Report for Essex Climate Action Commission

NET ZERO CARBON VIABILITY AND TOOLKIT STUDY

Technical Report August 2022

Three Dragons
Qoda
Ward Williams Associates

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Document control sheet	
Project name	Essex Climate Action Commission – Net Zero Carbon Viability and Toolkit Study
Project reference	
Report title	Net zero Carbon Viability and Toolkit Study
Doc ref	Technical Report
Date	August 2022
Prepared by	Lin Cousins, Dominic Houston, Laura Easton, Sarah Price, Tim Wilcockson, Mark Stevens
Reviewed by	Lin Cousins, Mark Felgate, Laura Easton
Quality statement	In preparing this report, the authors have followed national and professional standards, acted with objectivity, impartially, without interference and with reference to appropriate available sources of information. No performance-related or contingent fees have been agreed and there is no known conflict of interest in advising the client group.
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.

CONTENTS

Appendix 1 – Literature sources

Title	Author	When published	Scope
General			
The Future Homes Standard	DCLG	2019	Sets out the government's plans that by 2025, a Future Homes Standard will be introduced for new build homes to be future-proofed with low carbon heating and high levels of energy efficiency
Future Buildings Standard	DCLG	2021	Sets out the options for new standards for non-domestic buildings, with a preference for a 27% reduction in carbon emissions. This consultation and response forms the basis for the changes in Building Regulations for non-domestic buildings in 2021.
Draft National Policy Statement for Renewable Energy Infrastructure (EN-3)	DBEIS	2021	Provides the primary policy for decisions by the Secretary of State on applications they receive for nationally significant renewable energy infrastructure
net zero Strategy: Build Back Greener	HM Government	2021	The strategy sets out the government's vision for a decarbonised economy by 2050 and the long-term plan to achieve that transition. It includes an ambition that by 2035, no new gas boilers will be sold and a target of 600,000 installations of heat pumps a year by 2028.
Building the Case for net zero: A case study for low carbon residential developments	UK Green Building Council	2022	The report gives insight into some of the key considerations that developers, housebuilders, local authorities and consultants need to think about when planning new large-scale residential communities.
The Climate Crisis A Guide for Local Authorities on	TCPA & RTPI	2021	The RTPI and the TCPA believe that climate change should be the top priority for planning across the UK. The Guide sets out how planning can act locally, by

Title	Author	When published	Scope
Planning for Climate Change			making best use of existing policy, legislation, and technology.
LETI Climate Emergency Design Guide	LETI (London Energy Transformation Initiative)	2020	Proposes a set of KPI's for reducing energy consumption and GHG emissions; suggests fabric u-values and other measures to achieve these targets for a variety of buildings.Covers wide range of proposals and examples for new building and net zero, embodied energy and data feedback loop.
net zero and Sustainability Design Guide – net zero Annex	Government Property Agency	2020	The guide provides Key and optimising targets for achieving net zero Operational Energy alongside Whole Life Asset Management considerations
net zero Carbon Toolkit by Levitt Bernstein, Elementa, Etude and Passivhaus Trust.	Cotswold, West Oxfordshire and Forest of Dean District Councils (commissioning body), funded by LGA	2021	Highly illustrated toolkit for new and retrofit housing, with benchmarks for net zero.and practical design to construction processes and checklists to consider.
Climate Change 2022 – Impacts, Adaptation and Vulnerability	Intergovernmental Panel on Climate Change	2022	The IPCC report provides an assessment of climate change impacts and risks as well as adaptation.

Title	Author	When published	Scope
Essex			
net zero: Making Essex Carbon Neutral	Essex Climate Action Commission	2021	The report sets out a comprehensive plan for Essex to: reduce its greenhouse gas emissions to net zero by 2050 in line with UK statutory commitments; and to make Essex more resilient to climate impacts. ECAC makes recommendations that are considered both necessary for Essex to be net zero by 2050 as well as achievable. Many of the recommendations are for measures to be taken, or be well underway, by 2030.
Essex Climate Action Commission – Technical Annexes Built environment Land use and green infrastructure	Essex Climate Action Commission	2021	Supporting technical reports to 'net zero: Making Essex Carbon Neutral'
Action Plan in Response to the Essex Climate Action Commission's Report	Essex County Council – Report to Cabinet	2021	The report presents ECC's initial climate action plan – both within its own estate and service delivery and working on projects in partnership to develop a comprehensive, collective response to the report.
Essex Developers Climate Action Charter (final draft awaiting publication)	Essex Developers Group	2022	The Charter seeks collaboration across the development industry to respond to climate change across the built environment sector
Sustainability Guidance & Checklist – Garden Town Strategy	Harlow and Gilston Garden Town	2021	The Guidance sets out the principles and indicators for the Garden Town; intended to ensure its growth and management is high quality and sustainable.

Appendix 2 -Local authority interview discussion agenda

Introduction – thanks and explanation of interview protocol (i.e. individual comments not attributed and/or shared outside the study team.)

1. A review of the current planning position

   - Three Dragons to outline understanding of this from a web review.
   - Have we identified the key documents?
   - If no emerging new plan – also ask the Qs under heading 2

2. Similarly for emerging new policy (local plan update and/or supplementary guidance)

   - In terms of carbon reduction, do you think policies are about right for what you want to achieve as an authority and/or as a department?
   - Is there political buy-in to climate change policies?
   - And across the authority – manager / officers etc?
   - Do you see a trade off between zero carbon and other policy objectives – eg meeting affordable housing need and the provision of infrastructure?
   - Did you include viability evidence or costs information to support any emerging climate change related polices? And can you share this with us?
   - Our approach to economic viability will necessarily be high level, perhaps just 2 or 3 value areas across Essex – any thoughts on this approach? or other documents that may be useful for reference?

3. The July report from the Essex Climate Action Commission recommended that:

- *All new homes and all new commercial buildings granted planning permissions to be carbon zero by 2025.*
- *All new homes and non-domestic buildings granted planning permission to be carbon positive by 2030.*

   - What is your authority's response to this recommendation?
   - What will need to happen (e.g. new policies, other initiatives) to achieve this in your area?
   - Do you have any thoughts about what approaches would best achieve these objectives?
   - Is a separate approach required for non-residential development? What should this involve?

4. Any experience of implementing carbon reduction policies through the planning application process?

   - How did this work?
   - What practical elements are needed to achieve carbon reduction policies and are these different for different types of development?

- How do you evaluate what works well?

Depending on Local Plan review stage

- Will you be able to require higher building standards without adopted planning policy?
- How will you be best able to use policy to enforce a requirement for zero carbon homes – eg policy in LP, SPD, local guidance.
- Would this be best approached by each authority in Essex or is there merit in a pan-Essex approach?
- Are you monitoring the delivery of low/zero carbon homes in your authority?
- What tools/mechanisms/procedures would assist you in doing this?
- Is development management prepared for assessing new schemes to ensure they deliver zero carbon?

5. How do you think the development industry locally is adjusting to the aim of zero carbon e.g. their views on the 2021 Building Regulations update and the objectives of Future Homes?
6. Do you have any good practice examples (e.g. guidance documents, development management protocols, development schemes permitted/under construction, good practice developers/ housing associations etc)

   - And how are these working?
   - Has any delivery of higher spec schemes been monitored, either officially or anecdotally?
   - What is working well and what does success look like?

7. One of our tasks is to develop a toolkit that can be used by the Essex councils (and developers etc)

   - What sort of things would be useful to you? Examples could include different options for carbon reduction such as fabric efficiency / heat pumps / solar and costs of alternative approaches
   - Are you aware of the LGA-funded Net Zero Carbon Toolkit? If so do you find this approach useful? Are there other aspects that could make this more useful? Are there any other tools or approaches that we should be aware of?
   - What is your experience of using the Essex Design Guide?
   - Are there lessons to be learnt from the Essex Design Guide that could be applied to a zero carbon approach?

8. Much of the discussion about zero carbon has been about the operational performance of dwellings. What is your view about including embedded carbon within the targets? Should zero embedded carbon be to the same timetable?
9. Are there any concerns about some of the supporting electric supply infrastructure requirements for zero carbon?

10. Are there particular developers and/or housing associations active in your area that you think we should speak with – either because they are important to your housing supply and/or because they are taking an innovative approach to carbon reduction

Appendix 3 – Notes from the development industry workshop

Workshop held on 20th January 2022

Attendees

Person	Abbreviation used in the notes	Organisation
		CHP
		Clarion
		Latimer (Clarion)
		Croudace Homes
		Rose Builders
		Countryside
		Ingeltonwood
		Thakenham Homes
		Moat
		Essex Housing
		Castlepoint Borough Council (representing Essex Developers Group)
		Figura Planning (Uttlesford)
		Essex County Council
Lin Cousins	LC	Three Dragons
Laura Easton	LE	Three Dragons
Dominic Houston	DH	Three Dragons
Tim Wilcockson	TW	Qoda
Sarah Price	SP	Qoda
Mark Stevens	MS	Ward Williams Associates

ESSEX NET ZERO CARBON WORKSHOP 20TH JANUARY 2021

Essex County Council: Matthew Thomas

Three Dragons: Laura Easton, Dominic Houston & Lin Cousins

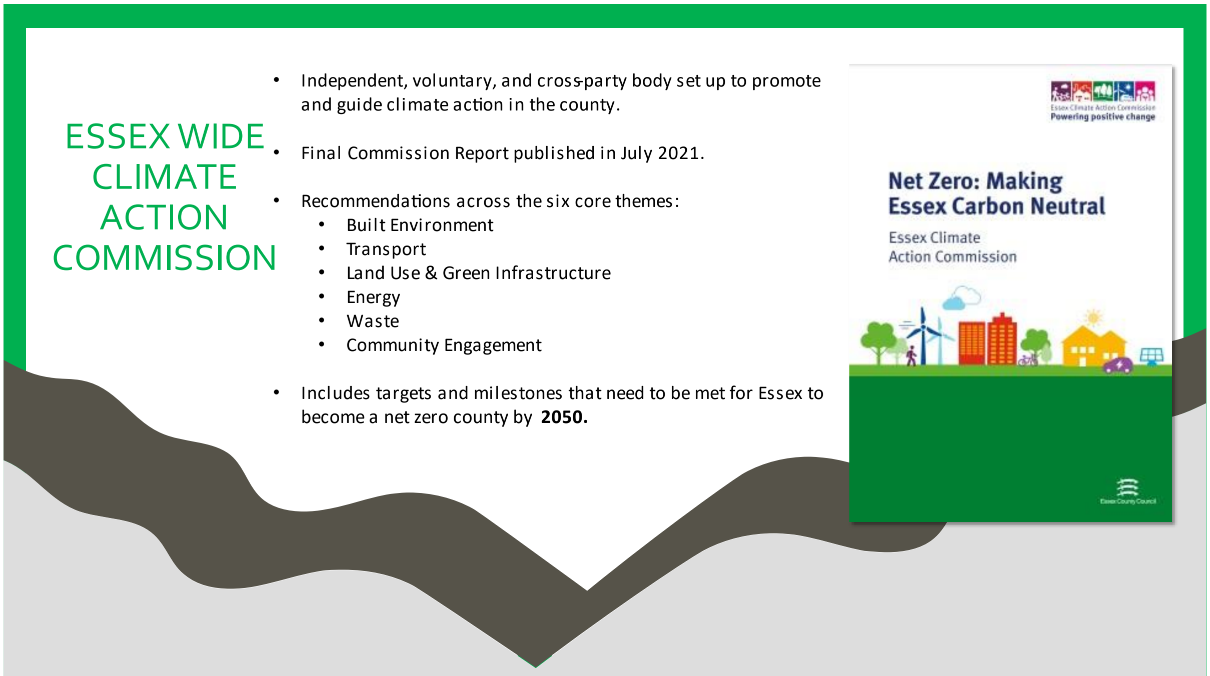
Qoda – Sarah Price & Tim Wilcockson

Ward Williams Associates – Mark Stevens

Introduction

- Essex County Council, Three Dragons, Qoda (was Enhabit) and Ward Williams Associates
- Context for this work:
- Overall objective of net zero carbon
- Work being undertaken
  - ECAC report
  - Developers Charter
  - New ECC net zero carbon planning team

LC introduced the workshop and its objectives and participants introduced themselves. LC explained that a note of the workshop would be circulated for any further comment and a final version of the note would be included in the consultant team's report to Essex County Council and which would be published. The workshop is being undertaken under the Chatham House rule i.e. organisations present would be listed (but not individual names) and that the notes would not identify the name/organisation of those offering comments (unless these are already a matter of public record).



MT explained the Essex Climate Action Commission (ECAC) and its six core themes. The Commission is voluntary and includes the County Council as well as other organisations. The built environment is the theme for the work being undertaken here.

The Commission has produced the July 2021 report and action plan, which sets the agenda. The link to the report will be shared in the workshop notes – see link below.

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

The Essex Developers Group has produced a charter for the development industry to sign up to – see link below:

https://www.housingessex.org/assets/uploads/2022/01/ECAC-Climate-Action-Charter-Dec-2021-v5.pdf

NET ZERO VIABILITY STUDY

- Study looking a how net zero carbon may be delivered by different types of development typologies in an Essex context.
- Outputs from the study may be used as supporting evidence formulation of climate change policies in local plans as well as for supplementary advice, masterplanning and decision taking on planning proposals.

Essex Design Guide – Climate Change Supplement

- **Stage I:** To create a dedicated climate change supplement section on the EDG website drawing out specific themes and show how these may help embed climate change mitigation and adaptation in development.
- **Stage II:** To further update the climate change section with new themes. For example one commission will investigate how climate change mitigation strategies can be delivered in listed buildings, conservation areas and heritage assets

MT discussed the Climate Change Supplement, which will be on the ECAC website soon. It will be used to provide more information in the Essex Design Guide. Referred to the Essex Design Guide and noted that there will be a climate change section, in what is the current placemaking section.

Walkable Neighbourhoods

Part A:

- Study exploring delivery of a walkable development model vs. a more traditional model to support local plan policy formulation
- It will look at viability, potential barriers as well as wider benefits of creating low car or car free neighbourhoods, particularly for health and well being.

Part B:

- Will explore the design and concepts for a series of new practical movement strategies and road types to serve a walkable neighbourhood– outcomes will be set out on the Essex Design Guide website as guidance for new developments

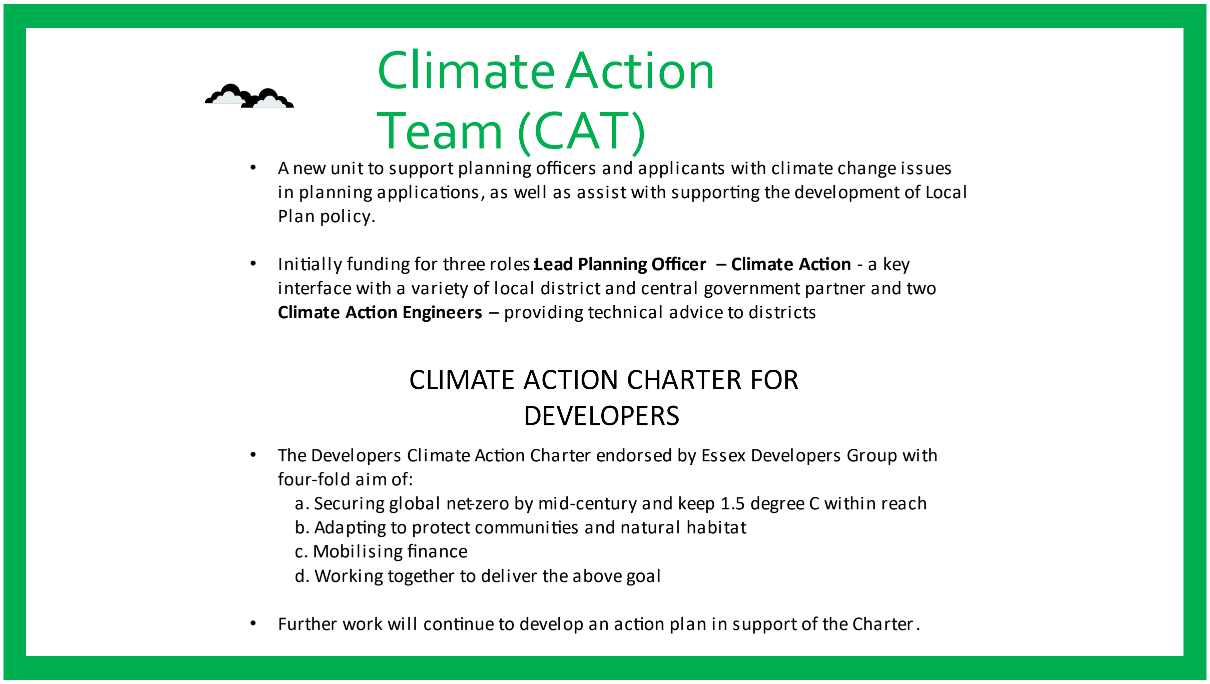
ESSEX GREEN SKILLS INFRASTRUCTURE REVIEW

- A commissioned review by Mace Group of Essex wide employment, training, and skills infrastructure in order to identify opportunities for innovation and green construction in development; including ensuring that services and processes supporting this have necessary skills and knowledge to meet climate change targets. It will includeastakeholderaction plan identifying resources and next steps.

MT introduced the Walkable Neighbourhoods study, which is in two parts:

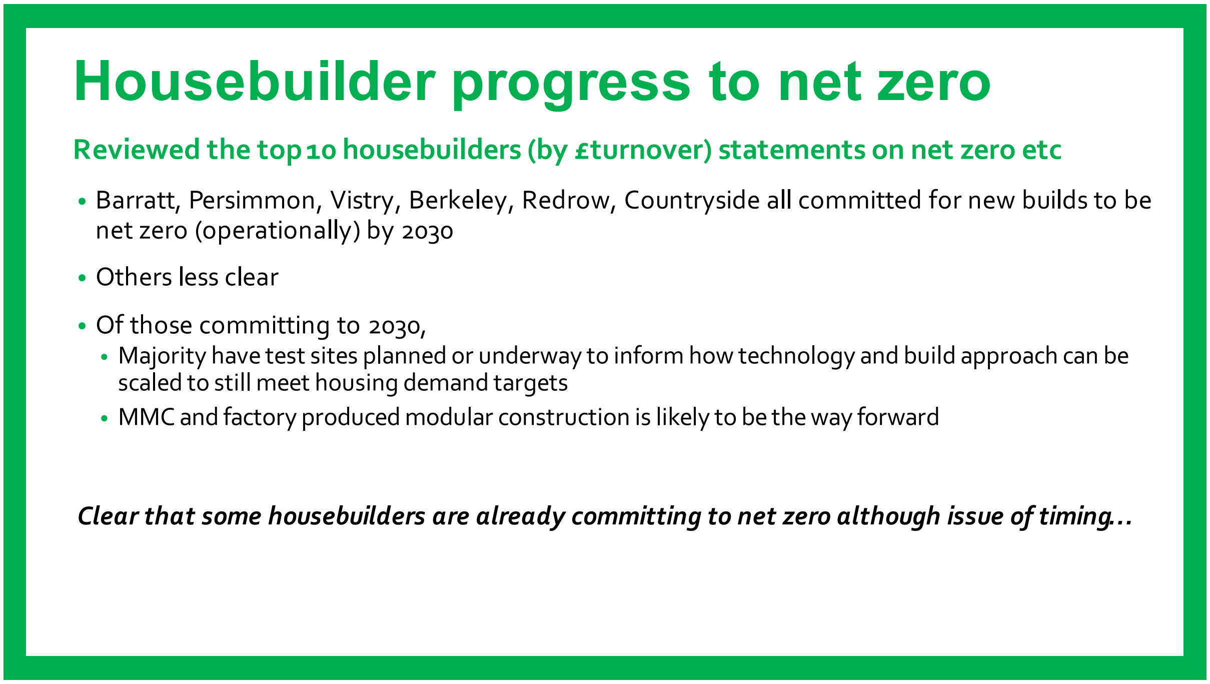
- Part A to be commissioned soon, to assist case officers with applications. Looks at viability of walkable neighbourhoods compared to a more traditional approach.
- Part B – a larger piece of work that drills down to the practicalities of different road types. This will also be part of the Essex Design Guide.

MT introduced the Green Skills Infrastructure Review, which includes an assessment of the skills gaps.



MT explained that the County Council will be using a new team to take forward development to zero development. This team will provide a technical resource function to assist local government and the development industry. It is proposed that the team will provide examination support and expert witness roles.

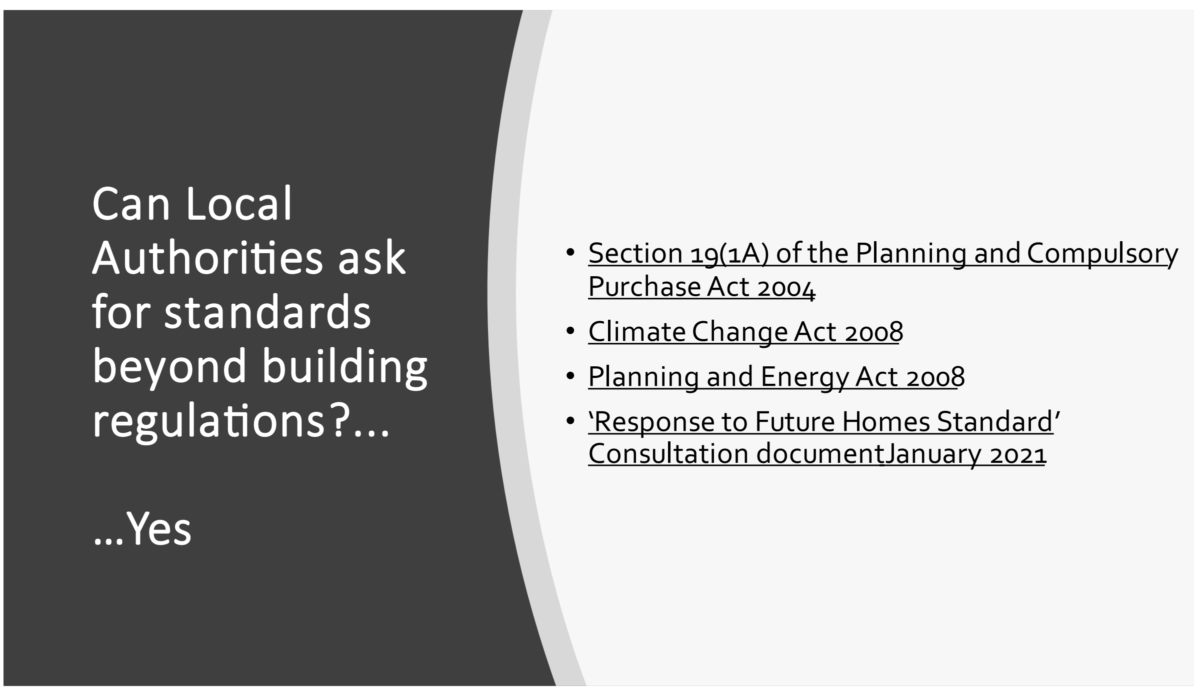
MT explained that the Climate Action Charter is being taken forward by the Essex Developers Group and has recently been endorsed by the group. The next stage will be an action plan.



DH noted that many of the country's largest housebuilders were already making a commitment to zero carbon dwellings. However the target date for this is 2030, which is different to the ECAC objectives.

Commentary

- There were no questions.



DH explained that LPAs can require higher standards for new buildings than set out by national government.

Commentary

- There were no questions.

Government 'Pathway' v. ECAC Timelines (New Build Only)

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

TW explained the national pathway to zero carbon, including the need for rented accommodation to meet EPC 'C' standard ('B' for non-residential). 2050 has the target of 100% reduction in emissions compared to 2013 building regulations, with grid decarbonisation part of this process.
By comparison, the ECAC has a set of earlier targets, which include carbon positive by 2030. By 2040 it is proposed that renewables will provide all of the county energy needs, which implies most roofs will have PV as well as new wind and wave generation

Commentary

- There were no questions

QODA Consulting Net Zero Group	Building Regs Part L 2021 (effective June 2022)	Future Homes Standard 2050	AECB Standard	Essex Renewables Approach	Passivhaus Classic	Passivhaus Plus Solar
Performance Gap?	~	~	✓	?	✓	✓
Includes Unregulated Energy?	✗	✗	✓	?	✓	✓
Embodied Carbon?	✗	✗	~	?	~	~
Impact on Grid Capacity?	✗	✗	~	?	✓	✓
Fuel Poverty?	~	~	✓	?	✓	✓
Comfort?	✗	✗	✓	?	✓	✓
Health & Well Being?	✗	✗	✓	?	✓	✓
Net Zero Compliant?	✗	✗ possibly with Grid decarbonisation	✗ possibly with Grid decarbonisation	?	✗ possibly with Grid decarbonisation	✓

TW explained the matrix on the slide. It was noted that there was an issue with performance gaps with building regulations (BR), partly as BR does not consider unregulated energy use (household appliances and EV charging), which could account for over 50% of energy used. Therefore, Future Homes does not really achieve net zero compliance, and it also relies upon grid decarbonisation (which is unlikely by 2025). TW explained that the only standard in the grid above that achieves net zero before the grid is decarbonised is Passivhaus with solar, which also deals with fuel poverty plus health and well-being.
It was confirmed that Passivhaus plus is the only way that net zero can be achieved by 2025.

Commentary

- It was agreed that grid decarbonisation is not the panacea – zero carbon requires direct action.
- It was queried whether full Passivhaus was required or just airtightness. TW confirmed that Passivhaus certification route is the most robust way. However, benchmarks around airtightness can be used as an indicator of the quality of the build. Good building fabric that is checked (with airtightness as quality control measure) will go a long way to achieving the standard when combined with required bolt on technologies (ASHP/MVHR/PV). It was agreed that certification was important in terms of reducing performance gaps.
- It was noted that capacity on-site to monitor and ensure air tightness (e.g. site airtightness champions) are very important in meeting this standard.

How are you dealing with carbon reduction for new development?

- What carbon standards are you working towards and when?
- Are you planning to build 'fabric first' or rely on technology (either for 2025 Future Homes or beyond)?
- What are the barriers to building to higher standards?

LC asked for comments from the workshop to these questions.

Commentary

- A housing association attending explained that they have adopted fabric first but deliver schemes with 50% specialist or affordable housing so need to make sufficient returns to cross-subsidise these. Uses EPC B as standard and uses the Essex Design Guide. This approach is undertaken regardless of the market, which means that the standard of delivery can be beyond what others in the that market might provide. Also piloting additional features such as PVs, plus EVC (subject to cost/grid capacity). Currently delivering a 25-dwelling scheme with a library in Harlow to EPC A with air source heat pumps (ASHPs). ASHPs are not yet standard, especially in non-residential buildings, so some risk. Is also delivering a scheme in Chelmsford with net zero carbon for construction and in use – but costs considerable.
- A second housing associations stated that they had adopted the Future Homes standard, with ASHP and better insulation. Have used ASHPs for a while and there are additional costs. Want to get as much new build rented stock net zero carbon ready. Big issue is retrofitting stock, and the additional costs on new build are cheaper now than retrofitting later on. Looking to put in EVCs and PVs as that's what market will require. When taking s106 affordable housing, the organisation asks for ASHPs but will not always get them.
- A market housebuilder stated that they follow fabric first and add on tech to meet planning policy. The organisation noted that the land market is tricky – needs level playing field whereas at the moment the incentive to go for higher standards is undermined by cheaper lower quality build offering more money for sites. LC asked whether this levelling means it needs to be set through building regulations or baked into local plan policy requirements? Very competitive market for land.

- Another private sector housebuilder agreed with this, stating that unless the landowner is enlightened then higher quality builds are priced out of sites. The housebuilder is looking at carbon reduction by 2025 and has installed electric vehicle charging points (EVCs) on each dwelling recently and is looking at ASHPs and PV. Also looking at more factory production – reduces carbon emissions and moving towards a fabric first approach in new homes.
- Another market housebuilder also takes a fabric first approach, which is the logical step in the hierarchy as well as the importance of minimising thermal bridging. The organisation noted that the HBF has a future homes task force to formulate solutions at scale across the UK. Agrees with land pricing issue, and also notes that supply chain and contractors have issues - that there aren't enough ASHPs available or contractors to fit them currently. Also energy infrastructure issues in some locations with the move to electricity for all heat plus car charging. Very supportive but need to be pragmatic.
- LC – are house buyers paying more for higher standards? Answer from the workshop is that this is not really happening at the moment, as any new home will have better energy efficiency than older stock. But views are changing, and it is probable that in due course there may be a premium. Recent Savills research was quoted showing younger buyers more likely to pay a premium for energy efficient housing.
- A housing association noted that there is anecdotal evidence for higher value car parking with EVCs. Also quoted Hastoe, which did a study of PH in Wimbish – understood that additional values may have covered extra cost. Latimer also stated that the ASHP and PV tech may not be as expensive as feared, and that contractors, when challenged can reduce their costs e.g. ASHP £10k to £5k or less through negotiation.
- Barriers to delivery of net zero carbon noted were:
    - SAP10 calculations that give a perverse result e.g. retrofit gas gets higher SAP 10 scores. Government is becoming more aware of SAP10 deficiencies as a carbon tool.
    - Achieving the standards at scale and at pace (issues around availability of relevant skills and 'parts' e.g. ground source heat pumps).
    - Differences in approaches between local planning authorities – variability of local plans – so building standards used in one place are not acceptable in the next.
- Essex County council noted that drivers of change could include rising energy prices which may drive HAs changing heating and building systems to avoid tenant fuel poverty (and arrears). Also older persons housing schemes likely to be interested in reduced energy costs. So some parts of the market may move more quickly?
- Example noted of an 80 dwelling net zero pilot scheme in Chelmsford –with involvement of Homes England.

Viability Testing

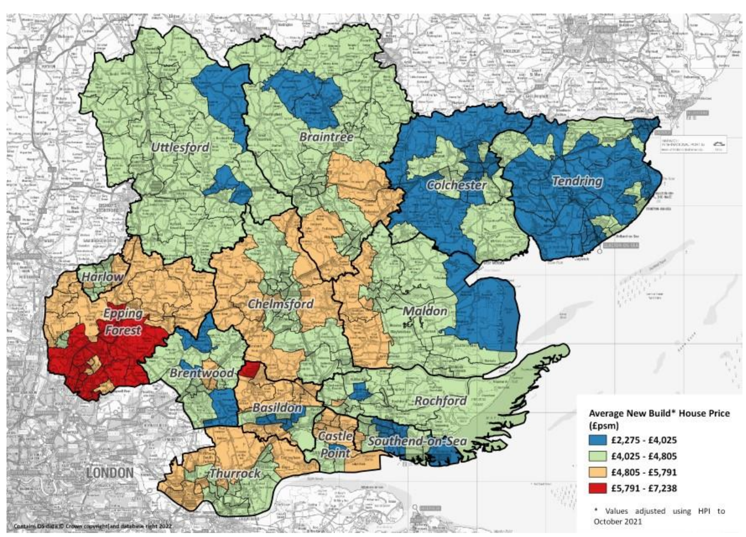
High level viability testing around the impact of higher standards on development typologies typical for Essex

Input	Source
Sales values	Land Registry/EPC
Build costs	BCIS based to Essex, varied by scale; additional allowance for site costs
Affordable values	Typical Local Plan policy – 30%, mix of rented and affordable home ownership
Benchmark land values	Existing use value + based on MHCLG/LPA viability assessments
Other development costs	Industry norms
s106	Essex guide to developer contributions plus generic local mitigation – sense checked with local studies
Building standards costs	Cost consultant / government impact assessments
Development typologies	C8-10 typologies in consultation with CC and LPAs

LE emphasised the high-level nature of the viability study. Will use 8-10 typologies based on review of local plan viability evidence and discussion with ECC. LRPP and EPCs for values, BCIS for dwelling build costs. Will use 30% affordable housing, maybe 40% in higher value areas. BLVs will uses EUV+, with EUV based on MHCLG as well as LP viability studies in Essex. S106 will be based on Essex guide plus sense check with local plan viability. Building standards have government impact assessments plus inputs from WWA. Notes will include more detail on values and costs (see annex), and LE is happy to discuss testing assumptions and invited people to contact her.

Value Areas

- Development will be tested in 4 value areas identified through data from Land Registry / EPC
- An overview of values– in reality each authority will be far more nuanced – report will make this clear
- Maps shows sales data for new houses – separate data for flats



LE explained value areas. Lower value houses in the coastal areas in the north of the County. Noted that there are more higher value areas for flats than for houses.

Typologies

- Large new community c5,000 dwellings over 25 years
- 250 dwellings – urban and rural
- 100 /120 dwellings on 1 ha urban
- 35 dwellings on 1 ha – urban and rural
- 16 apartments on 0.1ha urban
- 9 dwellings – urban and rural

- Without affordable housing

- Single unit
- Specialist older persons – 55 units on 0.5ha site
- Commercial site – additional costs on sqm basis
- School or other educational – additional costs

Image – Essex Portal

LE explained the viability testing typologies.

Commentary

- Important that the testing includes all ‘asks’ of development e.g. bio diversity net gain, electric vehicle charging points
- LE was asked if there was an intention for the consultant team to undertake further consultation with the development industry. LE explained that this workshop is the beginning. More details will be sent with the notes, and LE is happy to discuss further on a one-to-one basis. LC explained that this is a higher level than a local plan evidence base viability study and agreed to explore the option of a follow-on workshop.

Marginal costs of zero carbon
Initial draft costs

Semi 114 sqm with integral garage (dwg = 100 sq m)		Zero CO2 over BR 2021
Floor	U-value ≤ 0.11 W/m2.K	£400
Walls	U-value≤ 0.15 W/m2.K	£210
Roof	U-value ≤ 0.11 W/m2.K	£0
Windows	U-value ≤ 0.8 W/m2.K	£600
Doors opaque/semi-glazed	value ≤ 0.8 W/m2.K	£500
Air permeability	50 Pa (5.0 m3 /(h.m2))	£1,000
Heating	Low-carbon heating (e.g. Heat pump)	£6,000
PV		£3,000
Total		£11,710

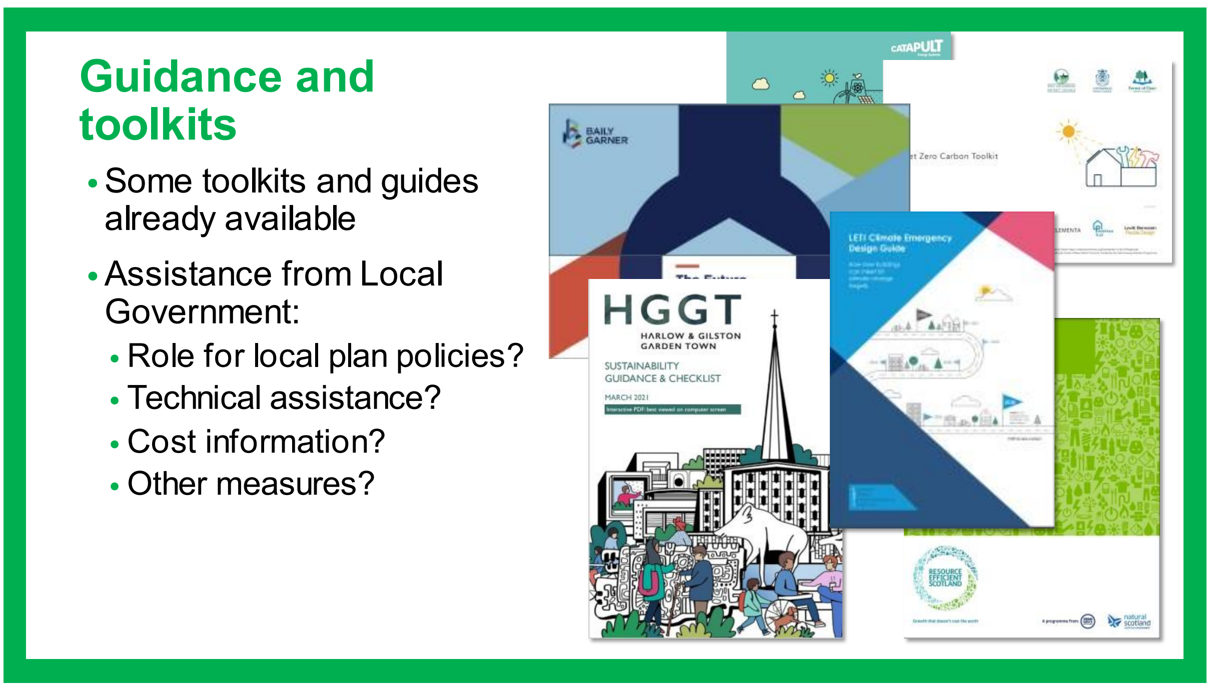
MS Explained that the figures in the table above are looking at uplift from 2021 BR and relate to net zero carbon (ie beyond the nationally proposed Future Homes Standard). The figures reported are an estimated extra over from the changed Building Regulations which are due to be introduced in June 2022. It was emphasised that the costs are initial estimates and may be amended. In addition, WWA will do more work to fit the initial costs with different scale typologies. MS confirmed that the costs relate to zero carbon on 2025 ECC timeline which is prior to fuller grid decarbonisation compared to Future Homes 2025 which is dependent on later grid decarbonisation.

Viability and Costs

- What is your experience of the costs of meeting higher standards?
- How have landowners recognised the implications of changing standards?
- What role do you think MMC/offsite construction can/will play?
- How might the marginal costs of higher building standards change over the longer term?

Commentary

- It was noted that the costs of heat pumps have been coming down – and one workshop participant indicated that current costs for a heat pump in a newbuild was about £4,500 – a figure that was supported by another participant with a third comment that a cost of £5,000 was more typical now.
- A housing Association noted that ASHP additional costs were about £5,000 but a recent scheme had a cost of £3,000 to switch from gas to ASHP.
- The issue of development lead in times was raised. This could be longer because of delays obtaining ASHPs. Similarly there could be delays obtaining factory made (timber) frames etc. However, these delays can be offset by the reduced overall build times for factory made units. LC undertook to consider the implications of the different factors for overall pace of build.
- Countryside – what about costs of infrastructure costs of electrification as well as costs of BNG. WWA responded that infrastructure costs will depend on scale. LC confirmed that we will include BNG and EVCs, plus some accessibility costs.



DH noted that there was already a library of technical guidance and toolkits available. Participants were asked what other assistance could usefully be provided by Local Government.

Commentary

- Consistency of the standards required is needed;
- The new approaches to development and associated technology are moving at a very fast pace. Policies that are too prescribed will quickly become out of date.
- The County Council could have a role in coordinating LPAs in Essex plus liaison with others elsewhere in the country.

- The Thurrock Climate Action Plan put forward as another example of good practice.
- It was suggested that smaller housebuilders may need more help

LC outlined the next steps and thanked participants for their time and inputs. MT also thanked people.

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dominic.houston@three-dragons.co.uk

Note : A selection of the slides relating to the proposed viability testing assumptions that were shown at the workshop were circulated to developer interviews contacted separately at a later stage in the research.

Appendix 4 – Developer interview – discussion topics

Introduction – thanks and explanation of interview protocol (i.e. individual comments not attributed and/or shared outside the study team.)

1. If relevant – The overarching aims of this study have already been discussed at the workshop attended, but any comments generally on this or the Developer's Charter?
2. Approach to meeting government and Essex targets. (2021 Building Regulations, First Homes at 2025 or net zero at same date) and any issues faced
3. Technologies used to meet the different standards – fabric first, other technologies
4. Is/would meeting the zero carbon agenda affect the viability of your development
5. Impact of achieving higher specifications on market values
6. Impact of different technologies on costs
7. Are there supply chain or labour availability/skills issues affecting move to higher specifications
8. Use of pilot projects and their implications
9. Any comments re the workshop notes circulated and costs and approach to viability testing proposed
10. Anything else to add?

Appendix 5 - Standards and Fabric Comparisons

Standards and fabric comparisons

1. This appendix is focuses on new build developments but many of the steps can be considered for retrofit projects.

2. A schedule of comparative standards is provided with suggested steps for implementation towards the Passivhaus standard. In this case it is assumed that the proposed Future Homes Standard 2025 will be the minimum requirement. However, it is recommended that where a measure can be incorporated in the fabric more sensibly and economically to avoid retrofitting difficulties or for future proofing, this measure should be adopted from the outset.

3. Examples of this include:

   - airtightness measures,
   - additional layers of insulation,
   - wastewater heat recovery,
   - thermal bridge free design.
   - It is also worth considering ventilation duct runs being pre-installed for later connection with MVHR for further upgrading opportunities.

4. Note: The new Building Regulations (BR) Part L Conservation of Heat and Power 2021 came into force on 15 June 2022. A new Standard Assessment Procedure with revised underlying assumptions (SAP version 10.2) underpin the assessment of building performance and the resultant ratings of dwellings. The reference values in SAP are for a notional building against which an actual dwelling is compared: if the actual dwelling meets or exceeds these reference values then a Pass should be achieved. Latest versions of the SAP document are available at: https://www.bregroup.com/sap/sap10/

5. In the context of the future of SAP, strong representations have been made and are being considered by the Department for Business, Energy and Industrial Strategy who commissioned this work. The recommendations made by the SAP11 scoping committee should be factored in as being the most likely direction of travel, so future proofing of design work now should pay dividends in the future. SAP11 is expected to be rolled out in 2025. The SAP11 scoping project report can be found here: https://etude.co.uk/how-we-work/the-future-of-sap-calculations/

6. For the purposes of carbon emissions, the Passivhaus approach accounts for both regulated and unregulated energy whereas SAP and Building Regulations omits unregulated energy (plug loads such as kettles, computers, cooking and appliances etc) which can account for as much as 50% of energy use in a home.

Table A5.1 Fabric specifications - Practical steps to improve current performance to BR Part L 2021

Fabric Specifications - based on 'on-site' carbon targets for a typical semi-detached home.			
	BR2013 Part L (standard climate data).	BR2021 Part L Standard (standard climate data)	Practical steps to improve current performance to BR Part L 2021 Approved Document takes effect 15 June 2022
Floor U-value (W/m2.K)	0.13	0.13	No change to current building regulation requirements.
External wall U-value (W/m2.K)	0.18	0.18	No change to current building regulation requirements.
Roof U-value (W/m2.K)	0.13	0.11	This requires an increase in thickness of insulation which will vary according to the characteristics of the material used. Typically this will involve adding insulation in the roof space either between and over the joists or between and over the rafters allowing always for appropriate ventilation. • To upgrade the roof insulation at ceiling level for example from current building regulations would require an additional **70mm of mineral wool** insulation.
Window U-value (W/m2.K) **Rooflights**	1.4 1.7	1.2 1.7	The double glazing requires an improved performance with the following specifications included: • Frame factor = 0.7 • Solar Energy Transmittance= 0.63 • Light transmittance= 0.80 The U-value of the window certified by the manufacturer is an uninstalled value. To ensure best practice it is essential that the frame is 'thermal bridge free' i.e. it is placed in and behind the line of insulation to make sure there are no heat losses through the frame. Poor installation will significantly waste both money and energy performance. U-value of Rooflight in horizontal position. (U value =1.4 + 0.3 roof window adjustment factor = resultant value of 1.7 W/m2.K: no change for 2021 Part L)
Door U-value (W/m2.K)	1.0 - opaque 1.2 – semi-glazed	1.0	Semi-glazed doors have up to 60% glass. If a door has more than 60% glass, it is then treated as a window. Solid or semi-glazed doors must have a certified u-value of 1.0 W/m2.K. The certification is normally supplied by the manufacturer via the wholesaler or retailer and is often indicated on a label attached to the window unit itself when first supplied to site. Sometimes the manufacturer and performance of the glazing can also be seen printed on the spacers in between the panes of glass.
Air permeability at 50 Pa	5.0 m3/(h.m2)	5.0 m3/(h.m2)	No change to current building regulation requirements. This is an air pressure test to check for air leakage or draughts. A trained and registered air tester conducts the test with regulated procedures and equipment.
Overheating	No explicit guidance	CIBSE guide >28^{0}C for 1%/year in bedrooms at night (22:00-07:00), OR 3% elsewhere (living rooms, kitchens, corridors etc and care homes) from May – September.	The detailed guidance is contained in the CIBSE Technical Manual TM59. In essence the guidance proposes a number of simple to achieve shading strategies to reduce the amount of solar heat gain through glazing. The first principle is to limit the amount of glass openings to South, West and East facades so it needs to be considered at the beginning of the design stage.. Additionally cross ventilation and window apertures are very important when combined with shading provided by balconies or brise soleil, shutters and external awnings or blinds. Shading by trees or large or climbing plants is seen as unreliable; curtains or internal blinds are insufficient for this level of heat reduction.

			Air conditioning is not recommended as it is an additional source of heat and energy use, and therefore CO_2 emissions, contributing in particular to the Urban Heat Island Effect. Good Homes Alliance 'Overheating Tool' is designed to help planning decisions in this regard - Overheating in New Homes – Good Homes Alliance Internal gains from occupancy, uninsulated HW pipes, and electrical equipment must also be considered in the overheating equation.
Heating appliance	Gas boiler (89.5% SEDBUK 2009)	Gas boiler (89.5% SEDBUK 2009)	No change to 2013 building regulations. Low-carbon heating (e.g. Heat pump with 250% efficiency) is always an option. Appendix D of Part L 2021 provides a good practice specification with Heat Pump (250% efficiency for space and water heating). Gas Combi 95% efficiency assumed for archetypes in BR2013 and BR2021.
Heat Emitter type	Regular radiators. Design flow temperature= 55^{0}C	Regular radiators. Design flow temperature= 55^{0}C	No change to current building regulation requirements.
Ventilation System type	Natural ventilation with intermittent extract fans	Natural ventilation with intermittent extract fans	No change to current building regulation requirements. Note: Chimneys and open flues have a significant and detrimental effect on ventilation rates and should be avoided.
PV	No	**For HOUSES** kWp = 40% ground floor area, including unheated spaces/ 6.5 **For FLATS** kWp = 40% of the dwelling floor area/ 6.5 x number of storeys in a block.	In the case of houses, the amount of power required to be produced by PV panels on a house is arrived at by the formula of 40% of the ground floor area, including unheated spaces, divided by 6.5 to give a figure in kWp. This means that for a 70m^2 2-storey house, with ground floor area being 35m^2 (35 x 40/100)/6.5 = 2.154kWp would be the energy legislated for. The system must be connected to the house meter. In the case of flats, the amount of power required to be produced by PV panels on a block of flats is arrived at by the formula of 40% of the dwelling floor area divided by 6.5 times the number of storeys in the block, to give a figure in kWp. On the above example a 4-storey block of 35m^2 flats would require 2.154 x 4 = 8.616kWp of electricity generation from its PV array. The system must not be connected to the meter of the individual flat but metered as an overall system on its own. In both cases above, panels need to be mounted on a southerly facing roof (South East to South West) and have no overshading. 45 degree tilt has been assumed. Average PV generation assumed 370W per panel. (Appendix D Table D1, Part L 2021 suggests omission of PV if alternative spec is followed).
Wastewater heat recovery (WWHR)	No	Yes	All showers must be connected to a WWHR unit, including showers over baths • The specification requires instantaneous WWHR with 36% recovery efficiency. (Appendix G SAP10.2 provides more detailed specifications). 250Ltr insulated cylinders are assumed with a heat loss factor of 1.97kWh/day.
Thermal Bridges Psi value (W/m.K)	Default y=0.15 ACDs or Calculated	Default y=0.20 ACD Average c. 0.08	N.B. To encourage calculated thermal bridge psi values, SAP version 10.2 states that the default y-value will be 0.20 W/m2K (an increase from 0.15 default). If the default y values are used, a Fail will result. Therefore thermal bridges must be calculated and where possible Accredited Construction Details (ACD) or similar are assumed. An average value of 0.08 has been assumed for modelling of archetypes.

CARBON EMISSIONS TARGET ($kgCO_2/m^2/yr$)	16.0	11.0	Overall improvements in the fabric specifications should achieve the target reduction. This will need to be demonstrated with an Energy Performance Certificate (EPC) calculated using the Standard Assessment Procedure (SAP) prepared by a Registered SAP Assessor under one of the nationally approved Quality Assurance schemes.	At least **31% less emissions** compared with 2013 Part L.

Table A5.2 Fabric specifications - Practical steps to improve BR Part L 2021 to achieve indicative Future Homes Standard 2025

Fabric Specifications - based on 'on-site' carbon targets for a typical semi-detached home.			
	BR2021 Part L Standard (standard climate data)	**Indicative Future Homes Standard Specification (includes measures already taken in 2021 Part L)**	**Practical steps to improve BR Part L 2021 to achieve indicative Future Homes Standard 2025**
Floor U-value (W/m2.K)	0.13	0.11	This requires an increase in thickness of insulation which will vary according to the characteristics of the material used. Typically on a suspended timber floor an extra 70mm of insulation will be required and on a 70mm concrete screed floor only an additional 30mm of insulation can achieve the 0.11 u-value required. In both cases perimeter insulation of 50mm is assumed to reduce thermal bridges. With this level of additional insulation it makes economic and environmental sense to aim for the higher standard from the start rather than trying to retrospectively upgrade in the future. Adding an additional 30 – 70mm of insulation now is an easy win - trying to add this in the future will be very expensive.
External wall U-value (W/m2.K)	0.18	0.15	This requires an increase in thickness of insulation which will vary according to the characteristics of the material used. Typically with a full fill cavity wall current insulation levels would need to be increased by 65mm; with a Timber frame I-studs construction insulation increase would be 50mm; and with a Structural Insulated panel wall insulation requirement would be an additional 65mm to achieve the 0.15 u-value. With this level of additional insulation it makes economic and environmental sense to aim for the higher standard from the start rather than trying to retrospectively upgrade in the future. Adding an additional 50 – 65mm of insulation now is an easy win - trying to add this in the future will be very expensive.
Roof U-value (W/m2.K)	0.11	0.11	No change compared to Part L 2021 requirements.
Window U-value (W/m2.K) **Rooflights**	1.2 1.7	0.8 (Uninstalled U-value – see earlier note)	Window performance upgrades from double to triple glazing. Given that triple glazed windows should pay for themselves in terms of energy saving over a five-year period compared to the current cost of a double glazed unit, then the cost uplift to replace the windows between 2021 and 2050 is a false economy quite apart from the disruption involved, additional CO_2 in embedded energy and future labour costs.
Door U-value (W/m2.K)	1.0	1.0	No change compared to Part L 2021 requirements.
Air permeability at 50 Pa	5.0 m3/(h.m2)	5.0 m3/(h.m2)	No change compared to Part L 2021 requirements.
Overheating	CIBSE guide >28^{0}C for 1%/year in bedrooms at night (22:00-07:00), OR	The overheating strategy should be already in the original design stage work so no	No change compared to Part L 2021 requirements.

	3% elsewhere (living rooms, kitchens, corridors etc and care homes) from May – September.	further requirements envisaged.	N.B. It is recommended good practice to insulate all internal hot water pipework to reduce unwanted heat gains in the summer months and provide more efficient conservation of energy.
Heating appliance	Gas boiler (89.5% SEDBUK 2009)	Low-carbon heating (e.g. Heat pump with min. 250% efficiency)	Fossil fuel boiler systems are to be phased out and replaced with low carbon technologies such as all electric heat pumps. Currently there is a Renewable Heat Incentive to help subsidise the cost and quarterly repayments of approximately 75% are spread out over 7 years. Gas Combi 95% efficiency assumed for archetypes in BR2013 and BR2021.
Heat Emitter type	Regular radiators. Design flow temperature= 55⁰C	Low temperature heating. Design flow temperature= 35⁰C	Underfloor heating or large radiators are both suitable for water heated efficiently to a low level temperature (around 35⁰C). The ability to operate at a low water temperature for space heating means that the boiler does not have to use so much energy and therefore helps reduce CO_2 emissions. (Note: A heat pump operates most efficiently when only low level temperatures are required.)
Ventilation System type	Natural (with extract fans)	Natural (with extract fans)	No change compared to Part L 2021 requirements.
PV	40% ground floor area	Already supplied under Part L 2021.	No change compared to Part L 2021 requirements. (Appendix D Part L 2021 suggests omission of PV if alternative spec is followed). Average PV generation assumed 370W per panel.
Wastewater heat recovery	Yes	Already supplied under Part L 2021.	No change compared to Part L 2021 requirements. (Appendix D Part L 2021 suggests omission of WWHR if alternative spec is followed). 250Ltr insulated cylinders are assumed with a heat loss factor of 1.97kWh/day.
Thermal Bridges Psi value (W/m.K)	Default y=0.20 ACD Average c. 0.08	Default y=0.20 ACD Average c. 0.08	No change compared to Part L 2021 requirements. N.B. To encourage calculated thermal bridge psi values, SAP version 10.2 states that the default y-value will be 0.20 W/m2K which Fails Building Regulations. Therefore thermal bridges must be calculated and where possible Accredited Construction Details (ACD) or similar are assumed. An average value of 0.08 has been assumed for modelling of archetypes.
CARBON EMISSIONS TARGET ($kgCO_2/m^2/yr$)	11.0 At least **31% less** emissions compared with 2013 Part L.	3.6 At least **75% less** emissions compared with 2013 Part L.	Overall improvements in the fabric specifications should achieve the target reduction. This will need to be demonstrated with an Energy Performance Certificate (EPC) calculated using the Standard Assessment Procedure (SAP) prepared by a Registered SAP Assessor under one of the nationally approved Quality Assurance schemes. At least **75% less** emissions compared with 2013 Part L.

Table A5.3 Fabric specifications - Practical steps to improve indicative Future Homes Standard 2025 to Passivhaus Classic

Fabric Specifications - based on 'on-site' carbon targets for a typical semi-detached home.			
	Indicative Future Homes Standard Specification (includes measures already taken in 2021 Part L)	Passivhaus Classic (indicative, to achieve energy balance) & AECB Standard Climate location specified.	Practical steps to improve indicative Future Homes Standard 2025 to Passivhaus Classic
Floor U-value (W/m2.K)	0.11	< 0.11	No change compared to Indicative Future Homes Standard 2025 requirements.
External wall U-value (W/m2.K)	0.15	< 0.15 Typically this is 0.11 in UK to achieve PH.	No change compared to Indicative Future Homes Standard 2025 requirements. N.B. In practice to achieve PH standard in the UK it is usually necessary to achieve a U-value of 0.11 W/m2.K for walls.
Roof U-value (W/m2.K)	0.11	< 0.11	No change compared to Indicative Future Homes Standard 2025 requirements.
Window U-value (W/m2.K)	0.8 (Uninstalled U-value)	< 0.80 (Installed U-value)	No change compared to Indicative Future Homes Standard 2025 requirements but Passivhaus requires thermal bridge free installation such that the installed u-value is no worse than 0.85 W/m2.K. In practice this means that the uninstalled u-value specified needs to be around 0.70 to 0.75W/m2.K.
Door U-value (W/m2.K)	1.0 (Uninstalled U-value)	< 0.80 (Installed U-value)	Door performance upgrade mainly achieved with thicker insulated door panels. No penetrations allowed (e.g. letter box flaps) through door so post boxes are external as in most European countries. Good seals around door and frame ensure draught free doorways with minimal heat losses. Passivhaus requires thermal bridge free installation such that installed u-value is no worse than 0.85 W/m2.K. (see above).
Air permeability at 50 Pa	5.0 m3/(h.m2)	Passivhaus Standard < 0.6 ach @50Pa AECB Standard < 1.5 ach @50Pa	The air pressure testing regime required by the Passivhaus standard reflects more the reality of the fabric condition with windows closed as it does not allow uncontrolled air vents, air bricks or similar natural ventilation but chooses only controlled ventilation routes. The achievement of this air test to below 0.6 air changes per hour means in practice that an air tightness barrier needs to be established from the early design stage and good quality air tightness tapes must be used to secure junctions around windows, doors and other external penetrations from air infiltration. Tests should be scheduled at regular intervals (at least 2 before final test) to ensure achievement of the standard and to check quality of seals. An on-site air tightness champion and 'tool box talks' for the construction team enable understanding and success.
Overheating	CIBSE guide >28^{0}C for 1%/year in bedrooms at night (22:00-07:00), OR 3% elsewhere (living rooms, kitchens, corridors etc and care homes) from May – September.	< 10% of hours in the year above 25^{0}C (5% recommended)	While the Passivhaus standard is not as stringent as the CIBSE guidance most Passivhaus developments are designed to at least a 5% risk factor. This is constantly under review and research and development of this aspect is currently ongoing at the Passivhaus Trust with a new overheating tool being trialed since February 2021. As the fabric standard and build quality control is designed to emulate a constant comfortable temperature year round overheating should be only a small risk, however some councils (e.g. Exeter) have already specified using climate data sets that are predictive of climate conditions in 2050 to compensate. This is not yet an option included in the Future Homes Standard.
Heating appliance	Low-carbon heating (e.g. Heat pump with min. 250% efficiency)	Low-carbon heating (e.g. Heat pump with min. 250% efficiency)	No change compared to Indicative Future Homes Standard 2025 requirements.

Heat Emitter type	Low temperature heating	Low temperature heating (usually underfloor or larger radiators work well with heat pump)	No change compared to Indicative Future Homes Standard 2025 requirements.	
Ventilation System type	Natural (with extract fans)	MVHR	Mechanical Ventilation with Heat Recovery is a key aspect of the Passivhaus standard as it provides comfort, filtered fresh air and good indoor air quality – this is beneficial for both health, mould prevention, odours and ventilation. The nature of the ducting required in MVHR means that this is best suited to new build projects and must be designed in at the outset. The filtration element of an MVHR system also makes this highly beneficial in polluted, noisy or inner city locations because it provides filtered fresh air at an optimum level without creating draughts nor having to open windows. Filter changes are a simple procedure.	
PV	No further requirement compared to Part L 2021	None required for PH Classic Standard but are included to satisfy UK Building Regulations and in the PH Plus or Premium standards.	No change compared to Part L 2021 requirements. Renewables are not a required feature of Passivhaus but act as a further enhancement and CO_2 reduction measure. On difficult sites where for example the orientation of roofing does not comply with the FHS Specification the fact that PV panels are not needed may be advantageous. Alternatively PV can provide off-setting opportunities for a site wide scheme. For building regulations compliance in England and Wales, PV must be supplied and installed according to the formulae provided. Average PV generation assumed 370W per panel for archetypes.	
Wastewater heat recovery	No further requirement compared to Part L 2021	None required but encouraged as a 'Fabric First' issue.	Wastewater heat recovery systems are not required in the Passivhaus standard but can be optionally added with beneficial effect as a further energy saving measure. 250Ltr insulated cylinders are assumed with a heat loss factor of 1.97kWh/day.	
Thermal Bridges Psi value (W/m.K)	Default y=0.20 Calculated only.	Thermal bridge free design. $\leq$0.04 and calculated.	All junctions of external walls, floors and roofs, window and door frames, external corners and ridges must be designed from the outset to be thermal bridge free. The architect or building designer will need to ensure that where a fabric element is exposed to the outside air that this is in some way wrapped or protected by insulation so that heat loss is kept to a bare minimum. This is normally calculated using computerised calculation software to show that the standard required is achievable. The calculations are already being done for Part L so there are no additional calculation requirements for Passivhaus. Once standard details are calculated and shown to work in practice these are re-usable at no further cost. N.B. SAP and PH Thermal Bridge calculations differ slightly in methodology.	
CARBON EMISSIONS TARGET ($kgCO_2/m^2/yr$)	3.6 At least **75% less** emissions compared with 2013 Part L.	N/A- Reduced CO_2 results from lower energy use. Better performance, lower carbon emissions.	Overall the Passivhaus fabric standard is equivalent to the proposed Future Homes Standard but with additional energy use, health and comfort benefits arising from a quality control process, improved thermal bridge free construction techniques, more robust air tightness, and better air quality and noise control from MVHR. Evidence from current Passivhaus projects indicates 80 -90% reductions in energy use without renewables and consequently a similar figure in terms of CO_2 emission reductions.	At least **75% less** emissions compared with 2013 Part L.

Figure A5.1 Comparison of different fabric standards used in the UK and their relative Carbon emissions when applied to a typical semi-detached two storey house. (Warwick study by Enhabit in 2021).

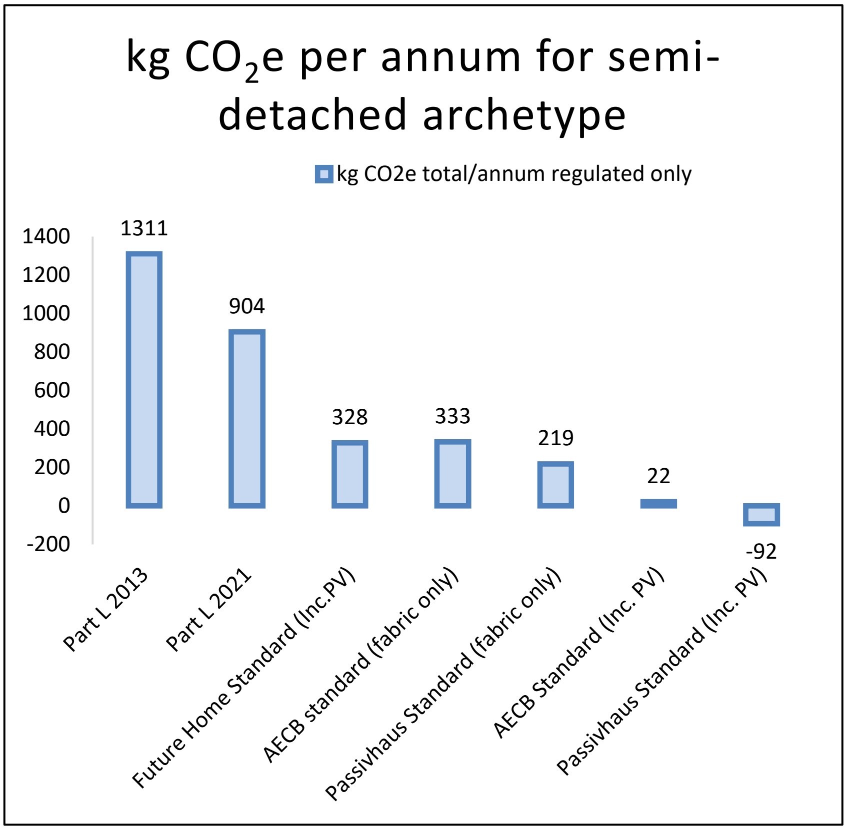


Table A5.4 Comparative building standards

Comparative Building Standards						
	EnerPHit [a] (Passivhaus Institute Refurb Standard for comparison)	PHI Low Energy Building	AECB Building Standard	Passivhaus Classic	Passivhaus Classic /Plus/Premium (with Renewables)	Future Homes Standard proposed
HEATING Space Heating demand $Q_{H,PH}$	**≤20/25 [b] kWh/m².year depends on climate zone**	**≤30 kWh/m².year**	**≤40 kWh/m².year**	**≤15 kWh/m².year**	**≤15 kWh/m².year**	None indicated so not measurable
COOLING Space cooling demand $Q_{C,PH}$	**≤15 kWh/m².year**	**≤30 kWh/m².year**	**≤40 kWh/m².year**	**≤15 kWh/m².year**	**≤15 kWh/m².year**	None indicated
OVERHEATING Frequency of overheating (temp. >25^0 C)	**≤ 10% of hours in the year**	**≤ 10% of hours in the year**	**≤ 10% of hours in the year (5% recommended)**	**≤ 10% of hours in the year**	**≤ 10% of hours in the year**	CIBSE guide >28^{0}C for 1%/year (See Fabric Specs Grid)
AIRTIGHTNESS Airtightness n50 Air Changes/hour	**≤1.0 ach @50Pa (MVHR)**	**≤1.0 ach @50Pa (MVHR)**	**≤1.5 ach @50Pa (MVHR) ≤3.0 ach @50Pa (MEV)**	**≤0.6 ach @50Pa (MVHR)**	**≤0.6 ach @50Pa (MVHR)**	≤5.0 $m^3/(h.m^2)$ @50Pa (Natural ventilation with Extract fans)
PRIMARY ENERGY RENEWABLE (PER) [c]	**≤ 60 kWh/m².year**	**≤ 75 kWh/m².year**	**≤ 75 kWh/m².year**	**N/A**	**≤ 60 / 45 / 30 kWh/m².year**	None indicated but Primary Energy will be one of the principal metrics used for measuring energy efficiency.
RENEWABLE ENERGY GENERATION	**≤ 60 + (Q_H - $Q_{H,PH}$)* $f_{øPER,H}$ + (Q_C - $Q_{C,PH}$) /2 kWh/m².year**	**N/A**	**N/A**	**N/A**	**N/A / 60 / 120 kWh/m².year**	None indicated
CARBON EMISSIONS TARGET ($kgCO_2/m^2/yr$)	**N/A- Reduced CO_2 Results from lower energy use**	**N/A**	**N/A**	**N/A**	**N/A**	(>75% reduction) 3.6

Note to table:

Q_H: *heating demand* **$Q_{H,PH}$**: *Passive House criterion for the heating demand*

$f_{øPER, H}$: *weighted mean of the PER factors of the heating system of the building*

Q_C: *cooling demand (incl. dehumidification)* **$Q_{C,PH}$**: *Passive House criterion for the cooling demand*

7. There are various low energy standards relevant to the UK which can be followed in order to obtain certification.

- **a**: The EnerPHit standard can also be achieved by the 'building component method' where each building element mush achieve a minimum standard that varies with climate zone. This is the preferred route for historic buildings or those that are difficult to retrofit for legal, structural, economic or other reasons.
- **b**: the space heating demand criteria depends upon the climatic zone.
- **c**: primary energy renewable (PER) is the new Passivhaus criteria to replace Primary Energy. Either can be used at present, the building only has to meet one of these.

Table A5.5 Fabric specification summary

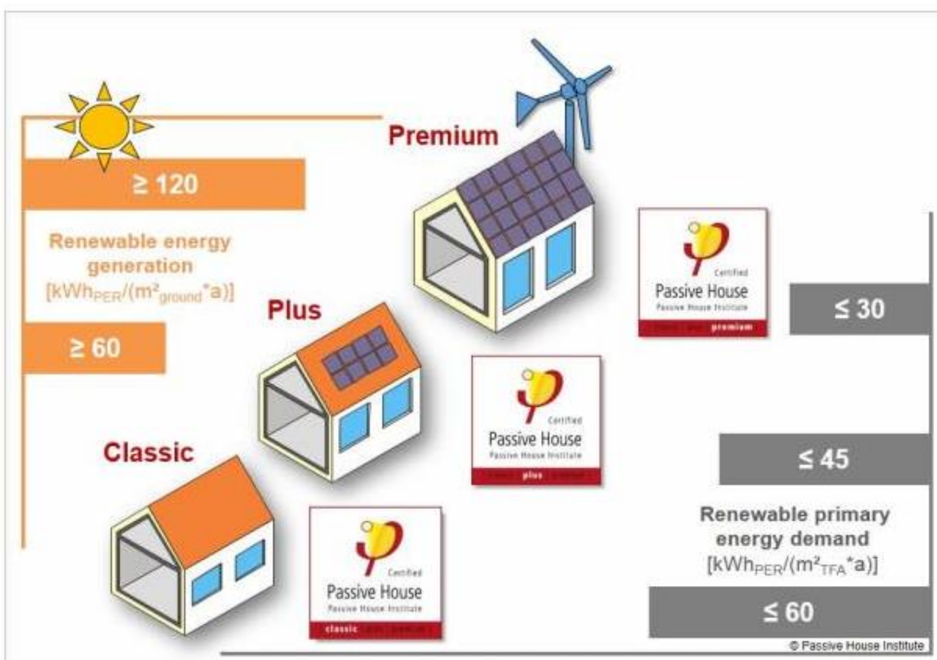
Fabric Specifications Summary - based on 'on-site' carbon targets for a typical semi-detached home.				
	Current 2013 Part L (standard climate data)	2021 Part L Standard (standard climate data)	Indicative Future Homes Standard Specification (includes measures already taken in 2021 Part L)	Passivhaus Classic (indicative, to achieve energy balance) & AECB Standard Climate location specified.
Floor U-value (W/m2.K)	0.13	0.13	0.11	$\leq$ 0.11
External wall U-value (W/m2.K)	0.18	0.18	0.15	$\leq$ 0.15 (Typically 0.11 for UK Climate)
Roof U-value (W/m2.K)	0.13	0.11	0.11	$\leq$ 0.11
Window U-value (W/m2.K)	1.4	1.2	0.8	$\leq$ 0.80
Door U-value (W/m2.K)	1.0 - opaque 1.2 – semi-glazed	1.0	1.0	$\leq$ 0.80
Air permeability at 50 Pa	5.0 m3/(h.m2)	5.0 m3/(h.m2)	5.0 m3/(h.m2)	$\leq$ 0.6 ach @50Pa for PH $\leq$ 1.5 ach @50Pa for AECB
Overheating	No explicit guidance	CIBSE guide >28^{0}C for 1%/year or 3% (see next cell to right)	CIBSE guide >28^{0}C for 1%/year in bedrooms at night (22:00-07:00), OR 3% elsewhere (living rooms, kitchens, corridors etc and care homes) from May – September.	$\leq$ 10% of hours in the year above 25^{0}C (5% recommended)
Heating appliance	Gas boiler (89.5% SEDBUK 2009)	Gas boiler (89.5% SEDBUK 2009) - Low-carbon heating (e.g. Heat pump 250%) is always an option.	Low-carbon heating (e.g. Heat pump 250%) Efficiency of at least 2.5 COP assumed	Low-carbon heating (e.g. Heat pump) Efficiency of at least 2.5 COP assumed
Heat Emitter type	Regular radiators	Low temperature heating	Low temperature heating	Low temperature heating (usually underfloor works well with heat pump)
Ventilation System type	Natural (with extract fans)	Natural (with extract fans)	Natural (with extract fans)	MVHR The nature of the ducting required in MVHR means that this is best suited to new build projects and must be designed in at the outset.
PV (Standard panel assumed 370W generation)	No	40% ground floor area as per formula. PV provision required unless target emission reached in other ways.	Assumed already installed under 2021 Regs, so no further PV required unless needed to achieve target CO_2 reductions. (e.g. for reasons of orientation or exposed location)	None required but needed for 'net zero' achievement now. Future provision could be combined with battery storage options and help towards national grid resilience.
Wastewater heat recovery	No	Yes - unless target emission reached in other ways.	Assumed already installed under 2021 Regs, unless target emission reached in other ways.	None required but encouraged as a 'Fabric First' issue.
Thermal Bridges Psi value (W/m.K)	ACDs or calculated	Calculated	Calculated	Thermal bridge free design. $\leq$ 0.04 and calculated.
CARBON EMISSIONS TARGET ($kgCO_2/m^2/yr$)	16.0	11.0 At least **31% less** emissions compared with 2013 Part L.	3.6 At least **75% less** emissions compared with 2013 Part L.	N/A- Reduced CO_2 results from lower energy use. Better performance, lower carbon emissions.
Net Zero Compliant?	✗	✗	✗ Currently not, but possibly in the future with decarbonisation of the Grid	✓ when combined with PV as in PH Plus.

The Passivhaus Standard Classes

8. Passivhaus has three recognised levels of performance[1]:

- Passivhaus Classic – that sets out the basic 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.
- 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.
- 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.[2]

Figure A5.2 Passivhaus standards (Passivhaus Trust)



[1] https://www.passivhaustrust.org.uk/passivhaus_awards/passivhaus-plus-premium/
[2] Classic, Plus, Premium: The new Passive House classes and how they can be reached [] (passipedia.org)

Fabric specifications table recommended for Essex Council

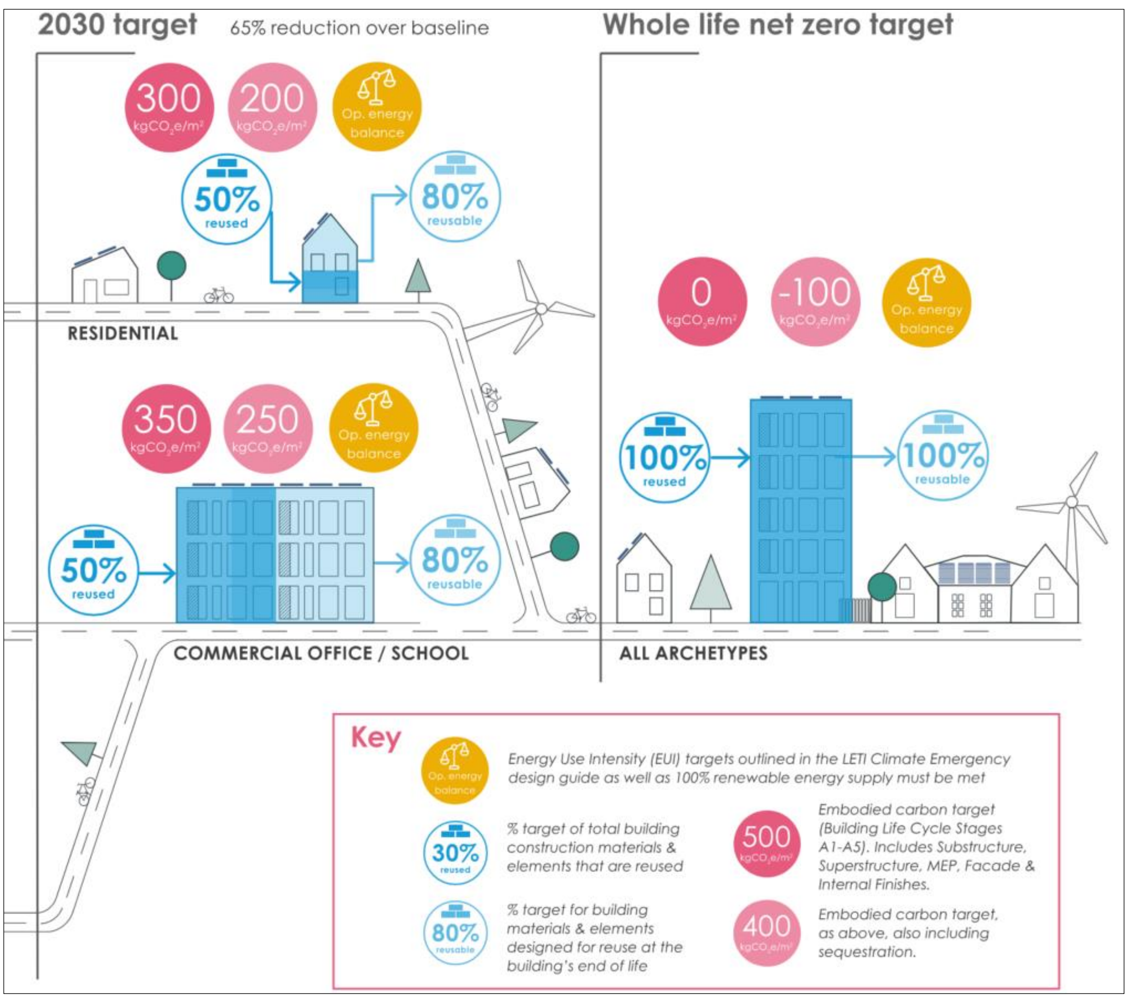
9. Based on Future Homes, UKGBC and LETI standards) and closely aligned with the design guide of the Government Property Agency, the following section identifies the key and supporting targets as well as additional guidance and recommendations for new buildings for:

- Construction
- Operational energy

Construction

10. Embodied Carbon impacts from the product and construction stages should be measured and offset at practical completion. The LETI Embodied Carbon Primer provides good practice guidance targets as illustrated:

Figure A5.3 Good practice guidance targets (LETI Embodied Carbon Primer)



11. Note that for the Key Targets to be achieved, specific building elements must be optimised by re-using materials and designing materials for re-use at the end of life or for ease of refurbishments or upgrades.

12. To achieve the key and supporting targets within the Construction phase, the following guidance and recommendations should be followed:

Materials

- Ensure longevity of material and systems specifications
- Consider natural and renewable materials
- Reduce the use of high embodied carbon materials

Design

- Simplify the design to use less materials (tonnes of material per m^2)
- Reduce the weight of dead loads where possible
- Restrict long structural frame spans
- Consider regular structural grid and future-proofed risers and central plant space
- Avoid over provision of MEP plant and reduce duct runs where possible
- Structural members should be designed for 100% utilisation rate
- Minimise structural weight, using lightweight materials to reduce foundation load and size

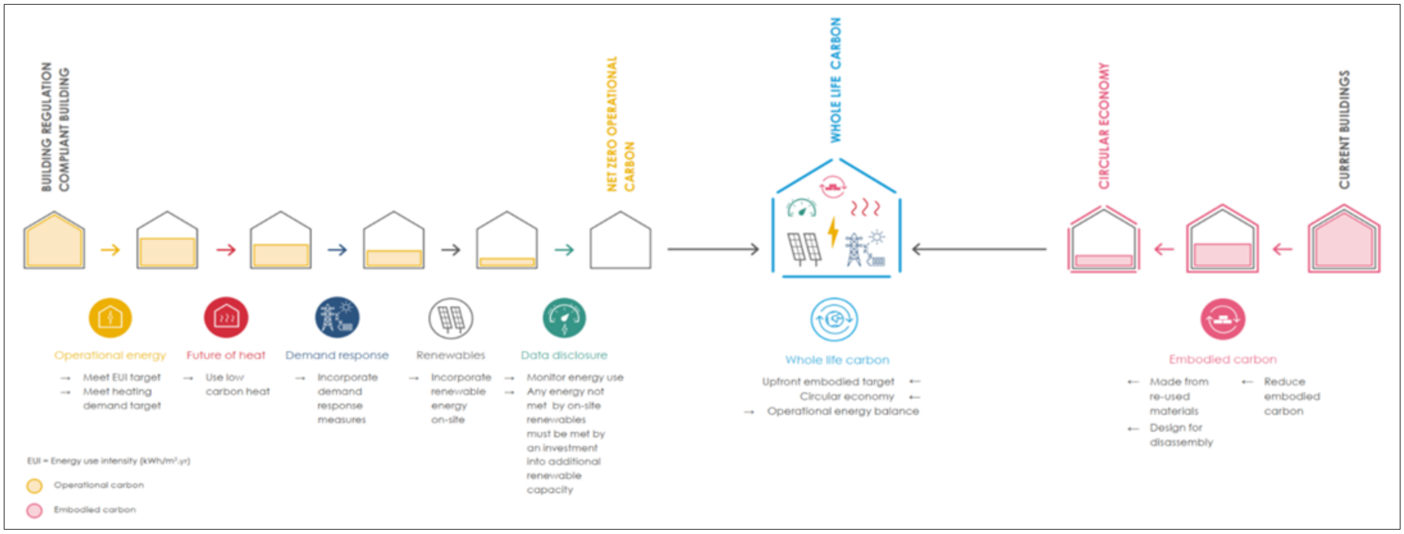
Transport

- Reduce transportation to site and onsite construction through off-site modular construction, manufacture, consolidation centres and distribution hubs
- Use existing materials on or near the site where possible

Manufacture and Assembly

- Explore design for manufacture and assembly (DfMA) solutions to reduce waste and site works
- Mechanically fix systems so that they can be demounted and re-used or replaced in the future to support a circular economy
- Consider end-of-life use of structure, including ease of demolition and reuse of structural elements and materials

Figure A5.4 Whole Life Asset Management Carbon (LETI Embodied Carbon Primer)



Operational Energy

13. Key Performance targets published by the RIBA, LETI, the UKGBC and other organisations are summarised below for space heating, total energy use and renewable generation:

Table A5.6 Key Performance targets to enable Net Zero Carbon for Operational Energy

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

14. In all cases an EPC rating of A or equivalent is required and the minimum % on-site Renewable Energy required by the Local Plan must be provided and achieved.

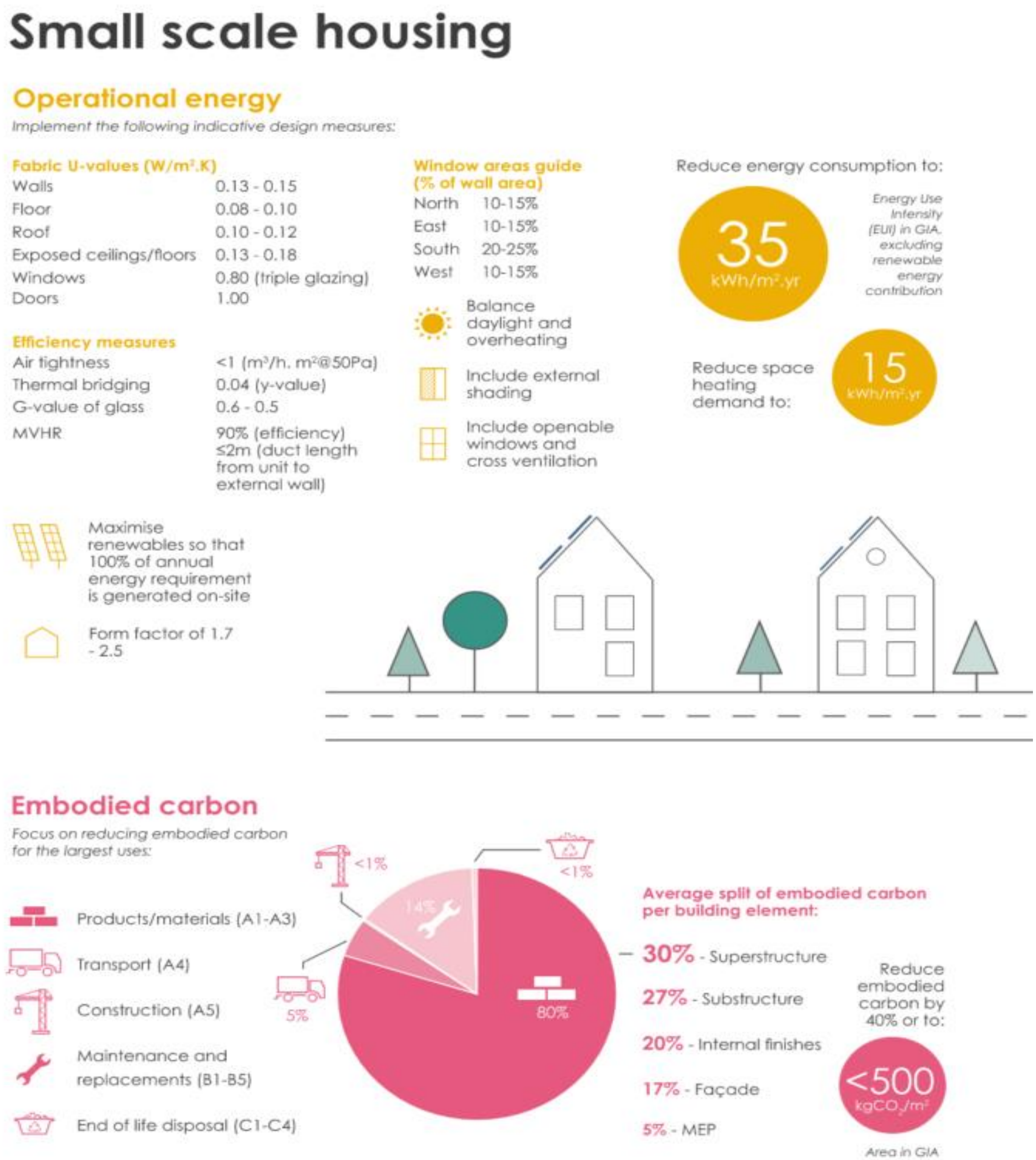
15. The following provides guidance to achieving the Key Performance Targets with specific building elements optimised for the location and orientation:

Table A5.7 Guidance to achieving Key Performance Targets

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)	$<1.0\ m^3/h.m^2$@50Pa
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.

16. For comparison - LETI Key performance indicators for Operational Energy and Embodied Carbon taken from Climate Change Design Guide3 including advisory data disclosure for planning reporting guidance in greater detail for a range of building types:

Figure A5.5 Key performance indicators for operational energy & embodied carbon (LETI) small scale housing, medium-large scale housing and schools (over next 7 pages)



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

Heating and hot water

Implement the following measures:

Fuel
Ensure heating and hot water generation is fossil fuel free

Heating
Maximum 10 W/m² peak heat loss (including ventilation)

Hot water
Maximum dead leg of 1 litre for hot water pipework

'Green' Euro Water Label should be used for hot water outlets (e.g.: certified 6 L/min shower head – not using flow restrictors).

Demand response

Implement the following measures to smooth energy demand and consumption:

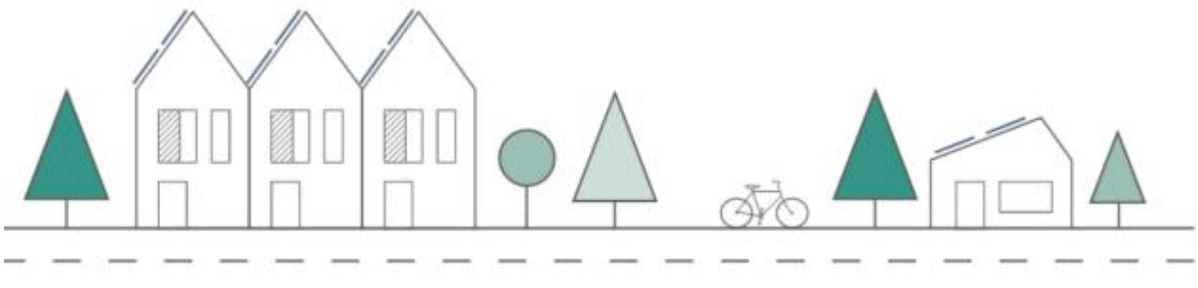
Peak reduction
Reduce heating and hot water peak energy demand

Active demand response measures
Install heating set point control and thermal storage

Electricity generation and storage
Consider battery storage

Electric vehicle (EV) charging
Electric vehicle turn down

Behaviour change
Incentives to reduce power consumption and peak grid constraints.



Data disclosure

Meter and disclose energy consumption as follows:

Metering

1. Submeter renewables for energy generation
2. Submeter electric vehicle charging
3. Submeter heating fuel (e.g. heat pump consumption)
4. Continuously monitor with a smart meter
5. Consider monitoring internal temperatures
6. For multiple properties include a data logger alongside the smart meter to make data sharing possible.

Disclosure

1. Collect annual building energy consumption and generation
2. Aggregate average operational reporting e.g. by post code for anonymity or upstream meters
3. Collect water consumption meter readings
4. Upload five years of data to GLA and/or CarbonBuzz online platform
5. Consider uploading to Low Energy Building Database.

Medium and large scale housing

Operational energy

Implement the following indicative design measures:

Fabric U-values (W/m².K)

Walls	0.13 - 0.15
Floor	0.08 - 0.10
Roof	0.10 - 0.12
Exposed ceilings/floors	0.13 - 0.18
Windows	1.0 (triple glazing)
Doors	1.00

Efficiency measures

Air tightness	<1 (m³/h.m²@50Pa)
Thermal bridging	0.04 (y-value)
G-value of glass	0.6 - 0.5
MVHR	90% (efficiency) ≤2m (duct length from unit to external wall)

Maximise renewables so that 70% of the roof is covered

Form factor of <0.8 - 1.5

Window areas guide (% of wall area)

North	10-20%
East	10-15%
South	20-25%
West	10-15%

Balance daylight and overheating

Include external shading

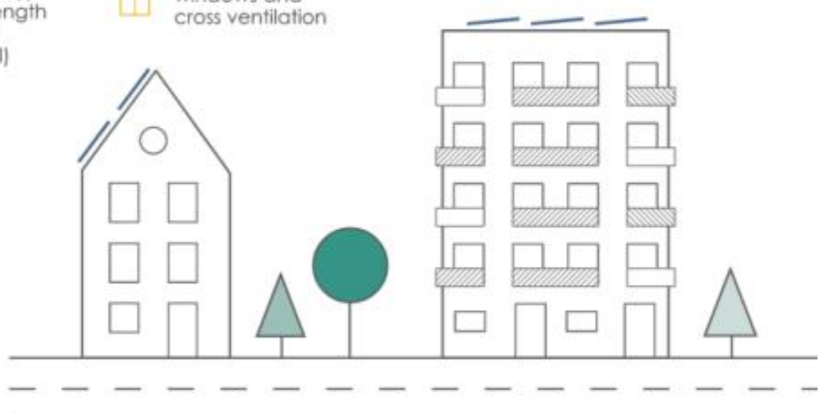
Include openable windows and cross ventilation

Reduce energy consumption to:

35 kWh/m².yr

Energy Use Intensity (EUI) in GIA, excluding renewable energy contribution

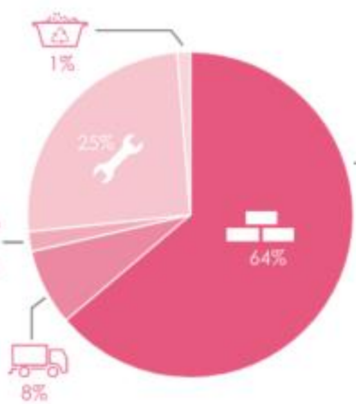
Reduce space heating demand to: **15** kWh/m².yr



Embodied carbon

Focus on reducing embodied carbon for the largest uses:

- Products/materials (A1-A3)
- Transport (A4)
- Construction (A5)
- Maintenance and replacements (B1-B5)
- End of life disposal (C1-C4)



Average split of embodied carbon per building element:

- **46%** - Superstructure
- **21%** - Substructure
- **16%** - Internal finishes
- **13%** - Façade
- **4%** - MEP

Reduce embodied carbon by 40% or to:

<500 $kgCO_2/m^2$

Area in GIA

Heating and hot water

Implement the following measures:

Fuel
Ensure heating and hot water generation is fossil fuel free

Heat
The average carbon content of heat supplied (gCO_2/kWh.yr) should be reported in-use

Heating
Maximum 10 W/m^2 peak heat loss (including ventilation)

Hot water
Maximum dead leg of 1 litre for hot water pipework

'Green' Euro Water Label should be used for hot water outlets (e.g.: certified 6 L/min shower head – not using flow restrictors).

Demand response

Implement the following measures to smooth energy demand and consumption:

Peak reduction
Reduce heating and hot water peak energy demand

Active demand response measures
Install heating set point control and thermal storage

Electricity generation and storage
Consider battery storage

Electric vehicle (EV) charging
Electric vehicle turn down

Behaviour change
Incentives to reduce power consumption and peak grid constraints.

Data disclosure

Meter and disclose energy consumption as follows:

Metering

1. Submeter renewables for energy generation
2. Submeter electric vehicle charging
3. Submeter heating fuel (e.g. heat pump consumption)
4. Continuously monitor with a smart meter
5. Consider monitoring internal temperatures
6. For multiple properties include a data logger alongside the smart meter to make data sharing possible.

Disclosure

1. Collect annual building energy consumption and generation
2. Aggregate average operational reporting e.g. by post code for anonymity or upstream meters from part or whole of apartment block
3. Collect water consumption meter readings
4. Upload five years of data to GLA and/or CarbonBuzz online platform
5. Consider uploading to Low Energy Building Database.

Heating and hot water

Implement the following measures:

Fuel
Ensure heating and hot water generation is fossil fuel free

Heat
The average carbon content of heat supplied (gCO_2/kWh.yr) should be reported in-use

Heating
Maximum 10 W/m^2 peak heat loss (including ventilation)

Connect to community wide ambient loop heat-sharing network to allow excess heat from cooling to be made available to other buildings

Hot water
Maximum dead leg of 1 litre for hot water pipework

'Green' Euro Water Label should be used for hot water outlets (e.g.: certified 6 L/min shower head – not using flow restrictors).

Demand response

Implement the following measures to smooth energy demand and consumption:

Peak reduction
Reduce heating and hot water peak energy demand

Active demand response measures
Install heating and cooling set point control

Reduce lighting, ventilation and small power energy consumption

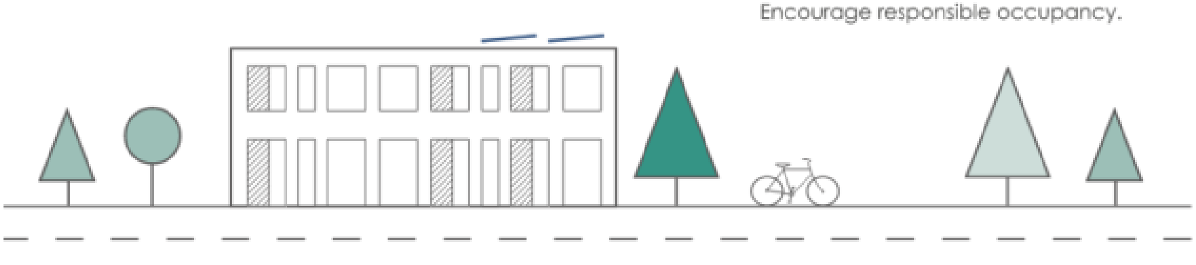
Electricity generation and storage
Consider battery storage

Electric vehicle (EV) charging
Electric vehicle turn down

Reverse charging EV technology

Behaviour change
Incentives to reduce power consumption and peak grid constraints

Encourage responsible occupancy.



Data disclosure

Meter and disclose energy consumption as follows:

Metering *(Metering strategy following BBP Better Metering Toolkit guidance)*

1. Record meter data at half hourly intervals
2. Separate landlord and tenant energy use meters and clearly label meters with serial number and end use
3. Submeter renewable energy generation
4. Use a central repository for data that has a minimum of 18 months data storage
5. Provide thorough set of meter schematics and information on maintenance and use of meters
6. Ensure metering commissioning includes validation of manual compared to half hourly readings.

Disclosure

1. Carry out an annual Display Energy Certificate (DEC) and include as part of annual reporting
2. Report energy consumption by fuel type and respective benchmarks from the DEC technical table
3. For multi-let commercial offices produce annual landlord energy (base building) rating and tenant ratings as well as or instead of a whole building DEC
4. Upload five years of data to a publicly accessible database such as GLA and/or CarbonBuzz.

Schools

Operational energy

Implement the following indicative design measures:

Fabric U-values (W/m²K)

Walls	0.13 - 0.15
Floor	0.09 - 0.12
Roof	0.10 - 0.12
Windows	1.0 (triple glazing)
Doors	1.2

Fabric efficiency measures

Air tightness	<1 (m³/h. m²@50Pa)
Thermal bridging	0.04 (y-value)
G-value of glass	0.5 - 0.4

Power efficiency measures

Lighting power density	4.5 (W/m² peak NIA)
Lighting out of hours	0.5 (W/m² peak NIA)
Small power out of hours	2 (W/m² peak NIA)

System efficiency measures

MVHR	90% (efficiency)
Heat pump SCoP	≥ 2.8
Central AHU SFP	1.5 - 1.2 W/l.s

Maximise renewables so that 70% of the roof is covered

Window areas guide (% of wall area)

North	15-25%
East	15-25%
South	15-25%
West	15-25%

Balance daylight and overheating

Include external shading

Include openable windows and cross ventilation

Form factor of 1 - 3

Reduce energy consumption to:

65 kWh/m².yr

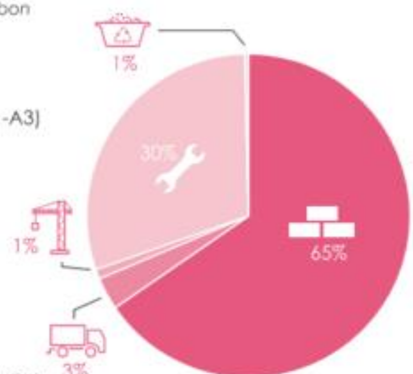
Energy Use Intensity (EUI) in GIA, excluding renewable energy contribution

Reduce space heating demand to: **15** kWh/m².yr

Embodied carbon

Focus on reducing embodied carbon for the largest uses:

- Products/materials (A1-A3)
- Transport (A4)
- Construction (A5)
- Maintenance and replacements (B1-B5)
- End of life disposal (C1-C4)



Average split of embodied carbon per building element:

- **30%** - Superstructure
- **21%** - Internal finishes
- **16%** - Substructure
- **16%** - Façade
- **13%** - MEP

Reduce embodied carbon by 40% or to:

<600 $kgCO_2/m^2$

Area in GIA

Heating and hot water

Implement the following measures:

Fuel
Ensure heating and hot water generation is fossil fuel free

Heat
The average carbon content of heat supplied (gCO_2/kWh.yr) should be reported in-use

Heating
Maximum 10 W/m^2 peak heat loss (including ventilation)

Hot water
Maximum dead leg of 1 litre for hot water pipework

'Green' Euro Water Label should be used for hot water outlets (e.g.: certified 6 L/min shower head – not using flow restrictors).

Demand response

Implement the following measures to smooth energy demand and consumption:

Peak reduction
Reduce heating and hot water peak energy demand

Active demand response measures
Install heating and cooling set point control

Reduce lighting, ventilation and small power energy consumption

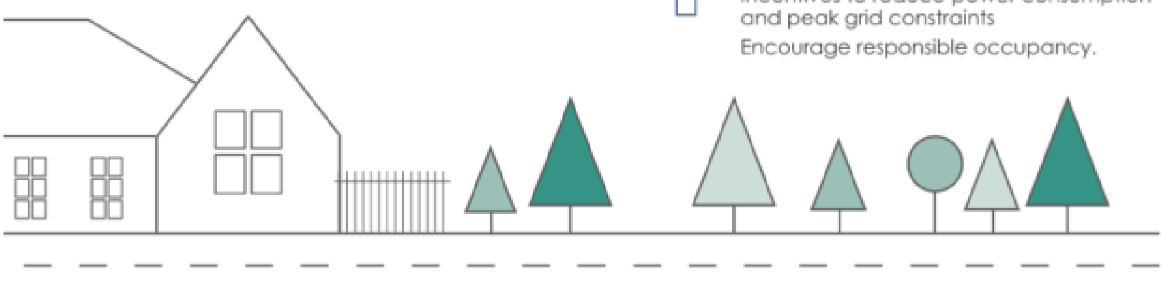
Electricity generation and storage
Consider battery storage

Electric vehicle (EV) charging
Electric vehicle turn down

Reverse charging EV technology

Behaviour change
Incentives to reduce power consumption and peak grid constraints

Encourage responsible occupancy.



Data disclosure

Meter and disclose energy consumption as follows:

Metering *(Metering strategy following BBP Better Metering Toolkit guidance)*

1. Record meter data at half hourly intervals
2. Clearly label meters with serial number and end use
3. Submeter renewable energy generation
4. Use a central repository for data that has a minimum of 18 months data storage
5. Provide thorough set of meter schematics and information on maintenance and use of meters
6. Ensure metering commissioning includes validation of manual compared to half hourly readings.

123 **Disclosure**

1. Carry out an annual Display Energy Certificate (DEC) and include as part of annual reporting
2. Report energy consumption by fuel type and respective benchmarks from the DEC technical table
3. Upload five years of data to a publicly accessible database such as GLA and/or CarbonBuzz. Include information about the building (do not anonymise).

Figure A5.6 LETI - Operational Energy Key Performance Indicators

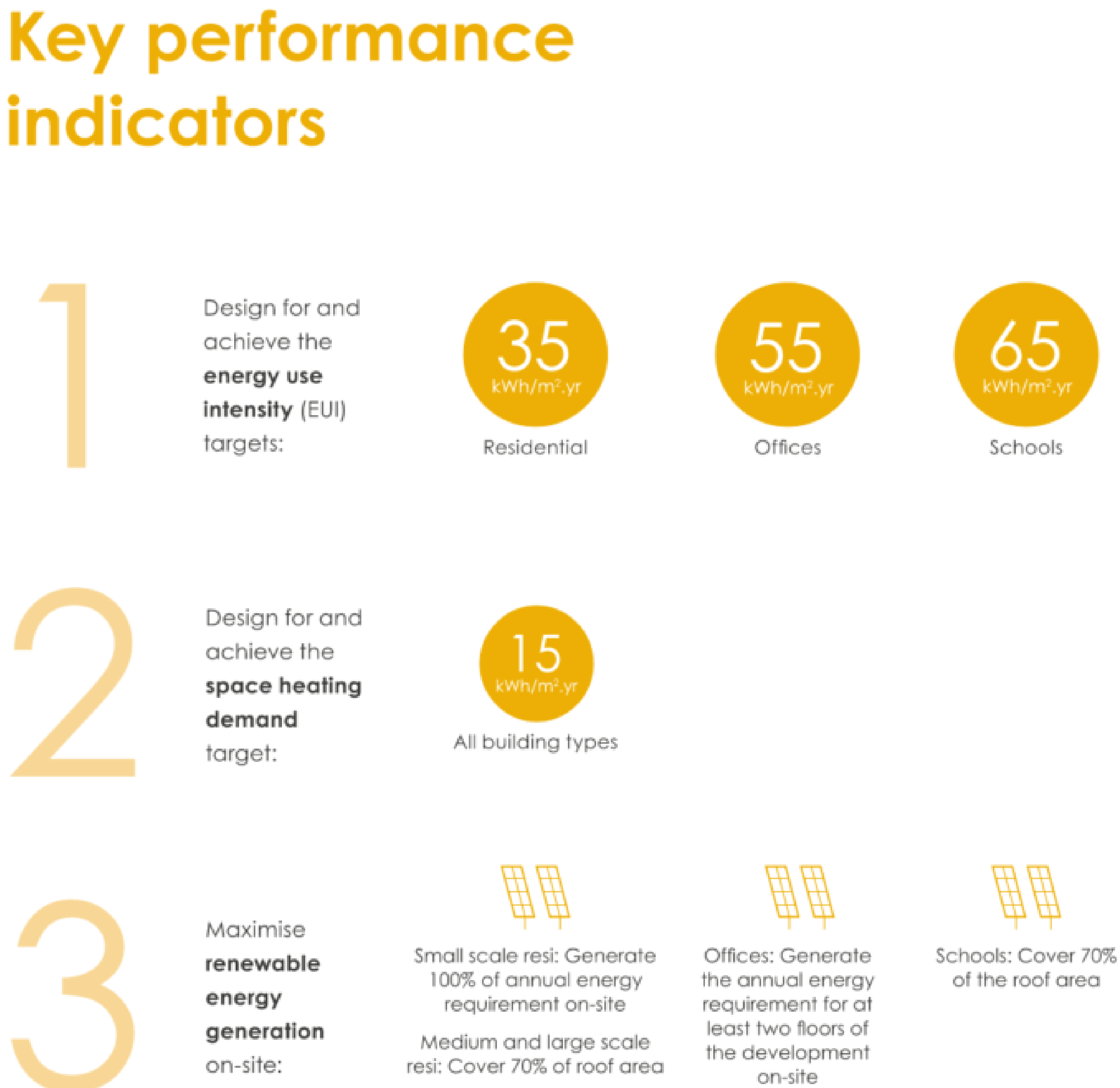


Figure A5.7 LETI – Embodied Carbon Key Performance Indicators

Appendix 6 – Site considerations

Orientation

1. A building's orientation combined with its glazing is key to minimising energy demand.[4]

Figure A6.1 LETI Design Guide: Why orientation is important

Purely by changing the building's orientation the space heating demand in this case increases from 13kWh/m^2.yr to 24 kWh/m^2.yr.

2. As the main windows rotate northwards in the UK climate, heat losses and annual space heating demands almost always increase. Consequently increased amounts of insulation are required to compensate, creating additional building costs at design and construction stage. South facing windows can normally be designed to achieve an annual net heat gain, however the amount of south facing glazing should also be optimised to prevent the risk of summer overheating. East and West facing windows can also be a source of overheating due to the low angle of the sun at the beginning and end of a day. Careful consideration of building layouts on a new site, along with horizontal shading techniques to the South and vertical shading options for East and West, will enable space heating and cooling targets to be achieved more easily.

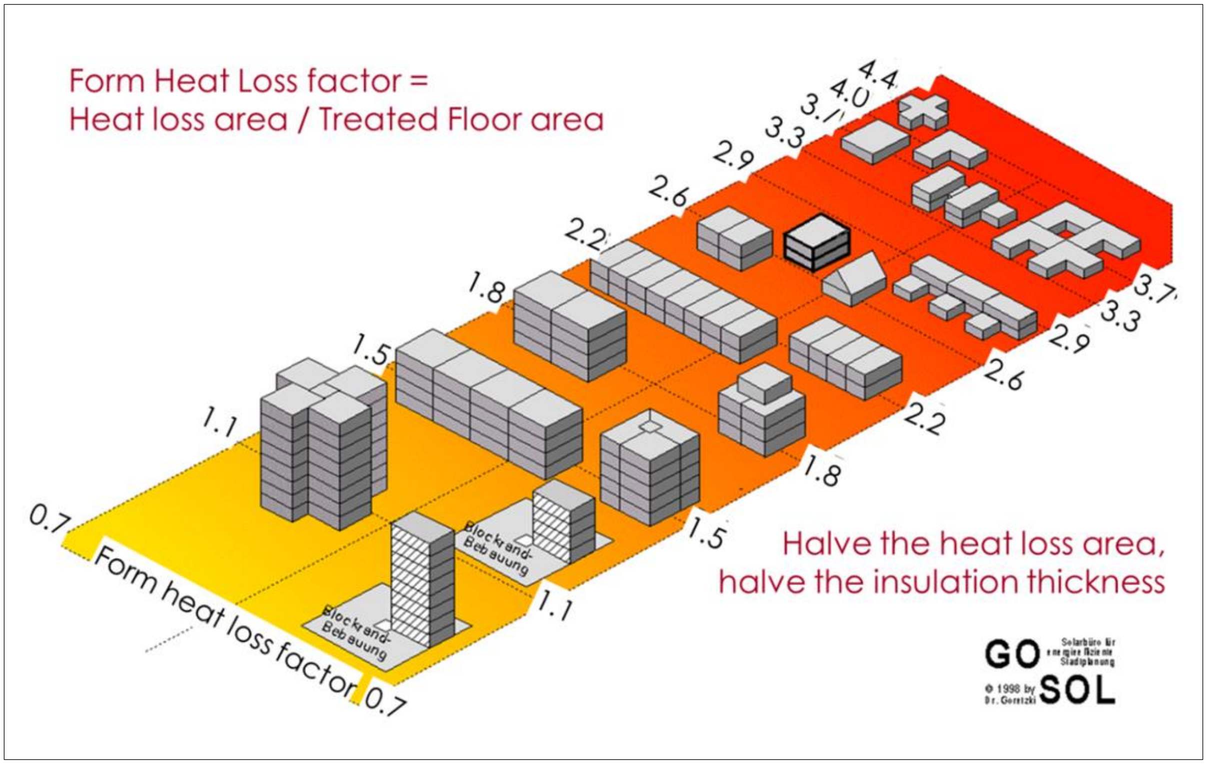
Form Factor[5]

3. A building's form factor is the ratio of its external surface area to the internal floor area. The greater the ratio, the less efficient the performance of the building and the greater the energy demand. Detached dwellings have higher form factors than terraced buildings or apartment blocks. If a building is designed with a poor form factor then the fabric efficiency will need to be

[4] https://www.leti.london/cedg (page 48)
[5] https://www.passivhaustrust.org.uk/news/detail/?nId=899

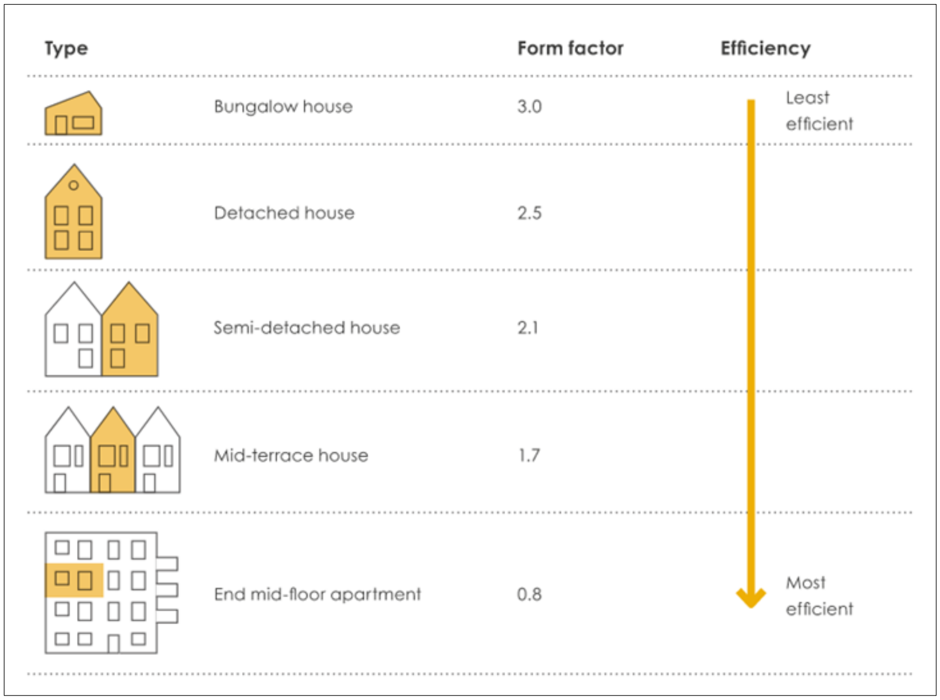
increased significantly to achieve the optimum levels of performance, which will increase costs as more insulation and more efficient systems will be required.[6]

Figure A6.2 Diagram from the BRE Passivhaus Primer Design Guide showing form factor for a range of different building types



[6] https://passivehouse-international.org/upload/BRE_Passivhaus_Designers_Guide.pdf

Figure A6.3 Illustration from LETI Design Guide showing archetypes and their typical form factors[7]

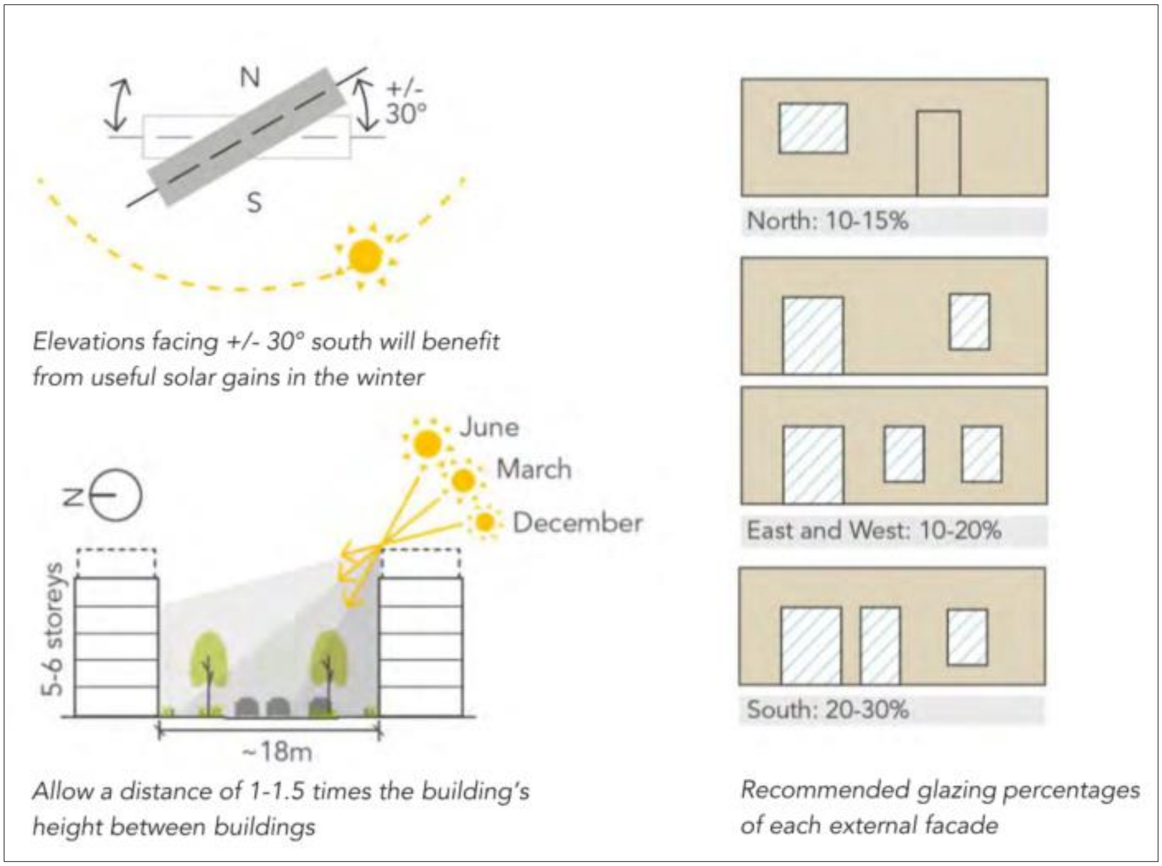


[7] https://www.leti.london/cedg

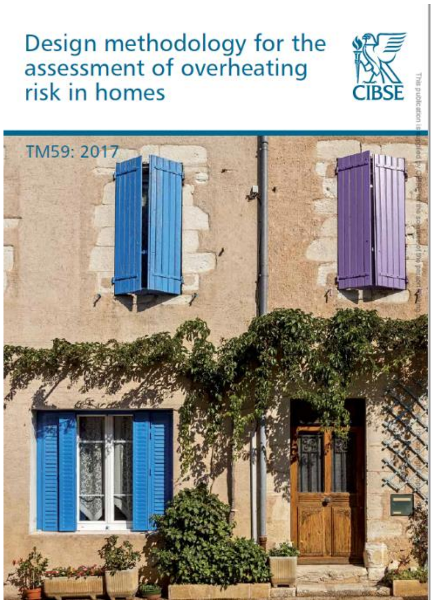
Shading, Solar Gain and Glazing Ratios[8]

4. The form of a building, its orientation and window proportions can significantly improve the building's efficiency and can be designed in from the start as the illustration below from the Cotswold Net Zero Carbon Toolkit illustrates.

Figure A6.4 Illustration from the Cotswold Net Zero Carbon Toolkit



[8] https://cotswold.gov.uk/media/05couqdd/net-zero-carbon-toolkit.pdf



5. The Good Homes Alliance commissioned a simple to use overheating tool for initial assessments of overheating risks[9]. The accompanying free downloadable booklet provides advice and recommendations for mitigation measures and is an easy to use check tool for designers, planners and LA's to assess overheating risks.

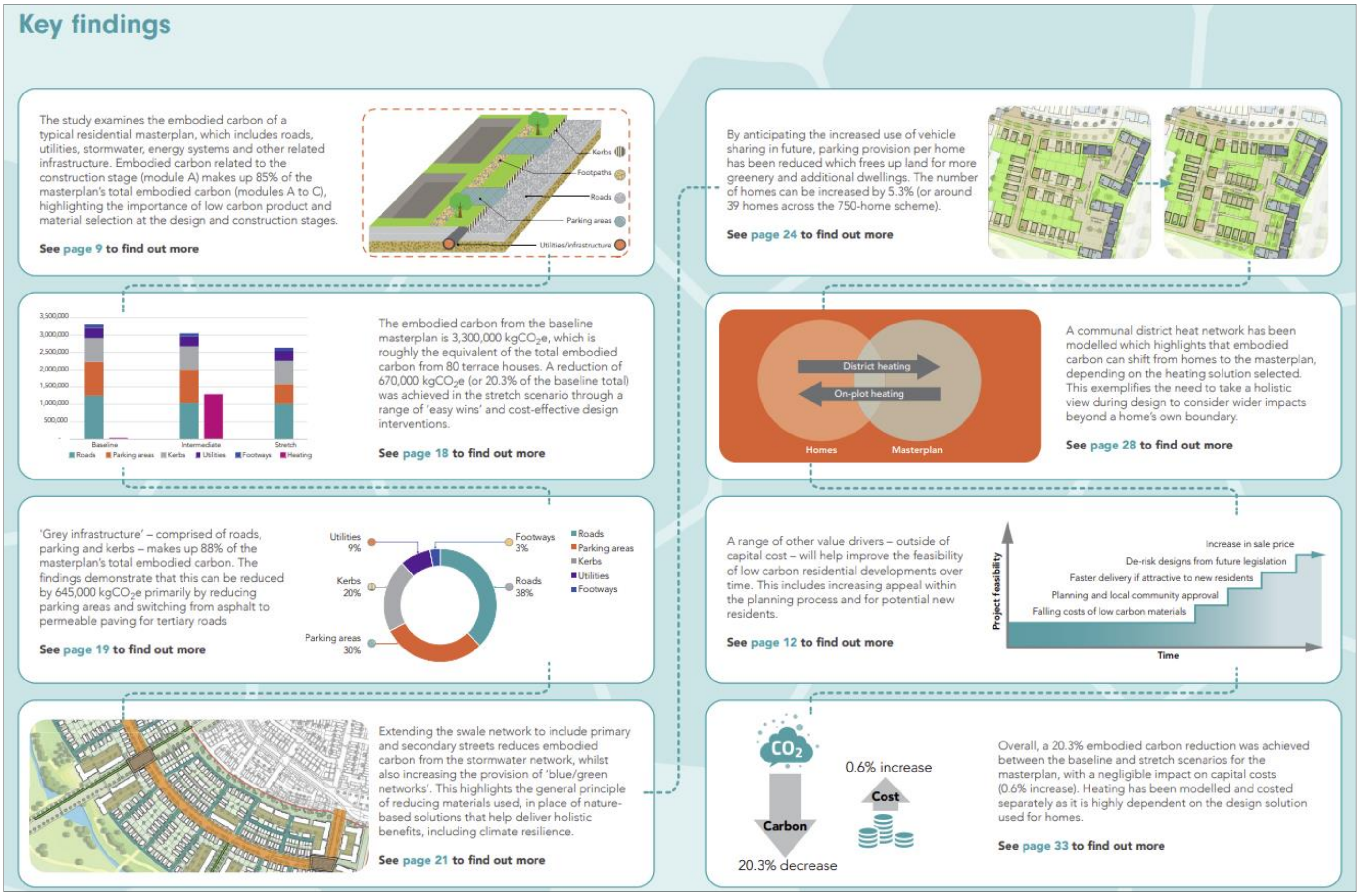
A more in-depth technical manual 'TM59: Design Methodology for the assessment of overheating risk in Homes' has been produced by CIBSE[10] and is cited in the new Building Regulations.

Masterplan considerations[11]

6. The UK Green Building Council has produced a useful document highlighting some of the 'easy wins' that help to reduce the carbon emissions even prior to the development of a new building site. The findings of the study show a modest increase in costs implementing a carbon emissions reduction strategy in the order of 0.6% can produce carbon reductions in excess of 20%. A summary of the key findings from this publication is reproduced below:

[9] https://goodhomes.org.uk/overheating-in-new-homes
[10] https://www.cibse.org/knowledge/knowledge-items/detail?id=a0q0O00000DVrTdQAL
[11] https://ukgbc.s3.eu-west-2.amazonaws.com/wp-content/uploads/2022/02/23075804/08737-Masterplan-v12.pdf

Figure A6.5 Summary of findings pre-development reduction in carbon emissions - UK Green Building Council



Appendix 7 – Air tightness and performance gaps

Airtightness fundamentals

1. As seen in the main report a focus on airtightness is fundamental to robust performance in conserving energy, reducing space heating bills and mitigating CO2 emissions. It is a key component of low energy buildings and forms a cornerstone of the Passivhaus approach.

2. In order to create an airtight construction, the primary air barrier must be designed with principles of CARE (Continuous, Accessible, Robust, and Explicit).

- **Continuous**: Air leakage can occur anywhere where there are discontinuities in the air barrier. Care must be taken at junctions of building elements and at penetrations to ensure its integrity is maintained.
- **Accessible**: The air barrier must be observable for inspection and reachable for maintenance and repair (particularly prior to final airtightness testing in construction). Contractor to make allowance in programme for testing.
- **Robust**: The air barrier needs to be robust enough to withstand subsequent construction and to last the lifetime of the building.
- **Explicit**: There must be conceptual clarity for everyone in the project on what constitutes the air barrier, where it is positioned and how its continuity is to be maintained. Site team to be given overview (training) by a competent third party or the Design Team.

3. Recommendations to help ensure that the construction stage goes according to plan to deliver the required target for airtightness are shown below:

- The contractor is responsible for delivering the airtightness target.
- The contractor should nominate an “airtightness champion” who should regularly monitor the site for potential issues and solutions to achieve the airtightness target and is responsible for all aspects of installation of the air barrier.
- Briefings should be given to any new individuals (i.e. sub-contractors, other trades) who join the construction team, explaining the importance of the airtightness layer, how to maintain it, and its implications for the overall project.
- In general, the number of penetrations of the envelope is to be reduced as much as possible. No internal electric runs or back boxes should penetrate the air tightness layer where possible. Instead, all services should run either in the joist or rafter zone, the internal stud walls or service voids formed between plasterboard battened off from the airtightness layer. Special grommets / sleeves are to be used for all unavoidable penetrations. Likely penetrations are:

- mains supplies (gas but not after 2025, water, electricity)
- ventilation pipes (inlet and outlet)
- soil vent pipe

4. A final airtightness test of the whole building to assess compliance against the target should be undertaken prior to completion as an indicator of the quality of built construction and as a reflection of the likely impact on Space Heating Demand and consequently has a direct bearing on operational carbon emissions and on economic affordability for the tenant or occupant.

The Performance Gap

5. The LETI guide provides a summary and background to the issue of the performance gap - a link to the full document can be found at the bottom of this page.[12] A short extract from the guide is shown below to illustrate its coverage.

Figure A7.1 Extract from LETI on the performance gap

A1.2: The Performance Gap

Summary

A prerequisite to implementing the transition to operational net zero targets advocated by LETI is bridging the gap between design and actual energy performance. Legislating for better standards has no effect if the buildings that are produced do not perform in practice.

In order to create the boundary conditions for a shift in culture to happen, LETI propose to institute an Assured Performance Framework (APF) and dutyholder regime. The APF revolves around independent reviews of design, construction and operation linked to RIBA Plan of Work stages, feeding learnings back into the loop using BSRIA Soft Landings principles. Central elements to this will be clear accountability through an accredited Performance Coordinator responsible for managing performance from inception through to completion and beyond; an overarching system for oversight of competence; a Complaints Resolution Service giving consumers a stronger voice; and more effective enforcement to deter non-compliance. LETI's proposals align with the proposed reform of the building safety regulatory system and proposed legislation to provide better redress for purchasers of new build homes. As such, it is hoped that there will be a legislative lever to uptake the proposal within the next iteration of the Building Regulations.

Background

The performance gap can typically be described as the deficit between energy predictions from building compliance tools and actual measured energy in-use. This determines whether a building and its systems work as expected when occupied and the extent of the gap where not. Expectations may be defined by regulatory targets, client and other requirements. The performance gap does not solely relate to energy, it has an impact on a number of variables including fire safety, acoustic performance, comfort, lighting and design quality. As such, a holistic approach is needed.

The current regulatory approach based on modelling for compliance (as opposed to modelling for performance) does not allow the size of the performance gap in the UK built environment to be pinpointed. The national standard assessment methodology for compliance was conceived for comparison purposes and relies upon a standardised set of operational assumptions. One of its key deficiencies is in disregarding unregulated loads, whose proportion of total energy use varies between sectors, accounting for more than 25% in non-domestic buildings[11]. Statistical evidence of performance gap in new buildings from a number of field testing programmes is consistently revealing underperforming envelopes (design vs as-built airtightness and thermal transmittance) leading to higher heating demand [12,13,14]. Using conservative assumptions to normalise the difference in heat balance scope, the Passivhaus Trust[15] has worked out that an average performance gap expressed as the overall additional energy use of a new build house amounts to 40% compared to its EPC modelling and anecdotal evidence suggests that it can be up to 500%. In order to deliver on LETI's

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[12] https://www.leti.london/_files/ugd/252d09_3b0f2acf2bb24c019f5ed9173fc5d9f4.pdf

Appendix 8 – Modelling of carbon emissions for archetypes

Modelling and results for different archetypes including one school (in PHPP)

Figure A8.1 Using SAP10.2 Beta methodology

Archetype and Building Standard	SAP10.2 Beta results Predicted EPC
End Terrace BREGS2021	A 96 (95.97)
Mid Terrace BREGS2021	A 98 (97.9)
Detached Bungalow BREGS2021	A 109 (108.74)
Detached House BREGS2021	A 101 (100.63)
Ground Floor Flat BREGS2021	A 109 (108.86)
Top Floor Flat BREGS2021	A 110 (110.12)
End Terrace FUTURE	B 89 (88.82)
Mid Terrace FUTURE	B 91 (90.92)
Detached Bungalow FUTURE	A 102 (101.53)
Detached House FUTURE	A 97 (97.32)
Ground Floor Flat FUTURE	A 102 (102.03)
Top Floor Flat FUTURE	A 103 (103.38)
End Terrace PHCLASSIC	B 88 (88.17)
Mid Terrace PHCLASSIC	B 89 (88.51)
Detached Bungalow PHCLASSIC	B 87 (86.68)
Detached House PHCLASSIC	B 89 (88.96)
Ground Floor Flat PHCLASSIC	B 89 (88.66)
Top Floor Flat PHCLASSIC	B 89 (88.79)
End Terrace PHCLASSICPV	A 98 (98.25)
Mid Terrace PHCLASSIC PV	A 99 (98.58)
Detached Bungalow PHCLASSIC PV	A 108 (108.39)
Detached House PHCLASSIC PV	A 102 (102.17)
Ground Floor Flat PHCLASSIC PV	A 109 (109)
Top Floor Flat PHCLASSIC PV	A 110 (110.33)

1. Predicted EPC ratings are based on the Beta version of the SAP10.2 methodology. These results are indicative for the modelled archetypes and are a guide only. Final approval of software will only occur closer to the official launch date of 15th June 2022.

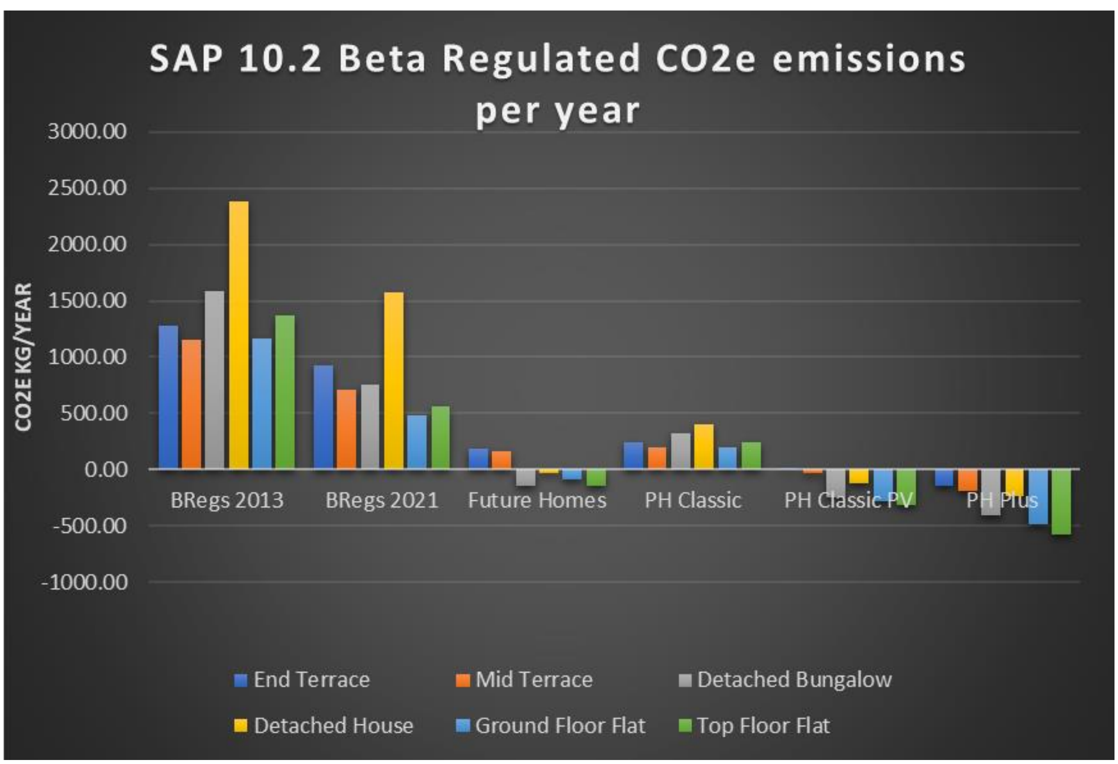
Results of CO2 emissions assessments:

2. See figures below - Note End Terrace PH Classic with PV achieves 99.8% reduction - almost net zero carbon rated - compared to 2021 Building Regs.

Figure A8.2(a) CO2 emissions assessments

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**	**Future Homes v. PH Classic with PV**
End Terrace	1276.13	921.07	183.77	236.71	1.86	-150.25	98.99%
Mid Terrace	1148.26	713.70	158.70	197.90	-36.95	-189.06	123.28%
Detached Bungalow	1588.32	748.95	-147.82	320.47	-247.55	-410.47	-67.47%
Detached House	2383.91	1568.62	-31.83	402.92	-121.41	-242.03	-281.43%
Ground Floor Flat	1165.73	477.21	-92.52	201.46	-280.26	-486.48	-202.92%
Top Floor Flat	1368.53	556.65	-149.24	243.77	-318.79	-573.16	-113.61%

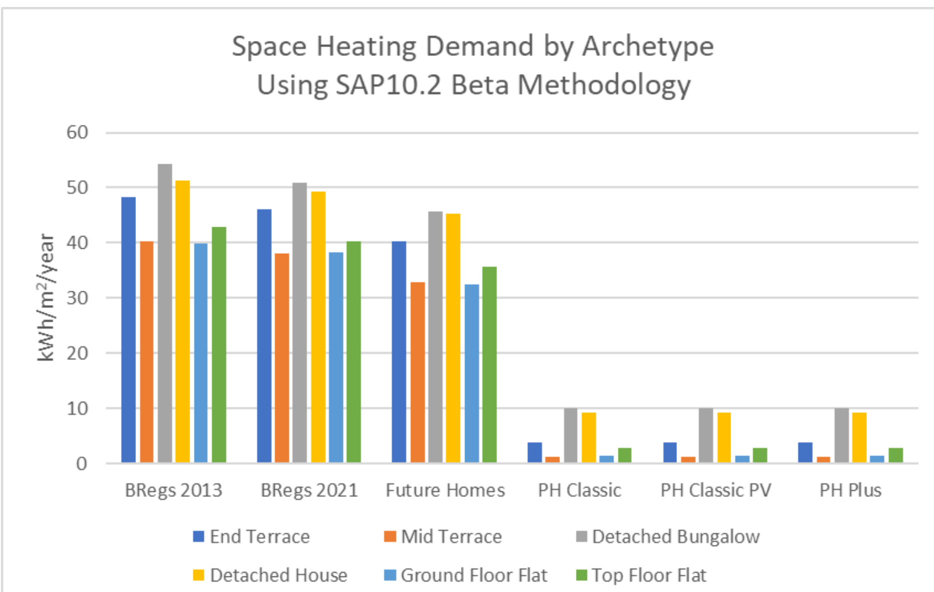
Figure A8.2(b) CO2 emissions assessment



Results of Space Heating Demand Assessments:

Figure A8.3(a & b) CO2 space heating demand assessments

Using SAP10.2 Methodology	Fails Building Regs		Passes Building Regs		Net Zero Carbon rated		
SAP 10.2 Beta Space Heating Demand kWh/m2/year (DER Box 99)	**BRegs 2013**	**BRegs 2021**	**Future Homes**	**PH Classic**	**PH Classic PV**	**PH Plus**	**Future Homes v. PH Classic with PV**
End Terrace	48.23	46.05	40.3	3.72	3.72	3.72	90.77%
Mid Terrace	40.25	38.01	32.95	1.2	1.2	1.2	96.36%
Detached Bungalow	54.21	50.84	45.6	10.11	10.11	10.11	77.83%
Detached House	51.33	49.22	45.21	9.18	9.18	9.18	79.69%
Ground Floor Flat	39.87	38.35	32.39	1.32	1.32	1.32	95.92%
Top Floor Flat	42.91	40.34	35.68	2.88	2.88	2.88	91.93%



Using PassivHaus Planning Package (PHPP) Methodology:

Figure A8.4 (a&b) Results of CO2 emissions assessments:

PHPP Total (Regulated + Unregulated) CO2 emissions/year	BRegs 2013	BRegs 2021	Future Homes	PH Classic PV	PH Plus
End Terrace	1487	1176	253	83	-72
Mid Terrace	1426	980	204	64	-92
Detached Bungalow	2187	1338	-167	-338	-482
Detached House	2925	2122	333	-18	-117
Ground Floor Flat	1398	751	20	-162	-361
Top Floor Flat	1599	823	-9	-201	-302

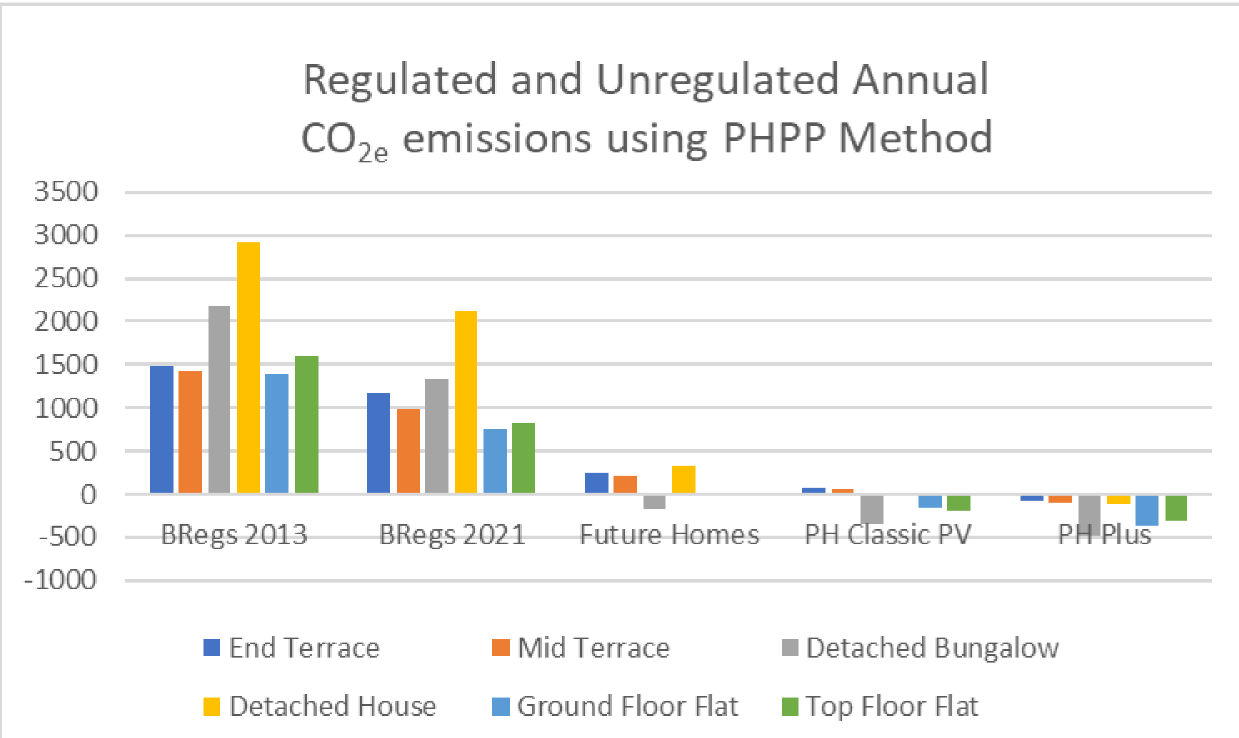


Figure A8.5 Results of Space Heating Demand Assessments:

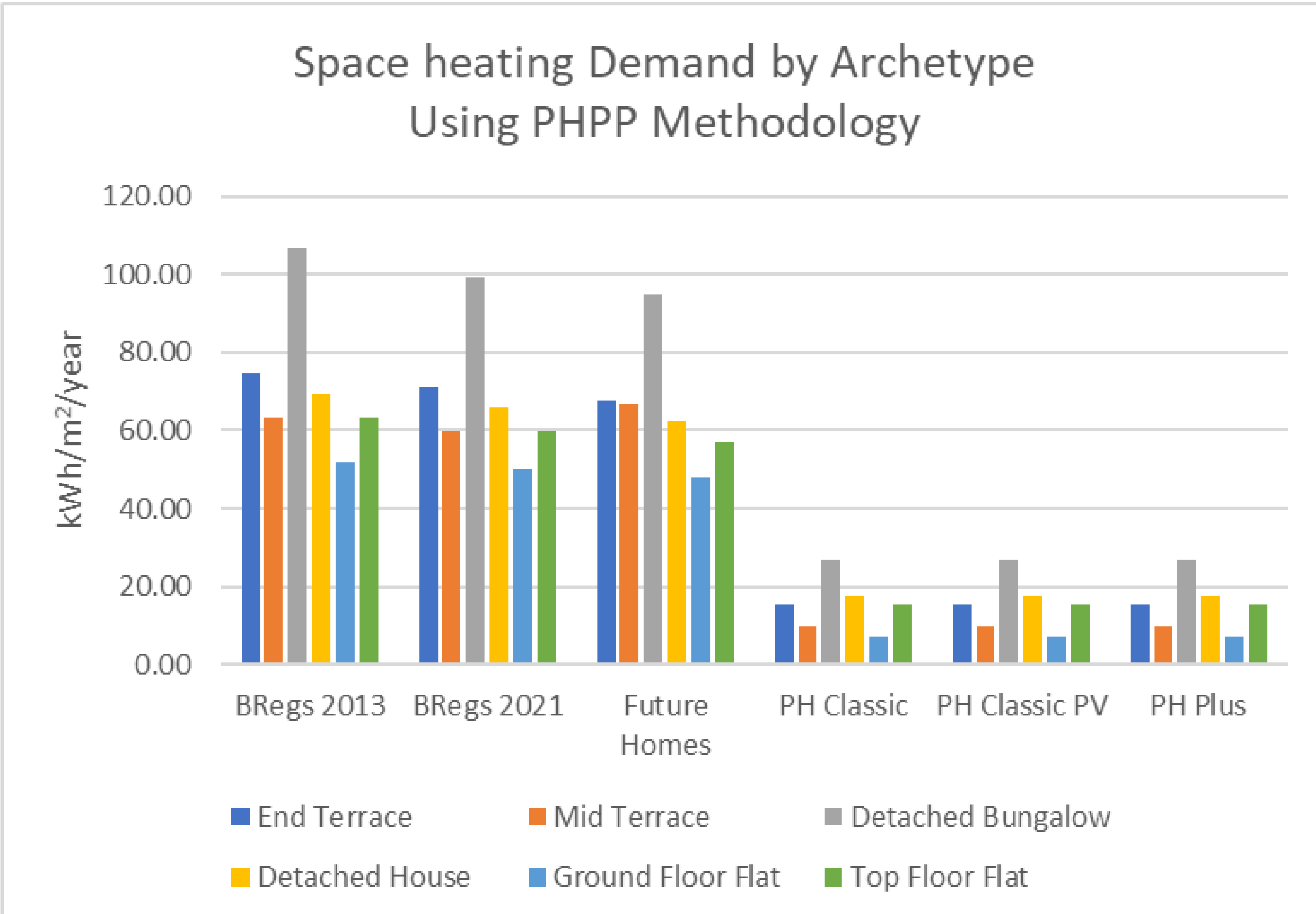
Using PHPP Methodology	Does NOT satisfy PH criteria - FAIL			Satisfies PH Criteria -PASS			
PHPP Space Heating Demand kWh/m2/year	**BRegs 2013**	**BRegs 2021**	**Future Homes**	**PH Classic**	**PH Classic PV**	**PH Plus**	**Future Homes v. PH Classic with PV**
End Terrace	74.47	71.30	67.66	15.35	15.35	15.35	77.31%
Mid Terrace	63.30	59.97	66.66	9.63	9.63	9.63	85.55%
Detached Bungalow	106.64	99.36	94.75	26.90	26.90	26.90	71.61%
Detached House	69.41	65.89	62.27	17.79	17.79	17.79	71.43%
Ground Floor Flat	52.08	50.34	47.76	7.18	7.18	7.18	84.97%
Top Floor Flat	63.28	59.57	57.23	15.51	15.51	15.51	72.90%
				Only Space Heating			

Note: Heating pattern in PHPP probably overstates the heat demand, especially in BR2013 because it assumes a steady state heat of 20^{0}C whereas SAP has a variable heating pattern. With tighter reporting from BR2021 and heat patterns standardised equally for all 7 days, this starts aligning with the PHPP approach.

3. Despite the space heating demand criteria not satisfying the required Passivhaus targets in the cases of the archetype Detached House, Bungalow and Top Floor Flat (all with higher form factor ratios) the space heating demand is still at least 71% less than in buildings constructed to the Future Homes Standard.

4. Building Regs fail to achieve the PHPP criteria on a number of counts but especially on Space Heating Demand (and therefore Fuel poverty issue) and on airtightness (and therefore comfort that is not even considered by BRegs). Cost and comfort have impacts on mental well being and physical health and therefore have a direct affect on local and national NHS budgets and capacity.

Figure A8.6 Space heating demand by archetype



Results by Archetype using PHPP Methodology

5. Charts show PHPP assessment including both regulated and unregulated results in blue columns. The residential archetypes are followed by an analysis of an archetype school. To align with the SAP approach we have also estimated unregulated energy and excluded it from the results in the orange columns.

Figure A8.7 PHPP assessment – End terrace archetype

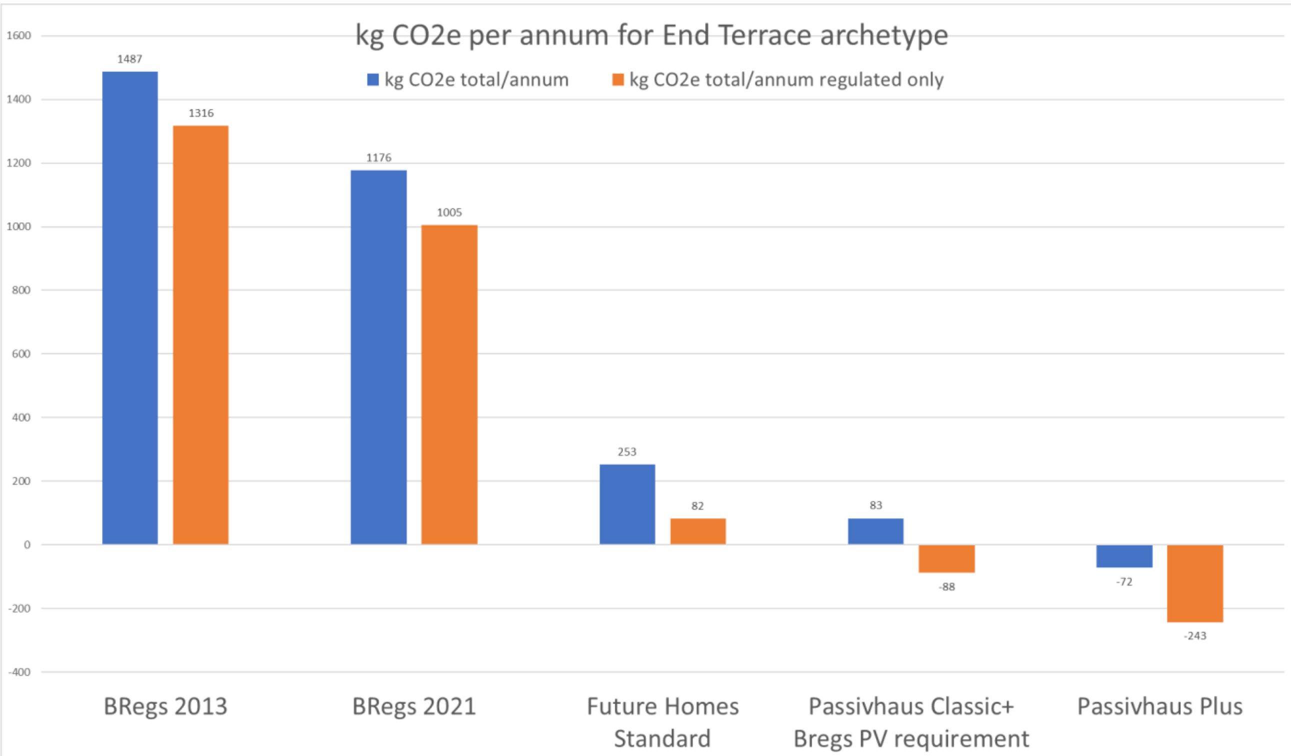


Figure A8.8 PHPP assessment – Mid terrace archetype

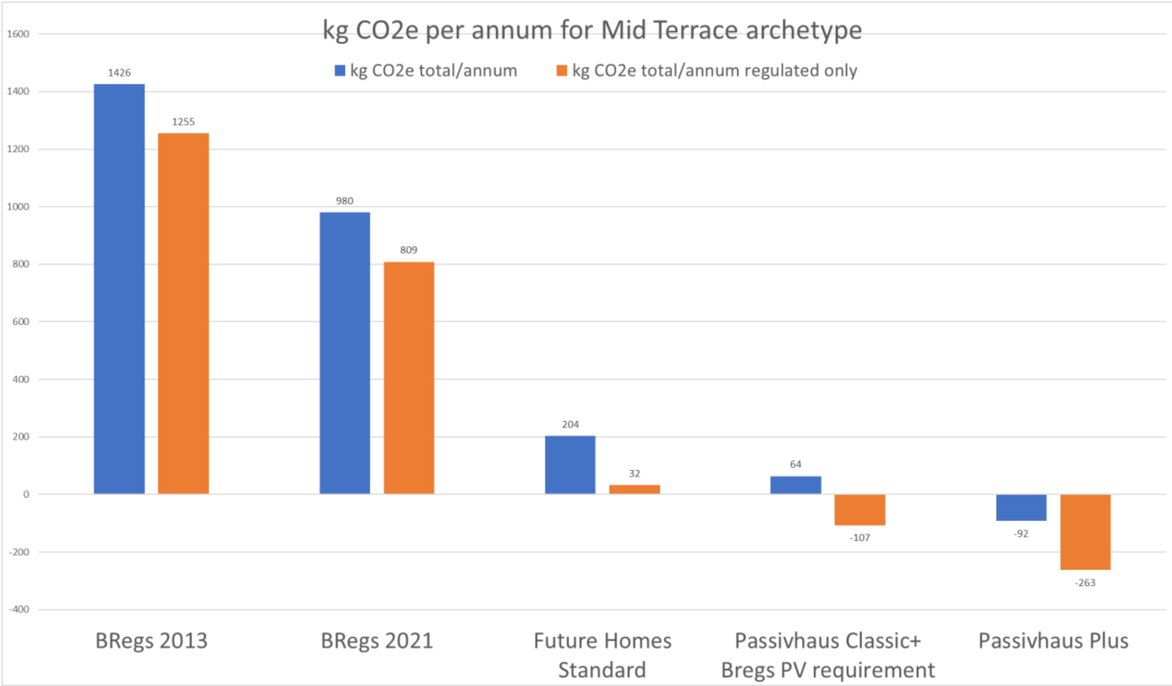


Figure A8.9 PHPP assessment – Detached bungalow archetype

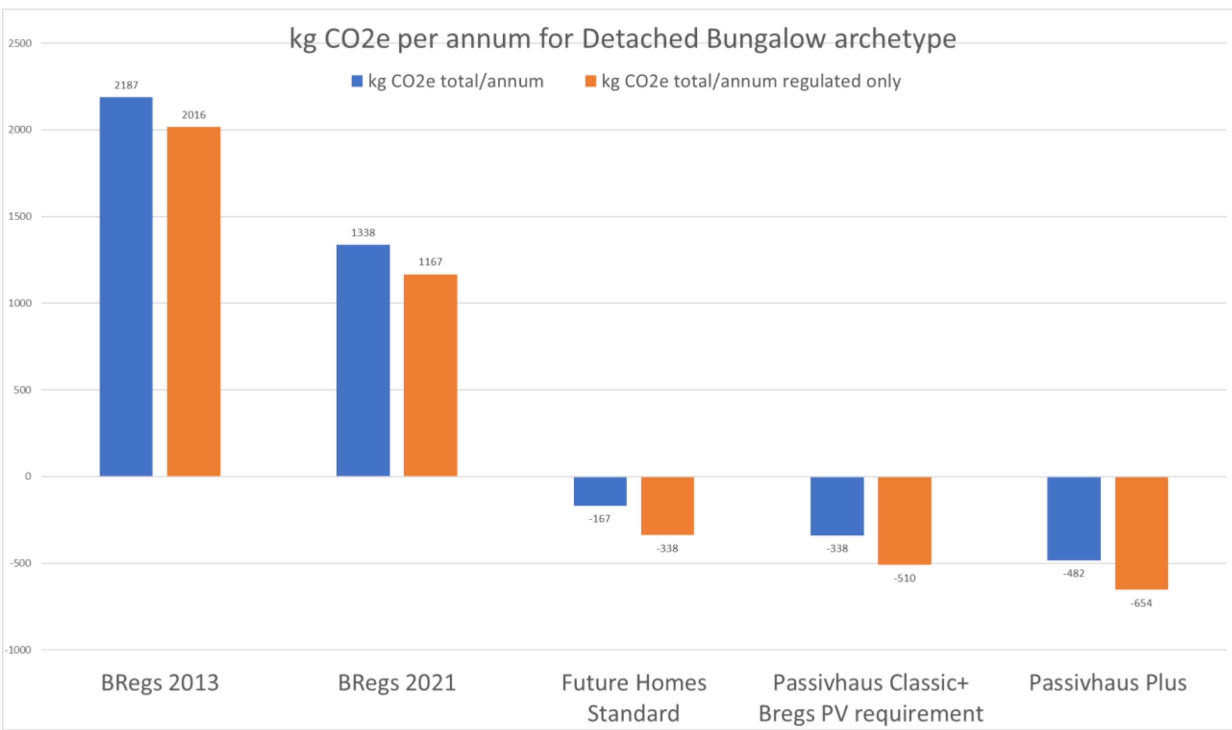


Figure A8.10 Detached house archetype

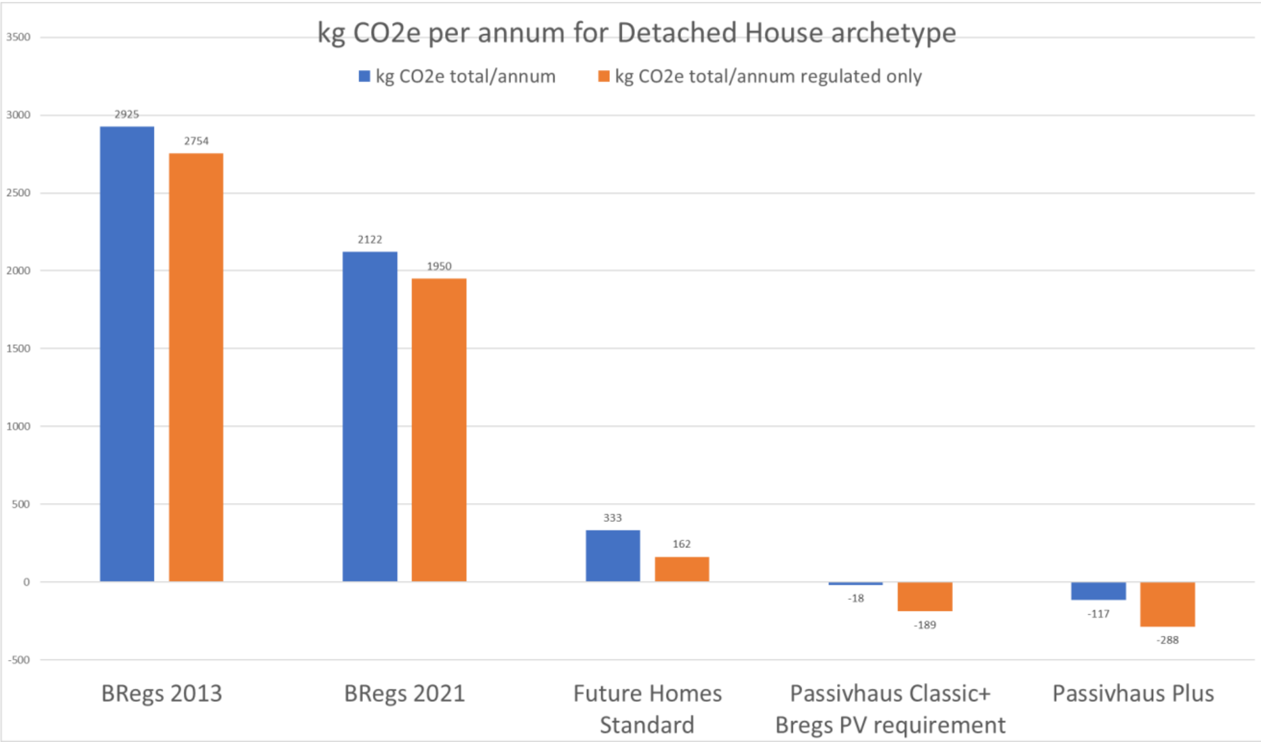


Figure A8.11 Top floor flat archetype

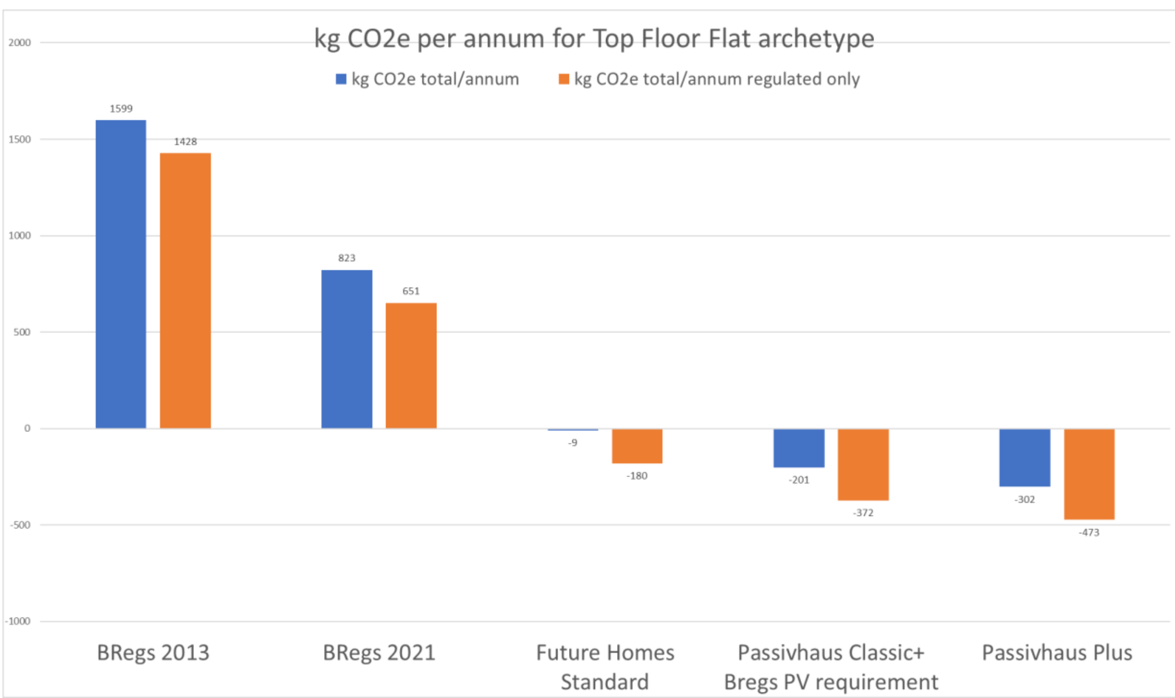


Figure A8.12 Ground floor flat archetype

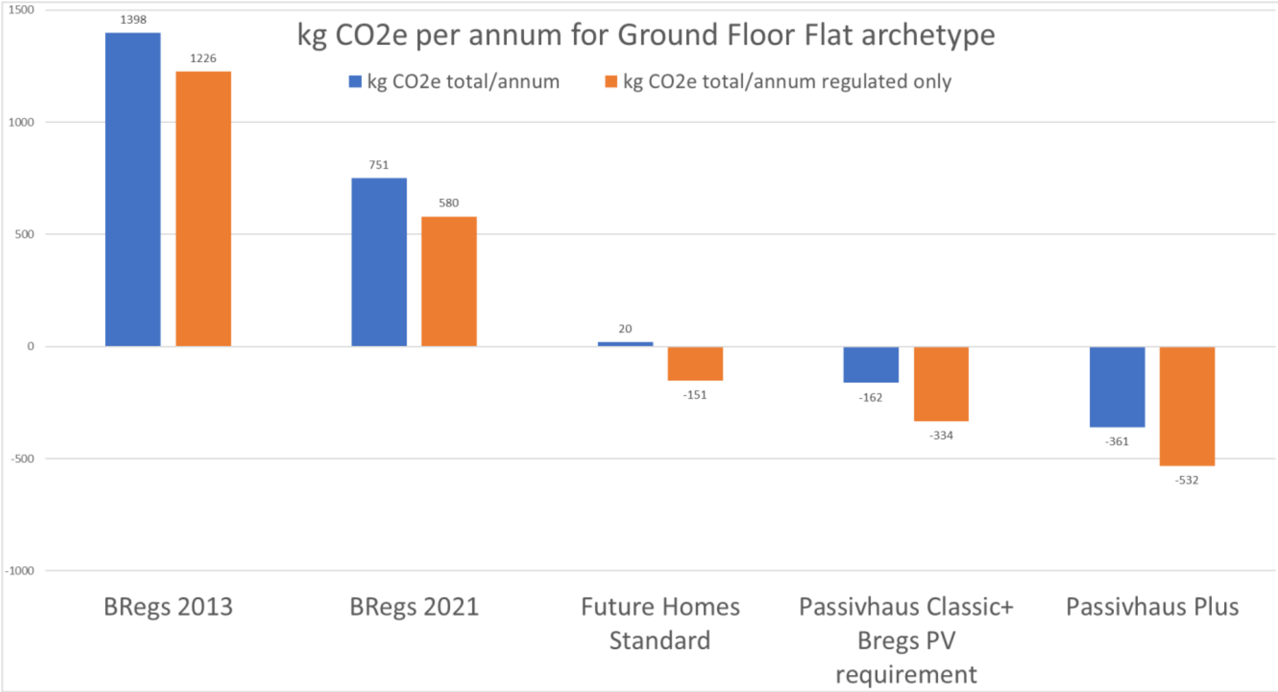
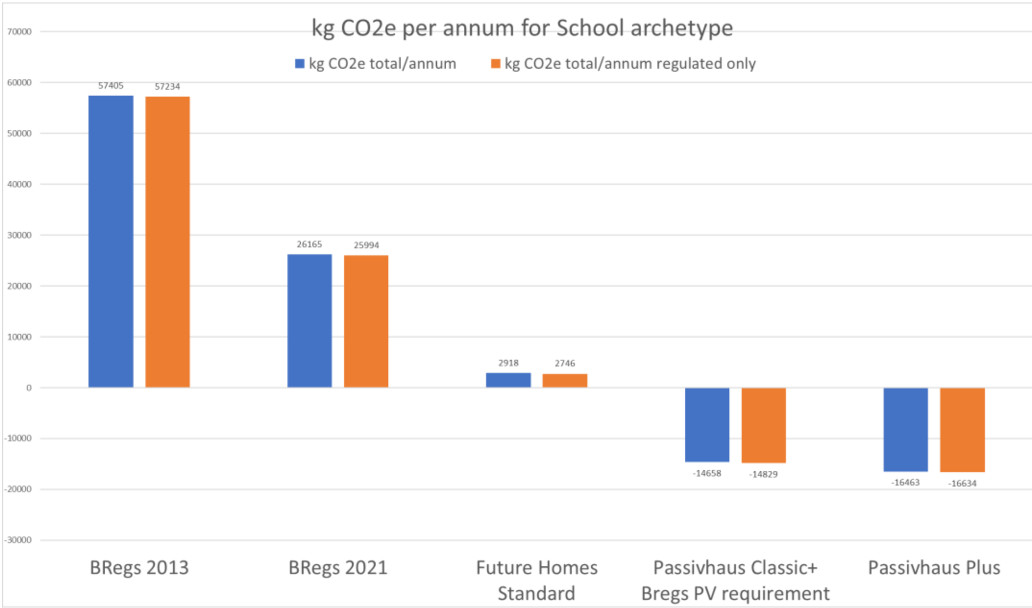


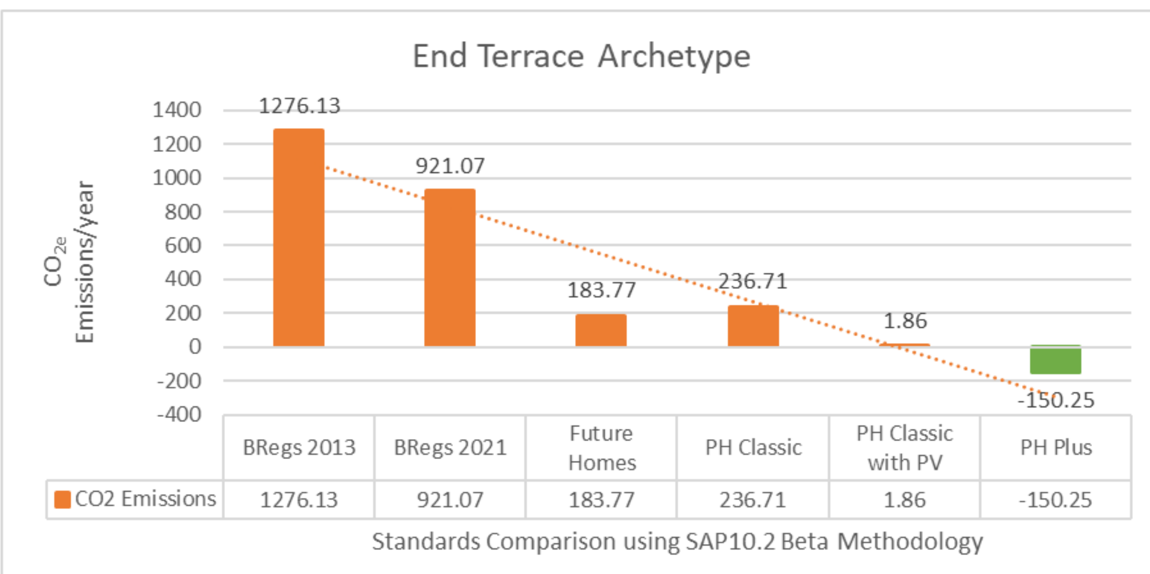
Figure A8.13 School archetype



Conclusion of modelling analysis

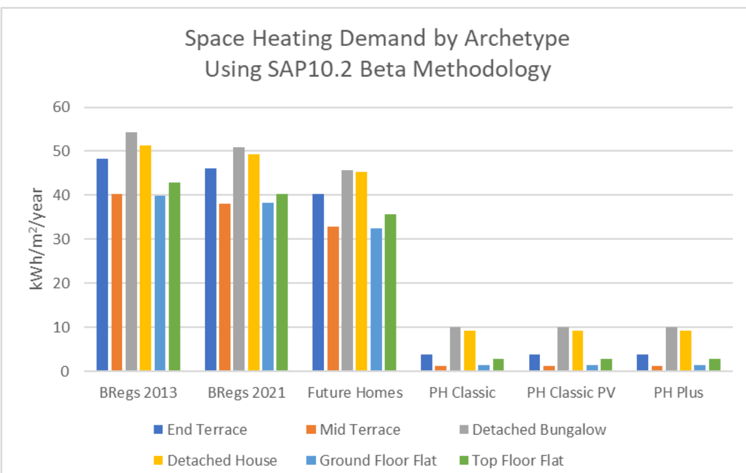
6. The initial End Terrace Archetype has been taken to analyse the trend line of carbon reduction emissions using the Building Regulations approach by adopting the SAP10.2 (Beta) methodology – as shown below.

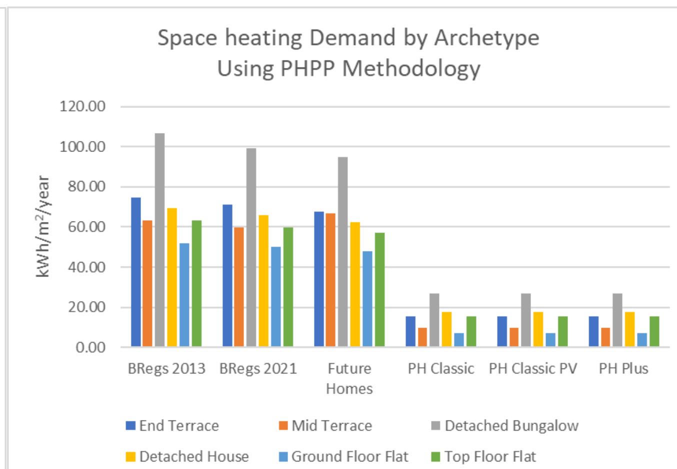
Figure A8.14 Trendline – end terrace archetype



7. The trend line shows a steady reduction in CO_2 emissions via different building standards routes but both require robust Fabric First approaches. The fabric in the Future Homes Standard (FHS) is slightly less robust than PassivHaus (PH) Classic but is bolstered by PhotoVoltaic (PV) panels. Both FHS and PH Classic achieve at least an 80% reduction in emissions compared to the 2013 Building Regs and so are within the government target to align with Net Zero by 2050 through the Decarbonisation of the National Grid. However in terms of future proofing, retrospective measures for enhancing the performance of the FHS building will be more complex especially when it comes to installing ducting for MVHR and ensuring airtightness measures have been implemented. PV allocation may have been installed already with the FHS possibly leaving no further space for additional panels, whereas it will be a relatively simple addition to install PV on a PH Classic which almost reaches Net Zero without dependence on the Grid: a further improvement in PV efficiencies or a couple more panels will tip the PH-built dwelling into Net Zero without much effort and a saving on having to enhance the fabric itself.

Figure A8.15 Space heating demand using the 2 methodologies





8. Whether the SAP10.2 methodology or the PHPP approach is used, the results show a clear message in terms of Space Heating Demand which is the key factor for issues of fuel poverty, health and well-being. The Passivhaus approach clearly performs significantly better than the Future Homes Standard whether analysed by the SAP method or the PHPP method. The carbon emissions trend tells the same story.

Appendix 9 – Typologies for viability testing

Typologies	1	2	3	4	5	6	7	8	9	10
Type	House	Houses	Houses	Houses / flats	Houses / flats	Flats	Houses / flats	Houses / flats	Houses / flats	Older persons
Land type Greenfield / Brownfield	BF	GF	BF	GF	BF	BF	GF	BF	GF	BF
No.units	1	9	9	35	35	120	260	260	5,000	55
Gross area ha	0.02	0.3	0.3	1	1	1	9.9	8.67	238.33	0.5
Net area ha	0.02	0.3	0.3	1	1	1	7.43	6.5	143	0.5
Mix	house	houses	houses	10% flats	10% flats	flats	10% flats	10% flats	10% flats	100% flats
Density		30dph	30dph	35 dph	35 dph	120 dph	35 dph	40 dph	35 dph	110 dph
Net to gross	100%	100%	100%	100%	100%	100%	75%	75%	60%	
Build out	1 yr	1 yr	1yr	6 mths to first sale then 40 pa	6 mths to first sale then 40 pa		6 mths to first sale then 40 pa	6 mths to first sale then 40 pa	25 years	2 years - no sales until end
% affordable	0%	0%	0%	30%	30%	30%	30%	30%	30%	30%
s106 per unit (£s)	2,500	5,000	5,000	10,000	10,000	5,000	12,000	12,000	40,000	5,000
Land value per gross ha (£s):										
VA 2,3,4	1.1m	0.375m	1.1m	0.375m	1.1m	1.1m	0.315m	0.8m	0.25m	1.1m
VA 1	0.5m	0.315m	0.5m	0.315m	0.5m	0.5m	0.25m	0.5m	0.25m	0.5m

Appendix 10 - Benchmark land values – further information

1. The principles set out in the PPG are also supported in recent RICS guidance[13]. However, the appropriate scale of the uplift to existing use value is not set out in any of the current guidance, although PPG does define that a 'premium' for a landowner should "*Provide a reasonable incentive for a land owner to bring forward land for development while allowing a sufficient contribution to fully comply with policy requirements*"[14]. There is a wide range of site specific variables which will affect the level of uplift required (e.g. whether the landowner requires a quick sale). However, for a strategic study, where the land values on future individual sites are unknown, a pragmatic approach is required.

2. Research by the Homes and Communities Agency in 2010 found that

   "*Benchmarks and evidence from planning appeals tend to be in a range of 10% to 30% above EUV in urban areas. For greenfield land, benchmarks tend to be in a range of 10 to 20 times agricultural value.*"[15]

3. More recent research from Lichfields (2020) has a similar finding.

   "*Unsurprisingly, the level of uplift was found to vary, with an increase of 20% common for brownfield sites and a multiplier of 15-20 times above EUV or an uplift of 20% plus an additional allowance of between £250,000 and £650,000/ha being applied in respect of greenfield sites.*"[16].

4. A similar review by Three Dragons of viability studies used as evidence in recent local plan or CIL examinations found that, where the approach was made clear in the report, a 20% uplift was the norm for brownfield sites and 10-20 agricultural value for greenfield site – there was little deviation from this. The review is set out in Appendix 10.

5. For Essex, we have arrived at realistic benchmark values through review of a number of data sources. These include in particular values used in previous Essex district councils' local plan viability studies including those found sound at examination[17] andexisting use values obtained from government published information on local land values[18].

6. Taking into account a premium, a range of values was identified. For the purposes of this study we have taken an average mid-point land value[19] using a 20% uplift to existing use values for

[13] Para 5.2 Assessing viability in planning under the National Planning Policy Framework 2019 for England RICS 2021
[14] PPG Paragraph: 016 Reference ID: 10-016-20190509
[15] P9 Homes and Communities Agency 2010, Annex 1 (Transparent Viability Assumptions)
[16] https://lichfields.uk/blog/2020/june/24/towards-the-standardisation-of-viability-assessments/
[17] For example Chelmsford Viability Assessment 2019 (HDH, Tendring Viability Study Addendum 2019 (Three Dragons & Troy Planning)
[18] Land Values for Policy Appraisal 2019 (published 2020) DLUHC
[19] The values points are not quite evenly spaced as have been tempered by findings in district viability studies and comments by council officers

brownfield sites and 15 times agricultural value for greenfield sites The exceptions to this are for the largest sites where we have applied a lower value to the 5,000 dwelling site (10 times agricultural value) and a mid-point between the average and lower value for the 260 dwelling site – this accounts for economies of scale on these sites and reflects known benchmark values for larger sites in Essex as evidenced through local plan viability evidence. In practice land may transact below or above this level. The land values have been presented to the local development industry and we have received no comment that they are out of step with the local market.

Appendix 11 – Standard input comparative analysis

Essex Overview

This appendix shows some of the background analysis using viability assumptions used elsewhere - Figure 11.6 in the main report lists the assumptions used in this study for Essex

Figure A11.1 Viability assumptions from most recent local authority area-wide viability studies in Essex (shown in 2 tables)

	S106	Infrastructure / Opening up costs	Density
Basildon PorterPE – February 2018 and update in September 2018	£3,230 p.u 3 Strategic sites separately costed at £8,348, £14,809 and £16,409 p.u	For greenfield sites Less than 200: £5,000 p.u 200 to 499: £10,000 p.u 500+: £17,000 p.u For brownfield sites: £300,000 p.ha Strategic sites separately costed	Under 15 units c. 33 dph 150 houses: c. 26dph 1,000 houses: c. 21dph 150 flats: 94dph
Castlepoint Castle Point CIL Viability Assessment PorterPE – August 2021	Range significantly by scale and location (Mainland or Canvey Island) and greenfield/brownfield Under 10 units: £1,500 p.u On Mainland Greenfield flats: £4,375 Brownfield flats: £2,300 30 to 300 houses: c. £16,000 500 houses: c £26,000 1,000 houses: c. £21,000 On Canvey Island Flats: c. £1,300 30 to 50 houses: c.£5,000 100 to 150 mixed: c £8,000 Approx. 25 strategic sites tested, ranging from 14 to 850 units, with an average s106 cost of £18,355 p.u	For greenfield sites Less than 50: £0 p.u 50 to 200: £6,000 p.u 200 to 499: £15,000 p.u 500+: £22,000 p.u For brownfield sites: £350,000 p.ha For mixed sites: £175,000 p.ha Strategic sites costed by site promoters ranging from £7,419 to £26,093 p.u	2 houses: 40 dph 6 to 1,000 houses: 30 dph All flats: 90 dph Mixed: 40 and 100 dph
Chelmsford HDH – June 2019	Large Greenfield: £4,000 p.u Medium Greenfield: £3,000 p.u Brownfield: £2,000 p.u Smaller Sites: £2,000 p.u Strategic: £10,000 p.u	Sensitivity tested at £5k bands ranging from £0 p.u up to £40,000 p.u	Varies by typology. Strategic & greenfield mainly at 35 dph, some at 30 and some at 50 dph Brownfield between 30 to 120 dph Flats between 65 to 160 dph
Harlow BNP – March 2018	All: £1,000 p.u	Typologies over 500 units have a £15,000 p.u cost applied	Varies by following typologies 10 Houses: 10dph 25 Flats: 350 dph 50 Mixed: 235 dph 100 flats: 235 dph 100 Houses: 375 dph 500 flats: 380 dph 650 flats: 210 dph 1,000 Flayts: 280 dph 2,000 flats: 630 dph
Southend Southend-on-Sea HELAA	All: £1,400 p.u	For greenfield sites Less than 50: £0 p.u 50 to 200: £5,000 p.u 200 to 499: £12,000 p.u 500+: £20,000 p.u	Varied. Appraisal tests 145 sites taken from the councils HELAA, each with their own net, gross and density assumptions

	S106		Infrastructure / Opening up costs	Density
Development Viability Appraisals PorterPE, MED Planning and DLP – November 2018			For brownfield sites: £150,000 p.ha Additional costs applied specific to sites i.e. if contaminated, flooded etc.	
Tendring Viability Study Addendum 2019 Three Dragons and Troy Planning	£5,000 £11,000 £11,100 £24,500 £12,500	Per dwelling Sites 125 plus SAMU1 only SAMU2 only SAMU3 only	£5,000 – 50-99 units £6,000 – 100-299 units £7,500 – 300+ units (+ SAMU1)	30 dph – main density
Uttlesford Viability Study June 2018 Three Dragons and Troy Planning	£7,000 £11,000 £40-50K	Per dwelling - sites up to 50 units Sites over 50 units Garden communities	£5,000 – 50-99 units £6,000 – 100-299 units £7,500 – 300+ units Or 15% build costs for garden communities	Average 35 dph But varies from 20 dph for RES, to 120 dph for flats Also studies at 40 & 60 DPH for mixed dev

	Phasing / Build Out Rate	Affordable Housing Assumptions	Other Policies that might impact Viability
Basildon PorterPE – February 2018 and update in September 2018	Sales lag of 6 months. Build out rate varies by each typology	31% Affordable housing (one strategic site at 25%). This is split 70% affordable rented and 30% for rent. Affordable rent assumed at 40% of OMV Intermediate assumed at 65% of OMV	10% at Cat2. Aside from additional build costs due to the extra floorspace, houses have an increased cost of £521 p.u, flats £924 p.u Sustainability: 2.5% of build costs Gypsy and Traveller sites on strategic sites.
Castlepoint Castle Point CIL Viability Assessment PorterPE – August 2021	30 homes: 14 per annum 300 homes: 41 per annum 1000 homes: 59 per annum 3 month lag for site prep 6 month lag between build and sale of first unit	Affordable housing of: • 40% in the mainland (everywhere by Canvey Island) And on Canvey Island • 15% on sites of less than 100 units which include flats • 25% on sites of less than 100 units which do not include flats • 40% on sites of 100 or more Split 50% affordable rent, 50% intermediate Affordable rent assumed at 50% of OMV Intermediate assumed at 67.5% of OMV	£120 per sqm for enhanced foundations relating to tidal flood risks and mitigation Biodiversity net gain: £1,018 p.u on greenfield and £243 p.u on brownfield
Chelmsford HDH – June 2019	Pre construction 6 months all sites Unit build time of 9 months Maximum delivery rate of a single outlet is 50 per annum	35% Affordable housing. This is split 33% to buy and 67% for rent. Capitalised values of Social rent: £1,700 p.sqm Affordable rent rent: £2,900 p.sqm Intermediate: £2,900 p.sqm Intermediate assumptions: 50% share 2.75% per annum rent payable on shared equity retained 10% charge for management deducted from rental income Capitalised at a yield of 5%	None
Harlow BNP – March 2018	4 units per month. Typologies greater than 500 units would achieve 10 per month	30% Affordable housing; split 85% affordable rent and 15% shared ownership Affordable rent: At LHA rates Shared Ownership Assumptions: 30% equity stake 2.75% charge on the retained equity 10% charge for management deducted from rental income Capitalised at a yield of 5%	10% accessible homes. BNP assume the cost of a flat is £11,000 p.u and the cost of a house is £26,000 p.u. Sustainability requirements of £5,000 p.u SuDS and attenuation at £2,500 p.u.
Southend	Not stated	20% on sites between 10 and 49.	None

	Phasing / Build Out Rate	Affordable Housing Assumptions	Other Policies that might impact Viability
Southend-on-Sea HELAA Development Viability Appraisals PorterPE, MED Planning and DLP – November 2018		30% on sites of 50+. Split assumed of 60% rented and 40% intermediate Affordable rent assumed at 47.5% of OMV Intermediate assumed at 67.5% of OMV	
Tendring Viability Study Addendum 2019 Three Dragons and Troy Planning	50 per outlet pa	30% AH 30% intermediate	Net to gross ratios: • Up to (& incl) 1ha – 100% • Over 1ha-2 ha – 90% • 2-4 ha – 80% • 4-6ha - 70% • 6+ha - 65%
Uttlesford Viability Study June 2018 Three Dragons and Troy Planning (note plan thrown out)	50 per outlet pa	40% - split 70/30	Net to gross ratios: • Schemes up to 0.4ha – 100% • 0.41 - 2ha – 90% • 2.1 - 15ha – 75% • 15ha+ - 60%

National overview

1. At some recent development industry workshops, responses to consultation and at examination, the use of 'standard' assumptions has been discussed. Different organisations have a variety of views on what is considered as 'standard'.
2. To help the decision maker, we thought it useful to review the most recent studies which have been subject to an examination, whether that be local plan or a development plan document or community infrastructure levy. Whilst this is a helpful exercise it should be noted that a number of these studies were undertaken prior to more recent changes in PPG, so should be considered within that context.
3. The analysis was undertaken in March 2021 and includes the following local authorities:

Figure A11 .2 Local authorities included in the analysis of local plan viability assumptions as per figure A11.3 below (<u>See figure 10.6 in main report for full set of assumptions used in this study)</u>

Local Authority	Document	Local Authority	Document
Bedford BC	LP	Runnymede	LP
Braintree (Jt N Essex)	LP Pt 1	South Kesteven	LP
Broxbourne	LP	South Oxfordshire	LP
Chelmsford	LP	Staffordshire Moorlands	LP
Cherwell	LP	Suffolk Coastal	LP
Chesterfield	LP	Sunderland City	LP
Craven	LP	Thanet	LP
Harlow	LP	Tower Hamlets	LP
Harlow	LP SS	Arun	CIL
Lancaster	LP Pt 1	Brighton	CIL
Mansfield	LP	Canterbury	CIL
Mid Devon	LP review	East Devon Review	CIL
New Forest DC -	LP	Harrogate	CIL
North York Moors NP	LP	Kirklees	CIL
Northumberland NP	LP	Tower Hamlets	CIL
Reading	LP	Bromley	CIL

4. The supporting evidence base studies produced on behalf of local authorities were undertaken by a wide range of consultants including BNP Paribas, Hyas, HDH, Montague Evans, Bailey Venning, Aspinal Verdi, LSH, Keppie Massie, DSP, Three Dragons, AGA, Aecom, WYG, C&W and Dixon Searle. Therefore the 'standards' set out in the following table cover not only a wide range of local authorities but also the views of all types of consultancy practices.

Figure A11.3 Analysis of viability assumptions used in recent local plan viability studies and found sound at examination – (See figure 10.6 in main report for full set of assumptions used in this study)

Assumption	Rates used	Commentary
Interest rates	6% to 7% cost Average rate 6.5%	The majority of those towards 7% are from studies undertaken in 2017/2018, since then interest rates have lowered and there is greater access to borrowing such as low interest offers from Homes England
Marketing, sales and legal costs – market housing	2.5% - 4% GDV Average 3.3%	Most studies use a combined figure for these costs
Legal costs – affordable housing	-	Most studies do not appear to identify separate marketing and legal costs for affordable housing although some do suggest that a reduced legal cost per unit should be included
Professional fees	4% - 12% build cost Average 8.6%	Some studies vary professional fees according to size of development with lower fees used for the larger schemes
Return - market	17.5% - 20% GDV Average 19.5%	Some studies used a percentage on cost rather than GDV. None exceeded 20% and in the majority of studies those at 20% were published prior to changes in PPG which suggested the 15% to 20% range as being suitable.
Return - affordable	6% - 20% AH GDV Average 8.3%	The majority of studies use 6% of affordable GDV. Some use 6% of costs. There are some outliers that do not follow PPG guidance and use the same return for market and affordable, which has effectively increased the average to 8%.
Contingency	2.5%-5% - unclear Average 3.7%	Studies are not always very clear as to whether contingency is included and on what basis. PPG only requires contingency for scheme specific testing, however many of the studies predate this guidance.
Plot costs/externals and site infrastructure:		
Small sites	Plot and site infrastructure 10% - 15% build cost	This is one of the most inconsistent areas with a variety of approaches used ranging from percentages on build costs, per hectare allowances,

Large sites	Plot 10% build cost and infrastructure either an additional 10% to 20% build cost or £5k to £45k per unit	per unit allowances. The approaches are also often mixed and also vary according to site type and size. The most common approach is a percentage on build costs for smaller sites and then a reduced percentage or the same for larger sites plus an additional per dwelling allowance to take into account a likely increased infrastructure requirement.

Appendix 12 – Results from economic viability modelling

Figure A12.1 Value Area 1 - viability testing results

Scheme Details			Base test (with no allowance for climate change policies)			Part L of Building Regs 2021 (effective from June 2022) - 31% Reduction in carbon			Meets Future Homes Standard 2025 (as set out in gov consultation) 75-80% reduction in carbon				Net zero using fabric first approach reference to table 10.8 in main report		
Scheme Ref	Greenfield/ Brownfield	Dwgs	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit	Scheme Headroom per market sqm	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit
Res1	Brownfield	1	-48,822	-121,622	-121,622	-51,822	-124,622	-124,622	-65,322	-138,122	-138,122	-1,201	-67,822	-140,622	-140,622
Res2	Greenfield	9	1,401,382	746,182	82,909	1,374,382	719,182	79,909	1,252,882	597,682	66,409	601	1,230,382	575,182	63,909
Res3	Brownfield	9	1,180,628	525,428	58,381	1,153,628	498,428	55,381	1,032,128	376,928	41,881	379	1,009,628	354,428	39,381
Res4	Greenfield	35	3,945,172	2,150,064	61,430	3,838,820	2,043,712	58,392	3,377,164	1,582,056	45,202	572	3,288,292	1,493,184	42,662
Res5	Brownfield	35	3,151,589	1,356,481	38,757	3,045,237	1,250,129	35,718	2,583,581	788,473	22,528	285	2,494,709	699,601	19,989
Res6	Brownfield	120	2,334,838	-1,103,402	-9,195	2,099,998	-1,338,242	-11,152	1,111,198	-2,327,042	-19,392	-421	740,398	-2,697,842	-22,482
Res7	Greenfield	260	30,188,762	16,853,674	64,822	29,426,958	16,091,870	61,892	26,120,096	12,785,008	49,173	623	25,483,502	12,148,414	46,725
Res8	Brownfield	260	26,019,758	12,684,670	48,787	25,233,053	11,897,965	45,761	21,818,104	8,483,016	32,627	413	21,160,702	7,825,614	30,099
Res9	Greenfield	5,000	283,450,237	39,669,237	7,934	268,811,312	25,030,312	5,006	205,266,214	-38,514,786	-7,703	-97	192,941,309	-50,839,691	-10,168
Res10	Brownfield	55	-2,631,929	-4,286,879	-77,943	-2,760,464	-4,415,414	-80,280	-3,301,661	-4,956,611	-90,120	-1,545	-3,504,610	-5,159,560	-93,810

Figure A12.2 Value area 2 - viability testing results

Scheme Details			Base test (with no allowance for climate change policies)			Part L of Building Regs 2021 (effective from June 2022) - 31% Reduction in carbon			Meets Future Homes Standard 2025 (as set out in gov consultation) 75-80% reduction in carbon			Net zero using fabric first approach reference to table 10.8 in main report		
Scheme Ref	Greenfield/ Brownfield	Dwgs	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit
Res1	Brownfield	1	16,168	-70,032	-70,032	13,168	-73,032	-73,032	- 332	-86,532	-86,532	- 2,832	-89,032	-89,032
Res2	Greenfield	9	1,986,292	1,210,492	134,499	1,959,292	1,183,492	131,499	1,837,792	1,061,992	117,999	1,815,292	1,039,492	115,499
Res3	Brownfield	9	1,765,538	989,738	109,971	1,738,538	962,738	106,971	1,617,038	841,238	93,471	1,594,538	818,738	90,971
Res4	Greenfield	35	5,728,011	3,611,554	103,187	5,621,659	3,505,202	100,149	5,160,003	3,043,546	86,958	5,071,131	2,954,674	84,419
Res5	Brownfield	35	4,934,429	2,817,972	80,513	4,828,077	2,711,620	77,475	4,366,421	2,249,964	64,285	4,277,549	2,161,092	61,745
Res6	Brownfield	120	4,313,377	532,177	4,435	4,078,537	297,337	2,478	3,089,737	-691,463	-5,762	2,718,937	-1,062,263	-8,852
Res7	Greenfield	260	43,277,964	27,555,712	105,984	42,516,160	26,793,908	103,053	39,209,298	23,487,046	90,335	38,572,704	22,850,452	87,886
Res8	Brownfield	260	39,152,888	23,430,636	90,118	38,391,084	22,668,832	87,188	35,084,222	19,361,970	74,469	34,447,628	18,725,376	72,021
Res9	Greenfield	5,000	520,595,525	233,657,525	46,732	506,057,264	219,119,264	43,824	442,949,140	156,011,140	31,202	430,800,386	143,862,386	28,772
Res10	Brownfield	55	-384,496	-2,399,641	-43,630	-513,030	-2,528,175	-45,967	-1,054,228	-3,069,373	-55,807	-1,257,177	-3,272,322	-59,497

Figure A12.3 Value area 3 - viability testing results

Scheme Details			Base test (with no allowance for climate change policies)			Part L of Building Regs 2021 (effective from June 2022) - 31% Reduction in carbon			Meets Future Homes Standard 2025 (as set out in gov consultation) 75-80% reduction in carbon			Net zero using fabric first approach reference to table 10.8 in main report		
Scheme Ref	Greenfield/ Brownfield	Dwgs	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit
Res1	Brownfield	1	86,978	-13,822	-13,822	83,978	-16,822	-16,822	70,478	-30,322	-30,322	67,978	-32,822	-32,822
Res2	Greenfield	9	2,623,582	1,716,382	190,709	2,596,582	1,689,382	187,709	2,475,082	1,567,882	174,209	2,452,582	1,545,382	171,709
Res3	Brownfield	9	2,402,828	1,495,628	166,181	2,375,828	1,468,628	163,181	2,254,328	1,347,128	149,681	2,231,828	1,324,628	147,181
Res4	Greenfield	35	7,839,436	5,345,406	152,726	7,733,084	5,239,054	149,687	7,271,428	4,777,398	136,497	7,182,556	4,688,526	133,958
Res5	Brownfield	35	7,045,853	4,551,823	130,052	6,939,501	4,445,471	127,013	6,477,845	3,983,815	113,823	6,388,973	3,894,943	111,284
Res6	Brownfield	120	11,776,306	6,709,426	55,912	11,541,466	6,474,586	53,955	10,552,666	5,485,786	45,715	10,181,866	5,114,986	42,625
Res7	Greenfield	260	58,779,440	40,252,360	154,817	58,017,636	39,490,556	151,887	54,710,774	36,183,694	139,168	54,074,180	35,547,100	136,720
Res8	Brownfield	260	54,654,365	36,127,285	138,951	53,892,561	35,365,481	136,021	50,585,699	32,058,619	123,302	49,949,105	31,422,025	120,854
Res9	Greenfield	5,000	804,567,940	465,970,940	93,194	790,091,930	451,494,930	90,299	727,254,025	388,657,025	77,731	715,157,290	376,560,290	75,312
Res10	Brownfield	55	1,106,777	-1,157,188	-21,040	985,519	-1,278,446	-23,244	474,955	-1,789,010	-32,527	283,493	-1,980,472	-36,009

Figure A12.4 Value area 4 – viability testing results

Scheme Details			Base test (with no allowance for climate change policies)			Part L of Building Regs 2021 (effective from June 2022) - 31% Reduction in carbon			Meets Future Homes Standard 2025 (as set out in gov consultation) 75-80% reduction in carbon			Net zero using fabric first approach reference to table 10.8 in main report		
Scheme Ref	Greenfield/ Brownfield	Dwgs	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit	Residual value (RV) for scheme	Scheme RV less Developer & Contractor Return	Scheme Headroom per unit
Res1	Brownfield	1	200,468	76,268	76,268	197,468	73,268	73,268	183,968	59,768	59,768	181,468	57,268	57,268
Res2	Greenfield	9	3,644,992	2,527,192	280,799	3,617,992	2,500,192	277,799	3,496,492	2,378,692	264,299	3,473,992	2,356,192	261,799
Res3	Brownfield	9	3,424,238	2,306,438	256,271	3,397,238	2,279,438	253,271	3,275,738	2,157,938	239,771	3,253,238	2,135,438	237,271
Res4	Greenfield	35	11,290,740	8,179,527	233,701	11,184,388	8,073,175	230,662	10,722,732	7,611,519	217,472	10,633,860	7,522,647	214,933
Res5	Brownfield	35	10,497,158	7,385,945	211,027	10,390,806	7,279,593	207,988	9,929,150	6,817,937	194,798	9,840,278	6,729,065	192,259
Res6	Brownfield	120	25,919,244	18,373,644	153,114	25,691,244	18,145,644	151,214	24,731,244	17,185,644	143,214	24,371,244	16,825,644	140,214
Res7	Greenfield	260	84,117,940	61,006,072	234,639	83,356,136	60,244,268	231,709	80,049,274	56,937,406	218,990	79,412,680	56,300,812	216,542
Res8	Brownfield	260	79,992,864	56,880,996	218,773	79,231,060	56,119,192	215,843	75,924,198	52,812,330	203,124	75,287,604	52,175,736	200,676
Res9	Greenfield	5,000	1,264,625,092	842,408,092	168,482	1,250,149,082	827,932,082	165,586	1,187,311,177	765,094,177	153,019	1,175,214,442	752,997,442	150,599
Res10	Brownfield	55	4,677,299	1,808,169	32,876	4,556,040	1,686,910	30,671	4,045,476	1,176,346	21,388	3,854,015	984,885	17,907