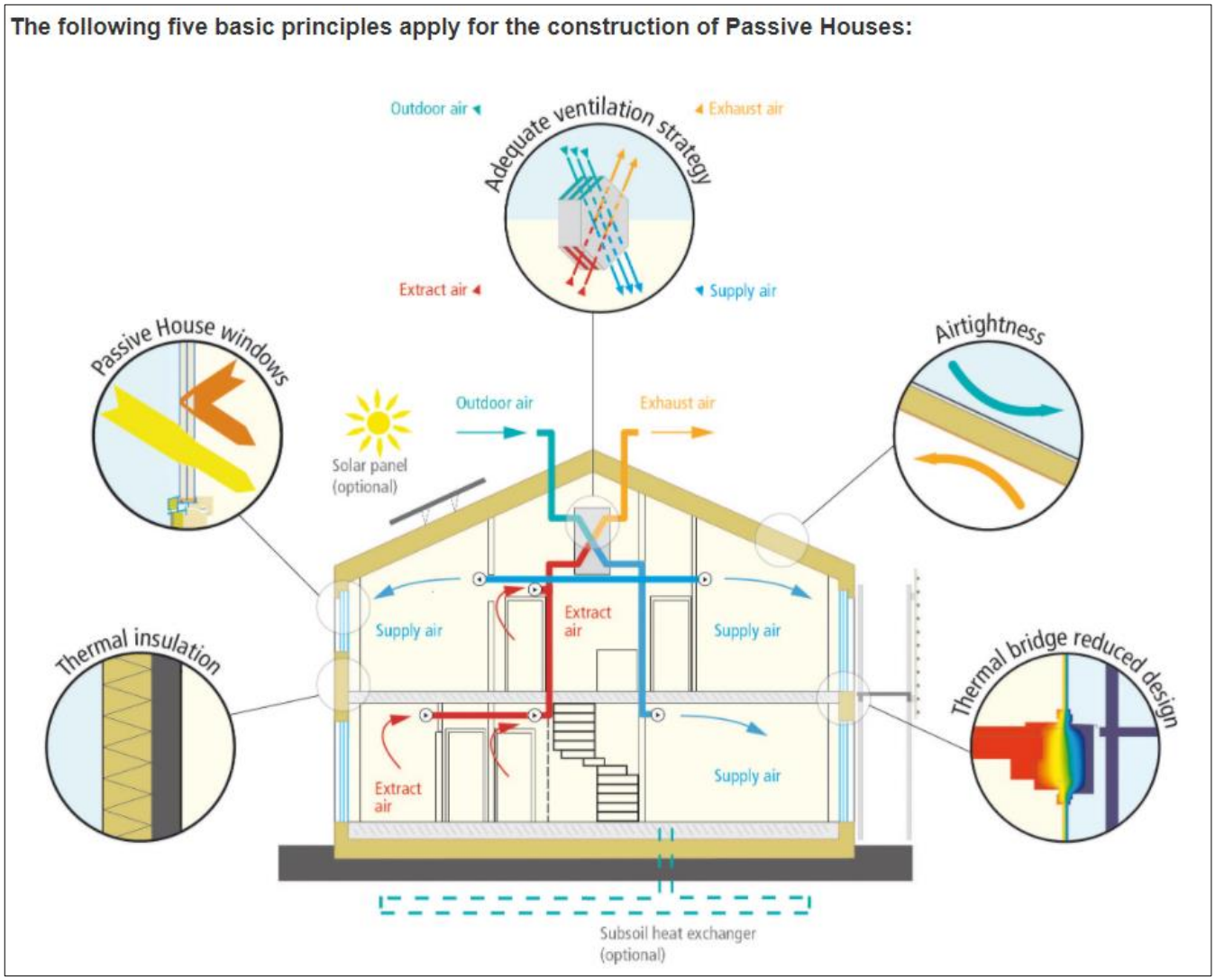
[34] Approved Document L1A – conservation of fuel and power in new dwellings
https://www.planningportal.co.uk/info/200135/approved_documents/74/part_l_-_conservation_of_fuel_and_power
[35] Approved Document L2A – Conservation of fuel and power in new buildings other than dwellings
https://www.planningportal.co.uk/info/200135/approved_documents/74/part_l_-_conservation_of_fuel_and_power/3
[36] http://www.passivhaustrust.org.uk/what_is_passivhaus.php
[37] https://vimeo.com/74294955
[38] https://www.passivhaustrust.org.uk/news/detail/?nld=899

Passivhaus approach reduces energy demand to an absolute minimum – it is the gold standard for energy efficiency.

3.36 Passivhaus is based on building physics principles, providing accurate predictions of building performance. Passivhaus buildings have been monitored for more than 30 years and have proved that they perform in accordance with their design predictions. The basic principles are illustrated in the diagram below:[39]

[39] https://passivehouse.com/02_informations/02_passive-house-requirements/02_passive-house-requirements.htm

Figure 3.11 Basic Passivhaus principles



3.37 Even if Passivhaus levels of performance cannot be achieved on a project, the principles can still be used to analyse any building (domestic or non-residential) and make sure the best possible results are achieved given any constraints.

3.38 To achieve this high standard of energy efficiency or any similar low-energy building standard, every design needs to follow these 5 key principles:

- **High levels of thermal Insulation**

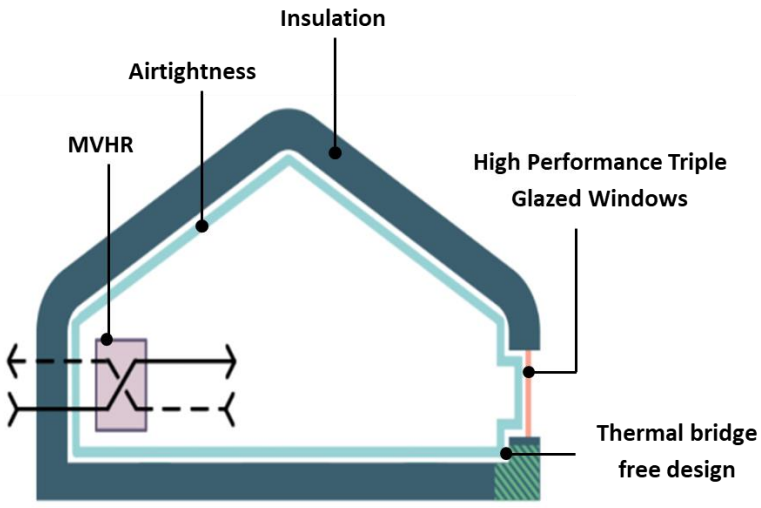
A well-insulated building envelope keeps warmth in during the cold months and heat out during warmer months.

- **High-performing Triple Glazed Windows**

Strategically positioned, highly insulated triple glazed windows do their bit to make optimal use of the sun's energy.

- **Mechanical Ventilation with Heat Recovery (MVHR)**

Passivhaus ventilation systems provide plentiful fresh, pollen and dust-free air with maximal energy efficiency achieved through heat recovery.



- **High levels of Airtightness**

Passivhaus buildings are designed to avoid leakage from the building envelope, thus boosting energy efficiency while preventing draughts and moisture damage.

- **Thermal bridge free design**

Avoidance of thermal bridges – weak points in the thermal envelope – contributes to pleasant, even temperatures while eliminating moisture damage and improving energy efficiency.

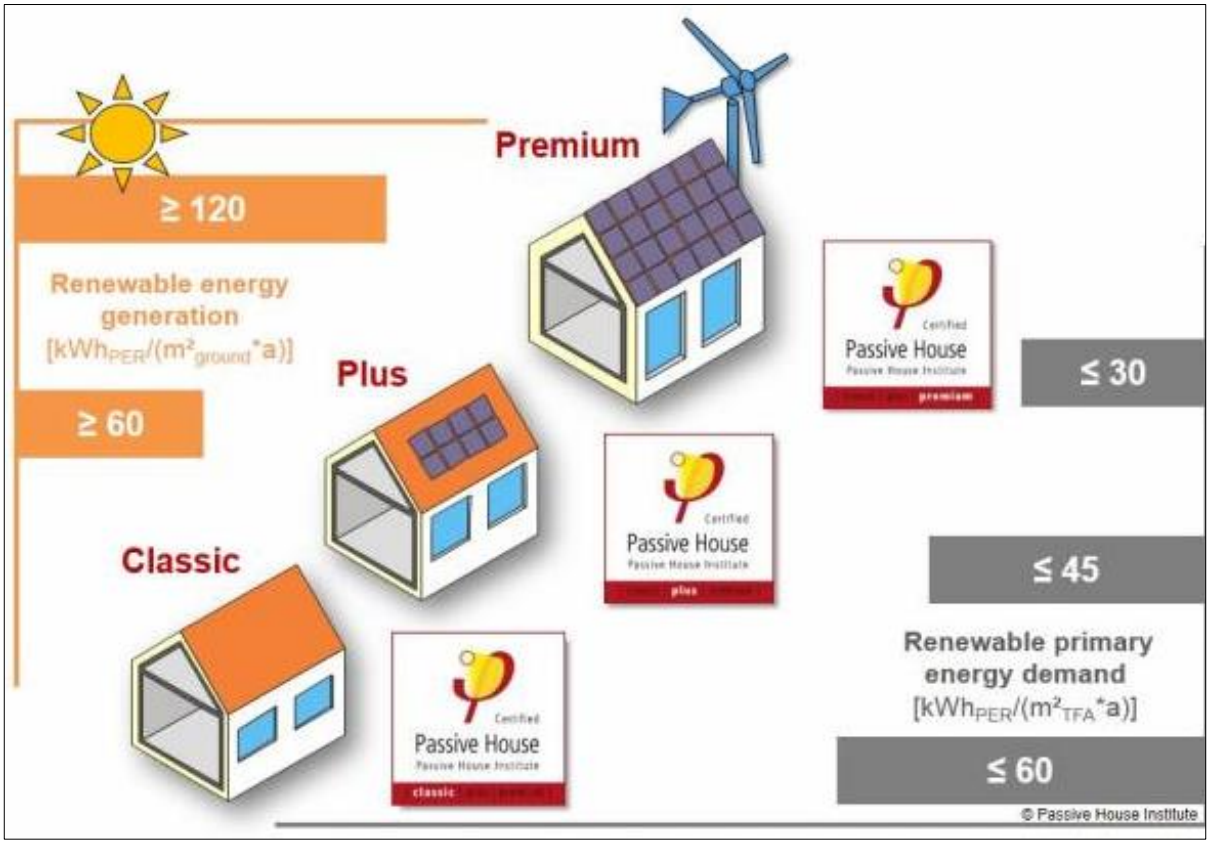
The Passivhaus Categories – levels of performance

3.39 Passivhaus has three recognised levels of performance[40]:

1. Passivhaus Classic – that sets out the essential low energy performance requirements that apply to all the levels in terms of the overall fabric, comfort and quality standards. This is the benchmark standard that we would recommend as a first step in readiness for meeting the net zero targets.
2. Passivhaus Plus – this adds an element of renewable energy such as photovoltaics to produce as much energy as is required for the operational needs of the building in everyday use and sometimes referred to as 'net zero'. The energy generated must come from renewable sources and provide enough energy to operate the building throughout the whole year.
3. Passivhaus Premium – where renewable generation exceeds requirements and the extra energy produced can be saved to the grid or be saved in batteries for example for usage elsewhere; sometimes referred to as 'carbon positive'. It is a challenging goal where the ambition is to go beyond economic and ecological considerations.

[40] https://www.passivhaustrust.org.uk/passivhaus_awards/passivhaus-plus-premium/

Figure 3.12 Passivhaus Categories: Passive House Institute Illustration[41]



Key concepts – energy and heat loss

Measuring Energy

3.40 Energy can take many forms and so it is important that we measure it consistently in order to be able to compare. The rate of flow of energy is known as power and is measured in watts. If we multiply a rate by time, then we get the total amount of energy delivered. Thus, throughout this report we refer to energy in kilowatt hours (kWh) – i.e. the number of thousand watts delivered in 1 hour. For example, a 100 watt bulb is consuming energy and producing light (and heat) at a rate of 100 watts. If you leave it switched on for an hour, then it will have consumed 0.1 kilowatt hours of energy. Leave it on for 5 hours, and it will have consumed 0.5 kilowatt hours.

[41] https://passipedia.org/certification/passive_house_categories

3.41 Gas and electricity companies measure energy usage in kilowatt hours and then multiply this by a standard rate to derive energy bills. So, the number of kilowatt hours of energy used in a building directly correlates with the size of the energy bills.

Calculating Heat Loss

3.42 One of the main ways buildings lose heat is by conduction through the walls, floors, roofs and windows/doors. We can measure this loss if we know how well (or badly) these elements conduct heat. The conductivity of a particular material is known as its lambda value (λ) and is measured in Watts per metre Kelvin (W/mK). The main thing to note here is that the lower the conductivity, the better the material is at insulating. For example, steel has a lambda value of around 50, whilst mineral wool has a value of between 0.035 and 0.045 W/m.K. Most insulating materials used in buildings have values between 0.020 and 0.060 W/m.K.

3.43 Once we know the conductivity of the material that makes up a thermal element, we can then divide by its thickness to get the thermal performance of the thermal element itself (e.g. a wall). This is known as a U-value and is measured in watts per metre squared Kelvin (W/m2.K). Again, the lower the U-value, the better the insulating effect. For very high performance buildings, U-values are typically 0.10 W/m^2.K; for new buildings in the UK, 0.20 to 0.30 W/m^2.K and for older buildings perhaps 2 W/m^2.K or more.

3.44 In order to calculate the difference between heat gains and heat losses, modelling the energy consumption of a building needs to take into account:

- the building fabric of the property;
- the orientation of the property;
- the indoor temperature;
- the external climate;
- the level of airtightness;
- the window heat losses and solar gains.

3.45 To keep the house heated at a particular temperature, the heat gains must balance the heat losses. As the free heat gains are usually lower than the heat losses, space heating is required to make up the difference between the two.

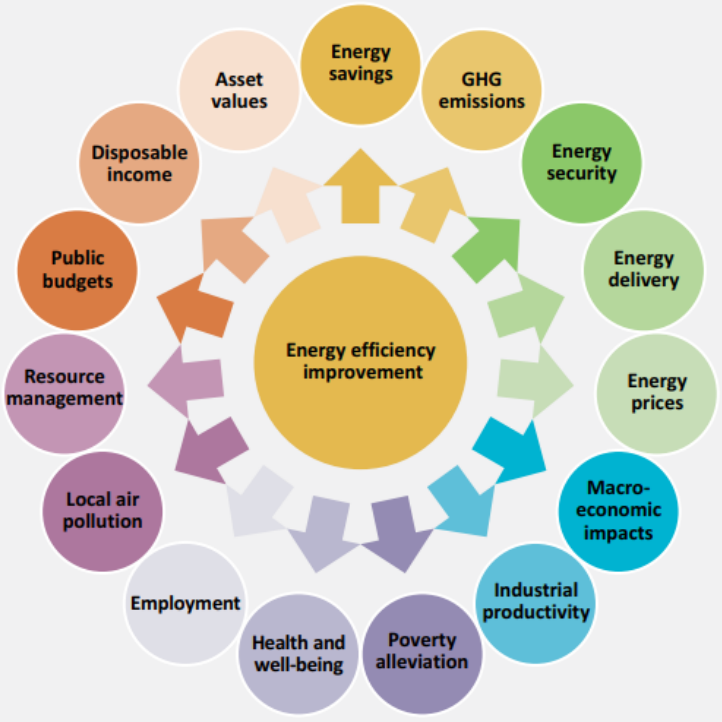
Space heating demand

3.46 The space heating demand is the amount of energy required to keep the house at a comfortable temperature (this is normally between 18 and 21 degrees Centigrade in the UK), and it is generally measured in kilowatt hours per metre squared per year (kWh/m^2/year). The Passivhaus Standard requires the space heating demand to be no more than 15 kWh/m^2/year to make it not only an energy efficient standard but also to provide an economical level of operational cost, making it more affordable to heat for those on reduced incomes. The nation

benefits as a bi-product because there is a reduction in demand on energy production by the national grid. This gives country-wide and local energy resilience, self-reliance and sustainability while at the same time reducing carbon emissions.

3.47 The multiple benefits of an energy efficient standard such as Passivhaus can be summarised in the diagram below from the International Energy Agency[42]

Figure 3.13 Multiple benefits of an energy efficient approach



Note: This list is not exhaustive, but represents some of the most prominent benefits of energy efficiency identified to date.
Source: Unless otherwise noted, all material in figures and tables in this chapter derives from IEA data and analysis.

Key point A multiple benefits approach to energy efficiency reveals a broad range of potential positive impacts.

Key points

3.1 While there is no single agreed UK statutory definition of net zero, the established principles are that emissions of greenhouse gases for a period are balanced by the amount of that gas that is removed.

[42] https://www.iea.org/reports/capturing-the-multiple-benefits-of-energy-efficiency

3.2 For new homes, it is important to consider i) carbon used in the building's product and construction stages (including embodied carbon), ii) operational carbon – carbon emissions associated with the building's operational energy, and iii) whole life carbon - the carbon emissions associated with the construction, use and disposal of a building.

3.3 The key requirements for a net zero carbon dwelling as follows:

1. **Ultra-low space heating demand**. Reducing space heating demand to a level in line with the Climate Change Committee recommendations[43] for new housing (i.e. 15-20 kWh/m^2/yr), ensuring that heating costs are minimised with a good fabric and ventilation system;
2. **Low total energy use**. The level of total energy use should be as low as possible and meet the local[44] energy use targets: an efficient heating and hot water system and low energy lighting; fittings (including for water use) and appliances need to complement the fabric and ventilation. Energy Use Intensity (EUI, kWh/m^2/yr) must be a key SAP output according to the SAP scoping group commissioned by the BEIS government department (see footnote reference 41 below). This differs from the current metric which focuses on cost but is open to misinterpretation because of the influence of fuel and cost factors that rapidly go out of date, while actual energy use measured in kWh is a factual element that can be easily understood by all stakeholders;
3. **No fossil fuels and low carbon heat**. A net zero Carbon ready home should use a low carbon heating system (e.g. heat pump), and no fossil fuels on-site.
4. **High renewable energy generation**. Alongside the reduction in energy use, renewable energy generation is critical for net zero and on-site solar PVs have an important role to play. Solar PV generation should become a more prominent SAP output.as advised by the SAP11 scoping group;[45]
5. **Energy flexibility**. New homes need to be better integrated in the wider energy system. They should have a reduced peak demand and an increased ability to use energy when clean energy is available. This opens the way to the beneficial effects of heat networks, energy storage (including thermal stores) and batteries.
6. **Reduced performance gap**. Carbon net zero should not be just a 'design objective', it must be delivered after construction and in operation. By focussing on the long term durability, repair and re-usability of the building fabric, embodied and whole life carbon considerations can be ameliorated. One way of ensuring long term reductions is to introduce monitoring for data feedback, which could flag up performance anomalies.

3.4 For the purposes of this report, targeted at new buildings, we have modelled buildings with high fabric standards that deliver the energy performance targets set out in the LETI definition

[43] https://www.theccc.org.uk/publication/uk-housing-fit-for-the-future/
[44] 'Local' here can refer to either UK national targets or regional targets set by a local council for example.
[45] See SAP11 Scoping Group document https://etude.co.uk/how-we-work/the-future-of-sap-calculations/

of Net Zero operational carbon and also included Solar PV. The LETI definition is seen as the 'gold standard' for net zero buildings in operation and is set out below:

- A new building with net zero operational carbon;
- Does not burn fossil fuels;
- Is 100% powered by renewable energy;
- And achieves a level of energy performance in use in line with our national climate change targets.

This means that an operational carbon balance is met, and, the

- Building Fabric for all building types must achieve a space heating demand of less than 15kWh/m2 /year; and
- No carbon offsets can be used to achieve this balance.

Chapter 4 National policy context net zero carbon

2021 Building Regs – a 31% reduction in CO_2

4.1 The government published an update to Part L and Part F of the Building Regulations in December 2021. This became operational in June 2022 and is intended to deliver a 31% saving in carbon emissions in new residential development. Meeting the 2021 Building Regulations can be achieved with various fabric measures.

4.2 While the development industry has already geared up for this change, the cost of achieving the new standards is still something of a matter for speculation and key national data about building costs, such as BCIS, have yet to catch up. In chapter 10, we set out costs based on the best available information at the time of writing.

2025 Future homes – net zero Ready – 75% reduction in CO_2

4.3 The next step set out by government in achieving net zero is the further reduction in carbon emissions at 2025 as set out in the Future Homes consultation.[46] Thereafter, government is relying on grid decarbonisation to achieve net zero in all new homes by 2050. Decarbonisation of the grid will happen over time so, for example, by 2035, grid decarbonisation will be part way there.

4.4 There is no clarity about how the 2025 standard (of 75% reduction) is to be achieved. It is reasonable to assume another update to the Building Regulations but this has yet to emerge. The Future Homes Standards 2019 Consultation indicated that it will not be until 2024 that there will be 'implementation consultation'.[47]

4.5 However, as part of the 2021 update to the Building Regulations, 'fossil-fuel heating systems' in any domestic new build properties are not permitted from 2025 onwards. There are various ways in which traditional fossil fuel boilers can be replaced, for example, using air source heat pumps. The Future Homes Standards 2019 Consultation indicates in its draft notional standard for Future Homes Standards specification, that heating appliances should be Low-carbon

46 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/852605/Future_Homes_Standard_2019_Consultation.pdf

47 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1040925/Future_Buildings_Standard_response.pdf

heating (e.g. Heat pump)[48] These are to replace gas boilers that are within the framework of the 2021 Building Regulations.[49]

4.6 Underpinning Building Regulations is the Standard Assessment Procedure or SAP system. The new version of SAP is 10.2 which was adopted alongside the 2021 Building Regulations in June of this year. However, there is already a new SAP (SAP 11) being scoped[50] which seeks to influence the delivery of new homes that are net zero carbon-ready by focusing on what SAP defines as its key outputs. Consequently, SAP11 and the Future Homes Standard Building Regulations (when they emerge) should have their key objectives lined-up to achieve the net zero Operational Carbon standard for new homes from 2025.

4.7 Neither Building Regulations nor government statements of policy nor planning guidance include targets for space heating demand and/or total energy use or how these relate to the reduction of carbon emissions that is being planned by government. However, some local authorities are reviewing how these other measures can be incorporated into their policies and we return to this point later in this chapter.

Electricity grid capacity

4.8 Underpinning the shift away from the use of fossil fuels is increasing use of electricity generated from renewable sources. Currently the UK uses approximately 3 times more energy than the electricity grid can produce (the balance being met by fossil fuels like gas). Continued investment in renewable and storage technologies and improved efficiencies are moving the country towards a better clean energy balance however moving to heat pumps and electric transport will also increase demand on the electricity generating infrastructure. The National Grid is however confident that through the use of smart technology and shifting peak loads around the system there is plenty of capacity to supply our national transport needs and that this increase can be provided by wind and solar power.[51]

4.9 But the switch to the use of renewable energy (electricity) will not be enough to ensure the 'lights stay on'. Energy conservation through fabric efficiency is essential as part of the balance with national power sources. This issue is picked up throughout the report.

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[48] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/956094/Government_response_to_Future_Homes_Standard_consultation.pdf

[49] Ibid – see Table 2

[50] https://www.etude.co.uk/wp-content/uploads/2021/06/Making-SAP-and-RdSAP-11-fit-for-Net-Zero-Full-report.pdf

[51] https://www.nationalgrid.com/stories/journey-to-net zero-stories/can-grid-cope-extra-demand-electric-cars

Local authority powers

4.10 Local authorities would seem already to have powers to adopt policies to reduce carbon emissions that are ahead of government policy and in the Building Regulations.[52] The legislative background for this is set out in the text box below.

Figure 4.1 Key UK legislation relating to climate change

Section 19(1A) of the Planning and Compulsory Purchase Act 2004
Requires local planning authorities to include in their local plans "policies designed to secure that the development and use of land in the local planning authority's area contribute to the mitigation of, and adaptation to, climate change".

Planning and Energy Act 2008
The government's 'Response to Future Homes Standard' Consultation document, published in January 2021, confirms that Local Authorities retain the power under The Planning and Energy Act 2008 to set local energy efficiency standards for new homes as stated in section 1 of that Act. The Planning and Energy Act 2008 specifically allows the setting of energy efficiency standards that exceed the energy requirements of Building Regulations. Requirements should be 'reasonable'.

4.11 The importance of the Planning and Energy Act 2008, was restated by the government in 2021 in its Response to Future Homes Standard' Consultation document which said that:

"*..... local planning authorities will retain powers to set local energy efficiency standards for new homes.*"[53]

4.12 Further guidance to local planning authorities is set out in the National Planning Policy Framework[54]. This states that:

"*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" (NPPF Para 153).*

The NPPF is also clear that local authorities can refer to non planning matters in developing their plans:

[52] Further government advice is found at https://www.gov.uk/guidance/climate-change#statutory-duty-on-Climate-Change

[53] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/956094/Government_response_to_Future_Homes_Standard_consultation.pdf Para 2.40

[54] https://www.gov.uk/government/publications/national-planning-policy-framework--2

"Other statements of government policy may be material when preparing plans or deciding applications, such as relevant Written Ministerial Statements and endorsed recommendations of the National Infrastructure Commission."[55]

4.13 However, Planning Practice Guidance would appear to contradict the government statement set out in its Response to Future Homes Standard' Consultation document. The PPG states:

"The National Planning Policy Framework expects local planning authorities when setting any local requirement for a building's sustainability to do so in a way consistent with the government's zero carbon buildings policy and adopt nationally described standards. Local requirements should form part of a Local Plan following engagement with appropriate partners, and will need to be based on robust and credible evidence and pay careful attention to viability. In this respect, planning authorities will need to take account of government decisions on the Housing Standards Review when considering a local requirement relating to new homes".[56]

4.14 It should be noted that the paragraph from the PPG quoted above was last updated in 2015 while the response to the Future Homes Standard Consultation is from January 2021. However, at a recent planning examination, a planning inspector appears to have followed the approach set out in the PPG and requested a modification to a policy in an Area Action Plan that required:

" *.....zero operational carbon on-site through ultra-low energy fabric specification, low carbon technologies and on-site renewable energy generation...*"

The inspector has asked for the council to strike out the specific targets the policy contains (and that go beyond current government policy). The examinations relates to the Salt Cross Area Action Plan examination – in West Oxfordshire and full details can be found at https://www.westoxon.gov.uk/planning-and-building/planning-policy/salt-cross-garden-village/salt-cross-area-action-plan-examination/:

4.15 As there still appears to be some ambiguity about local authority powers, one option open to ECAC (working with the district and unitary authorities in Essex) is to seek legal opinion on this that can be shared across Essex and this will help in providing a degree of certainty.

Approaches in UK jurisdictions

4.16 Through the Climate Change Act 2008, the UK government set a target to significantly reduce UK greenhouse gas emissions by 2050 and a path to get there. The Act commits the UK government by law to reducing greenhouse gas emissions by at least 100% of 1990 levels (net

[55] Paragraph 6 of the NPPF - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf
[56] Planning Practice Guidance - Paragraph: 009 Reference ID: 6-009-20150327

zero) by 2050. This includes reducing emissions from the devolved administrations (Scotland, Wales and Northern Ireland), which currently account for about 20% of the UK's emissions[57].

4.17 As well as being covered by the Climate Change Act, Scotland, Wales and Northern Ireland have separate climate change policies. We have set out the headline policies and commitments in the table below. Net zero targets have been formally adopted through legislation in England, Scotland and Wales and at the time of writing in Northern Ireland a Climate Change bill is still being debated.

[57] Climate Change Committee https://www.theccc.org.uk/the-need-to-act/a-legal-duty-to-act/

Figure 4.2 climate change legislation in the UK

England	Scotland	Wales	Northern Ireland
Net zero by 2050 Commitment to reduce emissions in 2030 by at least 68% (compared to 1990 levels) Commitment to cut emissions by 78% by 2035 (compared to 1990 levels) (legislation in draft form[58]) New residential buildings – 31% reduction in emissions from June 2022 through update to Building Regulations 2013 Part L Carbon zero ready by 2025 through Future Homes Standard (Regulations to be published 2024)	net zero by 2045 The Climate Change (Scotland) Act 2009 as amended by the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019) commits to Reduce emissions by: •56% by 2020 •75% by 2030 •90% by 2040 •100% by 2045 against the baseline of 1990 levels	Net zero by 2050 Welsh Statutory Instrument to The Environment (Wales) Act 2016 (Amendment of 2050 Emissions Target) Regulations 2021 - effective from 12th March 2021 introduced a target of •63% reduction in carbon by 2030 •89% reduction by 2040	No climate change legislation in place but the Climate Change Bill introduced March 2021 had an overarching target of delivering net zero emissions by 2045 However, at committee stage (8/12/21) "target is highly ambitious ..... the Committee did not come to an agreed position on this aspect of the Bill" Amendments published March 2022 change 2045 to 2050[59] NI Assembly aim to achieve legally binding targets in 2022

Other measures emerging in local authority policies

4.18 A small number of authorities in updating their local plan and/or other statutory planning policies e.g. area action plans are seeking to introduce measures other than a simple reduction in carbon emissions in line with Building Regulations. These local authorities have declared a

[58] https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035
[59] http://www.niassembly.gov.uk/assembly-business/legislation/2017-2022-mandate/non-executive-bill-proposals/climate-change-bill/

climate emergency and argue that they need to go further and faster than the approach outlined by central government. A small number of authorities are at an advanced stage of plan preparation – already at examination or with an examination shortly to start. Two examples of the approach are set out below but it should be noted that there are many other plans being produced and examined that do not follow this approach and rely on the government timetable set out in Future Homes.

Cornwall Council – Climate Emergency Development Plan Document
Pre-Submission consultation February 2021, (Examination June 2022)
Policy SEC1 – Sustainable Energy and Construction
2b - New Development – Residential
Residential development proposals will be required to achieve net zero Carbon and submit an 'Energy and Carbon Statement' that demonstrates how the proposal will achieve:
•Space heating demand less than 30kWh/m2/annum;
•Total energy consumption less than 40kWh/m2/annum; and
•On-site renewable generation to match the total energy consumption, with a preference for roof-mounted solar PV.
Where the use of onsite renewables to match total energy consumption is demonstrated to be not technically feasible (for example with apartments) or economically viable renewable energy generation should be maximised as much as possible; and/or connection to an existing or proposed district energy network; or where this is not possible the residual is offset by a contribution to Cornwall Council's Offset Fund.

Bath and North East Somerset Council Local Plan (Core Strategy And Placemaking Plan) Partial Update
Proposed Submission Draft Document August 2021 (Examination June/July 2022)
SCR6 Sustainable Construction Policy for New Build Residential Development
New build residential development will be required to meet the standards set out below.
New build residential development will aim to achieve zero operational emissions by reducing heat and power demand then supplying all energy demand through onsite renewables. Through the submission of a sustainable construction checklist, proposed new dwellings will demonstrate the following;
• Space heating demand less than 30kWh/m2/annum;
• Total energy use less than 40kWh/m2/annum; and
• On site renewable energy generation to match the total energy use, with a preference for roof mounted solar PV
• Connection to a district heating network where available

4.19 The outcome of the examination process for authorities proposing to use targets illustrated by the above will be important for ECC and will need to be kept under review. It will also be important to link the final decision on the suitability of these policy types with the robustness of the evidence available to justify this type of approach.

Key points

4.20 The Climate Change Act 2008 commits the UK government to reduce greenhouse gas emissions by at least 100% of 1990 levels (net zero) by 2050. This objective applies to all four UK jurisdictions, although there are differences in targets set along the way

4.21 In England, two key dates are this year and 2025. In June of 2022, the 2021 update to the Building Regulations Parts F and L became operational. This is intended to deliver a 31% saving in operational carbon emissions in new residential development. Meeting the 2021 Building Regulations can be achieved with various fabric measures.

4.22 In 2025, new dwellings are to achieve a 75% to 80% reduction in CO_2 emissions. Thereafter, the government is relying on grid decarbonisation to achieve net zero in all new homes by 2050. There is no clarity about how the 2025 standard is to be achieved but it is reasonable to assume there will be another update to the Building Regulations. However, the 2021 update to the Building Regulations sets out that 'fossil-fuel heating systems' in any domestic new build properties are not permitted from 2025 onwards.

4.23 Legislation is already in place (including the Planning and Energy Act 2008) that gives local authorities powers to adopt policies to reduce carbon emissions that are ahead of government policy (including the Building Regulations). However, there remains some ambiguity about this and it is being recommended that ECAC seeks legal opinion on this which can be available for all Essex authorities.

4.24 Emerging in some local plans are policies that seek a combination of standards that reduce carbon emissions while also setting space heating and energy demand standards. These approaches are being tested at examination and it will be important that their progress is kept under review.

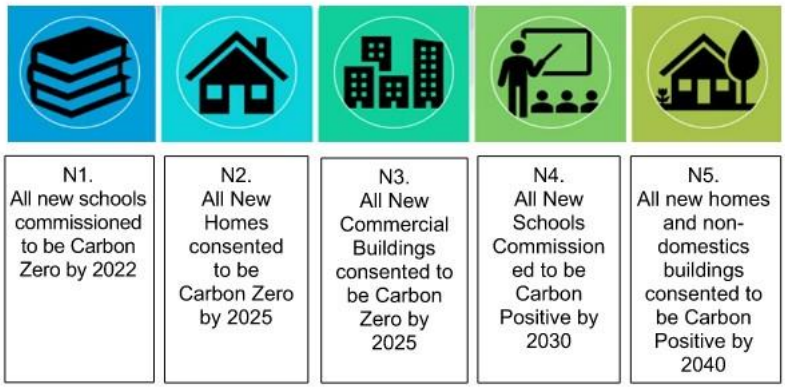
Chapter 5 The Essex policy context

Local policy context

5.1 The Essex Climate Action Committee (ECAC) describes itself as,"... *an independent, voluntary, and cross-party body, bringing together groups from the public and private sector, as well as individuals from organisations, to promote and guide climate action in the county. As a Commission, our purpose is to provide expert advice and up-to-date recommendations to move Essex to net zero by 2050.*"[60]

5.2 ECAC's 2021[61] report sets out an action programme across a range of development types, including education and commercial buildings as well as residential. Other of ECAC's objectives include, that by 2030, 100% fuel poor homes are to be retrofitted & supplied with renewables and, by 2040, 75% farm land adopts sustainable land practises. The key stages are shown in the following illustration.

Figure 5.1 ECAC's key stages to net zero carbon[62]



5.3 A comparison of the key recommendations for (new) residential development from ECAC with the equivalent government targets (as far as they are currently known) are set out in the table below.

60 Essex Climate Action Commission, net zero: Making Essex Carbon Neutral, 2021
[61] ibid
[62] ibid

Figure 5.2 ECAC and government targets compared

Government targets		ECAC targets	
2021 Building Regs amendment - Interim 31% reduction of CO_{2e}	2022	2022	All new schools net zero. All new builds with PVs.
Future Homes standard 'net zero Ready' 75% reduction	2025	2025	All consents for new homes and commercial buildings to be carbon zero
All private rentals EPC 'C'. Non-domestic rentals EPC 'B'.	2030	2030	All new builds carbon positive All fuel poor homes retrofitted & supplied with renewables
		2040	Essex renewables meet all county needs
net zero with Grid Decarbonisation contribution 100% Reduction compared with Building Regs 2013. (SAP calculation).	2050		

5.4 The ECAC targets clearly mirror those of national government but seek to do so at a much faster pace. Importantly, ECAC sets out that all new buildings should be net zero carbon in 2025, whereas the government's target is that by 2025 there should be a 75% carbon reduction and net zero is not achieved until 2050. The ECAC is calling for this standard to be reached some 25 years earlier.

5.5 The ECAC targets do not have the same statutory authority[63] as government targets[64]. Instead, ECAC relies on political leadership and on supporting exemplar projects to guide and encourage planning authorities and the development industry to meet the ECAC standards. This point was picked up in the local authority and developer interviews undertaken for this study (and described later in the report).

5.6 A key point to achieving net zero earlier than the government pathway is that the grid has not yet decarbonised to the extent that it might by 2050. Therefore, assuming an all electric energy provision - building to net zero today is harder than it will be in 2025, which again is more

[63] Government targets can be secured through changes to the Building Regulations and/or national planning policy
[64] The ECAC targets could also gain 'weight' by being included in adopted local plans.

difficult than in 2050. This requires more stringent fabric improvements and more onsite generation to building to net zero sooner.[65]

Essex Developers Climate Action Charter

5.7 The Essex Developers Group (EDG)[66] has signed up to a Developers Climate Action Charter[67]. The Charter has been adopted by the EDG as well as Homes England and the South East Local Enterprise Partnership and the Essex Planning Officers Association (representing the 15 councils of Essex).

5.8 The charter restates the ECAC targets that all new homes that are consented should be carbon zero by 2025 and carbon positive by 2030. The Charter also seeks to showcase best practice pilots and larger scale zero carbon house building schemes and retrofit programmes. While it is acknowledged that the Charter cannot legally bind its signatories or impose legal obligations on them, it is an important statement of intent between the development industry and local planning authorities. It also provides a mechanism for sharing best practice. The signatories to the charter have made commitments to take actions to achieve the following goals:

- Two thirds all dwellings to be retrofitted as far as possible to net zero carbon standards by 2030;
- Existing residential buildings - carbon emissions reduction of 50% by 2030 and Carbon Zero by 2040;
- All new homes consented to be carbon zero by 2025;
- All new homes and non-domestics buildings consented to be carbon positive by 2030 (along with the schools zero carbon programme).

5.9 In order to take forward the principles of the Charter, the following actions have been agreed:

[65] Therefore we present all carbon modelling as if trying to achieve a net zero building in the next 3 years, using the June 2022 carbon factors for all the modelling.
[66] For a list of group members see https://www.housingessex.org/members-directory/
[67] Three Dragons were directly briefed on the Charter – attending a meeting of the EDG in January 2022.

Figure 5.3 ECAC and EDG Charter Actions

Action	Notes
1. Net Zero Carbon Show Home	Developers are encouraged to include within Show Homes where appropriate key features of a net zero carbon home, such as a renewable heating source (not using fossil fuels) and application of very high building fabric standards. These homes could show how to install highly energy efficient systems and appliances in new homes and build in integrated renewable energy technology such as rooftop solar pv; including these features in show homes on major sites will encourage prospective home buyers to consider the advantages of including these features. Developers may also show how a commercial or community building can be built to a high standard such as BREEAM Excellent/Outstanding.
2. Case Studies	Identification of exemplar fossil fuel free developments undertaken by Essex developers either in the County or elsewhere to demonstrate incorporation of energy and water efficiency solutions to the development as a whole or to buildings. The aim is to demonstrate how these can be included in viable and affordable schemes which are working towards a net zero carbon outcome. Developers will be encouraged to put forward examples to be uploaded into a Directory of Best Practice hosted on the Essex Design Guide website. Developers will be able to add to the Directory on an ongoing basis, and particularly when they have secured an award or commendation. The Climate Action Commission will also use this site to showcase good examples.
3. Sponsorship of Apprenticeships in Design and Green Construction Skills Training	Developers will be encouraged to work with Essex local authorities to offer apprenticeships in key 'green' skills areas from design to construction. This may include sponsorship through a university or college course in 'green' skills.
4. Essex Housing Awards 2022	These annual awards, sponsored by the Essex Developers' Group and South Essex Housing Group; includes within the 12 categories a dedicated award for Climate Action and also progress towards zero carbon. The Climate Action Commission has agreed to sponsor one of the awards this year and will also develop from next year an expanded range of awards to reflect opportunities and solutions to achieving green and net zero development.
5. Climate Change Sustainability Statement	The Commission will produce a Climate Change Sustainability Statement in consultation with the Developers Group that will act as a Climate

Action	Notes
	Change response checklist of features that can be included when designing a layout, green and blue infrastructure, and buildings. It will complement the Health Impact Assessments to ensure we are creating climate resilient places of safety, comfort and which maximise wellbeing.
6. Supporting the Supply Chain and the Work of Smaller Developers	The Climate Action Commission has undertaken a study of green skills training availability and supply chains across the County. The next step will be to work with developers as well as businesses and training providers to ensure that the skills and goods supply chains can be supported in Essex to work towards sustainable construction, and climate resilient development.
7. Climate Action Advice packs for residents, businesses and schools	The business pack has been specifically developed to help SME businesses access the most relevant information and advice on climate change and sustainability, with tips and ideas to help businesses thrive whilst keeping their impact on the environment low.

Local Authority planning policies

Ages of the local plans and implications for policies

5.10 The local plans of all 14 Essex local planning authorities were reviewed (including the two unitary authorities). A number of local plans have been adopted in the last two years or where the plan has been through examination and is very close to adoption at the time of writing (Braintree, Brentwood, Castle Point, Chelmsford, Colchester, Epping, Harlow and Tendring). Of the remainder, four local plans were adopted before 2012 and, of the two other local plans – that for Maldon, was adopted in 2017 and for Thurrock, in 2015. For these older local plans, work to update them is already underway and at different stages in the process – as it is for some plans more recently adopted.

5.11 The plans generally have policies to address climate change but with a growing emphasis in those more recently adopted. However, few of the policies set specific targets. Rather they offer broad guidance and/or are supportive of measures to reduce carbon emissions. Examples of this policy approach (from very recent plans) are quoted below:

- "*All new development (including changes of use), should incorporate climate change adaptation measures and technology from the outset including reduction of emissions, renewable and low carbon energy production, passive design, and through green infrastructure techniques, where appropriate.*" Policy SPL3, Tendring District Council, Adopted Local Plan, January 2022;
- "*New development will be expected to deliver high standards of sustainable design and construction and efficient energy usage, taking account of predicted changes to heating and*

cooling requirements as a result of climate change". Policy PL3, Harlow Council, Adopted Local Development Plan, December 2020.

5.12 Some of the planning authorities supplement their climate change policies with 'management' and/or action plans e.g. Colchester's Climate Action Plan.

Relationship with Building Regulations

5.13 A couple of plans specifically refer in their policies to the need to meet the standards set out in Building Regulations or a standard in excess of this, as is the case of Brentwood.[68]. Probably the most 'ambitious' plan is one of the oldest in terms of adoption. The Rochford Local Plan (adopted in 2011) has a target of meeting net zero carbon in new development by 2016.[69]

Key points

5.14 The Essex Climate Action Committee (ECAC) has set out an action programme that is more stretching than government targets requiring that all new building are net zero by 2025 and are carbon positive by 2030. The publication of the ECAC targets post dates most of the adopted local plans of the local planning authorities in Essex (including the two unitary authorities) and the plans reflect this. Many include a reference to tackling climate change; offering broad guidance and/or are supportive of measures to reduce carbon emissions but not identifying specific targets.

[68] Bentwood Borough Council, Brentwood Local Plan, Adopted 2022, Policy BE01
[69] Rochford District Council, Local Development Framework, Core Strategy 2011, Policy ENV9

Chapter 6 Local authority perspectives

Planning policies

6.1 The previous chapter described the relationship between the age of local plans and the policies they have adopted. In the interviews with the planning officers, a point raised by several interviewees is the time needed to collect the relevant evidence and then take a plan through all the stages to its adoption. Policies that relate to a fast-moving agenda, such as climate change, can quickly become out of date. This, in part, helps explain the general nature of most plan policies and the implicit reliance on government 'legislation', primarily through the Building Regulations, to reduce carbon emissions in new developments. The government's ability to update the Regulations is seen as a much speedier process and gives consistency between planning authorities.

6.2 There were also comments that indicated an understanding, amongst some officers, that local authorities could not adopt policies that went beyond national targets (and Building Regulations). We dealt with the point about legislation earlier in the report and it is important that authorities feel able to set their own standards where this is justified by the evidence they have available.

6.3 Not all authorities see tackling climate change as their top planning priority and other local matters are important in decision making, for example, delivery of affordable housing. When this is the case, the authority relies on Building Regulations to set the pace on reducing carbon emissions for new developments and promotes other issues through their plan.

Use made of guidance

6.4 Not all the officers interviewed were aware of the work of ECAC or the targets for carbon reduction it has set out. Even when aware of the ECAC targets, these are not necessarily seen as directly relevant to the work of the planning authority. Concerns raised included:

- That the targets went beyond what local planning authorities could specify, whether in a plan policy or in deciding on planning applications – again reflecting concerns about the legitimacy of a local planning authority going beyond Building Regulationsin its plan making;
- That the ECAC work does not carry any 'weight' in terms of setting policy or decision-making;
- That it distracts from the job of getting plans adopted;
- The ECAC targets are not affordable i.e. would have a negative impact on development viability;
- The ECAC targets are more suited to large-scale greenfield development rather than smaller 'infill' sites.

6.5 There was more awareness of the Essex Design Guide [70]amongst interviewees – which may simply reflect that it has been in operation for much longer than the ECAC report. Five interviewees noted the use of the Guide by the authority and/or referencing applications to the Review Panel. For those authorities where the interviewee did not highlight use of the Design Guide, it could be that other officers in the authority would have commented more positively on use of the Guide.

6.6 Two interviewees specifically indicated that the Guide could be a suitable vehicle to provide additional guidance on achieving reduced carbon emissions in new development. But this did not have general support amongst interviewees who cited the '*lack of teeth*' with the Essex Design Guide and the use of more localised guides as reasons why the Design Guide is not more widely used in connection with reducing carbon emissions.

6.7 Examples of 'local' guides include the Maldon District Design Guide (from 2017)[71] and the Harlow Gilston Garden Town Sustainability Guidance and Checklist (from 2021)[72]. This guide is tailored to the development of the Garden Town and sets out that it:

"*..... provides practical and technical guidance on how to apply sustainability indicators and policies (environmental, social, and economic) in the HGGT Vision and partner authorities Plans to new major developments in the Garden Town.*"

6.8 The Harlow Gilston Garden Town Sustainability Guidance devotes a section to energy efficiency and carbon reduction. There is a very useful checklist of issues and which set out that, "*A Whole Life Carbon (WLC) Assessment should be undertaken at pre-application, planning application, and after practical completion, as new homes are expected to last 60+years, with carbon emission reduction in line with the targets in the Checklist.*"[73].

Option for bespoke Essex net zero guidance

6.9 Interviewees were asked for their views on the usefulness and content of a potential Essex toolkit/guide for planners to help meet the ECAC targets. Views were very mixed but there was only limited support for a general guide. The case against a general guide is illustrated by these comments:

"*.....prefer all standards to come through building standards at a national level, so there is consistency and shared standards which are easier for both developers and planning officers...*"

[70] The Guide can be found at **https://www.essexdesignguide.co.uk/. The website explains that, "**The Essex Design Guide was established in 1973 by Essex County Council. It is used as a reference guide to help create high quality places with an identity specific to its Essex context. The preceding publication was released in 2005. The 2018 edition seeks to address the evolution of socio-economic impacts on place-making."

[71] file:///C:/Users/user/Downloads/Maldon_District_Design_Guide_SPD%20(1).pdf

[72] https://hggt.co.uk/wp-content/uploads/2021/10/HGGT-Sustainability-Guidance-and-Checklist-Mar-2021.pdf

[73] Ibid page 21

"There is a lot of design advice already."

"Any pan Essex guidance or toolkits will not have any significant weight in decision making, so of no real use."

6.10 However, local authorities are facing issues for which further support, on a consistent Essex-wide basis, would be of use. This would be a mix of information and of expertise that could be called on when dealing with specific applications and/or reviewing plan policy. Importantly, whatever is made available, has to be capable of rapid updating when there is new information or a change in local or national policy (e.g. a Building Regulations change). The type of support sought is illustrated by the following interviewee comments:

"Would be useful to have information about different technologies/approaches and costs."

"Useful to have more evidence re costs involved which reflect local situation."

".....need expertise 'on your side' (and need to be kept up to date)."

"Useful to understand the impact (costs) of different standards ....."

6.11 The evidence from the interviews indicates a possible role for ECAC with two main elements.

- First, focused information concentrating on:
  - Government standards – current and emerging and ECAC objectives;
  - Local authority 'powers' to set their own standards;
  - Design options to meet (different) standards;
  - Guidance on costs for different standards.
- Second, direct technical support to local authorities providing expertise to assist in developing new policies and in dealing with applications. So officers can address the question – does this application meet the standard in national/local policy?

Local authority perspective of developer approach

6.12 The local authority interviews highlighted a very mixed approach across the development industry. Local planning authorities still face resistance to higher standards from some developers. We asked the question, *"How do you think the development industry locally is adjusting to the aim of zero carbon e.g. views on the 2021 Building Regulations update and the objectives of Future Homes?"* and the following comment from one interviewee is typical of responses to the question:

"Some developers see higher environmental standards as part of their product. Others don't have as much enthusiasm but overall there is some movement to more sustainable housing development."

6.13 Regional/national developers are said to be more engaged with the net zero agenda than smaller/local developers and that this gives the larger housebuilders an important advantage, as was explained by one interviewee:

"*.....national volume housebuilders have the resource to change designs and deliver lower carbon.....*"

Key points

6.14 Policies that relate to a fast-moving agenda, such as climate change, can quickly become out of date. This helps explain why local plans avoid overt targets and rather rely on government 'legislation' (through the Building Regulations) to reduce carbon emissions in new developments.

6.15 While tackling climate change has been moving up the planning agenda, it is not the top planning priority for all the authorities and other local matters are important in decision making, for example, delivery of affordable housing.

6.16 At the time of the survey there was variable understanding of the ECAC, its report and the targets. Even when aware of the targets, these are not necessarily seen as directly relevant to the work of the planning authority.

6.17 Although respondents expressed limited support for a general guide, there were calls for further support, on a consistent Essex-wide basis, as a mix of information and of expertise that could be called on when dealing with specific applications and/or reviewing plan policy.

6.18 From the local authority perspective, the development industry is seen to have a very mixed approach to decarbonisation measures. Regional/national developers are said to be more engaged with the net zero agenda than smaller/local developers and that this gives the larger housebuilders an important advantage.

Chapter 7 Development industry perspective

National perspective

7.1 The Home Builders Federation, in a recent survey of around 2,000 people (reported Q1 2022),[74] found that 73% are worried about energy performance of their current home and that around a quarter say that energy efficiency will be crucial to their next home move. Whilst only a snapshot, it does indicate a growing sentiment and awareness around individuals' carbon footprint. Whether this is driven by a desire to address climate change or economic challenges of rising energy costs, it does illustrate to the housebuilding industry that the issue is becoming important alongside the more traditional factors such as price points, location and space.

7.2 Whilst there is demand for energy efficiency in new builds this might not necessarily be reflected in sales values. The October 2021 RICS Residential Market Survey[75] suggests that two-thirds of respondents reported no change in buyer appetite for energy efficient homes in the past year and the majority of agents surveyed (three quarters) stated that a property's energy efficiency rating had little or no impact on its selling price. Conversely, just under one-quarter thought the opposite and that it would influence price. Also, the survey was of the whole market and there may be an expectation that new build will already be more energy efficient than older properties.

7.3 A subsequent report[76] found that three quarters (77%) of people in the housing market are likely to choose a green home for their next purchase indicating that there is a shift towards 'green credentials' helping to make a home more saleable but, at the moment no evidence that there is a corresponding increase in house prices or rentals.

7.4 Added to this backdrop of consumer demand are two further drivers of change in the housebuilding industry, namely:

- Regulation and standards through changes to current (particularly Part L and Part F) 2021 Building Regulations and future home standards to come in 2025;
- Sustainable investment and in particular environment, social and governance approach (better known as ESG), whereby there is a reallocation of capital towards companies that are at the heart of solving the worlds challenges, such as climate change and pioneering better ways of doing business. At the heart of ESG is resilience, through the inevitable climate transition and better connection/accountability as stakeholders (with investment) to business.

[74] https://www.hbf.co.uk/news/location-location-insulation-new-homes-week-research-shows-desire-sustainability/
[75] https://www.rics.org/globalassets/rics-website/media/knowledge/research/market-surveys/uk-residential-market-survey-october-2021.pdf
[76] Shakespeare Martineau, Green Homes Report – What Buyers Want. Noting that the basis of the survey or those commissioning the report is unclear.

7.5 To gain an insight into the approach of housebuilders, a review of annual reports, sustainability reports and strategies of the top 20 housebuilders (by turnover as reported by NHBC[77]) has been undertaken. This was web-based research and therefore relied upon housebuilders having easily accessible, up to date published material on their websites.

7.6 Whilst the majority (12 out of 20) of those reviewed have published targets there were a number that either had no published targets or were not clear. It was notable that the majority of housebuilders with no published targets towards net zero were private businesses.

7.7 Those that have published targets towards net zero have generally expressed targets in the following ways:

- New build development – operational
- New build development – embodied (i.e. construction materials)
- Company operations e.g. offices, vehicles etc

7.8 A number of the reports have mentioned the Sustainable Finance Disclosures Regulations 2021, which whilst introduced in 2019, only came into effect in March 2021. The aim of these Regulations is to encourage the financial sector to support sustainable activities and to move away from harmful one, much like the approach of ESG. The Regulations require companies to improve their disclosures to allow for clearer understanding and comparisons of sustainability characteristics and to counter 'greenwashing'.

7.9 Whilst it is not clear whether the reporting of targets is a direct result of the Regulations it is telling that most of the recent reports now contain more detail than in the past – importantly a number of the largest housebuilders in the UK have now publicly declared policies towards addressing climate change and net zero carbon including:

- Barratt, Persimmon, Vistry, Berkeley, Redrow, Countryside, Cala and Hill Group all committed for new builds to be net zero (operationally) by 2030;
- Crest Nicholson, Keepmoat Homes and Taylor Wimpey[78] are intending to meet 2025 Future Homes Standards;
- Bellway, Bloor, L&Q, Miller Homes, Avant, Lovell, Galliard, Fairview and London Square either have no published commitment/targets or these are unclear.

7.10 Of those committing to operational net zero by 2030, the majority have test sites planned or underway to inform how technology and build approach can be scaled to still meet housing

[77] Housing Market Intelligence Report 2021

[78] Taylor Wimpey statements on net zero are not clear – there is also an indication in their 2021 Environmental Strategy that there will be a 75% reduction in emissions from new homes by 2030 and it is understood that they did object to the 2025 targets set out in the consultation on Future Homes.

demand targets[79]. A number of the housebuilders recognise that modern methods of construction (MMC) and in particular factory[80] produced modular construction is likely to be the way forward in terms of fabric. A variety of technologies are considered but generally solar (with batteries), mechanical ventilation heat recovery and waste water heat recovery and air source heat pumps are all being trialled.

7.11 As well as committing to net zero in terms of operation carbon performance of new builds, many of the housebuilders have made the same commitment in terms of their own operation as businesses, although this does in some case have an extended timeframe of 2050. There is some but limited commentary on embedded carbon, either in respect of housebuilding or the running of the business.

Essex developers

7.12 As part of the study, a workshop was held with members of the development industry active in Essex. Attendees included members of the Essex Developers Group (EDG) as well as other organisations, and the discussion was structured around a presentation with Q&A sessions. Notes from the workshop are found in the Technical Report. Recognising that the workshop was undertaken before the recent rapid increase in energy costs, the key issues discussed at the workshop were:

- Agreement that waiting for grid decarbonisation is not a suitable response to the need for net zero carbon. Some of the workshop attendees were already making progress with higher building standards (e.g. EPC A/EPC B or Future Homes), although there is a recognition of the higher costs involved. Housing associations were particularly mindful of the costs of retrofitting and were considering whole life costing implications of their developments;
- Much of the response needed for better energy efficient housing and net zero relates to higher construction standards, rather than just adding costly PV or space and hot water heating technology items. These higher construction standards include the airtightness required for Passivhaus as well as attention to thermal bridges and installation of insulation;
- There are current cost and supply issues for air source heat pumps (ASHPs), although it is unknown whether this will extend into the longer term and there can be successful price negotiations in the short term;
- In general, there is not an increase in market values for housing built to a higher energy standard, although there may be a premium in due course;

[79] Z house at Salford, German Beck at York, Europa Way at Leamington, Langley Grange at Scisett, Beaulieu at Chelmsford, Virido at London.
[80] Persimmon, Berkeley and Countryside have all stated that they already operate MMC factories

- The additional costs mean that bids for land are less competitive for those organisations providing higher building standards compared with developments that rely on the standards set by Building Regulations.

7.13 The separate interviews and meeting with developers also showed a general acknowledgement that it is necessary to build higher quality houses with better environmental performance. However, it is clear that different organisations are working at varying speeds and that not all organisations have a clear plan in terms of standards moving forwards. The 2021 change in Building Regulations is generally not seen as a major challenge but there is a lack of clarity about the proposed 2025 Future Homes standards (i.e. zero carbon ready) and little progress towards true zero carbon housing by 2025 in advance of grid decarbonisation. Whilst there are some pilot Future Homes standards being developed, in general the organisations being interviewed were not yet at the stage of building to this standard (although one sizeable pilot is to be delivered imminently) and as a result it is questionable whether full net zero can be practically achieved by 2025. Much new housing is currently at Building Regulations (2013) and for housing associations there is concern about retrofitting going forward.

7.14 Progress being made for lower carbon developments includes the beginning of ASHP installation at scale by some organisations, although supply chain and skills constraints are evident. There are some specific concerns about the practicalities of using ASHPs on flatted developments. Additional insulation and other fabric first approaches are being used although there was less concern about this aspect compared with issues around the use and supply of ASHPs. Some of the discussion around a fabric first approach included benefits of reduced snagging from higher construction standards, which offset some of the other higher development costs. Off-site construction/Modern Methods of Construction (MMC) is being considered but thus far the barriers include suitable designs as well as supply constraints. Some organisations are considering setting up their own factories for off-site construction. The use of Mechanical Ventilation with Heat Recovery (MVHR) is growing, often in combination with ASHPs but other solutions such as infrared and direct electric heating are also being considered. PV systems and battery storage are also being used. There are concerns about electric power infrastructure being sufficient to deal with the increased demand from electrification of homes and at-home vehicle charging and there are implications for developable site areas if more substations are needed.

7.15 Generally, there is little progress towards dealing with embodied carbon although it is clear that organisations are thinking about this and there are some examples of moves to reduce embodied carbon, such as measures to reduce the carbon emission from construction practices and the transport impacts of materials procurement. Some organisations are not convinced that net zero, including embodied carbon can be achieved on site and therefore some off-setting will be required.

7.16 The organisations consulted reported that there were cost implications from higher building standards. Although responses varied, most fell between 10% to 20% additional cost (from

2013 Building Regulations) to get to Future Homes standard, with approximately 15% being typical. These costs stem from fabric improvements as well as the installation of low carbon heating such as ASHPs, with the latter being responsible for the largest part of the additional costs. There are expectations of costs reducing as economies of scale emerge and as supply increases and competition drives down prices of technology such as ASHPs. Some organisations, such as Swan Housing, have established their own factories for off-site construction.

7.17 As designs evolve there are the opportunities to reduce costs, such as integrating PV panels into roof structures. However, in the short term it is not clear that landowners recognise the need for higher standards and the impact on development viability of the higher costs.

7.18 To date, there is little evidence in Essex of higher market values for energy efficient housing, although at the premium end of the market there would be an expectation for better quality across the board, including energy efficiency. It was reported that most buyers see new Building Regulations housing as being more energy efficient than older stock and were not necessarily prepared to pay more for what may be perceived as a marginal gain over Building Regulations. Within this, there was the suggestion that better energy efficiency would increase saleability in parts of the market on ethical or running cost grounds. It is not clear whether the steep increases in gas prices at the time of writing may raise the importance of energy efficiency in the housing market.

7.19 There is some disquiet in the development industry about the variety of carbon standards and timescales being pursued by planning authorities, which is important as most of the organisations consulted operate across a broad area of the country. Some authorities, such as the Greater London Authority are seen to be leading the way with the policies in the new London Plan while other authorities are clearly seeking to tackle climate change but do not (yet) have effective policies in their local plans. At the same time, some of the development industry questioned whether the agenda is moving more quickly than the housebuilding industry and its supply chains can react. While some organisations are keen to make progress towards net zero, where this incurs additional development costs it can reduce the competitiveness for sites compared with other bidders are developing to Building Regulations and no more.

Key points

7.20 It is clear that there are changing attitudes to the energy performance of buildings and that part of the development industry response to net zero will be driven by consumer pressures as well as access to finance. However, in the short term it is not apparent that these changing attitudes are quickly translating into higher market values, although better energy efficiency is generally seen as part of a higher quality premium building.

7.21 There is a widespread view within the development industry that it is necessary to build higher quality houses with better environmental performance. In order to achieve this, some house

builders are pursuing higher construction standards, as well as adding solar PV and low carbon heating and ventilation to their products. It is reported that the marginal cost for Future Homes standard may be about 15% higher than currently although there are expectations that this will decrease as economies of scale and competition between suppliers take place, and as house design is optimised. In the short term there are supply chain issues, which will also have an impact on cost.

7.22 The Essex Developers Climate Action Charter is an important document, setting out how the development industry will work together to respond to climate change across the built environment sector.

7.23 The variety in the different building standards being pursued by planning authorities is not considered helpful by the development industry. Some housebuilders question whether the agenda is moving more quickly than the housing building industry and its supply chains can react.

Chapter 8 Net zero Guidance for local planning authorities

Introduction

8.1 There is a range of guidance available for the development industry and for planning authorities about making progress towards net zero. This study has included a review of some of the best-known guides and considered their potential role in delivering net zero in Essex.

Review

8.2 The table below provides an outline summary of the key guidance available with a discussion following that summarises the key points.

Table 8.1 Net zero Guidance

Title	Organisation	Date	Summary	Audience
Rising to the Climate Crisis - A Guide for Local Authorities on Planning for Climate Change	TCPA and RTPI	Third edition October 2021	Designed to support the policy outlined in the National Planning Policy Framework and online Planning Practice Guidance as well as the 2008 Climate Change Act. Focuses on mitigation (particularly energy use and generation), adaptation, and resilience. Rehearses the Section 19 of the 2004 Planning and Compulsory Purchase Act (as amended by the 2008 Planning Act) duty. Provides guidance on policy approaches and recommends the use of established assessment frameworks. Example policy wording is provided	Local Authorities and politicians
LETI Climate Emergency Design Guide	London Energy Transformation Initiative	January 2020	Considers operational and embodied carbon. Provides an overview and also considers demand response and energy storage as well as the issue of data disclosure about in-use performance of buildings and recommendations about the framework for measuring building performance. The guide sets out how different standards will reduce energy consumption for different building types.	Architects and housebuilders.

Title	Organisation	Date	Summary	Audience
Harlow & Gilston Garden Town Sustainability Guidance & Checklist	East Herts, Epping Forest and Harlow District Councils	March 2021	Provides details of design approaches in order to help applicants meet the Garden Town goals of becoming net zero-carbon by 2030, and, to build strong and integrated communities across new and existing places. Has detailed checklists for: • Building standards • On site renewables • Landscape • Movement and transport • Water use and drainage • Whole life materials use (circular economy) • Waste management • Air Quality Also includes digital sustainability, social & economic sustainability,	Developers, design teams, consultants and contractors.
net zero Carbon Toolkit	LGA with West Oxfordshire, Cotswold and Forest of Dean District Councils	August 2021	Provides guidance for new homes and retrofit dwellings, primarily on small to medium scale housing and covers all stages of building design, construction, maintenance and operation. Sets out the broad principles and more detailed information on implementation including development timelines. Recommends the use of Passivhaus specification.	Architects and housebuilders.
Building the Case for net zero: A case study for low carbon residential developments	UK Green Buildings Council	2022	The report sets out key considerations for developers, housebuilders, local authorities and consultants when planning new large-scale residential communities, based on the Trumpington Meadows development site (Cambridge) case study. It includes design changes to reduce embodied carbon and discusses the implications for the infrastructure costs.	Developers, housebuilders and local authorities

Title	Organisation	Date	Summary	Audience
The Future Homes Standard – A practical toolkit towards net zero	Baily Garner	2020	Notes the role of carbon reduction as part of a wider organisation restructuring. Includes design implications and a high-level review of technologies to meet higher building standards, and then advice on layouts. Includes a matrix of how different approaches meet changing standards up to 2025 Future Homes and potential cost implications.	Housebuilders and advisers.
Local Area Energy Planning: Supporting clean growth and low carbon transition	Catapult Energy Systems	October 2018	Guidance for local government to plan for decarbonised energy networks, in order to play a role in the national objectives. Includes: • Key environmental, social and economic drivers underpinning the national Clean Growth Strategy provisions for heat, energy networks and energy performance of buildings. • Ways in which Local Area Energy Planning can address the delivery challenges of the Clean Growth Strategy. • The planning policy framework for Local Area Energy Planning • Recommendations	Local authorities and energy network stakeholders.
Climate Change Assessment Tool and Guidance	Zero Waste Scotland	2015	Sets out adaptation and mitigation principles for addressing climate change. Excel based toolkit covers governance, emissions, adaptation, behaviour and procurement, and produces scores to assist in producing action plans.	Scottish Public Sector organisations

8.3 The 2021 TCPA and RTPI guide is considered particularly useful for planning authorities. It sets out planning guidance within the context of the NPPF and other planning regulation and guidance, and provides example policy approaches that have been developed in setting new local plan development management policies. The guide operates at different levels and can be helpful for planners or politicians starting out in developing climate change policy approaches, as well as those seeking more detailed guidance. The document includes a useful set of definitions as well as context, roles and plan making steps.

8.4 The 2020 London Energy Transformation Initiative (LETI) guide is focused on architects and housebuilders and is often quoted as a particularly useful document, including by development industry consultees contacted as part of this study. It positions itself as a design guide rather than a policy guide, and mirrors ECAC in advocating net zero carbon by 2025. The guidance in the document outlines how buildings should be designed now and standardised by 2030. The guide provides an overview and considers whole life carbon – both operational and embodied, as well as capacity building to meet the skills needed.

8.5 The more local 2021 Harlow & Gilston Garden Town Sustainability Guidance uses a checklist format to take the reader through the steps towards the garden town goals of becoming net zero-carbon by 2030 and, to build strong and integrated communities across new and existing places. While this is place-specific, the approach can be transferred to locations elsewhere in Essex.

8.6 The 2021 LGA funded net zero toolkit provides guidance for new homes and retrofit dwellings, primarily on small to medium scale housing and covers all stages of building design, construction, maintenance and operation, focussed on architects and housebuilders. By contrast, the UKGBC 2022 case study document considers the approach to large scale development and the design options and cost implications.

8.7 The other guides reviewed all contained useful information for both the development industry and planning authorities, including specialist energy network planning.

Key points

8.8 There is a considerable weight of guidance available both for the development industry and for planning authorities. These resources are generally freely available and it is likely that there will be further guides produced as more examples are built out and information becomes available. Given the wealth of general guidance already available, there is not a clear case for developing general guidance specifically for Essex.

Chapter 9 Options for achieving net zero

Standards to meet and ways of meeting them

9.1 This chapter considers the different options for achieving net zero and compares their carbon emissions and costs for the consumer.

9.2 In order to understand the impacts of the changes in standards we have modelled some typical house types to assess their impact on carbon emissions and against a number of other criteria. We review the following standards:

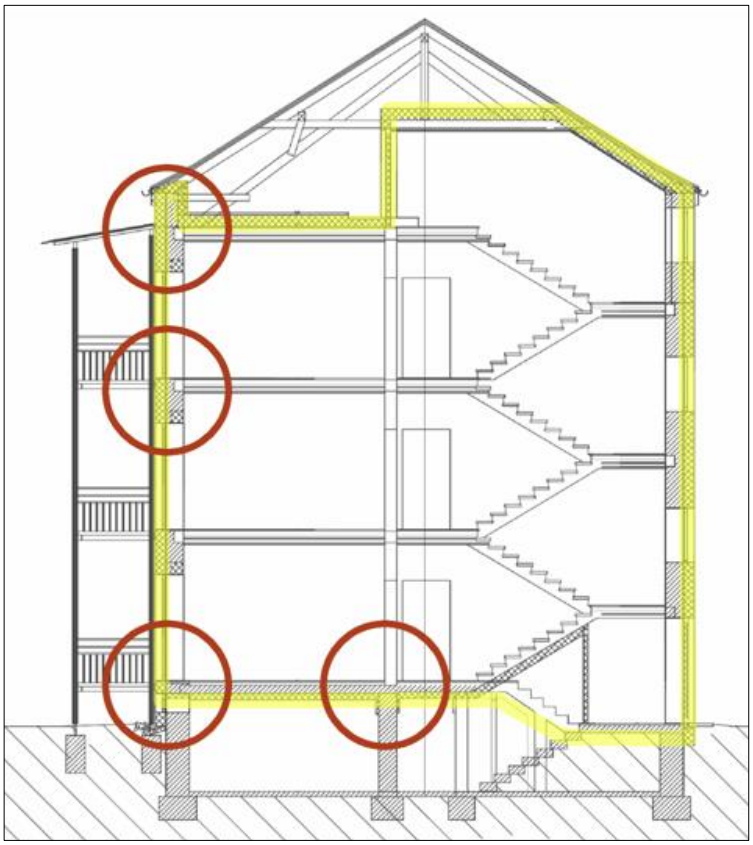
a. **Base case: 2013** Part L Building Regulations. The current position for most new builds in the planning process;
b. **2021 Part L** Building Regulations : came in to force on 15th June 2022;
c. **2025 Part L** Building Regulations : the Future Homes Standard scheduled for implementation in 2025[81];
d. "**net zero ready**" standard based on the **Passivhaus Classic** standard that is similar to the Future Homes standard but with some important refinements;
e. "**net zero carbon**" which is closely aligned with the UK Green Building Council (UKGBC) Framework Definition and the London Energy Transformation Initiative (LETI) in its Climate Emergency Design Guide. These closely match the requirements of the **Passivhaus Plus** standard.

See Figure 9.3 for an outline specification of the above standards.

9.3 Part L of the Building Regulations is concerned with the conservation of fuel and power and so sets the minimum standards for the performance of building elements such as roofs, walls, floors, windows and doors. It also provides requirements for limiting heat gains and losses from draughts and thermal bridges – weak points in the insulation which allow higher rates of heat transfer compared to the materials surrounding them: these are most common at wall and floor junctions, corners and eaves. Thermal or cold bridges are important for reasons of comfort, risks of moisture and mould which damage the fabric of the building or can be harmful to health if unchecked, and for energy conservation and therefore fuel bills.

[81] To do this we have needed to make assumptions about the detailed 2025 standards ahead of their publication. We have done this with reference to the government's consultation on the Future Homes Standard published in 2019 and found at https://www.gov.uk/government/consultations/the-future-homes-standard-changes-to-part-l-and-part-f-of-the-building-regulations-for-new-dwellings

Figure 9.1 Examples of key areas for eliminating thermal bridges by detailed design[82]



9.4 In the example above just 4 thermal bridges are ringed but in reality there are many more when considering the building in 3 dimensions. A short reference to thermal bridges is included here as calculated thermal bridges are now required by the 2021 Building Regulations as they gain increasing importance when designing very low energy houses.

9.5 Additionally, there are requirements for the minimum efficiencies of building services such as heating systems, ventilation and controls. The Building Regulations underpin the Future Homes strategy for achieving net zero for the UK by laying out the standards expected that have been calculated to contribute approximately a 75% reduction in carbon emissions with an anticipated and corresponding reduction of at least 25% in the emissions created by the national grid infrastructure in order to achieve the 100% reduction in emissions by 2050, compared to the carbon emissions calculated under the 2013 Building Regulations. The calculations are prepared using a Standard Assessment Procedure or SAP. The SAP provides the evidence that creates an Energy Performance Certificate or EPC for Building Regulations purposes.

[82] Illustration from Passivhaus Institute

9.6 We have compared the Building Regulations based standards with the performance based standards specified by the Passivhaus Institute, as explained in chapter 3.

9.7 It is important to note the subtle differences between Future Homes and Passivhaus standards. Whereas Future Homes uses natural or extract ventilation, Passivhaus uses MVHR (Mechanical Ventilation with Heat Recovery). The Future Homes proposal uses a generic u-value of 0.15 W/m2K for walls whereas Passivhaus is climate location based and in the UK a more standard figure for walls would be 0.11 W/m2K.. The Future Homes Standard uses photovoltaics whereas Passivhaus Classic does not. The PH Classic with PV is modelled with the same amount of PV panels as provided in the Future Homes Building Regulations formula.

Figure 9.2 Comparing Future Homes Standard with Passivhaus Classic - with same amount of photovoltaic panels.

Element/Standard	Future Homes	v.	Net Zero Carbon with PV
Ground Floor	0.11	=	0.11
External Walls	0.15		0.11
Flat Ceilings	0.11	=	0.11
Part Glazed Doors	1.00		0.80
Windows	0.80	=	0.80
Fully Glazed Doors	0.80	=	0.80
Thermal Bridging	ACD Psi Values		Psi value 0.04
Ventilation	Natural		MVHR
Air Tightness	5		0.6
Heat Source	ASHP 250%	=	ASHP 250%
Emitters	UFH + Rads 1st Floor	=	UFH + Rads 1st Floor
Controls	Programmer, 2+ room stats	=	Programmer, 2+ room stats
Hot Water	250l, 1.97 kWh/day	=	250l, 1.97 kWh/day
PV	Yes	=	Yes
Lighting	100% Low E	=	100% Low E
Building Standard	**Bregs 2025**	v.	**PH Classic + PV**

The floors, walls, and cold roofs (flat ceilings), doors and windows all show u-values (an indicator of the rate at which that element loses or transfers heat).[83]

Thermal bridging uses similar heat loss values that are known as psi values based on Accredited Construction Details. The 2021 Regulations now require these to be individually calculated as it is considered that the ACDs are inadequate for describing every type of thermal bridge encountered.

Ventilation is described as 'natural' when using the familiar standard extract fans and air vents encountered in most houses in the UK. MVHR (Mechanical Ventilation with Heat Recovery) is a ducted system of ventilation that provides fresh filtered air and extracts stale air while at the same time recovering heat during winter months.

Air tightness is a measure of 'draughtiness' with 5 air changes per hour (ach) in the case of the Future Homes Standard.

As a low carbon heat source we have assumed an Air Source Heat Pump (ASHP) system to heat hot water and provide space heating. As a fossil fuel gas boilers will be banned for new installations from 2025.

Emitters refer to Underfloor Heating (UFH) or radiators, with programmer and at least 2 room thermostats for controls.

The Hot Water insulated cylinder is a standard 250 litre unit with a daily heat loss of 1.97 kWh per day. We have used the same amount of photovoltaics (PV) on the roof for our archetypes and the same amount of low energy lighting.

[83] See key concepts section 3.36

9.8 The residential house types (known as archetypes) that are modelled for the purposes of the above standards comparisons are:

- Detached bungalow;
- Detached family house;
- End terrace house (or semi detached);
- Mid terrace house;
- Ground floor flat;
- Top floor flat.

We have also modelled a school – with results shown in the Technical Report for information

9.9 In modelling the standards, the assumptions used are shown in the table below.

Figure 9.3 Key characteristics of the standards assessed*

Element/Standard	Base Case	Part L 2022	Future Homes	Net Zero Ready - No PV	Net Zero Carbon with PV
Ground Floor	0.13	0.13	0.11	0.11	0.11
External Walls	0.18	0.18	0.15	0.11	0.11
Flat Ceilings	0.13	0.11	0.11	0.11	0.11
Part Glazed Doors	1.20	1.00	1.00	0.80	0.80
Windows	1.40	1.20	0.80	0.80	0.80
Fully Glazed Doors	1.40	1.20	0.80	0.80	0.80
Thermal Bridging	ACD Psi Values	ACD Psi Values	ACD Psi Values	Psi value 0.04	Psi value 0.04
Ventilation	Natural	Natural	Natural	MVHR	MVHR
Air Tightness	5	5	5	0.6	0.6
Heat Source	Gas Combi 95%	Gas Combi 95%	ASHP 250%	ASHP 250%	ASHP 250%
Emitters	Radiators	Radiators	UFH + Rads 1st Floor	UFH + Rads 1st Floor	UFH + Rads 1st Floor
Controls	Programmer, room stat & TRVs	Programmer, room stat & TRVs	Programmer, 2+ room stats	Programmer, 2+ room stats	Programmer, 2+ room stats
Hot Water	NA (Combi Boiler)	NA (Combi Boiler)	250l, 1.97 kWh/day	250l, 1.97 kWh/day	250l, 1.97 kWh/day
PV	No	Yes	Yes	No	Yes
Lighting	100% Low E	100% Low E	100% Low E	100% Low E	100% Low E
Building Standard	**BRegs 2013**	**BRegs 2021**	**Bregs 2025**	**PH Classic**	**PH Classic + PV**

*A fuller explanation of the Passivhaus (PH) categories can be found in chapter 3.

9.10 While some of what we say will inevitably be speculative, there are software tools based on the published 2021 Building Regulations Approved Document that allow us to model carbon

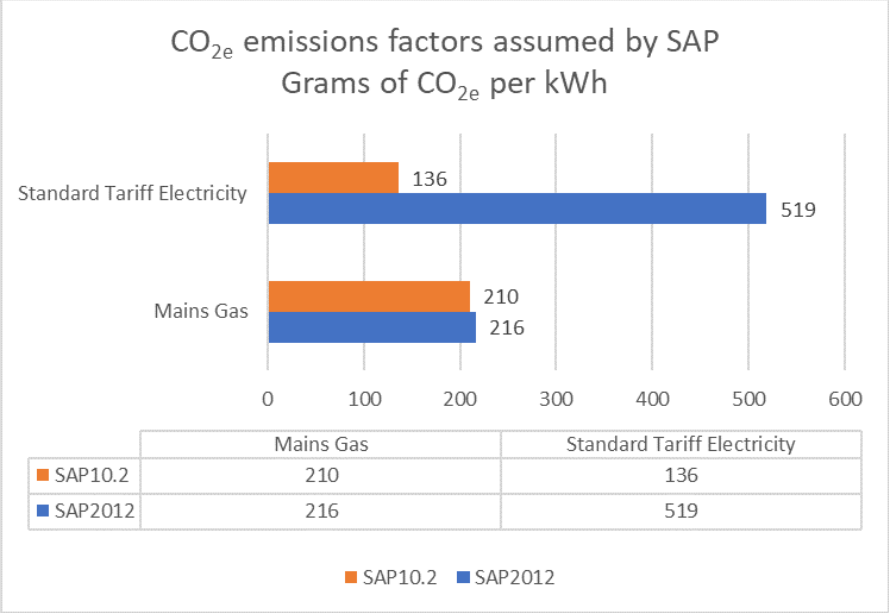
emissions and provide a broad indication of consumer costs for the series of archetypes set out above. There are two methodologies for doing this:

- SAP10.2 Beta Software Methodology;
- Passivhaus Planning Package (PHPP) Software Methodology.

9.11 The outgoing 2013 Building Regulations uses the SAP 2012 methodology which calculated that for every kilowatt hour of gas energy consumed 216 grams of carbon dioxide (CO_2) would be released into the atmosphere. With the impact of renewables on the production of natural gas the factor has been slightly reduced to 210grams CO_2/kWh. However, the impact of the switch to renewables for electricity has a more marked impact, reducing the CO_2/kWh from 519 grams of CO_2 to 136.

9.12 These changes are illustrated in the graphic below highlighting that, as a result of renewables contributions to the national grid, the fuel factor for standard tariff electricity is estimated to have reduced by almost 74%

Figure 9.4 Changes in the carbon emissions



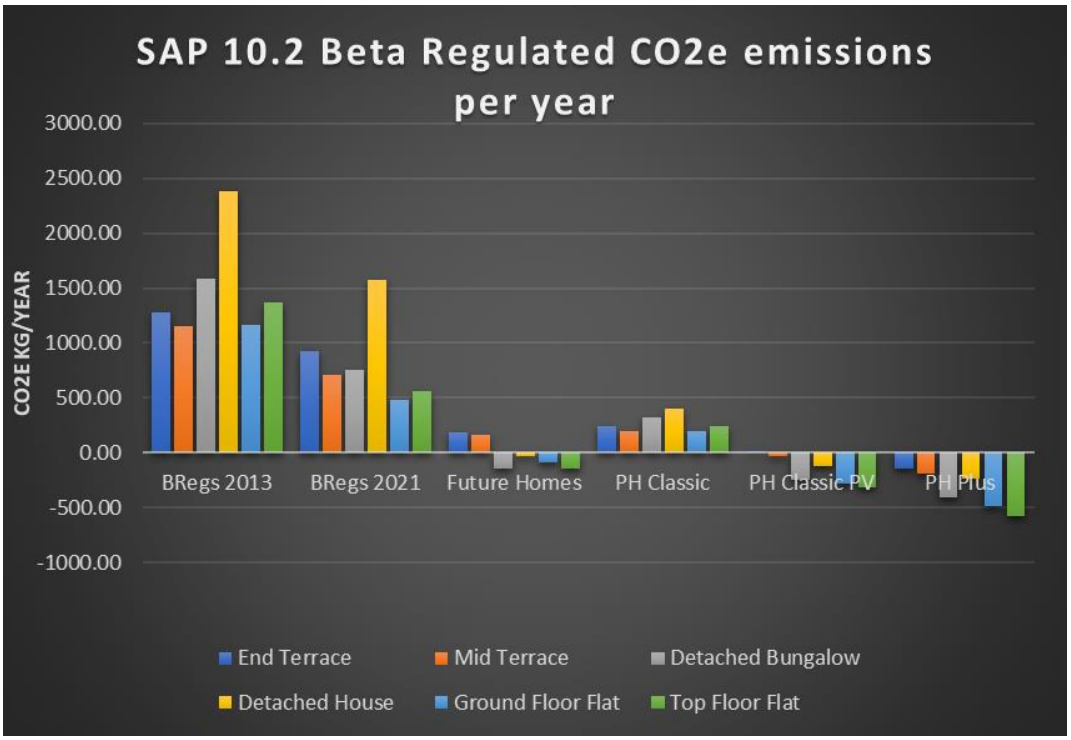
9.13 The effect of the calculated emissions favours newer technologies such as the electrically driven air source heat pump (ASHP) while the higher emitting gas boiler is penalised by comparison.

Carbon emissions for the archetypes – modelling results

9.14 The evaluation of carbon emissions demonstrates a reduction in emissions across all house types and across all the standards modelled. The testing has used both the SAP 10.2 and the

PHPP modelling techniques. Results using the former are reported here and those using the PHPP approach are shown in the Technical Report. The results are different but give a consistent picture of improvements across the different standards.

Figure 9.5 Carbon emissions for dwelling archetypes and at different standards – presented graphically and as a table



SAP10.2 Method	Fails SAP10.2 Net Zero Carbon Assessment			Net Zero Carbon rated		
SAP10.2 Beta Regulated CO2 emissions/year (DER Box 272)	**BRegs 2013**	**BRegs 2021**	**Future Homes**	**PH Classic**	**PH Classic PV**	**PH Plus**
End Terrace	1276.13	921.07	183.77	236.71	1.86	-150.25
Mid Terrace	1148.26	713.70	158.70	197.90	-36.95	-189.06
Detached Bungalow	1588.32	748.95	-147.82	320.47	-247.55	-410.47
Detached House	2383.91	1568.62	-31.83	402.92	-121.41	-242.03
Ground Floor Flat	1165.73	477.21	-92.52	201.46	-280.26	-486.48
Top Floor Flat	1368.53	556.65	-149.24	243.77	-318.79	-573.16

9.15 Archetypes built to the 2013 Building Regulations, when assessed using SAP10.2 for the 2021 Building Regulations, will all fail to achieve net zero carbon as is anticipated for buildings constructed to the 2021 Regulations, which aim to achieve a reduction of at least 30%. The results start looking more promising with the Future Homes standard with four of the

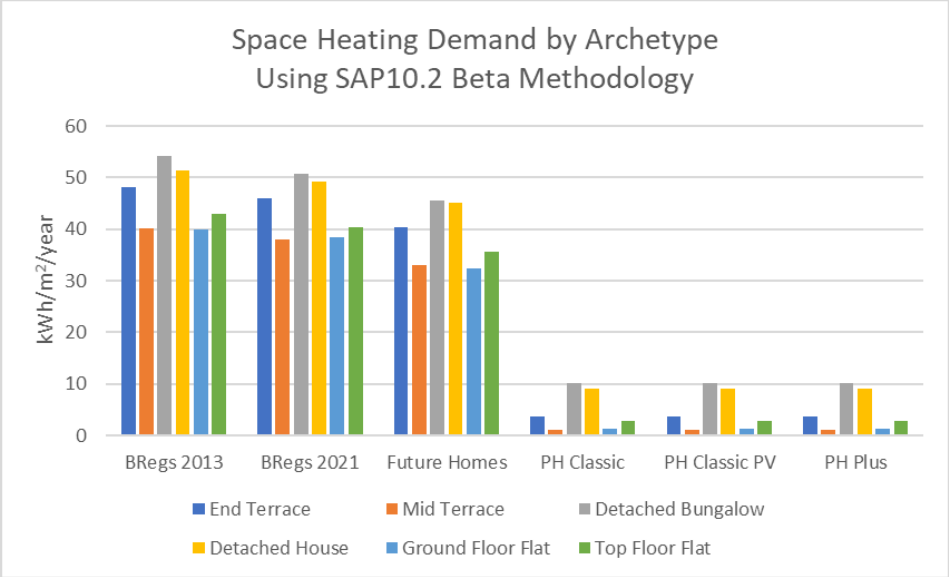
archetypes achieving net zero – highlighted in green. With the Passivhaus Classic standard, there is a significant reduction in carbon emissions when compared to the 2021 Building Regulations but this is achieved without photovoltaics. When PVs are added to the PH Classic, at the same level as used on a Future Homes specified property, this specification achieves net zero except in the case of the end terrace model – it is however only a slight margin off being net zero and produces 99% less CO2 than the Future Homes standard.

Space Heating and Fuel Poverty

9.16 The Standard Assessment Procedure (SAP) also reflects the costs associated with heating a home. However it will only ever be half the story because SAP assesses the regulated energy costs but not the unregulated. Additionally the cost factors can be wildly out of date especially during the current energy supply crisis: SAP 2012 assumed a standard electricity tariff at around 13pence per kilowatt and the new SAP10.2 will assume a figure around 16.5pence per kilowatt. This may not reflect real costs at the time of writing but gives an indication of the impact of different standards on energy costs.

9.17 An alternative approach is to estimate the likely energy use in kWh per square meter of space that is being heated per annum – known as kWh/m2/yr. This provides a reliable metric for both human comfort and costs. Modelling of our housing archetypes built to 6 different building specifications shows some striking results.

Figure 9.6 Space heating demand by archetypes using SAP 10.2 method

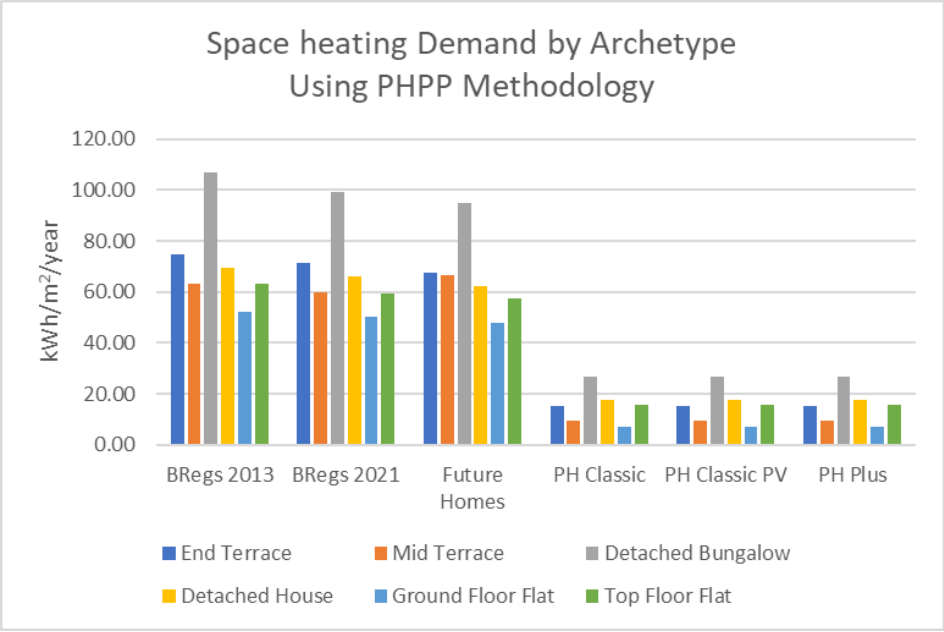


9.18 One of the significant aspects of the above chart is how the Passivhaus Classic model, which uses no renewables but otherwise is closely specified to the Future Homes standard, is nevertheless considerably less wasteful of space heating energy. In large part this is due to the

airtightness specification of Passivhaus which is set in our model at 0.6 air changes per hour at 50 Pascals of pressure in an air test as compared to the Future Homes standard requirement of 5.0 air changes per hour. In the UK the fabric u-value of the walls needs to be around 0.11 for Passivhaus generally to respond to local climate conditions so this has been adopted over the Future Homes specification of 0.15W/m^2 - a difference of only 0.04 W/m^2 - otherwise floors, roofs and windows have the same u-values. The results are also a function of the Future Homes Standard natural ventilation approach which is essentially uncontrolled draughts and intermittent fans as compared to the Passivhaus requirement for Mechanical Ventilation with Heat Recovery (MVHR). MVHR has the added benefit of optimising the provision of filtered fresh air at a controlled rate thereby giving health advantages and comfortable even temperatures, neither of which are a concern of the SAP model. The graph would appear to show that the PH properties are all achieving the PH space heating demand requirement maximum of 15kWh/m2/year and therefore providing considerable benefit to low income occupants.

9.19 If we now compare the PHPP analysis of the same archetypes, located in a south England climate zone, the space heating demand increases, in some cases almost doubling (notice the changed axis values on the left of the chart). This is because PHPP accounts for unregulated energy plug loads as well as regulated energy. In some of the PH cases the space heat demand limit required for achievement of the PH certification has been exceeded. However, the three Passivhaus types still out perform the other standards assessed across all the archetypes.

Figure 9.7 Space heating demand and unregulated demand - using PHPP method



9.20 There is a significant difference in the Building Regulations Heat Demand figures when compared with the Passivhaus approach. The 'PH Classic PV' column is modelled with the same amount of PV Panels as the Future Homes standard requires and is primarily

differentiated by airtightness and MVHR and yet the Passivhaus columns with PV are almost all complying with net zero Carbon – the end terrace only misses net zero by 0.2% which could be easily tweaked in the fabric. The reduction in space heating when you compare "Future Homes" with "PH Classic plus PV" speak for themselves even under the government's own preferred procedure for assessment. For example the detached bungalow which is the worst performing archetype is often a house type occupied by people with disabilities for obvious accessibility reasons but who may also be on a low income: even in this case the 'PH Classic with PV' is over 77% less costly to run in terms of space heating than the proposed Future Homes Standard. From this it can be seen that Passivhaus has additional health and well-being advantages.

9.21 Passivhaus (PH) principles are applicable to any building whether residential or not, consequently we do not differentiate for the purposes of policy as PH is based on building physics. However, within the PH approach different uses of buildings are included to inform the efficient use of that building with economics and energy supply as key factors. The Space Heating Demand target of 15kWh/m2.year is the same for both residential and non-residential buildings. If the ECC moves towards Energy Use Intensity targets LETI provides a range of realistic targets depending on the type of building.

Will costs of new technologies decrease over time?

9.22 Traditionally, the cost of new technologies tends to reduce over time as they become mainstream but the current international economic uncertainties makes forecasting future costs of new technologies particularly difficult. Elsewhere in the report we have set out the rather mixed views of the development industry on this point.

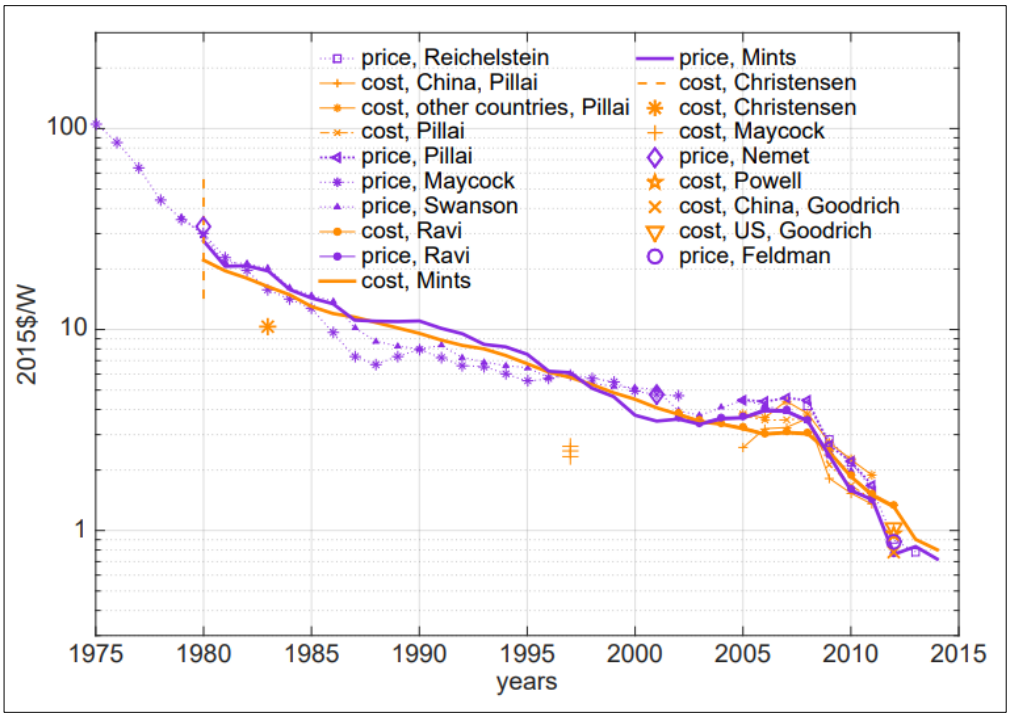
9.23 But drawing an analogy from the cost of photovoltaic panels (PV), reduction in costs seem to be a strong possibility. Costs of PV have fallen substantially over the past 40 years as reported in a study conducted by the Massachusetts Institute of Technology, published in Science Direct in 2018[84]. A number of reasons for this reduction were cited including:

- Improvements to module efficiency and materials costs were important;
- Since 2001, increasing plant size enabled economies of scale to reduce costs;
- Market-stimulating policies were responsible for a large share of PV's cost decline.

9.24 The chart below tracks the costs and prices of PV modules from 1975 to 2014.

[84] Evaluating the causes of cost reduction in photovoltaic modules (sciencedirectassets.com)

Figure 9.8 Reduction in the cost of PV – 1975 to 2014[85]



Module cost in purple - Module price in orange

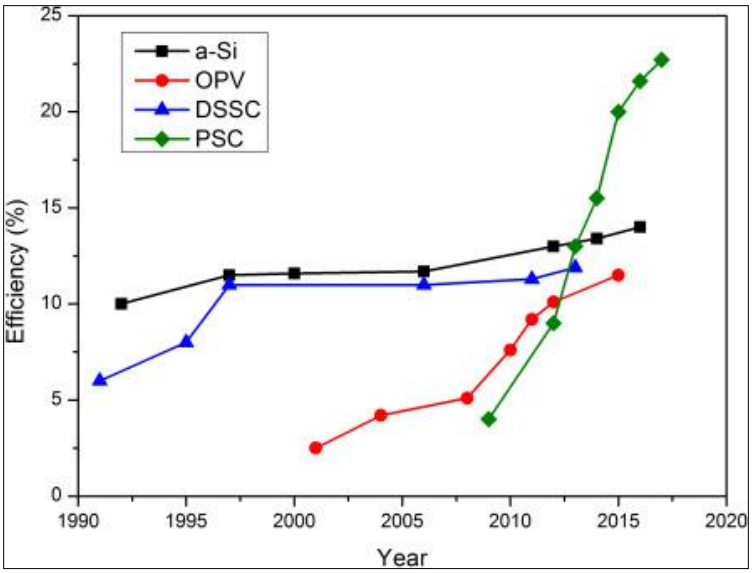
9.25 There are encouraging signs in Oxford[86] of a new composite material approach to producing PV panels that will make them cheaper to produce but with greater generation efficiencies, by 30%, at a more affordable cost for the mass market. Production is being ramped up in Germany even now with the hope of improving efficiency and driving down costs within just a few short years.[87]

9.26 Material property research and development into perovskite solar cells has boosted efficiency to a reported 30% efficiency, greater than standard solar PV panels.

9.27 The image below shows the rise in efficiency of perovskite solar cells development from 2009-2017 (PSC - green line) compared with other more common PV panels.

[85] Evaluating the causes of cost reduction in photovoltaic modules (sciencedirectassets.com)
[86] https://www.oxfordpv.com/perovskite-silicon-tandem
[87] https://www.sciencedirect.com/topics/engineering/perovskite-solar-cells

Figure 9.9 Increased efficiency of PV panels[88]



Air Source Heat pumps (ASHP)

9.28 Following the recent announcement by the Chancellor that VAT will be zero rated on the supply and installation of heat pumps, there is a promise of more affordable low carbon heating technology to replace gas boilers. The Octopus Energy company, a major energy provider, has also invested over £10 million in a production and training centre for heat pumps in Slough. The ambition of the company is to drive down the unit costs and to train a workforce of installers to ensure correct and more efficient installations at a cheaper price.[89] Octopus Energy is intending to roll out its new 'low cost' heat pumps this year.

Other options to reduce carbon emissions

Heat networks

9.29 BEIS have set out a far reaching Heat and Buildings Strategy in a document published in October 2021. In it, the government states[90]:

[88] https://www.sciencedirect.com/topics/engineering/perovskite-solar-cells
[89] https://www.heatpumpsscotland.org/octopus-energy-heat-pump-installation/
[90] https://www.gov.uk/government/publications/heat-and-buildings-strategy pages 159 and 160.

> Through the Heat Network Transformation Programme, we will continue to grow the market for low-carbon heat networks through the 2020s and provide financial support through the Green Heat Network Fund, combined with heat network zoning in the latter half of the decade.

9.30 One of BEIS's principal approaches is to work with local authorities to identify and develop existing and new heat network zones. A page from this document shown below best describes its ambition. The idea behind generating low carbon heat networks is to support the national grid's decarbonisation programme at a more local level

Figure 9.10 Extract from the BEIS Heat and Buildings Strategy

Heat network zoning

We consider zoning to be a solution for supporting the development of existing and new heat networks in the 2020s. We are proposing the introduction of heat network zones in England by 2025,[422] providing local authorities with the powers to identify and designate areas best suited for heat networks as the lowest cost, low-carbon solution. Given the diversity of local authorities we recognise that a one-size-fits-all is not appropriate and intend to ensure a flexible approach regarding the level of support and split of functions between central and local government (and industry), to ensure the most appropriate approach can be taken in each locality. Heat network zoning builds on the work the Heat Networks Delivery Unit has been doing since 2013 with local authorities to identify and develop heat network opportunities and we are already piloting how zoning could work through our City Decarbonisation Delivery Programme[423].

Heat network zoning will help drive demand for heat network connection and grow the market by requiring certain buildings in heat network zones to connect to networks, where it is cost-effective to do so. Providing certainty that some types of building within a heat network zone will connect to the network and use the heat provided will give project sponsors and investors greater assurance which helps support delivery of viable, large-scale heat networks. This also helps drive the pace of deployment while reducing cost and enabling new investment models. Giving local authorities the powers to require buildings within heat network zones to connect to the network would help households and businesses to plan for their transition to Net Zero. It would also provide investment certainty to heat network developers and local authorities.

We propose that within heat network zones, large public sector buildings, large non-domestic buildings, all new-builds and residential buildings which are already heated via communal systems (such as tower blocks) should be required to connect to the heat network within a given timeframe. We also propose that buildings could apply for an exemption from the requirement to connect, in order to avoid suboptimal outcomes – for example, where a low-carbon heating system is already installed. Many of these building types align with the buildings that are best equipped in 2020s for the transition, including public sector buildings, new-builds, social housing and large commercial and industrial buildings.

Starting the natural transition of these buildings in the 2020s will support the action needed to save emissions and grow the low-carbon heating markets ready for wholesale transition in the 2030s and 2040s.

[421] BEIS (2021), 'Proposals for heat network zoning' (https://www.gov.uk/government/consultations/proposals-for-heat-network-zoning).

[422] Scotland recently enacted proposals on zoning in the 'Heat Networks (Scotland) Act 2021'. See: https://www.legislation.gov.uk/asp/2021/9/contents/enacted.

[423] BEIS have worked with six cities (Bristol, Birmingham, Greater Manchester, Leeds, Newcastle and Nottingham) to pilot the identification of potential heat network zones. Whilst we are planning further, more detailed pilots this work has informed the approach outlined in our recent consultation, particularly in relation to the methodology and the data likely to be required in the identification and designation of potential zones.

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9.31 The Heat and Buildings Strategy highlights that heat networks can have a role in providing low carbon solutions in particular circumstances e.g. to provide hot water in high density (flatted) developments where ASHP not available.

Off-setting

9.32 Off-setting is sometimes cited as the last of the solutions for achieving net zero . Where carbon emissions are unavoidable or where onsite renewables are not viable, because of location constraints, the practice of off-setting comes in to play. An example of this might be the planting of trees where X amount of tree planting can displace or sequester x tonnes of carbon emissions. In practice tree planting will sequester only small amounts of carbon compared to the area required to off-set the carbon emissions of a building.

9.33 Grants from the Forestry Commission and work undertaken under the Treescape Fund has already made substantial progress in tree planting across Essex. However this ameliorating strategy for capturing carbon is an ongoing task often carried out by volunteer groups and it is difficult to attribute these initiatives to specific building programmes. There is also the danger of over accounting with many schemes trying to claim the same patch of forest.

9.34 In these circumstances building off-sets should be treated as a low contributor to decarbonisation to emphasise the need for reducing impacts through material choices, local sourcing wherever possible, local factory production, reduced transport and plant movements using low carbon fuels, and low energy design.

Key points

9.35 Testing a series of archetype dwellings has highlighted that changes beyond those included in the 2021 Building Regulations are needed to deliver net zero development. A fabric first approach using a 'classic' Passivhaus will deliver housing at net zero for all the archetypes tested – the exception being the end terrace (although even here this is less than 2% away from net zero). With the addition of photovoltaics, at an equivalent level to the Future Homes standard, new housing can become carbon positive.

9.36 Space heating demand, as a measure of the cost of heating a home and levels of comfort for occupiers, reduces as the new standards are introduced. However, it is only with a fabric first, Passivhaus, approach that there is a significant reduction in space heating demand (and consequently in household costs, with positive benefits for comfort and health.)

9.37 Other options for reducing carbon emissions such as heat networks and carbon off-setting can also have a role in reducing carbon emissions in new developments but these need to be seen as working alongside a fabric first approach and not as an alternative.

9.38 There is some evidence that costs of the new technologies will reduce over time but the evidence is not direct and it would be unwise to rely on this until more definitive evidence is available.

Chapter 10 Implications for viability of development

Overview of approach

10.1 In the previous chapter, the report looked at the various methods and technologies available to assist both residential and non-residential development meet the net zero targets set out by ECAC. This chapter deals with the development cost implications and how they could affect delivery and the ability of development to meet other plan policies for residential development. It describes the approach and inputs to an Essex wide economic viability assessment and the implications of the results.

10.2 With reference to plan-making, the National Planning Policy Framework (NPPF) recognises the importance of positive and aspirational planning but states that this should be done 'in a way that is aspirational but deliverable'[91] . It advises that cumulative effects of policy should not combine to render plans unviable.

"Plans should set out the contributions expected from development. This should include setting out the levels and types of affordable housing provision required, along with other infrastructure (such as that needed for education, health, transport, flood and water management, green and digital infrastructure). Such policies should not undermine the deliverability of the plan."[92]

10.3 Planning Practice Guidance (PPG) provides further detail about how the NPPF should be applied and contains general principles for understanding viability. The approach taken in this report reflects the latest version of PPG (at time of writing), as updated in September 2019 relating to viability. PPG states that viability assessments should be supported by appropriate available evidence and follow the government's recommended approach in respect of being proportionate, simple, transparent and publicly available[93].

10.4 The approach taken in this study is necessarily high level to account for the wide area remit. It follows PPG in that it uses publicly available data where possible, adjusted to reflect locality and takes average values accounting for land use, form, scale, location, rents and yields[94].

10.5 For residential viability testing we have used a standard residual value methodology as described in PPG[95].The residual value of development is the total value of the scheme less all development and policy costs, including planning obligations, developer return and costs

[91] Para 16 b NPPF
[92] Para 34 NPPF
[93] Paragraph: 010 Reference ID: 10-010-20180724 PPG
[94] Paragraph: 011 Reference ID: 10-011-20180724 PPG
[95] Paragraph: 010 Reference ID: 10-010-20180724 PPG

associated with land purchase. If the end value is positive, the scheme is said to be viable. For the testing we used the Three Dragons Toolkits for residential development.

10.6 The assessment of viability is based on a series of typologies reflecting the type of development likely to be delivered in Essex in the next few years. The typologies and testing assumptions have been sense checked with stakeholders through the development industry workshop and follow up interviews and in some cases have been amended to take account of comments. We have used the typologies to test the impact of:

- 2021 updates to Building Regulations which come into effect in June 2022 and require a 31% reduction in carbon emissions;[96]
- The government's Future Homes consultation which requires a 75-80% reduction in carbon by 2025;[97]
- ECAC's ambition for buildings to be net zero carbon by 2025.

In each case we have compared the scenario to a base case of the 2013 Building Regulations.

Typologies tested

10.7 10 residential typologies were tested, selected in conjunction with ECC and stakeholders. The typologies represent a broad spread of typical development schemes across Essex and are tested on both notional greenfield and brownfield sites. A full list is shown in the table below and further detail can be found in the Technical Report.

[96] https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l - volume 1 applies to dwellings and volume 2 to other buildings

[97] https://www.gov.uk/government/consultations/the-future-homes-standard-changes-to-part-l-and-part-f-of-the-building-regulations-for-new-dwellings

Figure 10.1 Details of residential typologies tested for this report

Scheme ref	Number dwellings	Scheme Type	Land use	Density per net ha
Res1	1	Single house	Brownfield	30
Res2	9	Houses	Greenfield	30
Res3	9	Houses	Brownfield	30
Res4	35	Houses and flats	Greenfield	35
Res5	35	Houses and flats	Brownfield	35
Res6	120	Apartment scheme	Brownfield	120
Res7	260	Houses and flats	Greenfield	35
Res8	260	Houses and flats	Brownfield	40
Res9	5,000	Large greenfield site Houses and flats	Greenfield	35
Res10	55	Specialist older persons apartments	Brownfield	110

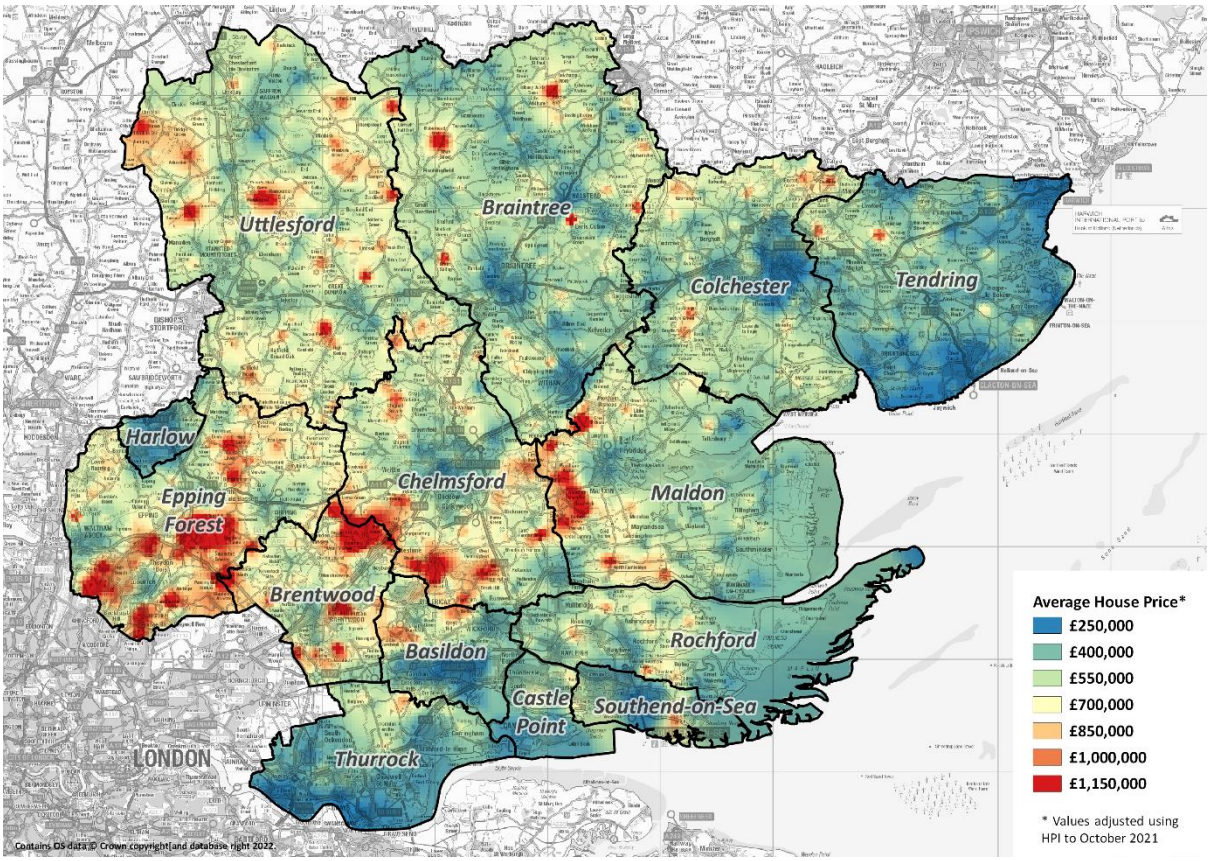
Assumptions used in the viability testing

10.8 The geographical Essex-wide scope of this study means that for viability we need to derive a set of viability testing assumptions that are robust enough to enable interpretation of the impact of net zero carbon on local development but, at the same time, can be applied across the county. To achieve this we have relied on published locally based information sources, sense checked with council officers and developer stakeholders – these are referenced in the paragraphs below.

Residential market values and value areas

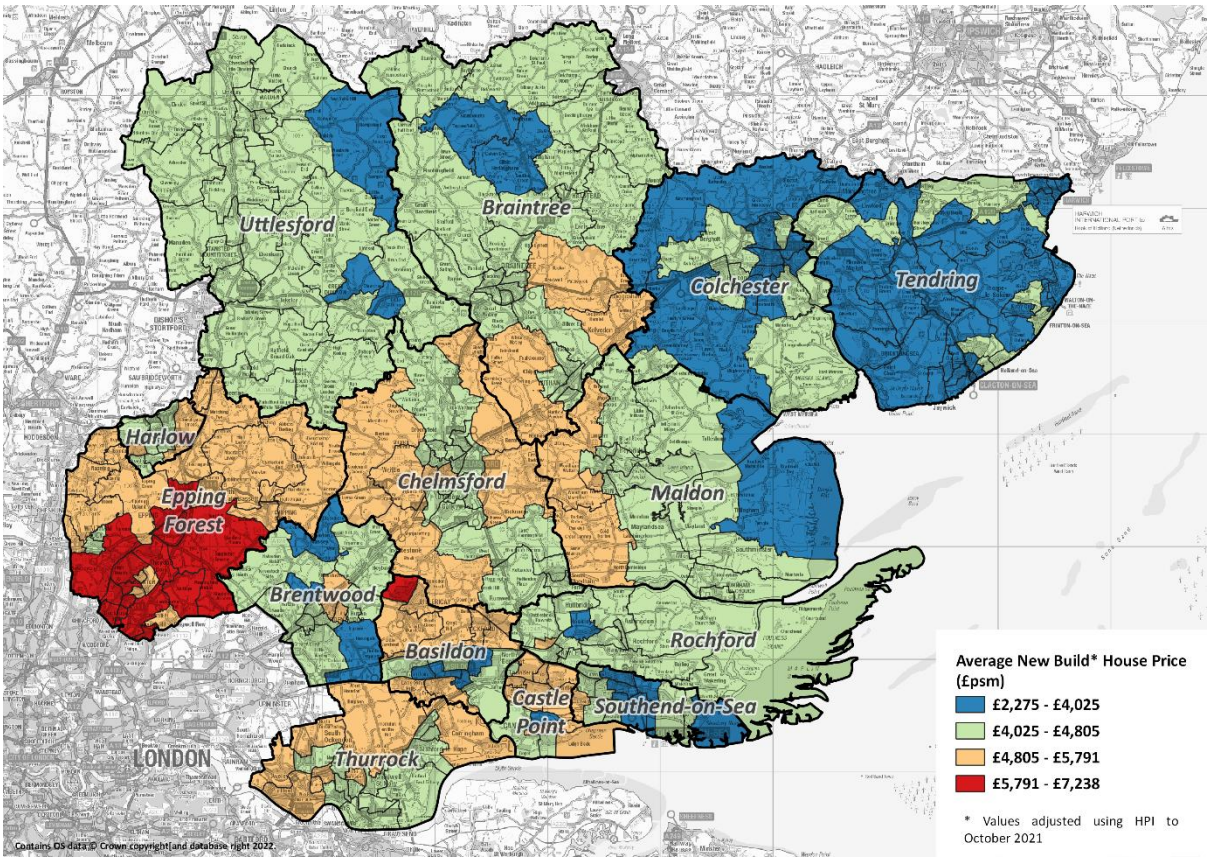
10.9 There is considerable variation in house prices across Essex and the heat map below demonstrates the range of values in the various districts, adjusted to the House Price Index at October 2021. Values tend to be higher in the north of the county and nearer to London, with most of the lower values in the coastal areas.

Figure 10.2 Essex house prices heatmap



10.10 To allow for high-level testing across the county an analysis of Land Registry data has identified 4 market value areas operating in Essex, although, as the previous map demonstrates, there will be a range of prices within each area. Each local authority will, of course, have its own subset of market value areas which will have been used for local plan viability testing but to avoid an overly complex set of results, we have taken the Essex-wide approach shown on the map below.

Figure 10.3 Essex house price value areas



10.11 Each of the typologies has been tested in all 4 value areas. For sales values we have taken the median point (rounded) of the range expressed as shown in the following table.

Figure 10.4: Essex house prices by value area - £ per sqm

House prices sqm	Houses	Flats
Value area 1	£3,750	£3,400
Value area 2	£4,440	£3,730
Value area 3	£5,200	£5,000
Value area 4	£6,400	£7,450

10.12 Some sales values are derived on a different basis:

- for the older persons scheme we have used the Retirement Housing Group guide[98] which equates the value of a 1-bed sheltered apartment with approximately 75% of the price of an *existing* 3-bed semi-detached house;

[98] CIL Viability Appraisal Issues RHG 2016

- for the large greenfield site we have reduced sales values by 5% which reflects local appraisals as well as our experience of similar developments elsewhere, indicating that values are likely to lower on such sites, especially initially, taking into account anticipated volume of dwellings and the time it takes to develop on-site infrastructure.

Benchmark land values

10.13 Planning Practice Guidance sets out the principles that area wide viability studies should follow when taking land values into account including thatbenchmark land value should:

- "be based upon existing use value
- allow for a premium to landowners (including equity resulting from those building their own homes)
- reflect the implications of abnormal costs; site-specific infrastructure costs; and professional site fees.[99]"

10.14 The Technical Report (appendix 9) includes further information about the guidance and information taken into account to derive the benchmark land values shown in the table below.

[99] PPG Paragraph 013 Reference ID: 10-013-20190509 and Paragraph 014 Reference ID: 10-014-20190509 PPG

Figure 10.5 Essex-wide benchmark land values

	Greenfield	Brownfield
Upper of range	£0.45m ha (£182,000 acre)	£2.0m ha (£809,350 acre)
Lower of range	£0.25m ha (£102,000 acre)	£0.5m ha (£202,350 acre)
Average (as used in study)	£0.375 ha (£151,750 acre)	£1.1m ha (£445,000 acre)
Note - Abnormal costs including flood resilience, contamination, levelling etc to come off land value as per PPG		

Residential cost assumptions used in the testing

10.15 To arrive at the general cost assumptions for Essex wide economic viability testing we have drawn on a number of data and other sources including:

- Published indexes, especially Building Cost Information Service (BCIS), Land Registry values and House Price Index (HPI), Energy Performance Certificates (EPCs) for dwelling size;
- Published local viability studies for local authorities in Essex;
- Discussion with ECC and district council officers;
- Stakeholder workshop and follow up interviews with developers;
- Industry norms and standard practice – the assumptions have been benchmarked against national and local appraisals, most of which have been through examination – see the Technical Report.

10.16 The testing has taken account of plan policies with Essex-wide application including, for affordable housing, where we have assumed that 30% of development over the 10 unit threshold is for this purpose. We are aware that some district councils, such as Uttlesford and

Epping Forest require a higher contribution and for others, such as Southend, it is lower. However, 30% represents a mid-range requirement for the county.

10.17 Building costs have been based on BCIS, rebased to the local indexes, and using the mean to lower quartile build costs. We have also included an allowance for site infrastructure and potential higher costs associated with meeting electric vehicle charging, biodiversity net gain and accessible housing.

10.18 For s106 (planning obligations) payments, we have referenced recent local plan viability studies and the Essex-wide Developers' Guide to Infrastructure Contributions (2020). Both s106 and site infrastructure payments have been increased significantly for testing the large greenfield site.

10.19 The assumptions are set out in detail in the table below.

Figure 10.6 Essex-wide residential viability modelling assumptions

Cost	Source	Level
Build cost	BCIS Essex – using 5-year mean index for mixed development for fewer than 10 houses, then sliding scale to LQ at 250 houses. Mean index for all flatted development	£1,320 sqm – houses £1,174 sqm – houses on sites over 250 dwellings £1,457 – flats 1-2 storeys £1,504 – flats 3-5 storey £1,736- specialist accommodation
External works / plot costs	Industry norm / local benchmarking	15% - fewer than 10 units 10% - over 10 units
Strategic infrastructure/opening up	Industry norm / local benchmarking	£5,000 unit - 10-250 units £10,000 unit – 250+ units £25,000 unit – large greenfield (5,000 units)
Circulation space - flats	Industry norm / local benchmarking	10% - 1-2 storey 15% - 3-5 storey 25% - older persons
s106	Discussion with stakeholders / benchmarking / Essex guide[100]	Range from £2,500 for single unit through to £40,000 per unit on large greenfield site

[100] Developers' Guide to Infrastructure Contributions ECC 2020

Cost	Source	Level
Affordable housing	Review of district local plans (existing and emerging) % also meets requirement that 10% of development should be for affordable home ownership[101]	30% of delivery on sites of 10 or more dwellings – of which 65% rented and 35% affordable home ownership
Affordable housing transfer value	Based on district local plan viability studies and capitalised net rent calculation	Blended value of 60% of open market ([102])
Developer return	Local benchmarking – within range expressed in PPG[103]	20%
Interest	Benchmarking and up to date Homes England borrowing rates	6%
Bio diversity net gain	Government impact assessment[104]	£998 unit – Greenfield £270 unit – Brownfield £14,000 ha – non-residential
Electric vehicle charging	Government impact assessment[105]	£865 per charger £100 ducting
Accessibility part M (2)	Part M4(2) - Government impact assessment 2020	£1,400 unit
Garages	Local benchmarking	75% of market homes £7,700 per unit
Build out	From Essex studies	6 months to first sale then 40 pa Large greenfield site – 25 years Older persons – 2 years, no sales until complete

Costs to reach the residential carbon reduction specifications

10.20 This section outlines the approximate additional costs for various building typologies in advance of updates to the Building Regulations to achieve net zero, starting with (for residential Buildings) conforming with Part L 2021, then the likely "next step" of Future Homes in 2025 2025 (for which little specific guidance is available) and finally buildings which are considered net zero in terms of the regulated carbon emissions.

[101] Para 65 NPPF
[102] Based on a 65/35 tenure split (rounded) rented units at 55% open market value & affordable home ownership at 70% of open market value
[103] Paragraph: 018 Reference ID: 10-018-20190509 PPG – to note that followed local precedent in identifying the upper point in the range
[104] Government Net Gain Impact Assessment – central scenario
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/839610/net-gain-ia.pdf
[105] https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l

10.21 It is very challenging difficult to provide an exact figure which can be applied as a blanket approach to all developments, as the design requirements to achieve the various steps towards net zero differ from site to site and will be governed by site specific opportunities and constraints.

10.22 The study team's cost consultants[106] have gathered data on various building typologies over the last 12 months, working with developers to identify the average costs they are seeing to adopt the technologies to deliver net zero carbon buildings, as well as preparing estimates with energy strategies which take this approach. The cost consultants have also received cost data on buildings which achieve the Part L 2021 requirements and have made assumptions based on design guidance from consultants on what achieving the Future Homes standards might cost.

10.23 All of the data only considers regulated carbon, and the cost associated with adopting net zero carbon for this measure. It is impossible, from a construction cost, to identify what the premium could be for unregulated carbon, as this is down to building user habits, and differs wildly between different demographics and socio-economic situations.

10.24 The following is a review of the extra over cost for achieving the various steps to net zero buildings for a range of building types. All of the figures quoted are an additional cost to the current Regulations (i.e. prior to the implementation of the Part L 2021 Regulations in June 2022) and assume an average UK location and are based on costs current at the first quarter of 2022.

Residential Buildings

10.25 The additional costs for the various improved building standards, are based on a series of additional measures to achieve the new standards. These are summarised in the table below

[106] Ward Williams Associates (WWA)

Figure 10.7 Additional specifications required to achieve carbon reduction standards

Standard	Additional Measures
Part L 2021	• At least 31% less Carbon emissions target (compared to Part L 2013) • Increased insulation • Provision of PV unless alternative route can be proven. (40% of Ground Floor Area formula) • Waste Water heat recovery; and • Better thermal performance of windows. • CIBSE TM59 overheating and shading considerations
Future Homes 2025	• At least 75% less Carbon emissions target (compared to Part L 2013) • *No formal guidance but* overall improvements in the fabric specifications should achieve the target reduction. To be demonstrated with an Energy Performance Certificate (EPC)and to include an alternative to fossil fuel boiler e.g. air Source Heat Pump plus efficient water cylinder.
Carbon Net Zero (as at 2025 in line with ECAC targets) **Equivalent to Passivhaus Classic + PV**	Carbon net zero will likely mean the following **additional** steps: • Provision of PV

10.26 Based on our research, the likely forecast costs associated with each of these steps is detailed below. In putting forward these costs we recognise that there are various options for achieving the new standards (particularly those further into the future) and that lower or higher costs than those used for this exercise could be applicable. The costs used here are necessarily high level and based on one set of assumptions at this time.

Figure 10.8 additional specifications required to achieve carbon reduction standards

Building Type	Cost of achieving Standard (£s)		
	2021 Building Regulations*	2025 Future Homes (+)	net zero (+)
Average 2-bedroom terraced house – circa 70m^2	3,000	12,000	14,000
Average larger 3-bedroom house, or small 4 bedroom – circa 97m^2	3,000	13,500	16,000
Average 1 or 2-bedroom apartment – circa 56m2 NIA (i.e. plus circulation)	1,900	8,000	11,000
	*Additional costs on current Regulations + Additional costs on 2021 Regulations		

10.27 In arriving at these costs, note should be taken of the following points:

- MVHR systems can sometimes be used to supplement low carbon heating. For example, WWA has evidence of projects constructed in the last year, where no heating was installed on the first floor, other than a small heat pad in bathrooms. MVHR systems have been used to heat the first floor by recirculating the waste warm air from the ground floor onto the first floor. In this instance, evidence shows that the cost of the ASHP installation as above, is reduced by around 30%;
- The stakeholder workshop and subsequent interviews have confirmed that the cost of purchasing and installing ASHPs and MVHR are in part inflated by skills and supply shortages and may reduce over time;
- In respect of terraced properties, the position of the plot in the terrace can alter the costs. The example above is a mid-terraced property. End of terrace units may see a further 10% increase in costs;

- In respect of apartments, the position of the apartment in the block will alter the costs. The example above is for a mid-floor unit and there could be a 5% increase on costs for the ground and top floor units;
- The above assumes all plots are heated individually (other than apartments); no central district heating main is present;
- Apartments use centralised air source heat pumps (or similar) and individual units draw off the heat from a heat source within the unit.

10.28 For the viability testing, each of the carbon reduction scenarios has been applied incrementally to the typologies. It is recognised that these costs are realistic averages from a range of possible technical applications and represent the most effective way to achieve the relevant standard.

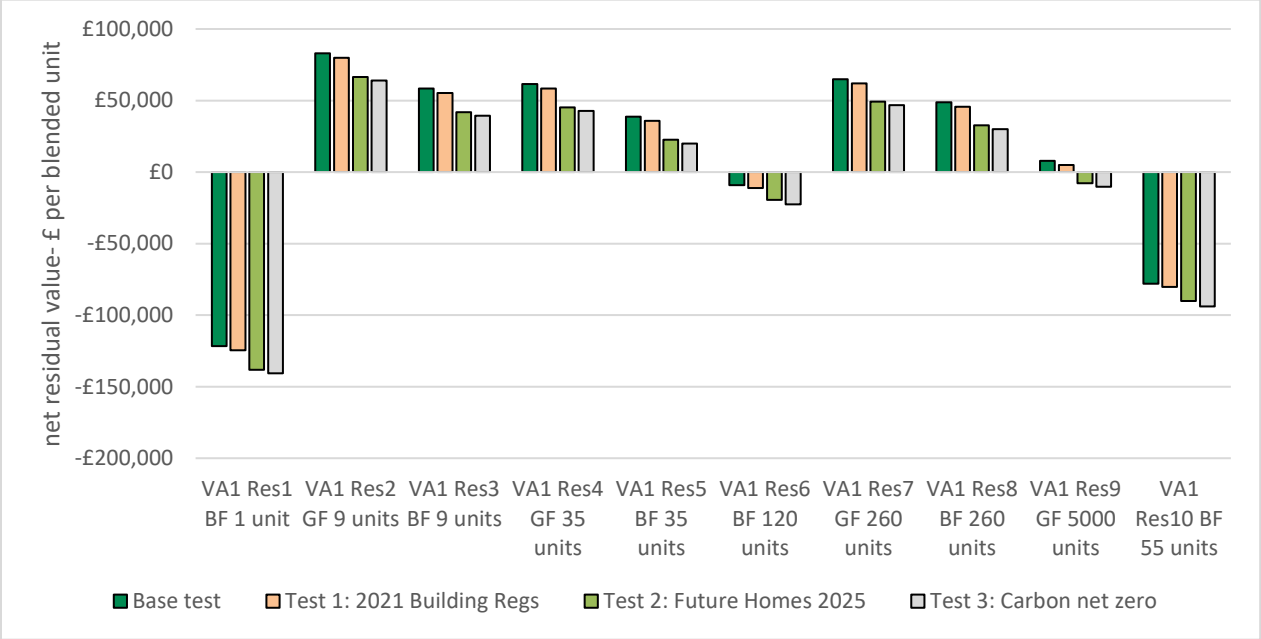
Residential testing results

10.29 This section summarises results of the economic viability testing for the residential typologies. The results are set out separately for each value area. We have focussed our comments on the effects of the carbon reduction scenarios and have not discussed general viability more generally. A full set of results can be found in the Technical Report.

Value area 1 – results

10.30 The results for value area 1 (VA1) are shown in the chart below, showing all 10 typologies. The base result and the 3 tests applied are shown by the differing coloured bars and legend at the bottom of the chart. The results are shown on a per unit basis at net residual value, i.e. after all costs including land purchase and developer return have been accounted for. A similar approach to the presentation of the results is adopted across all the residential viability testing reported in this chapter.

Figure 10.9 VA1 – testing results for residential typologies – net residual value per unit

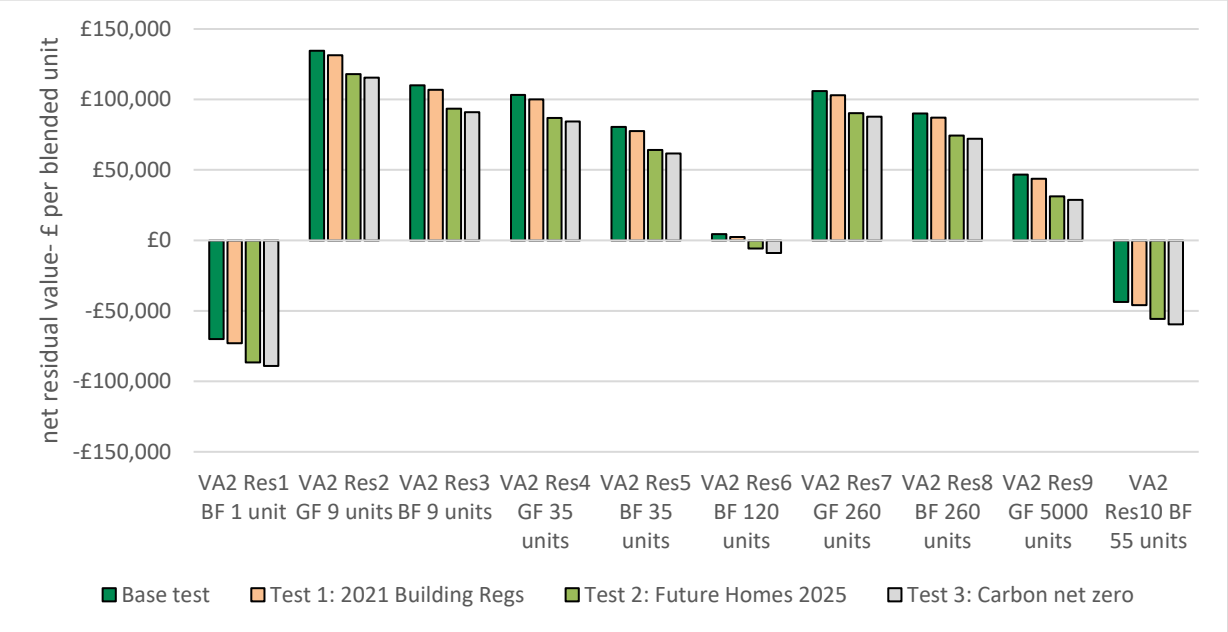


10.31 It can be seen that moving across the different standards (from the base case through to net zero carbon) reduces viability incrementally. The impact of moving from test 1 (31% carbon reduction) to test 2 (75-80% reduction) and test 3 (100% reduction) is greater than moving from the base test to test 1. Typology 9, 5,000 units, is viable at test 1 with a 31% carbon reduction but becomes unviable (with the assumptions used) when this is increased to a 75-80% reduction.

Value area 2 – results

10.32 The results for value area 2 (VA2) are shown in the chart below.

Figure 10.10 VA2 – testing results for residential typologies – net residual value per unit

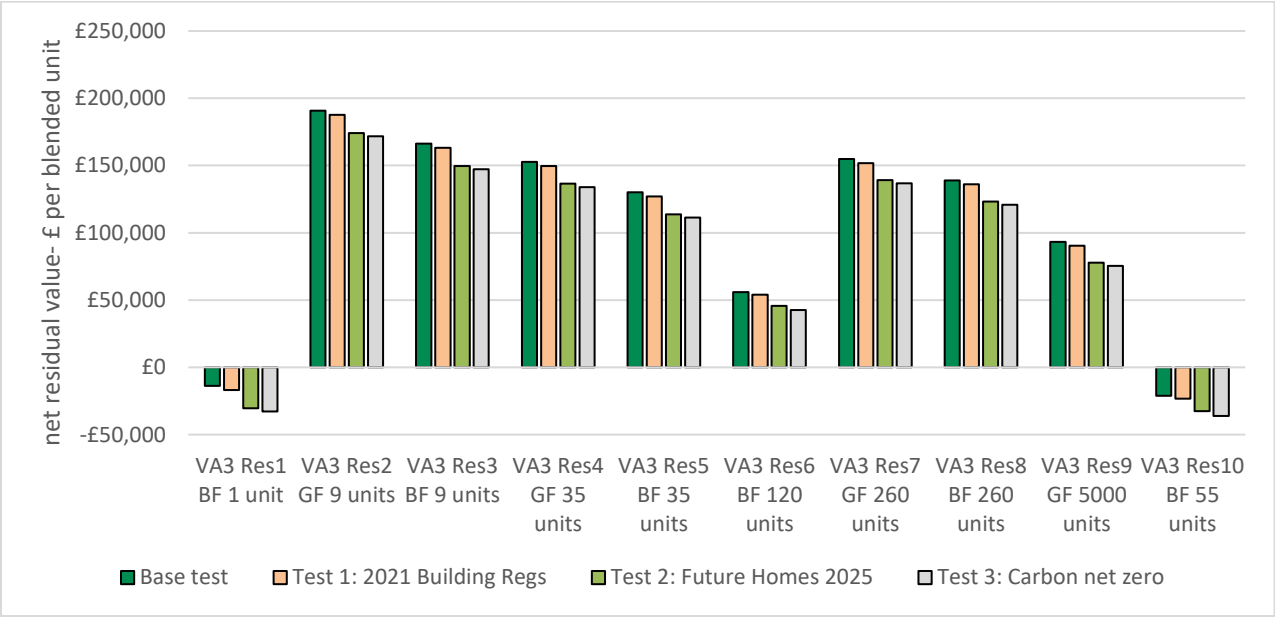


10.33 Results for VA2 are much like those for VA1. The impact of moving from test 1 (31% carbon reduction) to test 2 (75-80% reduction) and test 3 (100% reduction) is greater than moving from the base test to test 1. Typology 6, 120 apartments, is viable at test 1 with a 31% carbon reduction but becomes unviable when this is increased to a 75-80% reduction.

Value area 3 – results

10.34 The results for value area 3 (VA3) are shown in the chart below.

Figure 10.11 VA3 – testing results for residential typologies – net residual value per unit

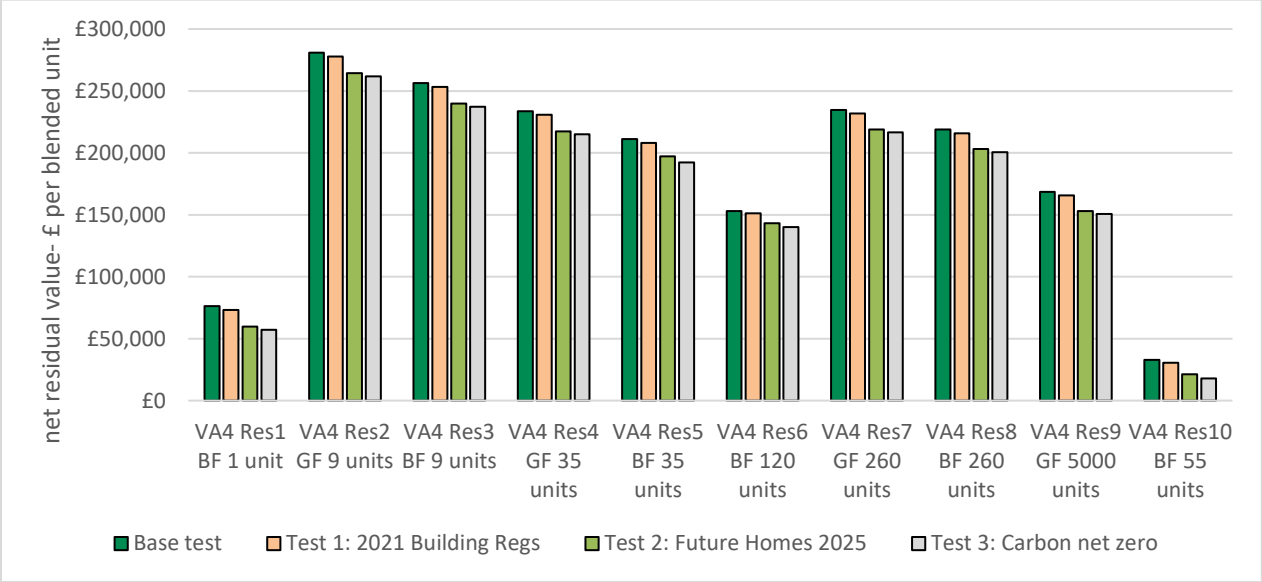


10.35 The impact of moving from test 1 (31% carbon reduction) to test 2 (75-80% reduction) and test 3 (100% reduction) is greater than moving from the base test to test 1. However all viable typologies in VA3 (typologies 2 – 9) have sufficient viability headroom to ensure that the incremental increases in costs do not render a scheme unviable that was previously viable. It is of note, however, that where schemes are marginally unviable, it may be possible for the developer to make savings (say for example by reducing market return) and then the additional cost of tests 2 and 3 could rule out this possibility. For example, the single unit is unviable by £16,800 with the 31% carbon reduction at test 1, but this 'unviability' increases to £30,200 at test 2 with 75-80% carbon reduction and £32,800 at net zero carbon (test 3).

Value area 4 – results

10.36 The results for value area 4 (VA4) are shown in the chart below.

Figure 10.12 VA4 – Testing results for residential typologies – net residual value per unit



10.37 The impact of moving from test 1 (31% carbon reduction) to test 2 (75-80% reduction) and test 3 (100% reduction) is greater than moving from the base test to test 1. However, the high values achieved in VA4 mean that all typologies are viable and have enough viability headroom to ensure that the incremental increases in costs applied by the tests do not render a scheme unviable that was previously viable.

Impact of moving from Future Homes to Carbon Net Zero

10.38 The costs of reaching net zero carbon, over and above the estimated costs of Future Homes 2025, were set out in figure 10.8 above, setting out the different costs for the different unit types, i.e. houses, flats of differing sizes. The table below demonstrates the impact of these on a per scheme basis taking into account the effects of cashflow across the development for the number of years it takes to build the scheme out. The results are similar for each value area[107] and are shown both as a total per scheme and as a total per blended unit.

[107] With some small differences arising from cashflow over a number of years

Figure 10.13 Cost to development of moving from Future Homes Standard to net zero carbon

Costs allowed for in the viability testing for moving from Future Homes to net zero carbon					
Scheme ref	**Site type**		**No. units**	**Difference – per scheme***	**Difference - per unit**, blended and cashflowed**
1	Houses	Brownfield	1	£2,500	£2,500
2	Houses	Greenfield	9	£22,500	£2,500
3	Houses	Brownfield	9	£22,500	£2,500
4	Mixed	Greenfield	35	£88,800	£2,540
5	Mixed	Brownfield	35	£88,800	£2,540
6	Flats	Brownfield	120	£360,000	£3,000
7	Mixed	Greenfield	260	£636,600	£2,450
8	Mixed	Brownfield	260	£636,600	£2,450
9	Mixed	Greenfield	5000	£12,149,000	£2,430
10	Flats (older persons)	Brownfield	55	£191,500	£3,500

*figures rounded; ** result is a blend between all types/sizes of unit modelled

10.39 The costs for net zero carbon (over those of Future Homes 2025) as modelled over the development period, average about £2,500 per unit for houses, £3,000 per unit for flats and £3,500 unit for flats in sheltered schemes. As a % of Gross Development Value the costs represent around 0.6% (dependent upon value area) for houses or mixed schemes. For the flatted schemes it ranges from around 0.8% for the 120 unit flatted scheme in VA4 up to 2.1% for the older persons scheme in VA1.

Key points – residential testing

10.40 The high level testing undertaken for this study has found viability to be strong across Essex with most development schemes able to meet the local policy costs including affordable housing. As this is not a local authority specific study, we do not comment upon general viability, unless relevant to this study, and each council will have their own policies to which they will require development to contribute.

10.41 With the majority of residential development there is sufficient viability headroom to absorb the costs of net zero carbon. The costs of moving from the Future Homes Standard to net zero carbon, as modelled over the development period, average at about £2,500 per unit for houses, £3,000 per unit for flats and £3,500 unit for flats in sheltered schemes.

10.42 We do note however that viability tends to be weaker in the lower value area and for certain types of scheme – flatted development, specialist older persons housing and single units, the latter 2 of which are only viable in the VA4. It is where some or all of these factors apply that the costs of meeting net zero carbon may mean that residential development becomes unviable when the additional costs are applied. This could mean that there may need to be an adjustment to land values to account for higher costs of development and/or a balance of policy considerations, unless other measures can be taken to improve viability.

Non-residential development costs

School Buildings

10.43 The variety of types of school building makes providing accurate additional costs for adopting a net zero approach very challenging. The facilities provided at schools differ between age groups accommodated and are also specific to the location of the school and the proximity to other services and facilities, and the proposed size of the development.

10.44 The study's cost consultants gathered evidence for the last 12 months, on the additional premium for developing a school to achieve BREEAM excellent and have used this as a guide to the additional costs for achieving a net zero school development.

10.45 BCIS are currently using an average rate of £2,275/sq m for new build schools (based on a mean UK location index of 100). Evidence on delivered projects has shown the premium for delivering a building rated BREEAM "Excellent" (as opposed to "Very Good") is in the order of 2%, which results in an adjusted average cost of £2,321/sq m. This is likely to mean that the Part L 2021 Regulations would be achieved for this base cost.

10.46 There is no guidance yet published on the requirements for schools in terms of their equivalent of the Future Homes Standard 2025[108], so it is not possible to forecast what achieving this standard may cost. However, drawing on selected reviews of energy strategies of schools and colleges who aspire of achieving net zero carbon, the premium has been estimated at between 8% and 12% over the rate identified for BREEAM "Excellent", depending on the specifics of the project. This would result likely build costs being in the range of £2,410/sq m to £2,600/sq m.

10.47 These are high-level figures only and would need to be reviewed on a project specific basis.

[108] For this, and the other non residential development types reported in this chapter, indicative costs were published in "*The Impact Assessment of Future Buildings*" (January 2021) for the new Part L (2021). We have considered these and discussed with developers to ascertain the current costs being realised in the market, for achieving these future standards.

Offices

10.48 Similar to schools, the variety of office types means that it is difficult to provide accurate estimates of the additional costs for adopting a net zero carbon approach. Offices vary in size and nature (i.e. city centre, rural, open plan, cellular, etc) and in scale and their location and proximity to other services and facilities.

10.49 However, as a guide and at the time of writing, BCIS are using an average rate of around £1,900/sq m for non-air-conditioned offices (although it varies slightly if these are over 6-storey). This excludes tenant or occupier fit out. Cost consultant evidence indicates that the premium over meeting the BREEAM "Excellent" standard (as opposed to "Very Good") is in the order of 4%, which results in an adjusted average build cost of £1,976/sq m. This is likely to mean that the Part L 2021 Regulations would be met for this base cost.

10.50 There is currently no published guidance on the requirements for offices in terms of their equivalent to the "Future Homes" Standard at present, so it is not possible to forecast what achieving this standard may cost.

10.51 In an attempt to establish some guidance on what net zero may cost, and because offices are more "plant heavy" than other building uses, the premium for achieving net zero, is in the order of 17% – 20%, resulting in a range of costs from £2,312/sq m - £2,371/sq m. This would result in starting point for the likely costs to be in the range of £2,410/sq m to £2,600/sq m.

10.52 These ranges exclude any specialist fit-out undertaken by the occupiers, which is difficult to cost as this will vary between the different businesses that occupy offices but noting the caution with which these figures are presented.

Warehouse and industrial premises

10.53 Again, the variety of type of industrial and warehouse buildings makes providing accurate additional costs for adopting a net zero carbon approach challenging. Warehouses and industrial buildings vary in size and nature and may include some office and welfare facilities as well as spaces for storage and processes.

10.54 While the energy demand for space heating and hot water for any embedded office and welfare facilities may have similarities to standalone offices, the proportion of this type of space within a larger building will vary.

10.55 In addition, the main warehouse and industrial spaces will have different space heating requirements, including unheated spaces as well as cooled and refrigerated spaces. We note that the government's 2021 Future Buildings Standards consultation response rehearsed some of these issues and suggested that solutions such as better fabric and low carbon heating were likely to form part of the approach, and that a standard approach for new warehouse and industrial buildings would be very difficult to implement.

10.56 As a guide, BCIS are currently using an average rate of £851/sq m for units of between 1,000 – 7,000 sq m. This excludes any specialist cooled spaces (or other uses). Without some form of guidance it is not possible to say what the increase on this cost will be.

Key points - non-residential development costs

10.57 It is clear that there are cost implications for higher building standards for non-residential development in Essex, with an additional 8%-12% for schools and 17%-20% for offices for achieving net zero carbon over current standards.

10.58 Much of the non-residential development in Essex will be undertaken on a design and build basis with the key determinants of whether schemes proceed related to the commercial (or educational) benefits to the occupiers. The suggested scale of the marginal costs for net zero suggests that the financial impact will not be readily overcome in all instances, although there may be significant operational cost savings that would be set against the additional build costs.

Chapter 11 Options development and evaluation

Options being evaluated

11.1 The report has analysed the statutory and local policy approaches to achieve net zero carbon development – residential and non residential. The approach promoted for Essex by ECAC is more ambitious than that put forward by the national government. As a reminder, the comparator table set out earlier is shown again below.

Figure 11.1 ECAC and government targets compared

Government targets		ECAC targets	
2021 Building Regs amendment - Interim 31% reduction of CO_{2e}	2022	2022	All new schools net zero. All new builds with PVs.
Future Homes standard 'net zero Ready' 75% reduction	2025	2025	All new buildings net zero.
All private rentals EPC 'C'. Non-domestic rentals EPC 'B'.	2030	2030	All new builds Carbon Positive All fuel poor homes retrofitted & supplied with renewables
		2040	Essex renewables meet all county needs
net zero with Grid Decarbonisation contribution 100% Reduction compared with Building Regs 2013. (SAP calculation).	2050		

11.2 There are then different options for achieving the targets. Again, drawing on information from earlier in the report, we have identified three options. These reflect key government and ECAC targets. For each option, we have put forward the way in which the target will be achieved – based on earlier study findings.

11.3 In the table 'KNOWN' refers to standards where we have clear government guidance on what is required. 'PART KNOWNS' are the options where there is an indication about what will be required but with details still outstanding. This applies particularly to the Future Homes standard.

Figure 11.2 Additional specifications required to achieve carbon reduction standards

Standard	Additional Measures
'KNOWNS'	
Part L 2013	• The current position for most new builds in the planning pipeline
Part L 2021	• At least 31% less Carbon emissions target (compared to Part L 2013) • Increased insulation • Provision of PV unless alternative route can be proven. (40% of Ground Floor Area formula) • Waste Water heat recovery; and • Better thermal performance of windows. • CIBSE TM59 overheating and shading considerations
'PART KNOWNS'	
Future Homes 2025	• At least 75% less Carbon emissions target (compared to Part L 2013) • No formal guidance but overall improvements in the fabric specifications should achieve the target reduction. To be demonstrated with an Energy Performance Certificate (EPC) to include an alternative to fossil fuel boiler e.g. air Source Heat Pump plus efficient water cylinder.
Carbon Net Zero (as at 2025 in line with ECAC targets) Equivalent to Passivhaus Classic + PV	*Carbon net zero will likely mean the following* ***additional*** *steps:* • Provision of PV

Evaluation criteria

11.4 We have devised a series of evaluation criteria that respond to the core aim of the research i.e. to assess the cost and viability of achieving net zero carbon development across a range of building types.

11.5 The criteria are a mix of quantitative and qualitative judgements and are from the perspective of the 'climate', occupier and developer/land owner – accepting that this is an entirely false distinction but is useful as an aid to understanding. The criteria being used are drawn from a number of sources, including the study specification, and are set out in the table below.

Figure 11.3 Evaluation criteria

Main group	Criteria
Climate	Carbon reduction (net zero compliant)
	Inclusion/exclusion embodied and non-regulated carbon
	Cleaner air improvements with CO2 pollution reduction
	Performance gap
	Impact on grid capacity
Occupier	Space heating demand and fuel poverty reduction
	Comfort
	Health and well being
	Maintenance costs
Developer/landowner	Capital outlay-impacts on development viability
	Local capacity to deliver (e.g. requires a bespoke manufacturing facility within X miles)
	Local skill set – for maintenance & installation
	Design considerations – visual, overheating possibility

11.6 The brief for this study makes it clear that it is considered critical to minimise carbon emissions of all new developments. Discussions with the client group and consultation with local authorities and the development industry, as part of this study, also indicate that 'climate emergency' considerations are paramount, but include the importance of housing delivery and meeting housing and occupier needs.

Evaluation process

11.7 The evaluation process uses a RAG (red, amber, green) approach – maximising quantitative information as far as possible. The analysis covers regulated energy use but not unregulated energy.

Figure 11.4 Evaluation of options – RAG approach

		Part L 2013	***Part L* 2021**	***Future Homes* 2025**	***Net Zero at 2025 – using Passivhaus Classic + PV***
Climate	Carbon reduction Regulated emissions only	Current state End terrace – 1276 kg CO2 per annum	End terrace – 921kg CO2 per annum	End terrace – 184kg CO2 per annum	Carbon positive End terrace – minus 150 kg CO2 per annum
	Embodied and non-regulated carbon	Not addressed	Not addressed	Not addressed	Measures unregulated energy – does not deal with embodied carbon
	Cleaner air	Extract or natural ventilation only	Extract or natural ventilation only	Extract or natural ventilation only	MVHR – filtered air
	Performance gap	Indeterminate	Indeterminate	Not known - depends on approach to Build Regs update	Passivhaus approach includes performance management
	Impact on grid	No change	No change	ASHP part of the package - grid decarbonisation achieves net zero (2050). Higher electric loading impacts on grid.	Lower regulated electricity consumption – produces more of own electricity (more PV)
Occupier	Fuel poverty reduction – space heating demand	No change	Slight improvement	Further slight improvement	Significant reduction in space heating demand
	Comfort	No change	Slight improvement	Further slight improvement	Significant reduction in space heating demand/improvement in comfort via MVHR

		Part L 2013	***Part L* 2021**	***Future Homes* 2025**	***Net Zero at 2025 – using Passivhaus Classic + PV***
	Health and well being	No change – health impacted by fuel poverty and poor heating	Slight improvement	Further slight improvement	Positive impact on health with improved comfort/ reduction in damp
	Maintenance costs	No change	No change	Potential Additional cost of ASHP in operation depending on cost of electricity v. gas	Potential additional costs re ASHP & MVHR maintenance (replacing filters etc) but reduced fabric maintenance (mould etc.)
	Retrofit to zero carbon costs	Very significant costs to achieve zero carbon	Significant costs to achieve zero carbon	Some cost to achieve zero carbon in advance of grid decarbonisation; no cost if post grid decarbonisation	Zero carbon achieved
Developer/ landowner	Viability	No change	Relatively small additional cost c £3,000 per house	Significant step up in costs – c £13,000 per house – potential impact on viability	Marginal further step up in costs – c £15,000 per house - potential impact on viability
	Local capacity (supplies)	No change	No change	Availability of ASHP etc a potential issue and impact on costs Increased use of manufactured components. Potential reduction in costs as a more competitive manufacturing base develops	Availability of ASHP and MHR etc a potential issue and impact on costs Increased use of manufactured components

		Part L 2013	***Part L* 2021**	***Future Homes* 2025**	***Net Zero at 2025 – using Passivhaus Classic + PV***
	Local skill set	No change	No change	Use of new technologies/ components - some (re) training required	Use of new technologies/ components - some (re) training required. Also increased on-site supervision during construction
	Design considerations	No change	No change	Concerns about large concentration ASHPs creating noisy environment	Concerns about large concentration ASHPs creating noisy environment Different design solutions – emphasis on orientation/location etc – not necessarily a problem but to be noted

Darker green shading indicates a more positive evaluation than the pale green colouring

Carbon positive

11.8 We have not assessed specific options for achieving carbon positive developments and there are various options by which this can be achieved for example additional provision of PV over and above Future Homes approach or additional offsetting e.g. more tree planting and/or provision of off-site renewable energy generation

Key points

11.9 Based on the critical importance of reducing carbon emissions, it is clear that provision of zero carbon housing is vital, which means that simply following the incremental progress required by Building Regulations will not be sufficient:

- Following Building Regulations (including Future Homes in due course) will make slow progress in reducing carbon, although in the short term it does provide relative benefits in terms of housing viability and deliverability, with the least impacts on the development industry. However, the Future Homes standards are proposed to become part of Building Regulations in 2025 and at that point there are some significant cost increases and impacts on viability and delivery. Although Future Homes will provide significant carbon reductions and some fuel poverty benefits, it does not address embodied carbon and there are potentially sizeable impacts on the electricity grid capacity;
- Full net zero carbon housing has the potential to provide carbon positive solutions (effectively mitigating carbon emission from other activity) and also has some advantages compared to Future Homes in terms of loading on the electricity infrastructure. It will provide significant fuel poverty benefits to occupiers although this will be at a significant development cost which may affect viability and deliverability.

11.10 Unregulated energy use and the resultant carbon is not dealt with effectively by any of the Building Regulations and Future Homes housing development standards reviewed here. While government standards are moving towards net zero, it is only when the specifications and standards are tightened, as in the Passivhaus Classic with PV, that the CO_2 emissions targets are capable of being achieved.

11.11 Embodied carbon is not part of any of the standards evaluated and would require additional research to be taken into account.

11.12 Overall, the implications of the options appraisal are that, on balance, carbon net zero housing provides greater and wider benefits at marginal costs. However, in some limited circumstances, there may also need for some housing built to Building Regulations/Future Homes until the industry is able to move completely to net zero.

Chapter 12 Conclusions and recommendations

12.1 The core aim of this research is to assess the cost and viability of achieving net zero carbon development across a range of building types. This has been considered through an extensive literature and technical review and consultation process. Options for achieving net zero carbon development have been identified and evaluated against a series of economic, social, and environmental criteria, including the capital costs for developers. Building on this, the research has considered how best to support local authorities to enable them to require higher environmental standards that will help to meet net zero targets.

12.2 While there is no single agreed UK statutory definition of net zero, the established principles are that emissions of greenhouse gases for a period are balanced by the amount of that gas that is removed.

12.3 For new homes, it is important to consider i) carbon used in the building's product and construction stages (including embodied carbon), ii) operational carbon – carbon emissions associated with the building's operational energy, and iii) whole life carbon - the carbon emissions associated with the construction, use and disposal of a building.

12.4 Building Regulations only deal with the first of these and this report has demonstrated that changes beyond those introduced in June 2022 as part of the 2021 Building Regulations are needed to deliver operational net zero development. The government's Future Homes Standard requires an associated decarbonisation of the electric grid for new buildings to achieve net zero and then, not until 2050. The ECAC targets are much more ambitious with all consents for new homes and commercial buildings to be operational carbon zero by 2025.

12.5 Following Building Regulations (including Future Homes in due course) will make slow progress in reducing carbon. Whilst Future Homes will provide significant carbon reductions and some fuel poverty benefits, it does not address embodied carbon and there are potentially sizeable impacts on the electricity grid capacity.

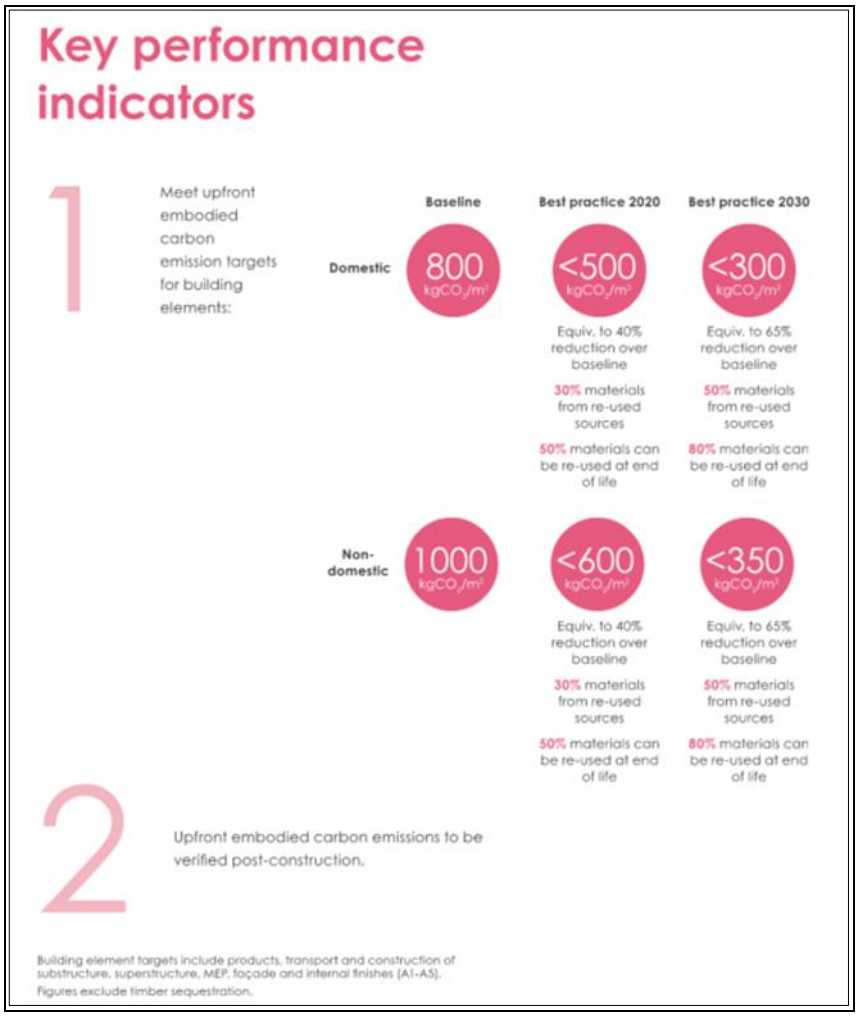
Local authority powers

12.6 The issue of whether local authorities have the ability to set their own standards (in excess of national policy) has been raised through the research. It is strongly argued that, provided these can be justified, local authorities may set targets in excess of national policy. However, there is still a note of caution about this and we make a specific recommendation that is intended to clarify the matter. However, our conclusions and recommendations are based on the power of planning authorities to set their own standards.

Achieving 'net zero'

12.7 Unregulated energy use and the resultant carbon is not dealt with effectively by any of the Building Regulations based housing development standards reviewed. Regulated energy is accounted for more accurately through use of the Passivhaus Planning Package. Embodied carbon is also not part of any of these standards and may need to be addressed as a separate strand of work. This strand may need to include establishing a common approach to measurement (e.g. the LETI approach), facilitating its adoption and in due course setting targets and monitoring the response. The LETI Embodied Carbon Key Performance Indicators are set out below for reference:

Figure 12.1 LETI – Embodied Carbon Key Performance Indicators[109]



The predicted design stage embodied carbon emissions should be verified post-construction.

[109] https://www.leti.london/_files/ugd/252d09_3b0f2acf2bb24c019f5ed9173fc5d9f4.pdf page 54.

12.8 The key requirements for a net zero carbon building are found to be :

- Low space heating demand and low total energy use
- No fossil fuels and low carbon heat
- High renewable energy generation;
- Energy flexibility with reduced peak demand
- Reduced performance gap and long term durability of the building fabric

12.9 Implied in these performance characteristics is that all new buildings will require an EPC rating of A (or equivalent commercial banding) with on-site renewable energy as required by the local plan.

12.10 A 'fabric first' approach is identified as the preferred method of achieving net zero development with a Passivhaus 'Classic' delivering housing net zero for a range of house types as were tested for this study when combined with the predicted decarbonisation of the National Grid. While the Future Homes standard and the Passivhaus Classic standard do not achieve operational net zero, they may do so by 2050 when combined with the decarbonisation of the National Grid. There is clear evidence that the Future Homes standard will not achieve the significant space heating demand reductions that Passivhaus guarantees. The Future Homes standard may indeed never achieve net zero carbon as a result of the 'performance gap' anomaly inherent in the UK Building Regulations. However, when Building Regulations levels of photovoltaics are added to a building built to the Passivhaus standard, 'carbon positive' can be achieved. Therefore we recommend that Passivhaus with PV are the standard adopted.

12.11 In practical terms this means a set of operational energy Key Performance Indicators need to be demonstrated when building new homes as illustrated in the table below:

Figure 12.2 Operational Key Performance Indicators

Building Type	Space Heating/Cooling Demand in kWh/m^2_{GIA}/year	Total Energy Consumption in kWh/m^2_{GIA}/year	Solar Electricity Generation in kWh/m^2_{GIA}/year
Residential	<15	<35	>35 on site for small scale; 70% of roof area for medium to large scale resi.
Schools	<15 - 20	<65	Exceeds metered energy use on site
Hotels	<30	<55	>120
Offices	<15	<55	>120
Light Industrial	<15 - 30	<55	>180

Source:

LETI Climate Emergency Design Guide[110] is the primary source of the KPIs with additional supporting targets drawn from the Government Property Agency net zero and Sustainability Design Guide - Net Zero Annex published in March 2022: (see below).

12.12 The following provides guidance to achieving the Key Performance Indicators with specific building elements optimised for the location and orientation.

[110] https://www.leti.london/cedg

Figure 12.3 Building elements to meet the operational Key Performance Indicators

Element	Supporting Targets
Form Factor	1.0 to 2.0 is more efficient
Recommended Glazing percentages for each external façade (% of wall areas)	East and West: 10-20% South: 20-30% North: 0-15%
Fabric U-Values in W/m^2.K	Walls ≤ 0.11 Floors ≤ 0.11 Roofs ≤ 0.11
Windows - U-Value installed	0.80 Triple Glazed
Doors - U-Value installed	0.80 (triple glazed or insulated solid door)
Air Tightness (Air permeability rate under pressure test)	$\leq$1.5 h^{-1} (n_{50}). Note: Passivhaus targets ≤ 0.6 h^{-1} (n_{50}).
Thermal Bridging (y-value)	0.04 W/m.K
G-value of glass	0.3 – 0.4
Low Carbon Concrete	Min. % GGBS or another substitute
Heating appliance	Low carbon heating. No fossil fuels. (e.g. ASHP)
Heat Pump Seasonal Coefficient of Performance (SCoP)	$\geq$ 2.8
Hot Water Cylinder Heat Loss	$\leq$ 1.8kWh per 24 hours
Heat emitters	Low temperature heating
Hot water pipework	Insulated sleeves
Cold water pipework	Insulated where risk of freezing
Waste Water Heat Recovery	System installed as per Building Regulations
Ventilation	Mechanical Ventilation with Heat Recovery (MVHR) with $\geq$ 90% efficiency. Easily accessible filters.
CO_2 levels	<900 ppm with sensors for ventilation
Total VOCs	< 0.3 mg/m^3
Daylighting	> 2% average daylight factor, 0.4 uniformity
Lighting	Low energy lighting with sensors or controls for daylight cut off.
Free or night time cooling	Where possible allow for cross ventilation
Overheating	< 5% of hours in the year above 25 ^{0}C. Allow for external shading. Follow CIBSE TM59 guidance where possible.
Chiller SEER (where relevant)	$\geq$ 5.5
PV Panels	$\geq$ 370W per panel minimum. Minimum Provision in line with Building Regulations.

Sources drawn on for the above table are:
The Government Property Agency Net Zero and Sustainability Design Guide - Net Zero Annex published in March 2022, Passivhaus Institute, LETI Design Guide, RIBA and QODA's own experience of delivering low energy buildings. Many targets are not directly tackled by Building Regulations (which includes the Future Homes standard) but are key for achieving the KPIs in Figure 12.2. See also the Technical Report Appendix 5 for further comparisons.

12.13 Further standards and fabric comparisons with practical steps are contained in the Technical Report Appendix 5. The use of the Passive House Planning Package (PHPP) software will greatly aid the fine tuning of specifications to achieve the targets and could provide a means of verification at design stage with photographic evidence provided as required by the new SAP 10.2. This helps address the 'performance gap', identified in the literature, between the specification for a new building and its actual built form.

12.14 In addition, the continuity of insulation demonstrated by photographs and the supervision and protection of the air tightness barrier are both key to a durable net zero dwelling (see also Technical Appendix 7).

12.15 Site considerations of orientation and form factors are also important for the successful achievement of a net zero dwelling and must be assessed alongside the risks and opportunities of shading and solar gains. (see also Technical Report Appendix 6).

Alternative approaches

12.16 Emerging in a small number of new local plans are alternative measures of energy use – focusing on space heating demand and total energy use. These measures are inter-related to levels of carbon emissions but are not currently within government targets. With a fabric first, Passivhaus, approach there is both a reduction in carbon emissions as well as space heating demand (and consequently in household costs, with positive benefits for comfort and health.)

12.17 This is a very fast changing agenda. If progress can be made and evidenced through local plan examinations and by working with the development industry, the option of adopting energy use and space heating demand as the metric for new policies will need to be kept under review and its relationship to current Building Regulations clearly set out. We make a specific recommendation below regarding this.

Development industry perspective

12.18 For this study, we only discussed the use of carbon related targets and focused on the timing of introducing net zero carbon targets so our report does not pick up on the alternative metrics discussed above.

12.19 It is clear that there are changing attitudes to the energy performance of buildings and that part of the development industry response to net zero will be driven by consumer pressures as well as access to finance.

12.20 The developer consultation confirmed that there is a widespread view that it is necessary to build higher quality houses with better environmental performance. Some house builders are pursuing higher construction standards (airtightness, awareness of thermal bridging, workmanship), as well as adding solar PV and low carbon heating and ventilation. From the development industry feedback, 15% represented a reasonable 'mid' point in the range of

comments we were given of the marginal cost uplift for Future Homes. However, there are expectations that this will decrease as economies of scale and competition between suppliers take place, and as house design is optimised. In the short term there may be supply chain issues, which can also have an impact on cost.

12.21 The variety in the different building standards being pursued by planning authorities and the varying timescales for requirements in different locations is not considered helpful by the development industry. Some parts of the development industry question whether the agenda is moving more quickly than the housing building industry and its supply chains and skills and capacity can react, noting that many of the major housebuilders are targeting 2030 for net zero carbon (operationally) in new homes.

Other options for achieving net zero

12.22 Options beyond a fabric first approach for reducing carbon emissions are limited. Heat networks and harnessing wind or water power sources locally may have a role but would be location or even site specific. These off-site solutions come with significant issues around planning, funding and implementation and would require further specific study.

Achieving net zero – viability implications

12.23 With the majority of residential development, there is sufficient viability headroom to absorb the costs of net zero carbon. Moving from meeting the potential Future Homes Standard 2025, as set out in the government consultation documents, to net zero carbon, the additional costs average about £2,500 per unit for houses and £3,000 for flats

12.24 We do note however that viability tends to be weaker in the lower value area and for certain types of scheme – flatted development, specialist older persons housing and single units, the latter 2 of which are only viable in the higher value areas. This could mean that there may need to be an adjustment to land values to account for higher costs of development and/or a balance of policy considerations, unless other measures can be taken to improve viability.

12.25 In respect of other forms of development the viability impact of policy towards net zero carbon is difficult to judge as development is less homogenous than housebuilding with both locational factors and variety of building types/uses the key drivers for cost. This issue is recognised by government in the 2021 Future Building Standards consultation response, where it is stated that whilst solutions could include better fabric and low carbon heating, a standard approach would be difficult to implement. As the majority of non-residential buildings are long term investments for those developing, it is generally self interest to construct quality, higher achieving building (standards) that will be both cheaper to run and manage in the long term.

Appraisal of future (standards) approach towards net zero

12.26 Overall, the study has clearly identified that net zero carbon housing provides the greater benefits in environmental terms and in dealing with fuel poverty. However, to continue the required delivery of new housing in Essex (as elsewhere), in exceptional cases where net zero has not been possible to deliver, housing should be future- proofed for easy retrofit technologies such as photovoltaics and battery storage solutions which are not reliant on deep fabric changes in order to move completely to net zero. The essentials of fabric, air tightness and space heating targets along with an efficient and complementary ventilation system cannot be compromised.

Recommendations

12.27 The recommendations we are making reflect the importance of achieving net zero development as quickly as is feasible and the reality of the development industry's position and the planning policies set by the local authorities for the functioning of the planning system.

12.28 It is acknowledged that this is a fast changing area of analysis and policy development and that ECAC should keep closely under review. A small number of local authorities are developing planning policies that consider both carbon emissions and the use of energy within buildings. This approach is intended to tackle both the need to reduce carbon emissions and minimise energy costs for occupiers. If this type of policy is endorsed at planning examinations, this would be a sensible approach for ECAC to pursue, working closely with the development industry. However, for the purposes of this report, the main focus of our recommendations is on operational carbon.

12.29 Our recommendations fall under a number of main headings.

Approach to new development

- **Recommendation 1**: Recognising that issues around energy use and carbon emissions is a fast changing area of policy development, it is critical that ECAC and the Essex planning authorities, keep under review approaches emerging elsewhere, particularly those backed at public examination. It will also be important to maintain a dialogue with the development industry to develop policies that are robust, sound and provide clarity of what is required for development to be acceptable. Such policies will also need to include consideration of issues related to the core aim of achieving net zero including, for example, overheating risk, indoor air quality and the use of accreditation schemes;
- **Recommendation 2:** Within the context of the above recommendation, and as far as is practicable, the objectives for new development in Essex expressed through planning policy, should adopt the following performance indicators for both residential and non residential developments:

Figure 12.4 Operational Key Performance Indicators

Building Type	Space Heating/Cooling Demand in kWh/m^2_{GIA}/year	Total Energy Consumption in kWh/m^2_{GIA}/year	Solar Electricity Generation in kWh/m^2_{GIA}/year
Residential	<15	<35	>35 on site for small scale; 70% of roof area for medium to large scale resi.
Schools	<15 - 20	<65	Exceeds metered energy use on site
Hotels	<30	<55	>120
Offices	<15	<55	>120
Light Industrial	<15 - 30	<55	>180

- Low total energy use (as indicated in Figure 12.4 above) with efficient heating and hot water system and low energy lighting;
- No fossil fuels and low carbon heat. A net zero Carbon ready home should use a low carbon heating system (e.g. heat pump), and no fossil fuels on-site;
- High renewable energy generation on-site or on 'additionality' principle (as indicated in Figure 12.2 above). This references the ECAC ambition to produce enough renewable energy within the county to meet its own needs by 2040;111
- Energy flexibility with reduced peak demand and an increased ability to use energy when clean energy is available; future proofing for battery storage or district network input upgrades should be included in the new building fabric and in the infrastructure of a new development;
- Reduced performance gap - net zero carbon needs to be delivered after construction and in operation. By focussing on the long term durability, repair and re-usability of the building fabric, embodied and whole life carbon considerations can be ameliorated.

- **Recommendation 3**: A fabric first approach, following Passivhaus principles, should be the priority. Figure 12.3 (under section 12.8 above) provides guidance to achieving the Key Performance Indicators for Building and performance elements. An important indicator of build quality is air tightness with an air testing regime being instigated to ensure the target is achieved and certified;

111 https://cmis.essex.gov.uk/essexcmis5/Document.ashx?czJKcaeAi5tUFL1DTL2UE4zNRBcoShgo=DQpTpTnU6jcId1uyqMUBXrpG%2fEumuEbWHOaYxcWHln9zElsDxvuXXg%3d%3d&rUzwRPf%2bZ3zd4E7Ikn8Lyw%3d%3d=pwRE6AGJFLDNlh225F5QMaQWCtPHwdhUfCZ%2fLUQzgA2uL5jNRG4jdQ%3d%3d&mCTlbCubSFfXsDGW9IXnlg%3d%3d=hFflUdN3100%3d&kCx1AnS9%2fpWZQ40DXFvdEw%3d%3d=hFflUdN3100%3d&uJovDxwdjMPoYv%2bAJvYtyA%3d%3d=ctNJFf55vVA%3d&FgPlIEJYlotS%2bYGoBi5olA%3d%3d=NHdURQburHA%3d&d9Qjj0ag1Pd993jsyOJqFvmyB7X0CSQK=ctNJFf55vVA%3d&WGewmoAfeNR9xqBux0r1Q8Za60IavYmz=ctNJFf55vVA%3d&WGewmoAfeNQ16B2MHuCpMRKZMwaG1PaO=ctNJFf55vVA%3d

- **Recommendation 4**: Off-setting carbon reductions should be seen as the last resort and only allowed in exceptional circumstances, for example, where there is evidence that a fabric first approach is not feasible. ECAC should review and provide further guidance on the types of circumstance in which off-setting might be considered acceptable;
- **Recommendation 5**: We recommend the use of PHPP software to account for unregulated energy and for transparency of targets. The key outputs to be demonstrated by the use of the PHPP software are:

Space Heating/Cooling Demand in $kWh/m^2_{GIA}/year$	Total Energy Consumption in $kWh/m^2_{GIA}/year$	Solar Electricity Generation in $kWh/m^2_{GIA}/year$

Embodied carbon

- **Recommendation 6**: As the performance of buildings improves with much lower energy demands and therefore less carbon emissions from the operation of heating and cooling systems, so the percentage proportion of embodied carbon increases in terms of the materials used and their transportation from source to site. However, the assessment of embodied carbon reductions and targets is in its infancy and not well understood, consequently it is recommended that embodied carbon reduction targets are explored and practical methodologies assessed with industry involvement.

Support for local planning authorities

Further support for local planning authorities and the development industry in Essex has value but it will need to be targeted at the issues faced by both groups. One of the study objectives was that this study should lead to the development of a toolkit to support the work of planners. However, we have concluded that a general guide (or toolkit) to developing at net zero is not recommended. There are already available excellent publications that do this and another version would not seem to serve any useful purpose. But there is a role for Essex-specific information that is widely available and should include:

- Development options for achieving net zero (and options around fabric and air tightness targets as steps on the way);
- The associated costs (and impacts on development viability);
- Examples of effective plan policies (and reassurance that local plans can go 'beyond' Building Regulations;
- Examples of successful schemes (particularly where these are part of the 'mainstream' housing delivery programme) – ensuring that associated costs and practical development issues are explored alongside the way these were overcome.

- **Recommendation 7:** A web based publication is produced (covering the above points) and strictly kept up to date. It will require an 'author' and system for receiving feedback from users and maintaining the quality of the content.
- **Recommendation 8**: ECAC organises a 'planning policy summit' for the local planning authorities, with lead policy officers and their political portfolio holders invited. The summit would provide information about the policy options open to LPAs, showcase successful developments, work through exemplar model policies potentially of use the authorities and set out the evidence available to them for decision making and monitoring. It would be part of the process that develops a common set of policies/standards for Essex and potentially extended to neighbouring authorities outside Essex;
- **Recommendation 9**: ECAC (facilitated by ECC) organises and pump primes the funding of a pan-Essex group of expert advisers who can, on a call down basis, assist local authorities (officers and members) and developers in assessing planning applications to ensure that they comply with plan policies and Building Regulations and advise on modifications needed to do so;
- **Recommendation 10**: As already identified by ECAC, ECC and the district/unitary authorities should work together to put in place a monitoring process to ensure buildings meet the necessary standards and the potential 'performance gap' is tackled. This process should include:
  - providing a photographic evidence trail (now required for SAP10);
  - site supervision for focus on the integrity and continuity of insulation
  - a clear air tightness strategy document;
  - site supervision ("air tightness champion") for focus on the integrity and continuity of the airtightness line. Air tightness tests by an accredited tester (such as a certified tester under the ATTMA[112] scheme) must be submitted on completion of a new building. To ensure the achievement of the air tightness target it is highly recommended that an interim test (or tests) is carried out and remedial action taken at appropriate earlier stage(s) of the construction (after the major building fabric works are complete but early enough to allow for remedial fixes if required).

Developing an SPD

- **Recommendation 11**: Local plan policies will require back-up to describe, for the development industry and the wider public, how policies to reduce carbon emissions in new development are to be achieved and what is required, for example with regards e.g. fabric, heating systems, mitigating any over-heating risk, energy flexibility, design package, tackling the 'performance gap', monitoring, and, potentially, mechanisms for improved energy storage. These can be achieved through an Energy and Carbon Reduction SPD or

[112] The Air Tightness Testing and Measurement Association (ATTMA); https://www.bcta.group/attma/

alternatively, as an additional section to the existing Essex Design Guide already in place. If the SDP route is followed, it will need to be championed by an Essex authority which has a recently adopted local plan and/or where a plan is being updated and taken to examination. If it proves difficult to develop an SPD (or this is not possible in the short term) as a fall back, an alternative will be to develop a practice guidance note or similar – as adopted policy by the Essex councils. While this guidance would have less force than an SPD it would strengthen the position of planning authorities in achieving the objectives of tackling climate change. ECAC, working with the local planning authorities, could put in place a mechanism for developing the SPD.

Local planning authority powers

- **Recommendation 12:** On the specific issue of the legitimacy of local plans seeking higher standards than those required by Building Regulation, we recommend that ECAC seeks a legal opinion on the role of local plans in setting standards beyond Building Regulations. This advice that then be shared with the local planning authorities and is available to support LPAs through the plan examination process.

Increasing capacity

- **Recommendation 13**: As already recognised by ECAC, the development industry workforce will require adapted and widened skills, as set out in the 2022 ECAC Report Green Skills in Essex[113]. The report included an Action Plan which echo the findings on skill gaps identified in this study. Increased capacity is also required in the production and delivery of factory produced products to support the shift to no/low carbon buildings in Essex. This requires further research to identify the best means of achieving the enhanced capacity and ECAC should take this forward and commission the necessary research.

Use of land and other interventions

- **Recommendation 14**: ECC can play a direct role in supporting development to the higher standards set out in this report – as can other public sector land owners across Essex. Such interventions fall under three main headings:
    - in its capacity as estate and asset owner (e.g. schools, country park centres, depots etc) should, where there are extensions or improvements to be made (as well as new build), adopt the standards set out in this report as exemplars of good practice;

[113] See – Green Skills Infrastructure Review for Essex, Mace for Essex County Council – March 2022 https://assets.ctfassets.net/knkzaf64jx5x/2boS3yEpHGwgLnZMXqRFfp/b9d705466aecf5e888d517db86800220/Essex-Green-Skills-Infrastructure-review-2022.pdf

- when the County Council disposes of assets it should undertake an energy review and implement retrofit measures in order to achieve a higher energy efficiency level OR require this of the purchaser;
- ECAC to seek to encourage all partner and public anchor organisations to do the same.

Monitoring progress

- **Recommendation 15:** It is important that progress towards achieving net zero in new development is effectively monitored and the ECAC targets are kept under review. A monitoring and reporting regime needs to be identified and put in place and it is recommended that ECAC commissions a feasibility study that examines how this can best be achieved and how it would be funded.

Appendix 1 Glossary

Acronym/key word	Definition
ASHP	Air source heat pump
BCIS	Building Cost Information Service, provides cost and price data for the UK construction industry. It is a part of the Royal Institution of Chartered Surveyors
BEIS	Department for Business, Energy and Industry Strategy
Building Regulations	Part L of the Building Regulations: Volume 1 - Dwellings Volume 2 – Buildings other than dwellings Most building work being carried out in England must comply with the Building Regulations. The Building Regulations are made under powers in the Building Act 1984.
CO2	Carbon dioxide
ECAC	Essex Climate Action Commission
EDG	Essex Developers Group
EPC A, EPC B	Energy Performance Certificate Ratings – from A (most efficient) to G
FHS	Future Homes Standard
MMC	Modern method of construction – a process that uses off-site construction techniques, such as mass production and factory assembly, as alternatives to traditional building methods. The location of the production site may be at a distance from the development or can be on site (with large-scale developments)
MVHR	Mechanical Ventilation with Heat Recovery - a continuous source of ventilation that extracts stale, moisture-laden air from a building and resupplies fresh, filtered air back in.
Net zero (or net zero carbon)	Carbon neutrality is a state of net-zero carbon dioxide emissions. This can be achieved by balancing emissions of carbon dioxide with its removal or by eliminating emissions from society. Source Wikipedia but note definition of net zero is further discussed in the body of the report
Net zero carbon – construction (or net zero Carbon – Whole Life operational)	When the amount of carbon emissions associated with a building's product and construction stages up to practical completion is zero When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative.
Net zero Carbon – Operational Energy	When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative.

Acronym/key word	Definition
Net zero Carbon – Whole Life	When the amount of carbon emissions associated with a building's embodied and operational impacts over the life of the building, including its disposal, are zero or negative
NPPF	National Planning Policy Framework (Last updated in 2021)
NPPG	National Planning Practice Guidance (Updates by topic on a regular basis)
PHPP	Passivhaus Planning Package – a methodology for assessing carbon emissions for different development standards
PV	Photovoltaic – the conversion of light into electricity – and typically is in the form of 'solar panels'.
RP	Registered provider of affordable housing. Typically a housing association but other organisations can provide affordable housing.
UKGBC	UK Green Building Council
U value	The rate of transfer of heat through a structure..