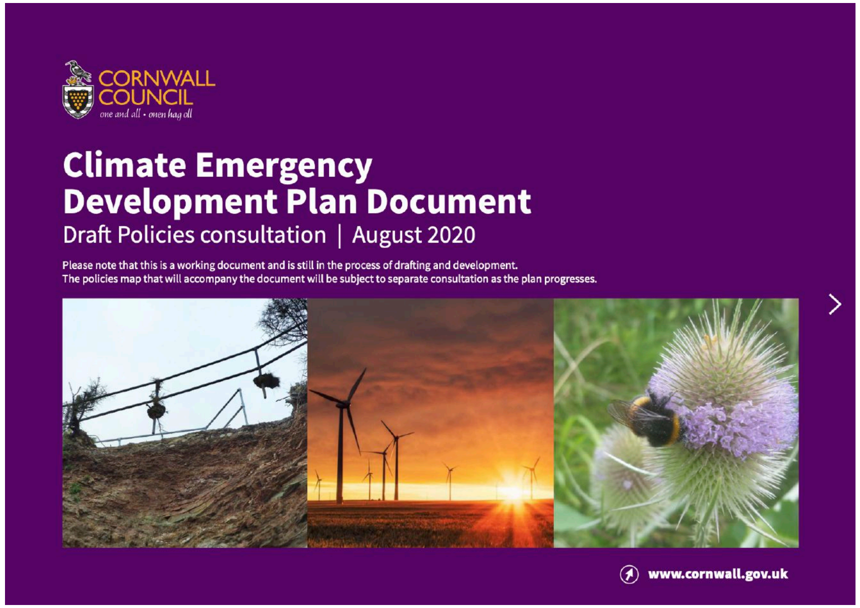
CORNWALL COUNCIL CLIMATE EMERGENCY DPD



ENERGY REVIEW AND MODELLING

Feb 2021 I Rev J

Currie & Brown

Etude

Executive summary

The Climate Emergency Development Plan Document (DPD) is part of Cornwall Council's response to the climate emergency and a key part of the Climate Change Action Plan, which aims to create a carbon neutral Cornwall by 2030, a full 20 years before the UK commitment. Draft Policy SC1 requires new developments to achieve a 19% improvement over the minimum standards from energy efficiency (fabric and services), a further 20% reduction from renewable energy and offsetting for residual regulated emissions.

Improved policies to deliver net zero operational carbon buildings

Cornwall Council and the South West Energy Hub commissioned this study to look at alternative approaches around five key requirements:

1. Ultra-low space heating demand.
2. No fossil fuels in order to end emissions on site, combined with a total energy use target, measured as an Energy Use Intensity (EUI).
3. Solar photovoltaic generation on site to balance annual energy use.
4. Energy demand flexibility in terms of when it needs electricity for heating so renewable energy can be used when it is available.
5. Reduction of the performance gap to ensure performance is delivered.

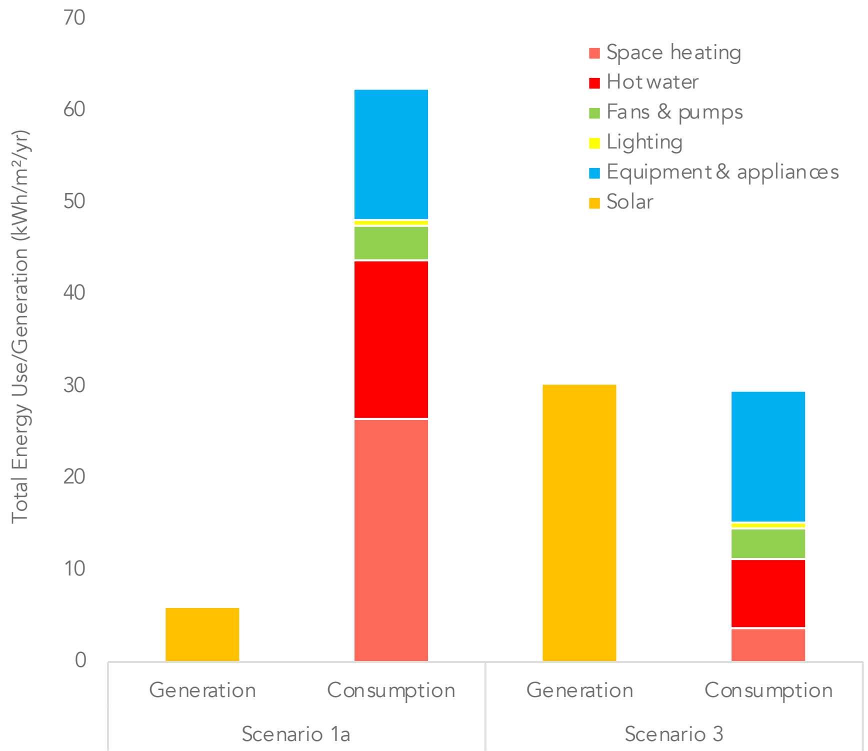
Comparison between proposed and improved policies: our findings

Energy and cost modelling have been undertaken for a typical typology, i.e. a semi-detached house. In summary:

- The policy proposed in the draft DPD would not deliver net zero carbon. Homes built to this standard would require retrofit before the 2030 (or 2050) deadline.
- The draft DPD policy would lead to running costs approximately 35-60% higher than the improved net zero carbon policies.
- Policies that do deliver net zero carbon would cost approximately 2-4% more in terms of construction costs compared to the draft DPD policy.

1	2	3	4	5
Ultra-low space heating demand	No fossil fuels and low total energy use (EUI)	Renewable energy generation	Flexible power demand	Reduced performance gap
15 kWh/m²/yr	35 kWh/m²/yr	Equal to the EUI		

Proposed new requirements for new homes in Cornwall Climate Emergency DPD.
These improved requirements would deliver net zero carbon new homes today.



Total energy use, expressed as an Energy Use Intensity (EUI), and solar generation for a semi-detached house that is just compliant with the draft policy (Scenario 1a) compared to one that achieves net zero carbon on site through excellent fabric, a heat pump and solar PV (Scenario 3)

1.0

The Climate Emergency DPD and a potential alternative policy for new buildings

This section considers the current main energy policy in the Climate Emergency DPD and whether it can deliver the Council's commitment to achieve net zero carbon.

An improved set of policies to deliver net zero carbon new buildings, based on recent industry guidance, is proposed.

The Climate Emergency DPD

The Cornwall Climate Emergency DPD is part of Cornwall Council's response to the climate emergency and the need for renewal post Covid.

It is a key part of Cornwall's Climate Change Action Plan, which sets out a programme of actions required to respond to the Climate Emergency and to create a **carbon neutral Cornwall in 2030**, a full 20 years before the UK commitment.

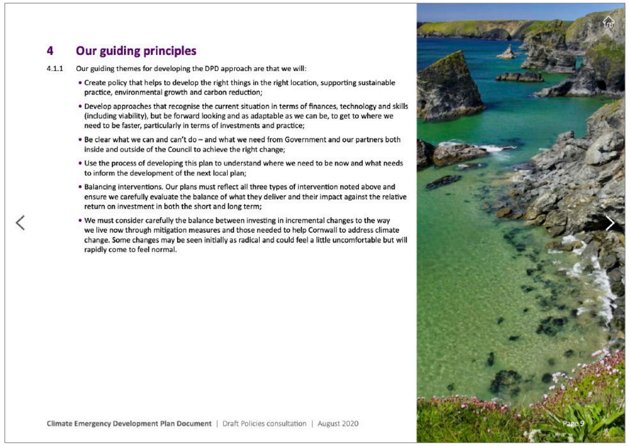
It covers a wide range of areas and issues including:

- Natural climate solutions (Policies G1-3)
- Agriculture and rural development (Policies AG1-4)
- Town centres, design and density (Policies TC1-4)
- Sustainable transport (Policies T1-3)
- Renewables (Policies RE1-6)
- Energy and sustainable construction (Policies SC1-2)
- Coastal change and flooding (Policies CC1-4)

Although our review and work focuses on **Energy and sustainable construction** and **Renewables**, we have made some general comments on the document (please refer to Appendix A).

As a general point, we think that it is important for the document to be as positive as it is ambitious. For example, renewable energy should be considered much more favourably as it has a key role to play: addressing the climate emergency means that most of our energy will need to be generated by renewables by 2050.

We would also recommend testing projected carbon emissions under the proposed policies against scientifically determined carbon budgets for Cornwall. There are different ways to do this, but an approach guided by the carbon budgets calculated by the Tyndall Centre (Appendix E) would be our recommendation to help inform decisions.



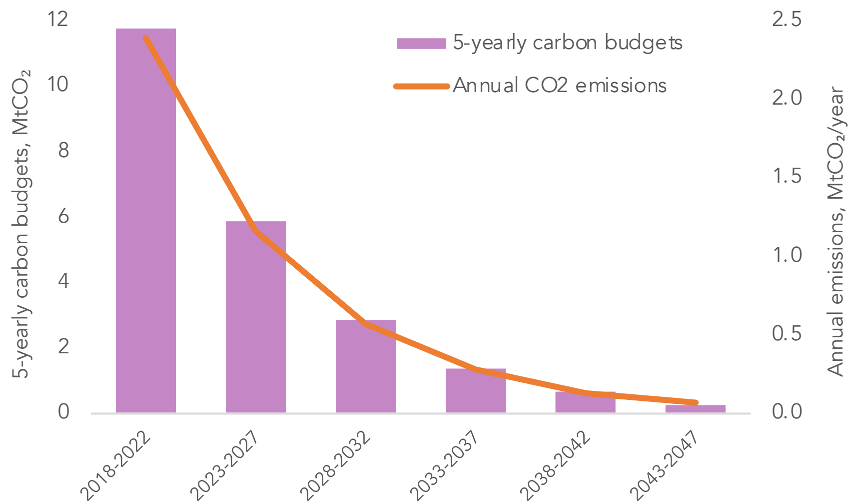
4 Our guiding principles

4.1.1 Our guiding themes for developing the DPD approach are that we will:

- Create policy that helps to develop the right things in the right location, supporting sustainable practice, environmental growth and carbon reduction;
- Develop approaches that recognise the current situation in terms of finances, technology and skills (including viability), but be forward looking and as adaptable as we can be, to get to where we need to be faster, particularly in terms of investments and practice;
- Be clear what we can and can't do – and what we need from Government and our partners both inside and outside of the Council to achieve the right change;
- Use the process of developing this plan to understand where we need to be now and what needs to inform the development of the next local plan;
- Balancing interventions. Our plans must reflect all three types of intervention noted above and ensure we carefully evaluate the balance of what they deliver and their impact against the relative return on investment in both the short and long term;
- We must consider carefully the balance between investing in incremental changes to the way we live now through mitigation measures and those needed to help Cornwall to address climate change. Some changes may be seen initially as radical and could feel a little uncomfortable but will rapidly come to feel normal.

Climate Emergency Development Plan Document | Draft Policies consultation | August 2020

Extract of the Cornwall Climate Emergency DPD



5-yearly carbon budgets and annual CO_2 emissions for energy use in Cornwall to stay well below a 2°C temperature rise, based on Tyndall Centre Carbon budgets report. The most recently reported historical emissions of 2.76MtCO$_2$ in 2019 must reduce 25% to 2.07MtCO$_2$ by 2021 to be on track to net zero.

Policy SC1 and the Part L Notional Building

Current requirements under Policy SC1

The carbon performance requirements of new developments in Policy SC1 is currently expressed in terms of a percentage improvement over a 'notional building' defined by Part L, and calculated for the purpose of Building Regulations.

This approach can create confusion and complicates post-construction verification relative to a simple absolute performance target.

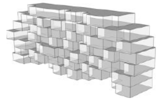
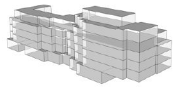
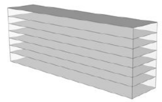
Issues associated with the notional building

The setting of the notional building, and in particular the fact that it has the same shape, orientation and, up to a point, the same proportions of glazing as the actual building is an issue

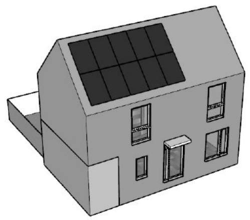
Improving thermal performance of a dwelling by reducing heat loss area, the amount of junctions and by optimizing glazing layout for solar gains are widely considered as three essential components of an energy efficient design. Unfortunately the notional building almost neutralises the impact of most of these changes: it allows inefficient designs to comply and does not reward efficient designs, since the dwelling is compared to one with similar settings.

Issues associated with the % improvement target

The % improvement over a notional building is an intangible performance requirement that cannot realistically be tested once a home is occupied. In addition to using an opaque relative energy performance target, it includes carbon emission factors and primary energy factors that introduce additional complexity. The SAP 2012/Part L 2013 carbon factor for grid electricity has been out of date for at least 5 years and is now around **three times higher** than last year's average grid emissions factor. This means use of % improvement as a performance metric can lead to the wrong outcomes and may continue to do so in the future.

		Improvement over Part L (%) SAP	Space heating demand ($kWh/m^2/yr$) PHPP
High form factor		35%	26
Medium form factor		35%	20
Low form factor		37%	13

A more efficient form factor can significantly reduce space heating demand. Unfortunately, Part L does not reward designs with more efficient form. The % improvement over Part L of the three buildings above is broadly similar despite the space heating demand being up to 50% smaller for the lowest form factor.



Carbon Emission Reductions			
Building Regs	SAP 10	Sap 10.1	Lifetime
18%	59%	75%	88%

The table above shows the percentage improvement above the notional building for a terraced house with a heat pump. Each column is calculated using a different carbon factor for grid electricity to show how misleading this approach can be. A current building regs calculation suggests heat pumps offer a modest improvement of only 18% in a typical new build, when in reality an 88% improvement is expected.

Recent guidance on new buildings

Policy SC1.1 focuses on requirements for new developments. It is based on Building Regulations (Part L) calculations and requires new developments to achieve a 19% improvement over the minimum standards from energy efficiency (fabric and technology), achieve a further 20% reduction with renewable energy and offset the residual regulated carbon emissions.

As these requirements are not sufficient to deliver net zero carbon new homes, we recommend they are amended to reflect the important research and guidance that has been published in the last 18 months.

The Committee on Climate Change report 'UK housing – fit for the future?' highlights that we need to build new buildings with 'ultra-low' levels of energy use. It also makes a specific reference to space heating demand and recommends a maximum of 15-20 kWh/m^2/yr for new dwellings.

A supporting technical study undertaken by Currie & Brown and AECOM confirms that a switch to low carbon heating is essential in achieving long term carbon savings, but that this must be supported by significant improvements in energy efficiency in order to manage running costs and avoid external costs to the wider energy system (e.g. electricity infrastructure). The study indicates that significant reductions in space heating demand can be achieved at lower cost than smaller improvements, as it enables savings in the size and extent of the heating system.

There is also a growing consensus on the need for total energy use as a key metric, expressed as an Energy Use Intensity (EUI). One of the key advantages is that it can be checked once the building is occupied without further modelling or analysis. The metric used in the DPD (% improvement over Part L) cannot be checked during operation.

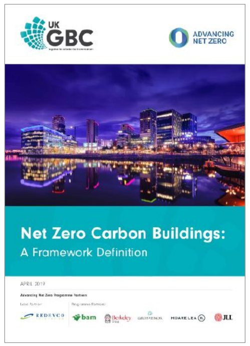
Generally, these research or guidance documents also highlight that the potential for offsetting from new buildings is extremely limited and should be reserved for exceptional circumstances, rather than standard practice.

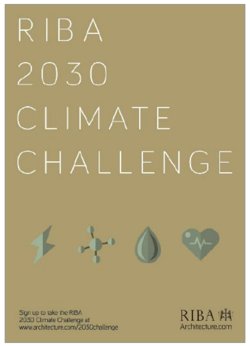
[1] *For comparison, Passivhaus requires 15 kWh/m^2/yr and new domestic buildings can have a heating demand ranging between 40-120 kWh/m^2/yr on average.*

15-20
kWh/m^2/yr

***The UK housing: Fit for the future? report** published by the Committee on Climate Change in February 2019 recommends ultra-low levels of energy use and a space heating demand of less than 15-20 kWh/m^2/yr*

***The costs and benefits of tighter standards for new buildings** report, produced by Currie & Brown and AECOM for the Committee on Climate Change's UK housing: Fit for the future? report*





Guidance on the need for net zero carbon buildings and total energy use targets has been published by the UKGBC, the RIBA and LETI

The crucial importance of decarbonising heat

Heat pumps – a key technology

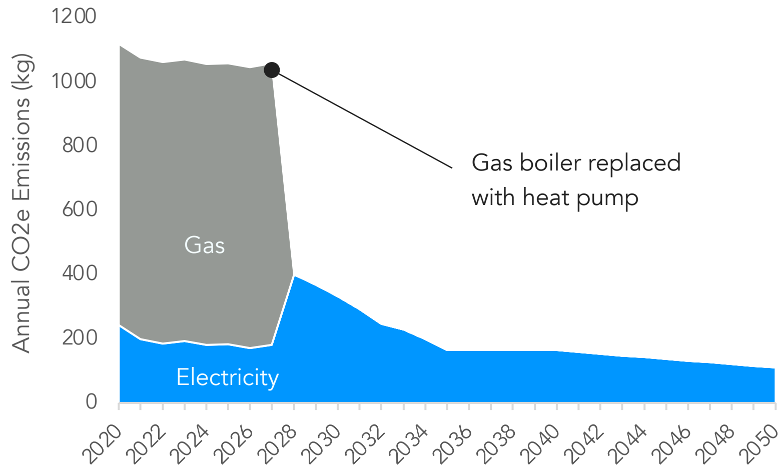
Due to the rapid decarbonisation of the electricity grid, electrification of heat now provides the most plausible pathway to net zero emission new buildings. Heat pumps are currently **the most viable technology** to achieve widespread electrification of heat at scale while limiting overall demand on the electricity network. They are therefore a key technology whose use needs to be rapidly expanded.

Biomass and green gas – a minor role

The net greenhouse gas emissions produced when burning biomass are highly variable and depend on what would have happened to the biomass had it not been burnt. The Climate Change Committee recommend that combustion of carbon containing fuels such as biomass is co-located with carbon capture and storage. This is unlikely to be practical at the scale of individual building heating systems. Due to these complexities, and the negative impacts on air quality caused by biomass heating, it is expected to play **a minor role in achieving net zero**.

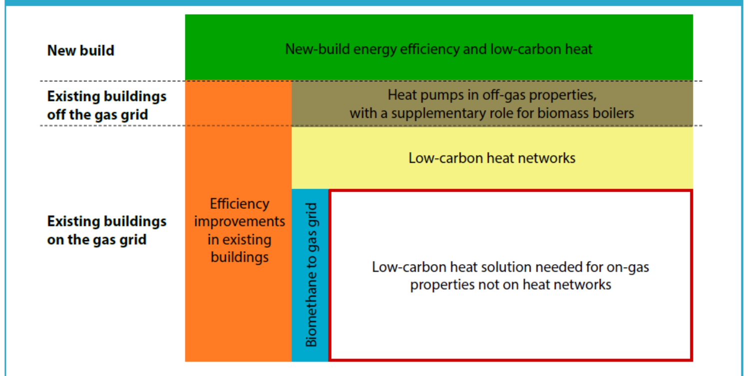
Hydrogen – an unlikely solution for new buildings in Cornwall

The Climate Change Committee sees a **limited role for hydrogen** where *'electrification reaches the limits of feasibility and cost-effectiveness'*. In practice, this is likely to mean industrial heat, top up heating for some buildings on very cold days, back-up power generation and heavy-duty vehicles. This view is based on a maximum practical capacity to produce up to 44TWh of hydrogen a year by 2050, **less than 10% of current gas consumption in buildings**.



Any gas boilers fitted from now on will need to be removed as soon as possible to remain within emissions budgets. Installing a gas boiler for just eight years before switching to a heat pump results in significant avoidable emissions. It is better to fit a heat pump today.

Figure B1.2. Low-regret measures and remaining challenges for existing buildings on the gas grid



Source: CCC (2016) *Next Steps for UK Heat Policy.*
Notes: The sizes of the blocks broadly reflect the scale of emissions reduction, but not precisely. Some potential for heat networks will be in new-build and off the gas grid, rather than all on-grid as presented.

The Committee on Climate Change report recommended hierarchy of measures for various building categories. New builds should not be connected to the gas grid.

Offsetting and new builds: Renewable energy credits as a replacement to carbon offsetting

Carbon Offsetting

Various forms of offsetting have been used by local authorities in the UK for over a decade now. Traditionally it has provided a mechanism that enables buildings that cannot technically achieve net zero carbon on site to be 'deemed' compliant with planning policy.

For example, it is technically challenging for a 6-storey block of flats to generate as much renewable energy as it uses on site, so the applicant could be required to pay into the Council's offset fund to receive planning consent.

This approach is no longer considered fit for purpose as a mechanism to net zero carbon new buildings. The UK's total capacity for offsetting (e.g. reforestation, peat restoration, carbon capture and storage) is already required to for 'hard to treat' sectors such as aviation and agriculture. **Offsetting should not be used for new buildings.**

Renewable Energy Credits

The limited use of Renewable Energy Credits offers a long-term solution that can deliver net zero carbon, providing it is only accepted in very specific circumstances:

1. **The proposed building must not use fossil fuels for heating.**
2. **Total energy use (EUI) must be below the target set in the DPD.**
3. **On-site renewable energy generation should be maximized.**

If these conditions are not met, it is likely that the building in question has not been sufficiently optimised and will need to be retrofitted in the next 30 years.

We recommend that any Renewable Energy Credit funds are not used for purposes other than to fund renewable energy on new buildings to minimize the risk of carbon leakage between sectors, which complicates carbon accounting.

End use of funding		Category	Suitable use of Renewable Energy Credits to deliver net zero carbon new buildings?
Solar photovoltaic panels on new buildings		Additional renewable energy generation	✓
Large scale renewable energy generation		Additional renewable energy generation	✓
Low / Zero Carbon Retrofit of existing buildings		Reduction of energy demand	✗
Solar photovoltaic panels on existing buildings		Additional renewable energy generation	✗
Reforestation. afforestation or peatland		Carbon removal	✗

Net Zero Carbon Homes | Recommended Policy Requirements

Based on Climate Change Committee guidance, which indicates that residual emissions from new buildings should be negligible, the following approach is recommended to deliver net zero carbon new buildings:

Space Heating Demand Limit & Overheating Risk

The energy used specifically for heating is a crucial and simple measure of how well the fabric of the building is performing. Space Heating Demand should be required to be less than 15–20 kWh/m²/yr. The risk of overheating should be assessed as 'Low' using the Good Homes Alliance Tool.

Fossil Fuel Ban and Total Energy Use Limit

There should be no fossil fuels used on site, i.e. no gas or oil boilers in any new properties and no new buildings should be connected to the gas grid.

The predicted total energy use, expressed as an Energy Use Intensity (EUI) should be limited in order to ensure that efficient heating systems are adopted and general energy use is reduced. Total energy use in new houses and flats should be less than 35 kWh/m²/yr.

Renewable energy to match consumption

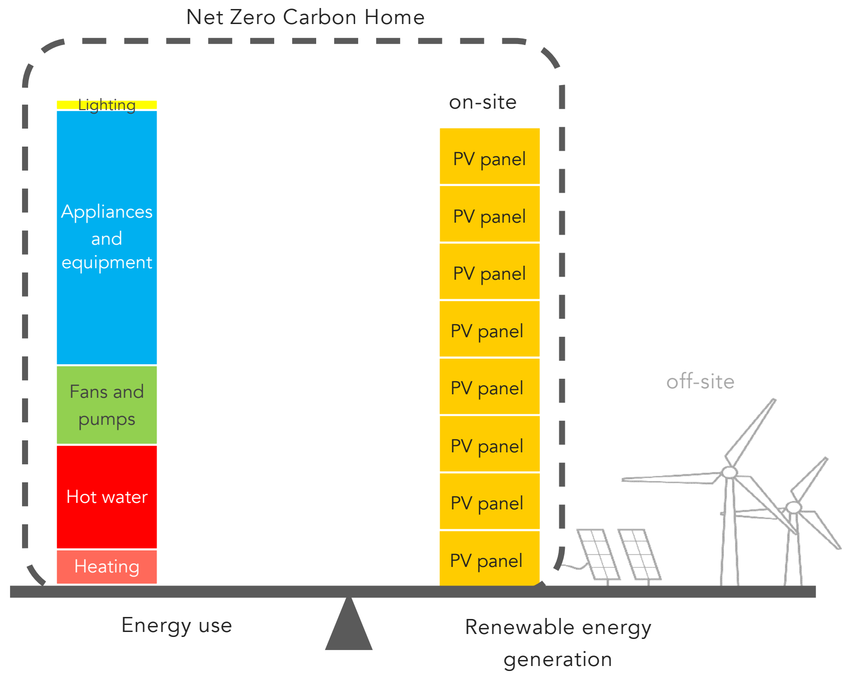
Photovoltaic arrays should be installed on-site with an output to match the calculated total energy use. In a limited number of cases this may be technically challenging. An energy credit mechanism will be needed to allow developers to pay for the installation of additional PVs elsewhere..

Flexible Power Demand

The home should be flexible in terms of when it needs to use electricity, so demand can be matched to windy and sunny periods. This can be achieved through good fabric efficiency and hot water storage.

Performance Gap

Policy is required to address the performance gap to ensure that net zero buildings are delivered on site. There are various ways this could be achieved.



A net zero energy balance on site is assumed to provide a reasonable proxy for net zero carbon, on the basis that solar generation displaces the majority of grid emissions that would otherwise occur. Once the electricity grid has decarbonised, a net zero energy balance ensures the energy needs of new homes are balanced by new solar generation, on a site that has already been developed, rather than a separate greenfield site. The example shown is for an efficient house heated by a heat pump. Each yellow block represents the energy produced by a single solar photovoltaic panel.

1	2	3	4	5
Ultra-low space heating demand	No fossil fuels and low total energy use (EUI)	Renewable energy generation	Flexible power demand	Reduced performance gap
15 kWh/m²/yr	35 kWh/m²/yr	Equal to the EUI		

Five key requirements for a net zero carbon ready new home

We recognise that the net zero policies proposed are a step change from the current regulations. Many builders and developers have begun to respond positively to the Climate Crisis declarations. Nevertheless, it may be helpful to adopt phased increases in energy efficiency to create a pathway to net zero carbon.

Fossil Fuels Eliminated

Connection to the gas grid for new homes could be outlawed by legislation by 2025 or even 2023. Building homes in the next 3 to 5 years that are connected to the gas grid could therefore impose a future cost on the owners of those properties to switch to a different heat source. **There is no advantage in deferring this exclusion,** so, in our view, this policy should be brought in with immediate effect.

Space Heating Demand Limit

A space heating demand of less than 30 kWh/m²/yr would provide some flexibility to allow up-skilling of the local construction industry.

Total Energy Use Limit (EUI)

To reflect the relaxed space heating demand, the Total Energy Use target could be adjusted to a maximum of 40 kWh/m²/yr.

Renewable energy to match consumption

Photovoltaic arrays should be installed **on-site with an output to match the calculated total energy consumption** with an energy credit provision for taller buildings to meet their onsite shortfall elsewhere.

Overheating

Overheating of new builds is a significant issue and one which can represent a risk to health. All homes should be designed to achieve a low overheating risk as defined by the Good Homes Alliance Tool. This policy should not be deferred or diminished.

Additional roof mounted photovoltaic panels will be required to compensate for any relaxation of the requirements

The construction industry may need time to train workers in how to build to better standards, but sending the right signals and trajectory now is crucial.

2.0

Energy and cost modelling

This section summarises the energy modelling undertaken on a typical semi-detached house typology (both SAP and PHPP) in order to compare the policy options.

A high level cost analysis was also undertaken for all options by Currie & Brown.

Finally, the impact of policy options in terms of energy running costs has been estimated.

The scope of this study focuses on one typical housing typology in order to test potential policy requirements.. A 3-bedroom semi-detached house was identified as an appropriate housing type for energy modelling. This is a popular type of house in Cornwall and also provides a middle ground in terms of heat loss area, and therefore thermal performance, between a terraced house and a detached house. A set of plans (shown opposite) were obtained from the planning portal.

Key features

The property has a gross internal floor area of 93m². The main entrance faces the street to the North East, while the rear of the house faces to the South West and features a small garden.

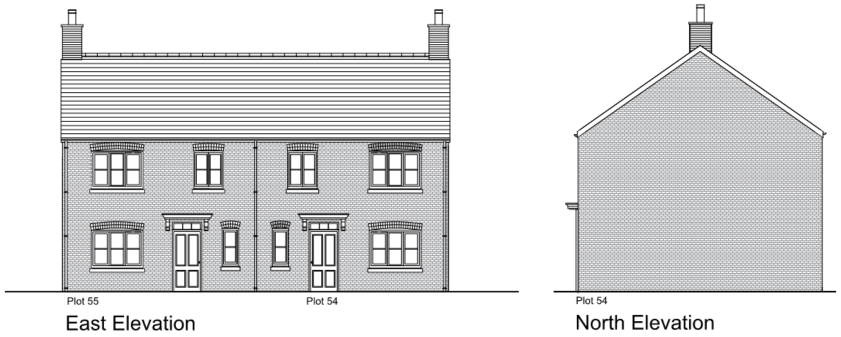
The property is a very typical basic semi-detached house, with reasonable glazing proportions and layout. Combined with the party wall, this results in a good form factor. A fake chimney is fitted to each house, but does not project downward into the property and therefore does not present an airtightness risk.

Approach to energy modelling

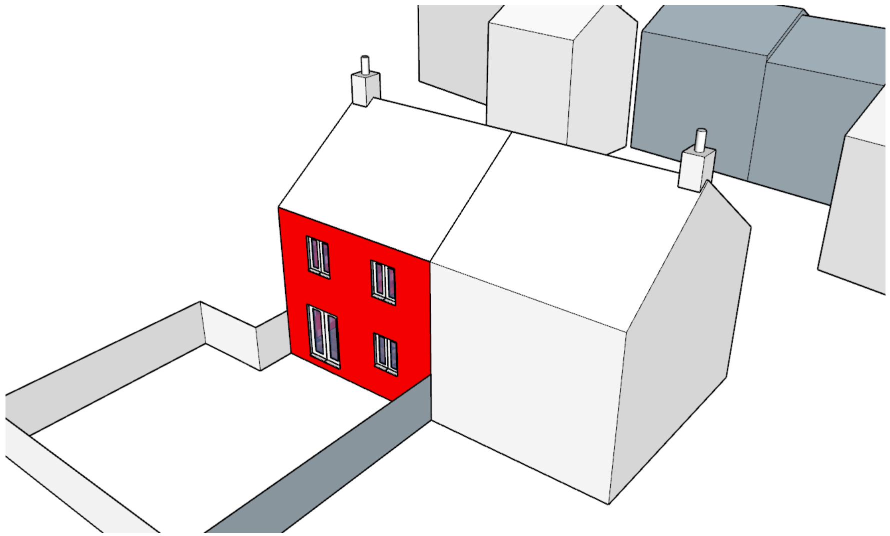
We modelled the house in both **Stroma FSAP 2012** (for standard Part L SAP calculations), and **PHPP 9.6a using DesignPH 2.0.06** (for PHPP calculations)

PHPP is the tool used for Passivhaus and AECB certification. It is known to provides a more reliable prediction of a building's space heating demand and energy use.

Our focus was on modelling the specification required to comply with the current draft DPD, and improved specifications that can deliver net zero carbon on site. In developing our assumptions, we have tried to adopt the mindset of a developer, i.e. finding the simplest and most economic ways of complying with each requirement.



A typical 3 bedroom semi-detached house was selected from the Wainhomes development at Nansledan, Newquay



Southern view - a 3D model of the house and surrounding features was created in DesignPH 2.0.06 and used to calculate solar gains and shading for PHPP

We have analysed four different versions of the chosen house as individual 'scenarios' to evaluate whether they are sufficient to deliver net zero carbon new homes in Cornwall.

Two of the **scenarios**, 1a and 1b, are based on different technical approaches to complying with the policies currently proposed in the Climate Emergency DPD. The specification used in these was informed by current developer practice.

A review of Energy Performance Certificates from recent new build projects in Cornwall provided typical airtightness values, and floor, wall and roof U-values, which were refined through observation of current construction practice by a large developer in Newquay.

As the current DPD policies were not sufficient to deliver net zero carbon, two additional scenarios, 2 and 3, were developed that could achieve this requirement.

Proposed DPD Policy SC1.1

1) Achieve a 19% carbon reduction improvement over current Building Regs Part L
2) Provide on-site renewable energy generation to achieve at least a further 20% reduction in the residual carbon emissions
3) Offset residual emissions through onsite measures or payment to an offset fund

Scenario 1a – A gas boiler is used. The 19% reduction over Part L is achieved through fabric improvement. Roof mounted PV achieve a further 20% Part L reduction.

Scenario 1b – An air source heat pump is used, which delivers more than the required 19% improvement over Part L so the fabric specification remains close to business as usual. Roof mounted PV achieve a further 20% Part L reduction.

Net Zero Policy

1) Limit space heating demand to 15 or 30kWh/m²/yr
2) No fossil fuels and limit total energy use to 35 or 40kWh/m²/yr
3) Match the total energy consumption with roof mounted PV

Scenario 2 – An air source heat pump is used. Space heating demand is reduced primarily through airtightness and use of heat recovery ventilation. Roof mounted PV is installed to match the total energy use.

Scenario 3 – An air source heat pump is used. Space heating demand is reduced through airtightness, heat recovery ventilation, additional insulation, reduction of thermal bridging and high performance triple glazing. Roof mounted PV is installed to match the total energy use.

Specification

The table below shows the specifications used for each of the four scenarios that have been modelled for the semi-detached house.

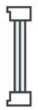
Scenarios 1a and 1b are compliant with the draft DPD policy while scenarios 2 and 3 have been designed to achieve net zero carbon on site.

	Scenario 1a (current DPD compliant)	**Scenario 1b** (current DPD compliant)	**Scenario 2** (Net zero compliant)	**Scenario 3** (Net zero compliant)
Description	Gas boiler -19% Fabric -20% solar PV	Heat pump -33% (due to heat Pump) -20% solar PV	Cost optimised fabric with heat pump and solar PV	Passivhaus with heat pump and solar PV
Net zero compliant?	✘	✘	✓	✓
Floor ((W/m²K, unadjusted)	0.135	0.135	0.135	0.100
Walls (W/m²K)	0.160	0.220	0.220	0.130
Roof (W/m²K)	0.094	0.130	0.130	0.094
Windows (W/m²K)	1.3 (double-glazed)	1.3 (double-glazed)	1.3 (double-glazed)	0.9 (triple-glazed)
Doors (W/m²K)	1.0-1.3	1.0-1.3	1.0-1.3	0.9-1.0
Thermal bridging (kWh/m²/yr)	3	3	3	2
Air Permeability (m³/m²/hr)	1	5	1	0.65
Ventilation	MVHR, 88% heat recovery	Continuous extract vent	MVHR, 88% heat recovery	MVHR, 88% heat recovery
Heating System	24kW Combi Gas Boiler supplying radiators at 60˚C and providing instantaneous DHW	5kW Monobloc Air Source Heat Pump supplying radiators at 45˚C. 150 litre DHW tank	5kW Monobloc Air Source Heat Pump supplying radiators at 45˚C. 150 litre DHW tank	5kW Monobloc Air Source Heat Pump supplying radiators at 45˚C. 150 litre DHW tank
Renewable Energy	2 x 270W Solar Panels	4 x 280W Solar Panels	10 x 320W Solar Panels	8 x 340W Solar Panels

Space Heating Demand

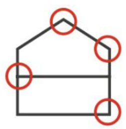
The first recommendation of our net zero policy package is a fabric efficiency target. The adjacent graphs show the results of calculations using PHPP 9.6a for the semi-detached house in Scenario 1b and Scenario 3. These represent respectively the worst and best cases in terms of building fabric efficiency of the four scenarios. The PHPP calculations provide a detailed breakdown of predicted heat losses and heat gains. Differences between the two scenarios are summarised below:

Building form – While the form is the same in both scenarios, for more complex buildings developers could simplify the building's form as a cost-effective way to minimise the area of the building exposed to cold air and reduce the number of complex junctions.



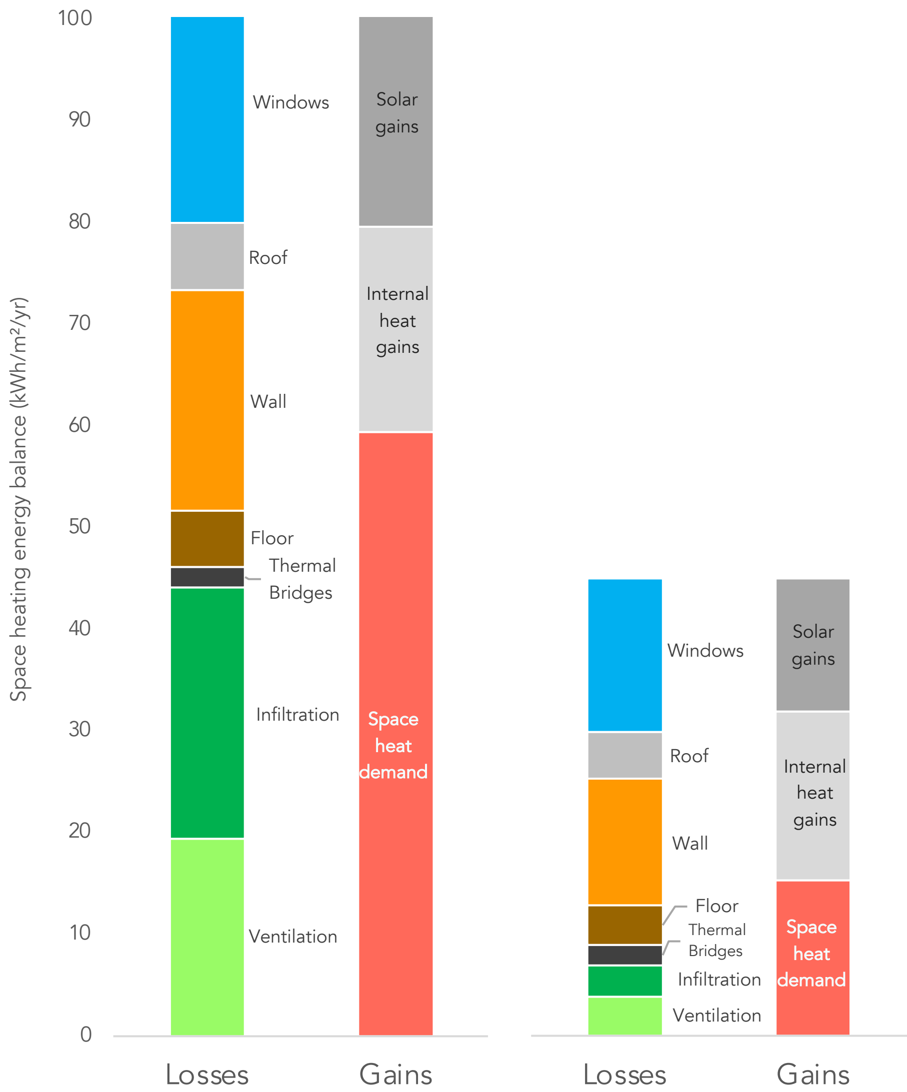
High performance windows – Triple glazing and insulated window/door frames are used in Scenario 3. Developers could also choose to optimize window proportions to further utilise solar gains in winter, while reducing the chances of summertime overheating.

Insulation – Excellent levels of insulation are combined with thermal bridge free design to minimize heat loss through floors, walls, roofs, and junctions between parts of the building in Scenario 3.



Airtightness – Scenario 3 achieves a very airtight thermal envelope, which limits heat loss due to infiltration of cold outdoor air. With good design, it can offer a very cost-effective way of reducing energy consumption.

Heat Recovery Ventilation – Ventilation is essential to a healthy indoor environment. Mechanical Ventilation with Heat Recovery provides fresh air while recovering up to 90% of heat from the outgoing air in Scenario 3.



Scenario 1b – The poorest fabric that is possible under the proposed DPD policy.

Scenario 3 – The highest fabric performance can deliver a lifetime of savings and warm, healthy homes.

Total energy use

The second recommendation of our net zero policy package is a target for total energy use, measured as an Energy Use Intensity (EUI). This is shown in the adjacent graph for the semi-detached house in Scenario 1a and Scenario 3, as calculated by PHPP.

Graphs for all four scenarios are shown in Appendix A.

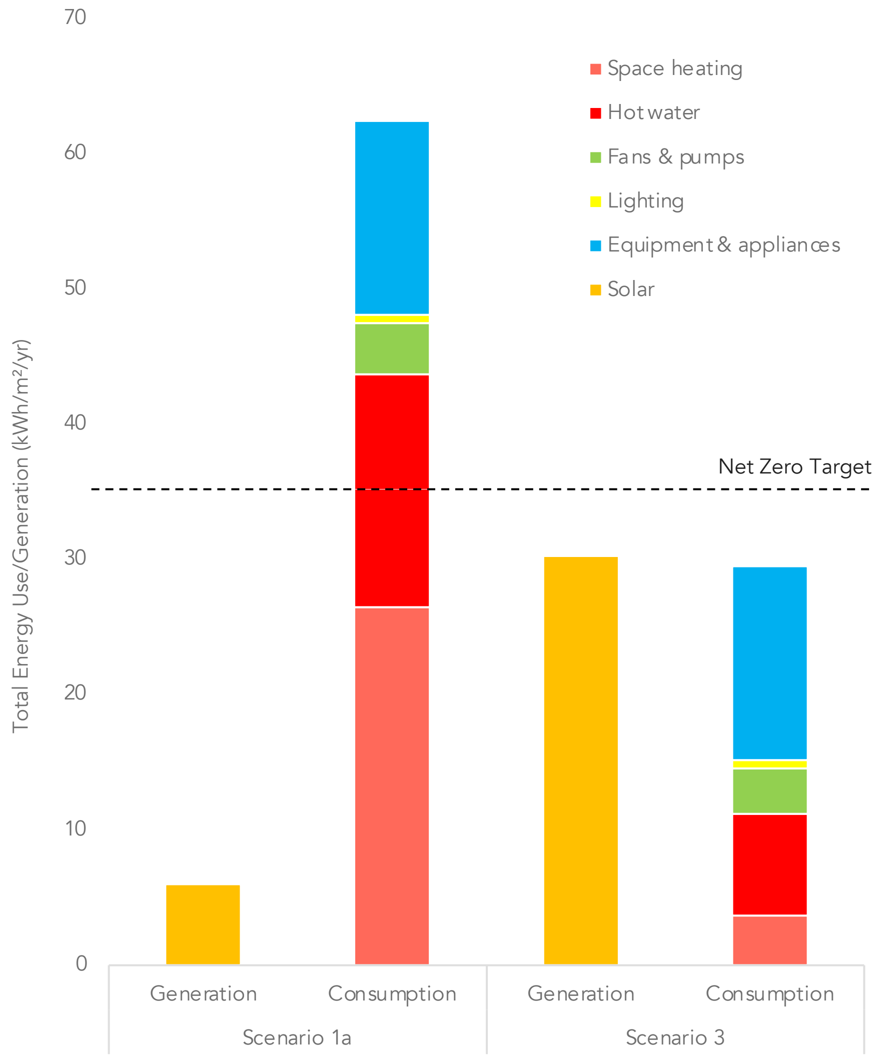
The total energy use of the net zero compliant house in Scenario 3 is **less than half** that of the house in Scenario 1. The reduction in total energy use is achieved through significantly improved fabric efficiency and use of an air source heat pump.

Importantly, the total energy use is **less than the 35kWh/m²/yr** recommended for net zero new homes by the London Energy Transformation Initiative (LETI), the UK Green Building Council (UKGBC) and the Royal Institute of British Architects (RIBA).

Solar energy generation

The third recommendation of our net zero policy package is a target to generate sufficient renewable energy on site to match consumption. Due to the efficiency of the fabric and heat pump, just eight solar panels are required to achieve a net zero energy balance on site in Scenario 3 .

The solar generation is based on the South Westerly orientation of the property that was modelled. A South facing home would require perhaps one less panel and an East or West facing home would likely require one or two more panels to achieve a net zero energy balance, due to the reduced solar irradiation associated with this orientation. There is more than enough roof space to achieve net zero for this property in any orientation.



Total energy use, expressed as an Energy Use Intensity (EUI) and solar energy generation for a semi-detached house that is just compliant with the draft policy (Scenario 1a) compared to one that achieves net zero on site through excellent fabric, a heat pump and solar PV (Scenario 3)

Energy modelling | PHPP Predicted carbon emissions of Scenario 1a and Scenario 1b

Approach

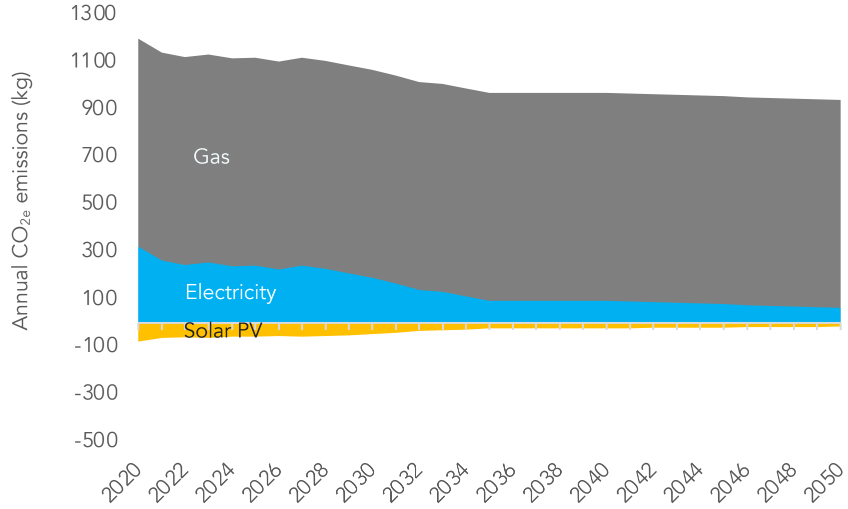
The PHPP energy modelling results provide a reasonable baseline projection of total energy use for the semi-detached house in each policy scenario. This can be further broken down into electricity and gas consumption so carbon emissions can be calculated and estimated from 2020 all the way to 2050. Carbon factors have been applied to gas and electricity consumption, and solar PV generation.

The carbon factor for gas is taken from SAP 2012 as it is not expected to change significantly. Annual carbon factors for electricity from 2020-2050 are taken from HM Treasury Green Book domestic consumption-based grid average figures. These figures are also used to calculate savings from solar PV generation.

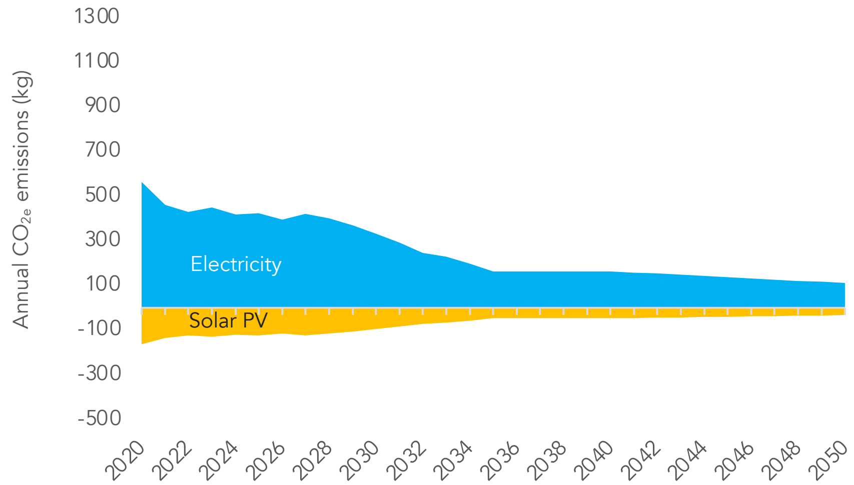
Current DPD Policy

In Scenario 1a, the proposed policy from the draft DPD is achieved through improvements in fabric efficiency and use of two solar PV panels. Over the study period 89% of emissions are due to the gas boiler, with net emissions of approximately 29.5 tonnes CO_2. This scenario is **not net zero carbon compliant** due to use of a gas boiler. As the Climate Change Committee have indicated, the UK's carbon sequestration capacity is saturated by demand from hard-to-treat sectors, therefore it is not possible to use any form of carbon offsetting to achieve net zero for a new home.

In **Scenario 1b** a heat pump is used instead of improved fabric efficiency. This achieves a 33% improvement over Part L, overshooting the required 19% improvement. Four solar panels are required to achieve the additional 20% reduction from renewable generation. Lifetime emissions of Scenario 1b, are approximately 5.7 tonnes CO_2. This scenario is **not net zero carbon compliant either** but is significantly better than Scenario 1a, with lifetime emissions 81% lower and no fossil fuels used on site.



Scenario 1a – Use of a gas boiler means this policy cannot deliver net zero emissions.



Scenario 1b – Use of a heat pump substantially reduces lifetime emissions, however there is not enough solar PV to achieve net zero emissions.

Energy modelling I PHPP Predicted carbon emissions of Scenario 2 and Scenario 3

Net Zero Carbon Policy

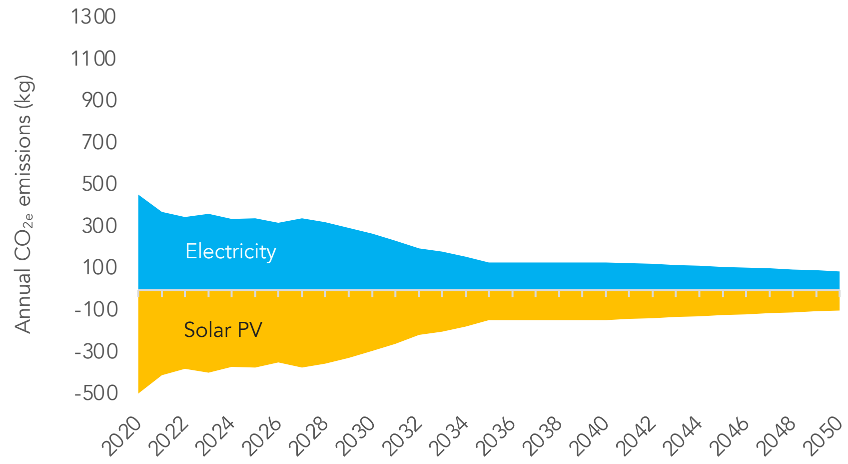
Scenario 2 is intended to represent a **cost optimised strategy** to achieve net zero carbon on site. Improvements to fabric efficiency are mainly achieved through improved airtightness and use of heat recovery ventilation.

Combined with an air source heat pump and 10 solar PV panels this scenario **achieves net zero carbon emissions on site**.

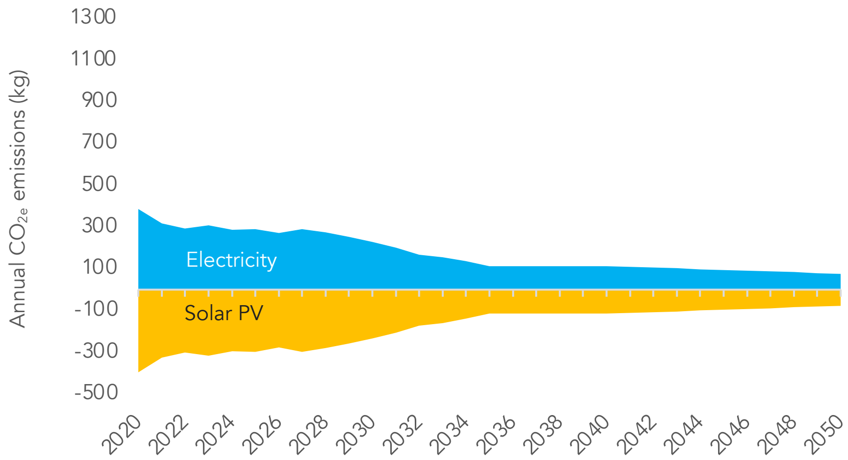
Scenario 3 represents a **best practice approach** to achieving net zero carbon on site which is fully compliant with published guidance and net zero carbon definitions (e.g. RIBA, LETI-UKGBC definition, etc.). In addition to the building fabric improvements in Scenario 2, triple glazing and additional floor, wall and roof insulation result in a highly efficient thermal envelope.

This reduces electricity consumption of the heat pump and means that only 8 solar PV panels are required to **achieve net zero carbon emissions on site**.

Additional benefits of this scenario would include reduced fuel costs and improved thermal comfort.



Scenario 2 – Improvements to building fabric efficiency combined with use of a heat pump and solar PV deliver net zerocarbon on site



Scenario 3 – Further improvements to building fabric efficiency combined with use of a heat pump and solar PV deliver net zero carbon on site

SAP 2012 calculations

In addition to PHPP modelling, we have also carried out Part L energy modelling based on SAP 2012 requirements. This enables comparison between the previous realistic carbon projections from PHPP with calculated improvement above Part L. The same specifications were used in both PHPP and SAP 2012 calculations.

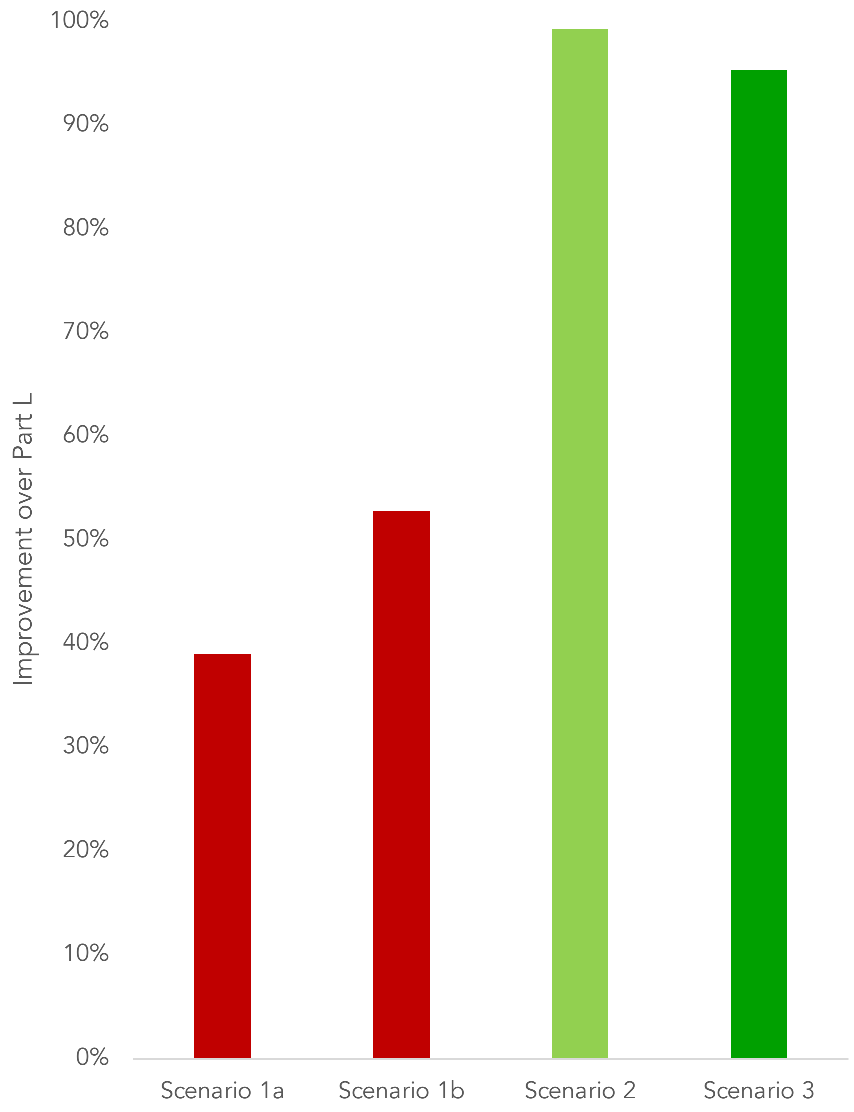
In Scenario 1a, the house has been modelled to comply with the proposed DPD policy by achieving a 19% improvement over Part L through energy efficiency and a further 20% through on site renewable energy generation (solar photovoltaic panels). This results in a 39% improvement overall.

In Scenario 1b, it was assumed that the gas boiler is replaced with an air source heat pump operating at a 45°C flow temperature. The heat pump offers a 33% improvement without any changes to the fabric compared to a building built to today's standards. Renewable generation is then added to achieve the required 20% improvement. This results in a 53% improvement overall.

Scenario 2, is a 'cost optimised' net zero scenario, which implements greater airtightness and heat recovery ventilation in combination with an air source heat pump to eliminate use of fossil fuels on site and reduce overall electricity use. Remaining electricity demand is then met on site through solar PV generation, delivering a 99% improvement.

Scenario 3, the fully compliant net zero scenario achieves the Passivhaus standard and has a space heat demand about four times less than a current new build. It also uses a heat pump, with the improved fabric meaning less renewable generation is required to achieve net zero. This scenario achieves a 95% improvement[1].

[1] *This illustrates some of the limitations of the current Part L methodology and in particular of the approach using the notional building. Scenario 2 will be less efficient than Scenario 3 but performs slightly better than Scenario 3 (albeit marginally). It is also surprising that only a 95% improvement is achieved despite the fact that Scenario 3 is fully Net Zero Carbon compliant.*



SAP 2012 results: the bar chart shows the respective improvements over Part L1A 2013 of the different scenarios: they range from a 39% to a 99% improvement.

SAP 10 calculations

SAP 2012 uses an outdated carbon factor for grid electricity of 519gCO_2/kWh. As a result, its carbon calculations can be misleading.

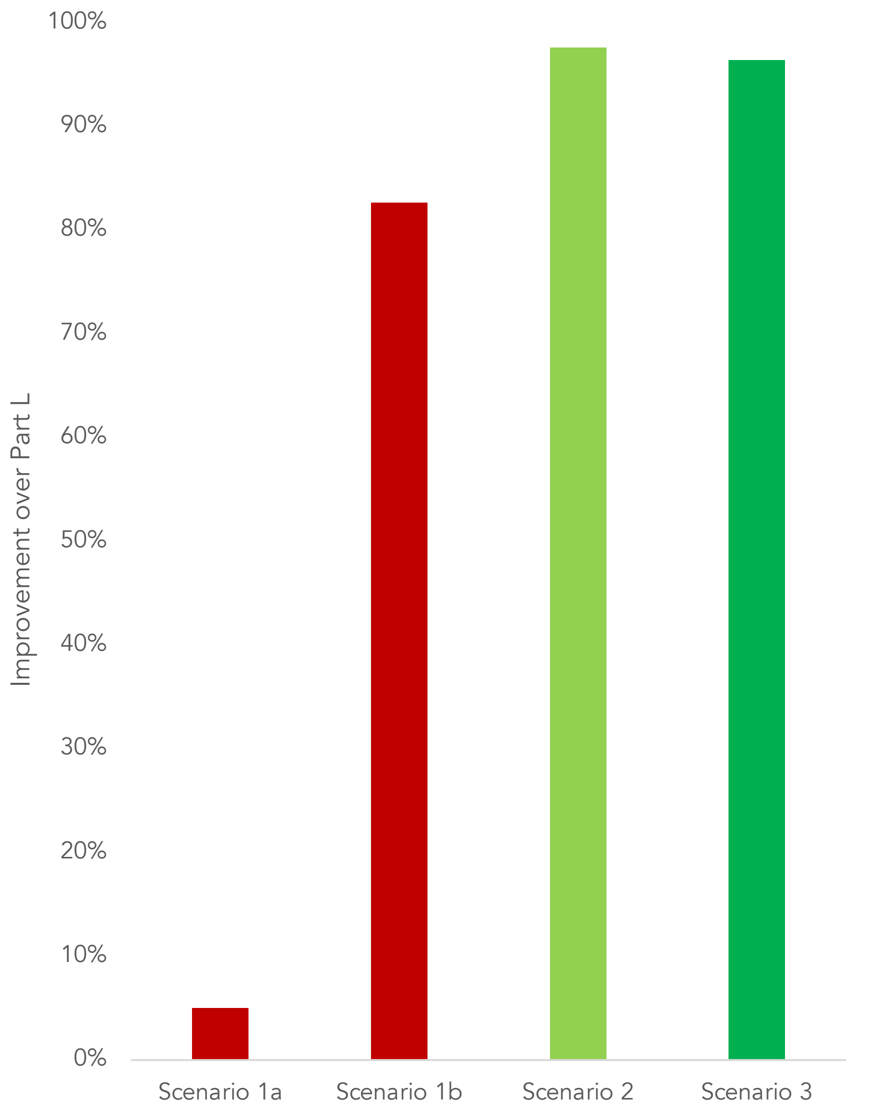
This issue will be addressed in future versions of SAP, and this will affect the carbon calculations of the four scenarios we have assessed. To quantify this, we have also modelled the four scenarios in Stroma FSAP 10 Beta*. This uses a carbon factor of 233gCO_2/kWh, which although better than the figure of 519gCO_2/kWh used in SAP 2012, is still outdated compared to last year's grid carbon factor of around 170gCO_2/kWh reported by Drax.

In Scenario 1a, despite the fabric upgrades, the house achieves no improvement over Part L through energy efficiency. A key risk in SAP 10 is that developers could achieve a 50% improvement just by fitting direct electric heating, without any fabric upgrades. Fitting the same amount of solar panels required by the policy using SAP 2012, and assumed in the cost calculations, only delivers a further 5% improvement.

In Scenario 1b, the house is heated with an air source heat pump. This offers a 76% improvement without any changes to the fabric compared to a building built to today's standards. Fitting the same amount of solar panels required under the policy using SAP 2012 delivers a further 7% improvement, resulting in an 83% improvement overall.

Scenario 2 and Scenario 3 implement greater airtightness, heat recovery ventilation, an air source heat pump and enough solar panels to achieve a net zero energy balance on site over the year. In both cases, targeting close to a 100% improvement is an effective strategy to use SAP as a tool for delivering net zero energy buildings. Scenario 2 achieves a 98% improvement and Scenario 3 a 96% improvement, the differences being due to technicalities in the way SAP calculations are peformed.

* We note that FSAP 10 Beta represents Stroma's interpretation of the current draft specification for SAP 10.1, released by the Building Research Establishment (BRE). It is not approved by the BRE or Stroma, and is available for evaluation only.



SAP 10 results: the bar chart shows the respective improvements over Part L of the different scenarios: they range from a 5% to a 98% improvement.

SAP 2012 vs SAP 10.1

As the previous results for SAP 2012 and SAP 10.1 show, the % improvement calculated by SAP depends strongly on how polluting the UK's electricity mix is. With the grid forecast to become steadily cleaner, the % improvement calculated by SAP is likely to change repeatedly.

If policy is set by specifying a particular % improvement, the required combination of fabric efficiency, low carbon heating and solar photovoltaic generation will change every time the carbon emission factor for electricity generation is updated. The use of heat pumps or direct electric heating will also become much more effective than fabric efficiency measures at delivering an improvement, while the effectiveness of solar PV will decline.

Total Energy Targets

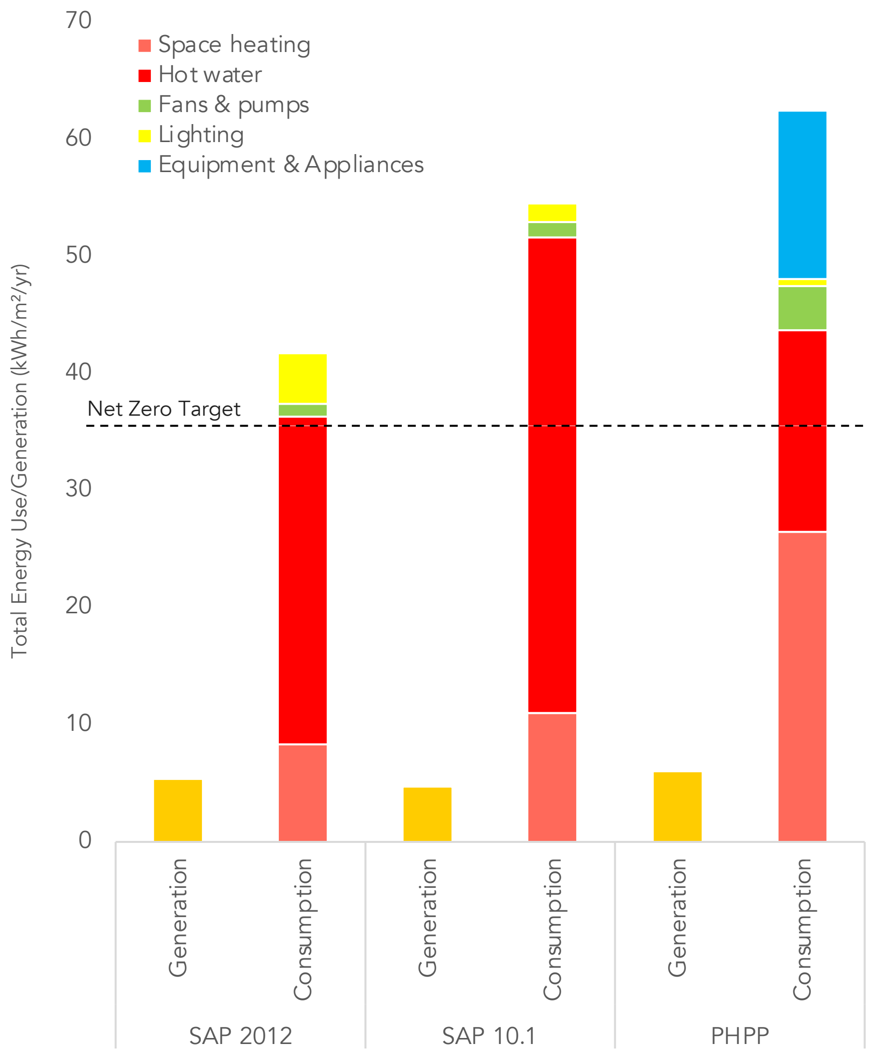
These issues can be avoided by use of a target for total energy consumption and renewable generation to match. Compared to the large differences in % improvement shown previously, the total energy use calculated between the different software packages is quite similar.

The main differences are:

1. An increase in domestic hot water consumption due to a new calculation that has been added to SAP 10.1.
2. Inclusion of an allowance for equipment and appliances to PHPP calculations.

These differences are relatively modest and are easily addressed by using appropriate assumptions in the energy model. Applying a fixed allowance for energy used by equipment and appliances to SAP calculations could enableit to be used to assess compliance with net zero carbon policy*.

*Further modelling would be required to determine an appropriate number. Our calculations for this report indicate that an allowance of around 15kWh/m²/yr is likely to be appropriate.



Total energy consumption and generation compared for Scenario 1a between SAP 2012, SAP 10.1 and PHPP. The differences in energy use are much smaller than carbon emissions, and will not change as the electricity grid decarbonizes.

Cost modelling | Capital cost difference and comment on viability

This page summarises the capital cost analysis undertaken by Currie & Brown. It should be noted that this is a high level analysis.

What is the baseline cost for this typology?

The assumed baseline cost is £171,924 and is based on Scenario 1a, which uses a gas boiler and achieves the draft DPD policy requirements through airtightness, heat recovery ventilation and modest improvements to wall and roof insulation.

What would be the impact of the net zero policy on capital costs?

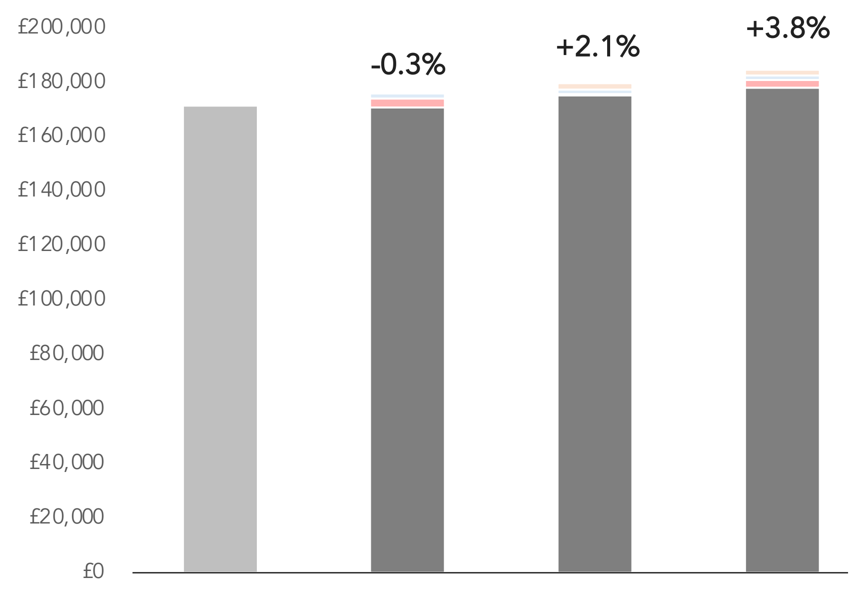
Requirement 1 - Space heating demand limit. This requirement affects the building fabric and ventilation costs. The additional costs of the changes considered in this evidence base are -£5/m^2 GIA for Scenario 2 and £31/m^2 GIA for Scenario 3.

Requirement 2 – Total energy use limit <35 kWh/m^2/yr. This requirement affects the choice of heating system. The additional costs of the changes considered in this evidence base are £19/m^2 GIA for Scenario 2 and -£17/m^2 GIA for Scenario 3. Scenarios 1b, 2 and 3 would all comply with the proposed fossil fuel ban. Scenario 1a would not.

Requirement 3 – Renewable energy. PVs are required to achieve a net zero carbon balance in Scenarios 2 and 3. The additional costs considered are £26/m^2 GIA for Scenario 2 and £22/m^2 GIA for Scenario 3.

Commentary and impact on viability

The additional costs of achieving a net zero compliant dwelling are modest, ranging from 2.1% to 3.8%. This is equivalent to around two to four months of house price inflation, based on the long-term average from 1970 to 2019.



	Scenario 1a (gas boiler)	Scenario 1b (heat pump)	Scenario 2	Scenario 3
Space heating demand limit	Baseline costs	- £3,218 /unit	- £499 /unit	+ £2,908 /unit
Total energy use limit	Baseline costs	+ £1,809 /unit	+ £1,763 /unit	+ £1,609 /unit
Renewable energy	Baseline costs	+ £840 /unit	+ £2,400 /unit	+ £2,040 /unit
Total	Baseline costs	**- £569 /unit**	**+ £3,664 /unit**	**+ £6,557 /unit**

Etude Currie & Brown

The impact on the potential policy options on the future carbon emissions of new homes is Cornwall is the focus of this document. However, running costs (i.e. energy and heating system maintenance costs) are also a key consideration: it is important that the impact on residents' energy bills is looked at, particularly from a social justice point of view.

Net zero carbon would also benefit running costs

Net zero carbon buildings offer a significant opportunity to reduce energy running costs. This is achieved by significantly reducing energy use, avoiding the need for standing charges associated with a gas supply, and through the savings and revenues from the on-site PV system. It will either produce 'free electricity' which the resident can use or store in a hot water cylinder or be exported to the grid, generating revenues.

In addition, the integration of new homes into tomorrow's smart energy system should not only enable the house to use energy at times when clean renewable energy is available but also the resident to make the most of Time of Use (ToU) tariffs. These benefits can be significant – up to 60% saving on energy costs - especially for residents with low incomes.

A 40% reduction in running costs

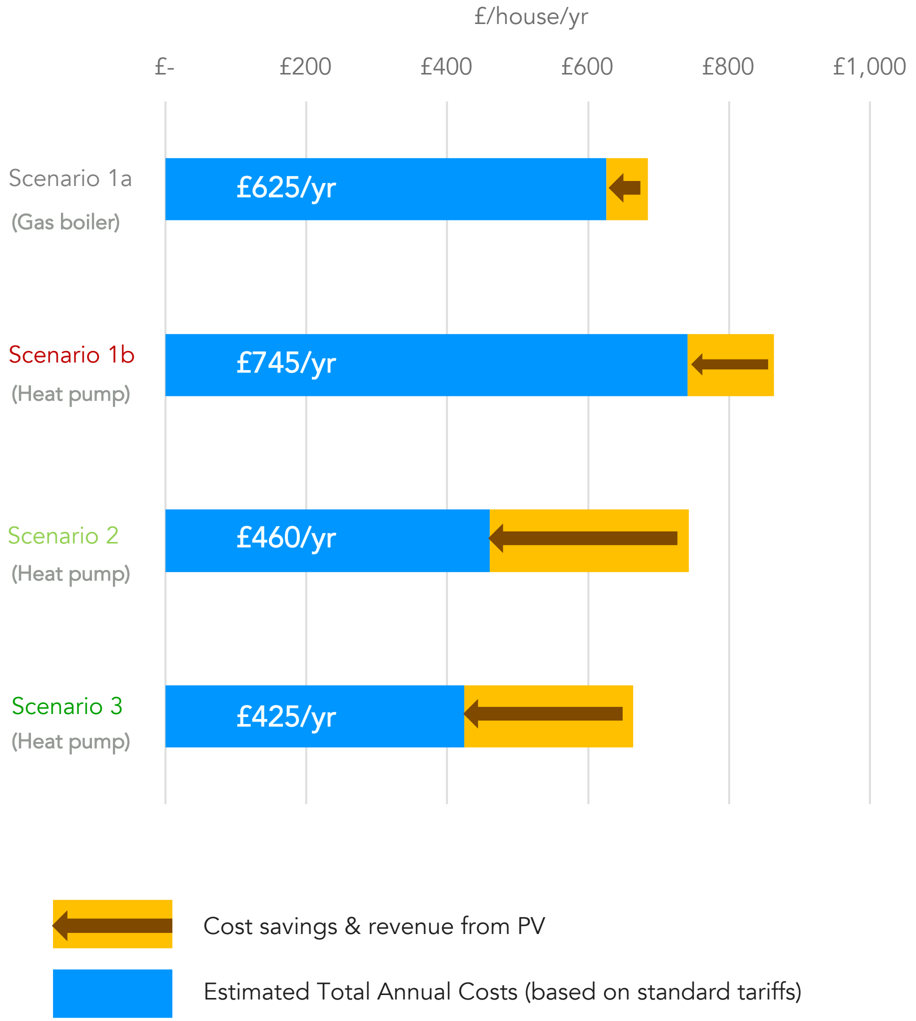
Scenario 1a is disregarded as it uses fossil fuels.

Both of the net zero carbon scenarios (2 and 3) lead to a saving in energy costs of approximately 40% relative to scenario 1b, with scenario 3 offering the lowest running cost.

These costs are based on UK average standard tariff rates, including standing charges and an allowance for routine maintenance.

The electricity export price is taken as 5.4p/kWh which is based on 2019 average system sell price from solar-trade association guidance. The analysis assumes that for scenarios 1a and 1b, 50% of the PV energy generated is used in the house and 50% is exported; for scenarios 2 and 3, that 30% is used and 70% exported.

The costs do not include end of life replacement of systems.



Total running costs based on PHPP modelled energy consumption and PV generation for a semi-detached house. This includes standing charges, energy charges and annual maintenance costs of £150 for a heat pump and £120 for a gas boiler.

3.0

Policy considerations

This section addresses policy considerations including:

- How to reduce the performance gap and ensure that the delivered performance of new buildings matches the ambition of the design and planning application
- The opportunities for Cornwall in terms of renewable energy
- Impact on electrical infrastructure
- How to address other typologies
- How this relate to BREEAM requirements

How to deliver performance (and reduce the performance gap)

Actual performance is what matters. The performance gap matters.

Unfortunately the actual energy performance of buildings often fails to meet the design estimate. This difference is commonly referred to as 'the performance gap'. Ensuring that delivered performance matches the ambition of the design requires three main elements: **more accurate models** that do not over-promise, **good construction quality** that does not under-deliver and **reliable feedback** once the buildings are occupied.

Accurate energy modelling

Energy modelling to predict the energy performance of buildings is most often carried out in order to demonstrate compliance with Building Regulations but these calculations do not include all energy uses in buildings. There are calculation and modelling platforms that are more comprehensive (e.g. PHPP)) but they are not currently commonly used. If developers chose to use a more simple compliance software package such as the Standard Assessment Procedure (SAP), then an uplift of a standard amount should be applied, particularly when calculating renewable energy requirements for net zero carbon, to account for the uses not modelled.

Construction quality management

Ensuring that buildings are constructed in accordance with the design requires regular site quality assurance checks. Therefore, in addition to Building Control, another process of construction quality management is needed. There are a number of schemes available (e.g. Passivhaus) which could provide the necessary oversight framework. Alternatively, Cornwall Council could chose to create a bespoke scheme of their own.

Post occupancy monitoring

Developers should be encouraged to carry out POE studies in order ultimately to prove that the performance gap has been closed in practice.

There are a number of different schemes to assure construction quality that could be used, or Cornwall Council could create its own scheme

Should we go beyond net zero operational carbon for new buildings in Cornwall?

Hard-to-treat sectors

The Committee on Climate Change have analysed the potential reduction in all greenhouse gas emissions that could realistically be achieved across the UK before 2050. It is clear from their analysis that some sectors and some types of emissions will be very much more challenging to decarbonise than others. Aviation and agriculture are expected to be the largest greenhouse gas emitters in the UK in 2050.

Carbon Capture and Storage (CCS)

The Committee on Climate Change's strategy for UK net zero carbon includes a sizeable element of 'engineered removals' – i.e. carbon capture and storage. However, this technology does not currently exist at the scale needed. Afforestation, wetland restoration and some other land use techniques will deliver some carbon capture, but the capacity is very small relative to the residual emissions challenge.

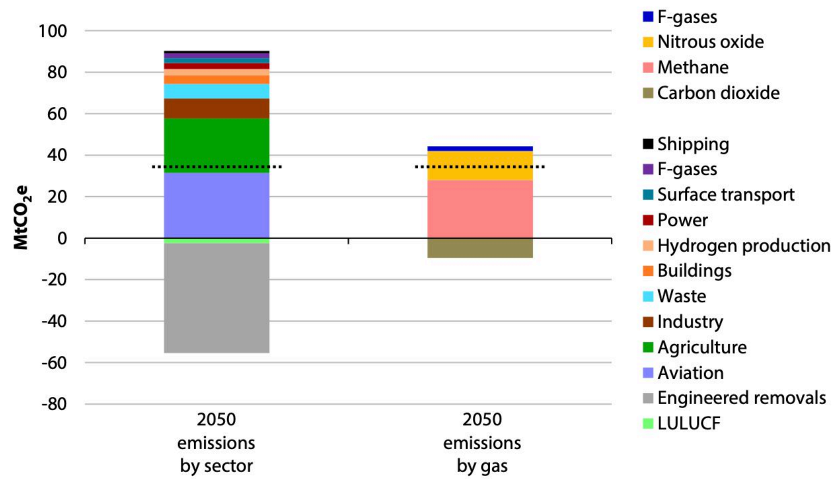
Beyond net zero carbon: energy positive buildings

Buildings and Transport currently contribute 67% of Cornwall's carbon emissions. For these sectors, the technology exists today to phase out all of those emissions. It is also feasible now to design buildings that generate more energy than they use, especially low density buildings such as housing.

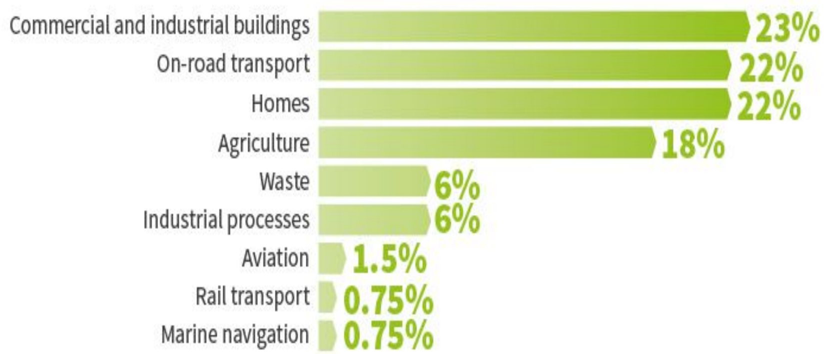
For Cornwall, where agriculture is such a large and vital part of the local economy, a policy of **energy positive buildings** may help to achieve the ambition of Carbon Neutral Cornwall by 2030.

Can Cornwall become a net exporter of renewable energy?

Cornwall has a particularly high solar and wind resource compared to the rest of the UK, and a geothermal electricity generation plant has successfully been developed. There is an opportunity for Cornwall to go well beyond net zero become a net exporter of renewable energy.



This graph by the Climate Change Committee shows that aviation and agriculture are likely to be the dominant GHG emitters in 2050.



Breakdown of emissions in Cornwall

(from Cornwall County Council 'Carbon Neutral Cornwall' website)

Implications for infrastructure

The electricity grid across the UK will need to adapt and be reinforced to be able to support a different energy demand and supply pattern than has historically been the case.

The key implications of net zero carbon for infrastructure include:

- Increasing demand for electricity for heating and other uses.
- A significant increase in the amount of renewable energy generated.
- A growth in small, distributed photovoltaic systems in urban areas.
- The growth of electrified transport

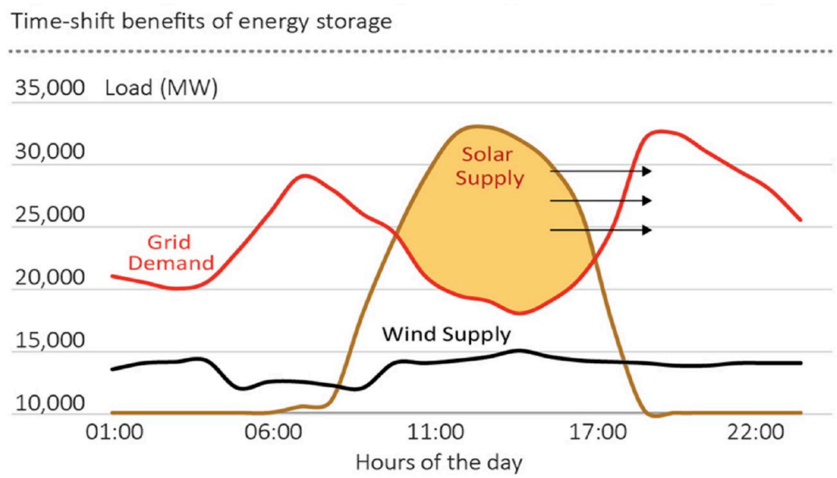
Forward planning

The District Network Operators (DNOs) are required by the regulator, Ofgem, to submit business plans for 5-year periods. The 2023-2028 business plans must be submitted in 2021.

Ofgem demands that business and investment plans are based on the established needs in each area and will punish' investments made without evidence of that need. The Climate Emergency DPD will form part of the primary evidence base which the DNOs can use to formulate their plans for future investment in the area, so policies for net zero carbon need to be clearly set out within it, and we recommend that Cornwall Council ensures the DNO is made aware of these in sufficient time to adapt their business plan.

Energy storage

The intermittent and seasonal nature of most renewable energy sources (e.g. due to weather dependency) needs to be managed to maximise the use of the renewable power. The Climate Emergency DPD should encourage the incorporation of demand management and storage systems (at the building and the network level) which will enable the system to be more flexible.



Notional graph of renewable energy supply vs energy demand showing how energy storage can help to match the supply to the demand.

The electrical infrastructure will have to be reinforced to support increased demand and a more distributed supply with more renewable energy

Comment on other typologies

There are a number of other common building types in Cornwall. These building types can vary widely, making it difficult to reliably determine generic forms, energy use or occupancy models. We have suggested *provisional* energy performance targets for these building types based on published guidance (e.g. RIBA, LETI. UKGBC) summarised below. In each case we have used the same structure of targets as for housing – space heating demand, total energy consumption and renewable generation. These are indicative.

Schools

1. Space heating demand of 15-20 $kWh/m^2_{GIA}/year$
2. Total energy consumption of 65 $kWh/m^2_{GIA}/year$ or less
3. Solar electricity generation that exceeds metered energy use on site

Tourism businesses – retail, hotels, leisure

1. Space heating and cooling demand of less than 30 $kWh/m^2_{GIA}/year$
2. Total energy consumption of 55 $kWh/m^2_{GIA}/year$ or less
3. Solar electricity generation of at least 120 $kWh/m^2_{GIA}/year$

Offices

1. Space heating and cooling demand of less than 15 $kWh/m^2_{GIA}/year$
2. Total energy consumption of 55 $kWh/m^2_{GIA}/year$ or less
3. Solar electricity generation of at least 120 $kWh/m^2_{GIA}/year$

Light Industrial

1. Space heating and cooling demand of 15-30 $kWh/m^2_{GIA}/year$
2. Total energy consumption of around 55 $kWh/m^2_{GIA}/year$ excluding specialist processes.
3. Solar electricity generation of at least 180 $kWh/m^2_{GIA}/year$

Existing buildings

Existing buildings present a much greater challenge than new and the rules cannot be as prescriptive. Space heating should aim to achieve <15-40 $kWh/m^2_{GIA}/year$ and solar PV can be installed on any building with a strong enough roof.

The first Passivhaus supermarket in the world was created in 2008 in Tramore, Ireland. It has solar photovoltaic panels and a ground source heat pump that provides water heating from waste heat taken from the cooling cabinets. © Joseph Doyle Architects

A Victorian terraced house retrofitted to achieve Passivhaus certification with a space heating demand of just 15kWh/m^2, Located in Kensal Green, London

Comment on BREEAM

BREEAM for net zero carbon

For non-residential buildings, a requirement to meet BREEAM Excellent or Outstanding has been considered as a simple and familiar requirement to encourage better energy and carbon performance. However, BREEAM is designed to deliver sustainable buildings but it **is not a net zero carbon delivery platform**.

BREEAM does incorporate calculations of energy demand, energy consumption and carbon emissions but these are opaque measures that are not easily calibrated against other calculation methods.

There are additional credits for Post Occupancy measurements which could potentially address Performance gap issues, but these are optional and not mandatory credits, so setting an overall BREEAM target does not give any certainty that this process would be undertaken.

BREEAM Excellent business park in Hayle © BRE

Alternative schemes

NABERS UK has recently been launched. This is a Design for Performance process to target a **specific energy** rating at the design stage of a new office development or refurbishment and verify performance when the building is occupied. It is expected to be administered by the BRE, alongside BREEAM and may be suitable for larger commercial schemes.

The BRE are currently considering updates to the BREEAM scheme that could, in the future, provide a better structure for delivering net zero carbon, but these are not yet available.

Recommendation

It is therefore recommended to use specific energy and carbon targets for non-residential buildings. BREEAM Excellent or Outstanding can be required in addition but not in lieu of these requirements.

4.0

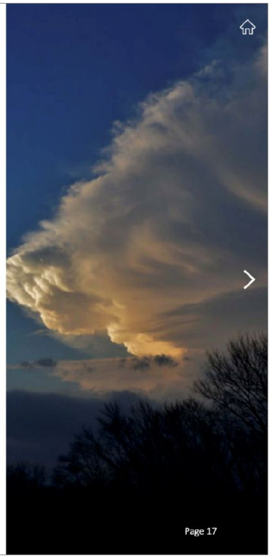
Appendices

11 What the Climate Emergency DPD covers

11.1.1 The Pre-submission DPD continues the thematic-based approach taken by the Scoping Report and that draft policies cover options for allocation and policies relating to the following topics:

- Renewable energy;
- Energy efficiency;
- Coastal Change and flooding
- Natural climate solutions;
- Sustainable transport, town centre development and design;
- Agriculture and rural development.

11.1.2 A number of issues are cross-cutting and will impact on all areas. In particular biodiversity is critically significant to our long-term survival and has been identified as being in a state of decline. The draft policy suggestions of the DPD recognise the critical importance of biodiversity in relation to climate change and further embeds the Council's Environmental Growth Strategy and the emerging approaches to nature recovery.



Could decarbonised heat be added? It is one of the most crucial priorities to reduce carbon emissions in Cornwall

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Policy RE1 - Renewable Energy principles

Proposals for renewable and low carbon energy-generating and distribution networks, considered in the context of sustainable development and climate change, will be supported where:

1) they contribute to national targets, taking account of the wider environmental, social and economic benefits of renewable energy gain and its contribution toward energy supply; and
2) It will not result in adverse impacts on the local environment that cannot be satisfactorily mitigated, including cumulative landscape and visual impacts, and the special qualities of all nationally important landscapes, heritage assets including their setting which must be conserved or enhanced; and
3) The use allows for the continuation of some form of agricultural or biodiversity use, proportionate to the scale of the proposal; and
4) It provides for a community benefit in terms of profit sharing or proportion of community ownership; and
5) For community-led proposals there is evidence of community consensus in support of the proposal; and
6) There are appropriate plans and a mechanism in place for the removal of the technology on cessation of generation, and restoration of the site to an acceptable alternative use;

All major development proposals should seek to integrate low carbon energy and decentralised energy networks into the proposal. Proposals for development of more than 100 dwellings or non-residential development of over 1,000sq.m will be expected to consider the integration of community energy networks in the development, taking into account the site's characteristics and the existing cooling, heat and power demands on adjacent sites.

Proposals for mechanical and battery storage will be supported. Particular support will be given to renewable energy proposals which provide power direct to an end user (rather than export to the grid).

There is little evidence to suggest that decentralised energy networks should form an important part of the solution to decarbonise heat in Cornwall. We would recommend omitting this paragraph.

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Proposed Policies

12.4 Policy C1 - Climate Change Principles for Cornwall

Policy C1 – Climate Change Principles

Development in Cornwall must represent sustainable development and manage our natural and cultural assets wisely for future generations. Proposals must contribute to and achieve the following objectives:

1) Be low carbon and make the fullest contribution to minimising greenhouse gas emissions in accordance with the following energy hierarchy:
   a) Be lean: use less energy
   b) Be clean: supply energy efficiently
   c) Be green: use renewable energy
2) Mitigate against and improve resilience to the effe[…]
3) Contribute positively to the health, wellbeing and […]
4) Contribute positively to environmental growth, pro[…] gain for biodiversity;
5) Ensure resource efficiency, minimisation of waste, […]
6) Maximise the ability to make trips by sustainable a[…] walking and cycling rather than car use for day to day living;
7) Use and reuse land efficiently through the delivery of appropriate higher densities of development on the most accessible sites (including town centres and public transport hubs such as stations);
8) Conserve the capacity for sustainable production of food, water, raw materials and energy and minimise the impact upon the quality, stability, and function of soil;
9) Conserve and enhance our natural and historic environment and cultural heritage and increase built and natural environment distinctiveness through locally distinctive, high quality and sustainable design and multi-functional green infrastructure provision;
10) Minimise or avoid light, water, air and noise pollution and improve or maintain air quality;
11) Protect and enhance carbon storage in our natural environment (including the marine environment); and
12) Improve or maintain the natural functioning of coastal and river processes, avoiding areas at risk of flooding and coastal change and further reducing flood risk elsewhere wherever possible.

The London Plan structure is fine but not ideal. Our analysis suggests a revised set of requirements would be more effective. These are contained within this report.

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Policy RE3 - Wind energy

Proposals for wind energy development will be permitted where they:

1) Are located in a 'suitable area' identified on the Policies Map or are for the repowering of an existing wind turbine/farm; and
2) Demonstrate that, following consultation, the planning impacts identified by the affected local community have been fully addressed by the proposal; and
3) Demonstrate that impacts as a result of size (height) and scale (number of turbines) and any enabling development such as vehicle access, storage technology etc on the character of the area, are or can be made acceptable with specific reference to the following considerations:

Not[…]

Is the Council proactively identifying areas as suitable for wind energy development in the development plan? Otherwise there is no route to market for onshore wind technology.

17.7 Policy RE4 - Solar Energy Installations

17.7.1 Cornwall benefits from the best solar resource in the UK. Solar energy provides a significant proportion of the renewable electricity in Cornwall with 588 mw installed capacity. This is 76% of all the renewable energy capacity in Cornwall.

Policy RE4 - Solar Energy Installations

Proposals for solar arrays that are focused on previously developed land or the repowering of existing solar farms will be supported.

Proposals for solar panel development, including both building mounted and standalone ground mounted installations will be supported where it is demonstrated that:

1) heritage assets will be conserved, in a manner appropriate to their significance, including views important to their setting.
2) impact on visual amenity and neighbouring uses is minimised, including cumulative impact;
3) there will be no adverse impact on aircraft safety;
4) there will be no unacceptable impacts on biodiversity and landscape including cumulative impact
5) the design provides a method to remove the structure and sets out a commitment restore the site.

Could Policy RE4 be more positive towards solar installations?

Appendix A | General comments and suggestions for the Climate Emergency DPD

18 Energy and Sustainable Construction

18.1 Introduction

18.1.1 Carbon Reduction and the Energy Hierarchy

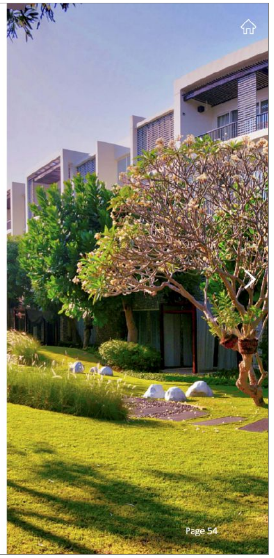
18.1.2 In order to make progress towards our target of being carbon neutral by 2030, it is essential that new development minimises carbon emissions[4]. Through the draft Climate Emergency DPD, we are proposing a requirement that developments follow the energy hierarchy; that is to prioritise energy reduction and energy efficiency first, before looking at renewables and offsetting residual carbon.

18.1.3 In Cornwall, fuel poverty affects 13% of all households which is approaching 33,000 homes (BEIS, 2019[5]). This is above the England average of 11%. Improving fabric standards and energy efficiency and minimizing future space heating requirements is not only the most sustainable approach, but is also a crucial element of addressing fuel poverty improving social equity.

18.1.4 Offsetting

18.1.5 In the short term it will be challenging and expensive to achieve zero carbon buildings across the board. It is likely that carbon offsetting will need to play a role to help us reach our ambitious target. Carbon offset contributions can then be used to fund improvements to the insulation of older houses and buildings, support local low carbon and renewable energy projects or rewilding and afforestation.

The statement on carbon offsetting is not consistent with what is technically possible on-site on most developments. It also does not acknowledge the very limited role that offsetting should play. We would recommend giving it less emphasis.



Proposed Policies

18.4 Policy SC1 - Energy and Sustainable Construction

18.4.1 In order to make progress towards our target of being carbon neutral by 2030, it is essential that new development minimises carbon emissions by adopting the energy hierarchy[6].

18.4.2 Measures are also needed to address emissions from existing buildings. In a residential property this means insulating every available loft and cavity walled building, along with the majority of solid walled buildings. Much of this falls outside the remit of planning, however, there are opportunities where applications are made for change of use, conversions, reversions and extensions. The Council supports increases in domestic renewable energy generation.

18.4.3 Often, there can be conflicts between energy efficiency/renewable technology and preserving our historic environment/heritage. Therefore, where improvements relate to historic buildings, we want to encourage applicants to refer to Cornwall Council's 'Improving Energy Efficiency in Historic Cornish Buildings' guidance (or any subsequent revision) which has been devised to demonstrate sensitive ways to make historic buildings more energy efficient.

18.4.4 There is more to this policy than the energy performance of buildings and we want to ensure that developments follow the principles of sustainable construction. It is essential to think of the lifecycle of a development and how adaptable it can be to environmental and socio-economic changes. The policy also provides a link to the priorities and design outcomes in the Cornwall Design Guide.

18.4.5 In summary, the intention of this policy is to:

- improve the energy efficiency of development;
- increase the installation of renewable energy on residential and non-residential development;
- reduce carbon emissions from residential and non-residential buildings;
- introduce a structured approach to offsetting residual emissions;
- increase the resilience and sustainability of development in Cornwall.

We would strongly recommend adding 'decarbonise heat' and articulate the most likely solutions for Cornwall, particularly the important role for heat pumps.

6 The ... targ ... iency ... through the Climate Emergency DPD and on our ability to meet the ambitious net zero target by 2030.

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Policy SC1 – Energy and Sustainable Construction

1 Energy - New Development

All proposals should embed the Energy Hierarchy within the design of buildings by prioritising fabric first, orientation and landscaping in order to minimise energy demand for heating, lighting and cooling. Proposals should also consider opportunities to provide energy storage where feasible.

Development proposals for 10 or more dwellings and non-residential development with a floor space of 1,000 m2 or more will be required to submit an Energy Statement that demonstrates how the proposal will:

1) Achieve a 19% carbon reduction improvement upon the requirements within Building Regulations Approved Document Part L (or achieve any higher standard than this that is required under new national planning policy or Building Regulations) based on energy efficiency measures;**7** and
2) Provide on-site renewable energy generation, or connection to a renewable or low carbon community energy scheme, that contributes to at least a further 20% reduction in the residual carbon emissions subsequent to 1) above; and
3) Provide onsite natural carbon offsetting/make financial contributions to Cornwall Council's carbon offset fund in line with Policy SC2 to enable all residual carbon emissions subsequent to 1) and 2) above to be offset by other local initiatives.

Developments will be required to connect to existing district energy networks in the locality or, where there is a future network planned, to be designed to be capable of connection to that network. Where appropriate, proportionate contributions will be sought to enable a network to be established or completed.

2 Energy - Existing Buildings

Significant weight will be given to the benefits of development resulting in considerable improvements to the energy efficiency and reduction in carbon emissions in existing buildings. Proposals that help to increase resilience to climate change and secure a sustainable future for historic buildings and designated and non-designated heritage assets will be supported where they conserve and where appropriate, enhance the design, character, appearance and historical significance of the building.

3 Domestic renewables

The Council will support domestic renewables such as solar panels where they require planning permission. Proposals should seek to minimise visual impact and not impact upon the appearance of the property when viewed from the public realm. Where fixed to a listed building proposals must ensure that: technology will not cause harm to the appearance and special historic character of the building; require minimal intervention with the fabric of the building; and shall be easily reversible.

4 Water

All dwellings (including conversions, reversions, change of use and extensions) must achieve an estimated water consumption of no more than 110 litres/person/day through the incorporation of water saving measures and should incorporate water reuse and recycling and rainwater harvesting wherever feasible.

7 This element of the policy will depend on the outcome of the national consultation on Building Regs and the Future Homes Standard, which proposed that local authorities be prevented from setting local standards for energy efficiency. In the event of a restriction on Local Authorities requiring stricter standards than Building Regulations, alternative text for part i would be required.

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Policy SC1.1 Energy is the focus of this document. It will be analysed in detail in this document. It should apply to all developments, including single homes.

Could policy SC1.2 be more explicit on the crucial role of retrofit to achieve Net Zero?

Policy SC1.3: The requirement not to see solar panels from the public realm is a significant barrier to Net Zero buildings, Is it necessary?

5 Materials and Waste

All development proposals should minimise use of materials and creation of waste through:

1) Prioritising the use of previously developed land and buildings where possible, whilst maintaining and enhancing local character and distinctiveness;
2) Reuse and recycling of materials that arise through demolition and refurbishment, including the reuse of excavated soil and hardcore within the site;
3) Prioritise the use of locally sourced, sustainable materials and construction techniques that have smaller ecological and carbon footprints;
4) Using locally distinctive, resilient, low maintenance materials that are appropriate for Cornwall's damp maritime climate (for example locally won materials such as slate and granite) as described in the Cornwall Design Guide;
5) Considering the lifecycle of the development and surrounding area, including how they can be adapted to meet changing community needs and how materials can be recycled at the end of their lifetime; and
6) Providing adequate space to enable and encourage greater levels of recycling across residential and non-residential developments. Space requirements for residential developments should follow those outlined in the Cornwall Design Guide.

Embodied carbon could be referred to in the policy.

Appendix B | Detailed specification of the Part L compliant baselines

Specification

The table below shows the specifications used for the three Part L compliant baseline scenarios that have been modelled for the semi-detached house, compared to the lowest cost net zero compliant option.

The specifications for the Part L 2021 and 2025 buildings were taken from the government response to the Future Homes Standard Consultation. Positive input ventilation is used in place of extract ventilation, due to high Radon levels in Cornwall.

	Part L 2013	**Part L 2021**	**Part L 2025 (FHS)**	**Scenario 2** (Net zero compliant)
Description	Typical developer specification to achieve compliance with Part L 2013	Notional building specification for Part L 2021, provided by government	Indicative notional building specification for Part L 2025, provided by government	Cost optimised fabric with heat pump and solar PV
Net zero compliant?	✘	✘	✘	✓
Floor ((W/m^{2}K, unadjusted)	0.1350	0.130	0.110	0.135
Walls (W/m^{2}K)	0.220	0.180	0.150	0.220
Roof (W/m^{2}K)	0.130	0.110	0.110	0.130
Windows (W/m^{2}K)	1.3 (double-glazed)	1.2 (double-glazed)	0.8 (triple-glazed)	1.3 (double-glazed)
Doors (W/m^{2}K)	1.0 – 1.3	1.0 – 1.3	1.0 – 1.3	1.0-1.3
Thermal bridging (kWh/m^2/yr)	3	3	3	3
Air Permeability (m^3/m^2/hr)	5	5	5	1
Ventilation	Positive input mechanical ventilation	Positive input mechanical ventilation	Positive input mechanical ventilation	MVHR, 88% heat recovery
Heating System	Gas Boiler	Gas Boiler with shower drain waste water heat recovery	5kW Monobloc Air Source Heat Pump supplying radiators at 55˚C. 150 litre DHW tank	5kW Monobloc Air Source Heat Pump supplying radiators at 45˚C. 150 litre DHW tank
Renewable Energy	-	9 x 320W solar Panels	-	10 x 320W Solar Panels

This page summarises the additional capital cost analysis undertaken by Currie & Brown. It should be noted that this is a high level analysis.

What is the baseline cost for this typology?

The assumed baseline cost is £167,400 and is based on a typical developer's approach to compliance with Part L 2013. The baseline house uses a gas boiler, and thermal performance of the building envelope is generally poor.

Part L 2021

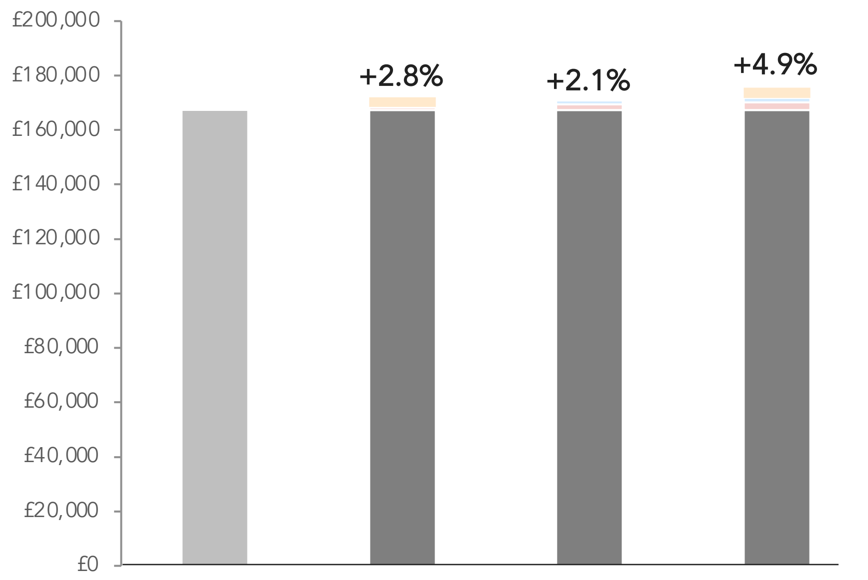
The government has provided a specification for the notional building that will be used in Part L 2021 in its response to the Future Homes Standard consultation. The cost of meeting this specification represents an increase of 2.8% above the cost of a building that currently meets building regulations. The cost increases are mainly due to the use of solar PV and some improvements to the U-values.

Part L 2025 (Future Homes Standard)

The consultation response also provided an indicative specification for the notional building in Part L 2025. The cost of meeting this specification would represent a 2.1% increase relative to a home compliant with current building regulations, mainly due to use of a heat pump , triple glazing and improved floor, wall and roof U-values.

Net Zero - Scenario 2

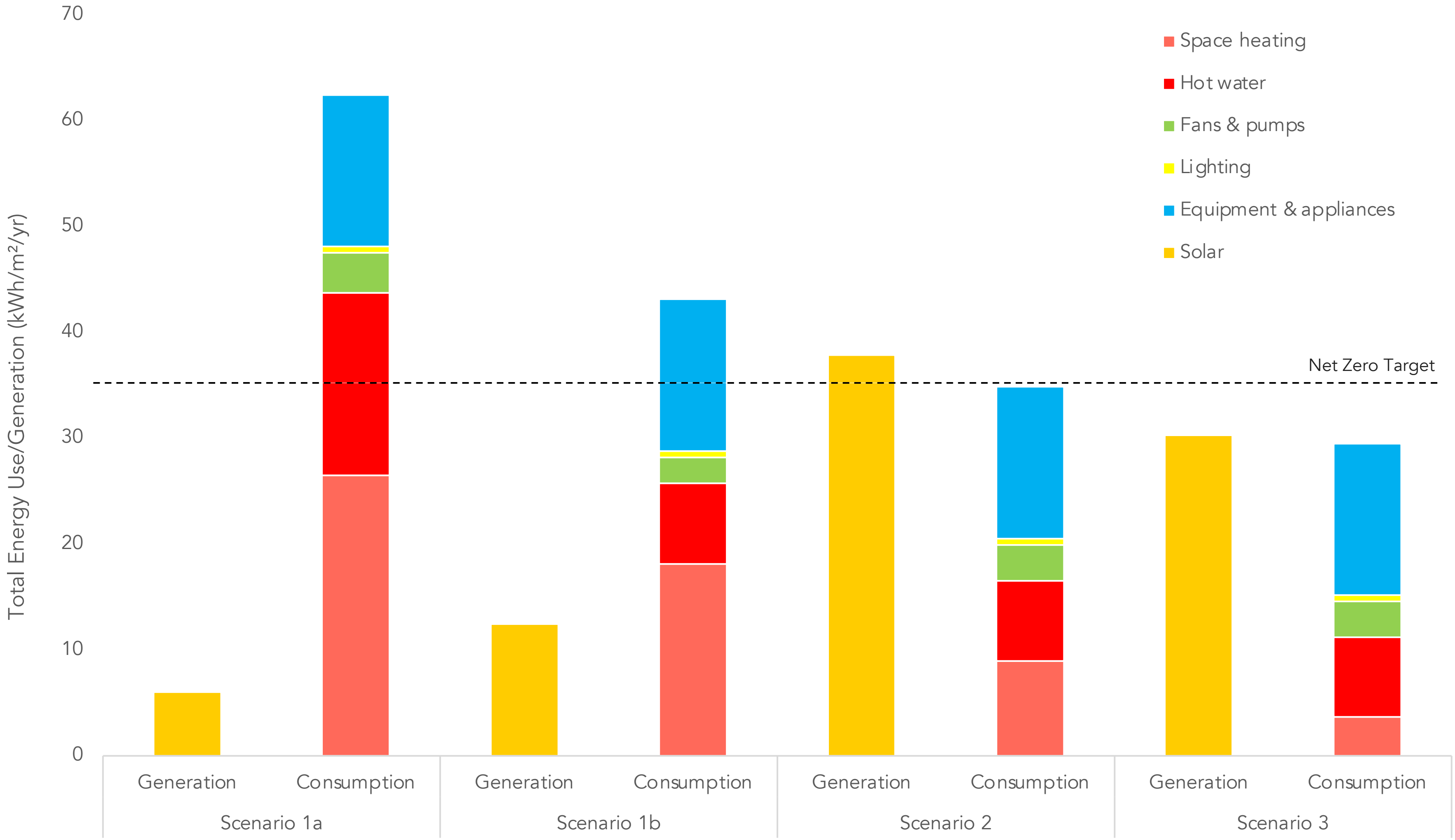
The additional costs of achieving a net zero carbon compliant dwelling are only 2.1-2.8% higher than Part L 2021 or 2025, respectively. This is equivalent to a few months of house price inflation, based on the long-term average from 1970 to 2019.



	Part L 2013	Part L 2021	Part L 2025 (FHS)	Scenario 2
Space heating demand limit	Baseline costs	+£920 /unit	+ £1,977 /unit	+ £2,719 /unit
Total energy use limit	Baseline costs	+£93 /unit	+ £1,562 /unit	+ £1,570 /unit
Renewable energy	Baseline costs	+3,660 /unit	+ £0 /unit	+ £3,900 /unit
Total	Baseline costs	+ £4,674 /unit	+ £3,538 /unit	+ £8,189 /unit

Etude | Currie & Brown

Appendix C I PHPP Calculated total energy use and solar energy generation for all scenarios



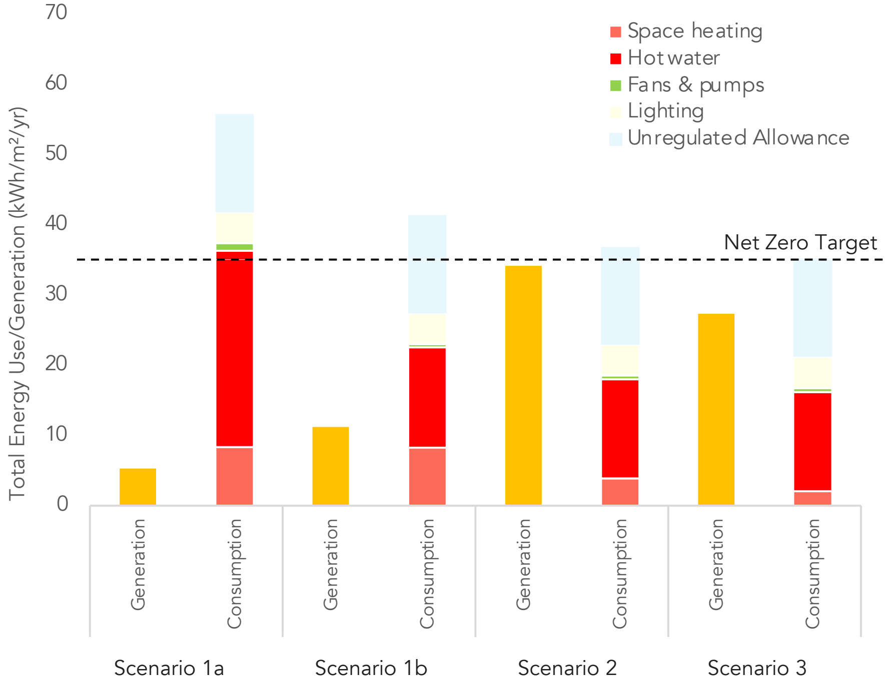
Total energy use for the semi-detached house in the four scenarios. It is straightforward to achieve a net zero energy balance on site, as demonstrated by Scenarios 2 and 3, which use just 10 and 8 solar panels, respectively.

Why SAP Calculations can be Misleading

When considering which tools can be used to deliver net zero buildings, it is useful to understand the differences between SAP and PHPP calculations. As shown by the graphs below, SAP calculations tend to:

1. Underestimate space heating demand
2. Overestimate hot water demand
3. Ignore energy use for equipment and appliances (an 'allowance' has been added to indicate total energy use if this were included)

As a result, SAP calculations may indicate a new home has lower total energy use than will likely be the case in practice.



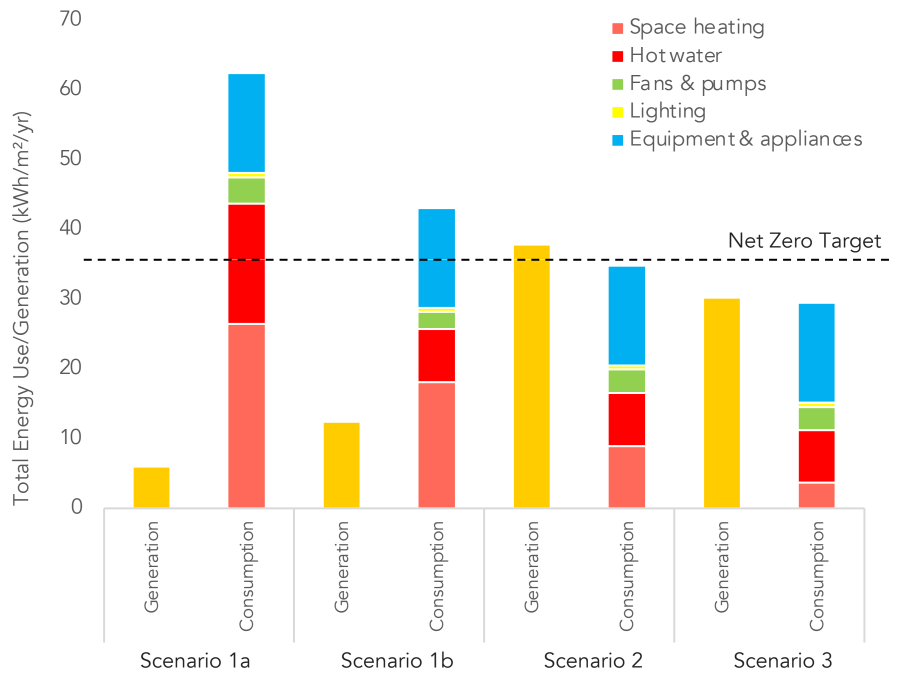
SAP 2012 total energy consumption and generation, modelled in Stroma FSAP, suggests that Scenarios 1b, 2 and 3 all meet the LETI total energy use target.

A Better Approach

There are different approaches that can be used to resolve these issues in planning policy that is targeting net zero. These include:

1. Applying a correction to SAP calculations, for example doubling or tripling calculated space heat demand
2. Adding an allowance for equipment and appliances
3. Permitting or requiring the use of alternative software such as PHPP.

The government is currently reviewing the future of SAP and considering its important role in delivering the UK's net zero carbon commitments, so some of these issues may be addressed in future versions.



PHPP total energy consumption and generation, modelled in PHPP 9.6a suggests that Scenarios 2 and 3 are the only ones that meet the LETI total energy use target.

Net Zero Operational Carbon

Ten key requirements for new buildings

By 2030 all new buildings must operate at net zero to meet our climate change targets. This means that by 2025 all new buildings will need to be designed to meet these targets. This page sets out the approach to operational carbon that will be necessary to deliver zero carbon buildings. For more information about any of these requirements and how to meet them, please refer to the: UKBGC - Net Zero Carbon Buildings Framework; BBP - Design for Performance initiative; RIBA - 2030 Climate Challenge; GHA - Net Zero Housing Project Map; CIBSE - Climate Action Plan; and, LETI - Climate Emergency Design Guide.

Low energy use

1. Total Energy Use Intensity (EUI) - Energy use measured at the meter should be equal to or less than:
   - **35 kWh/m²/yr** (GIA) for residential[1]

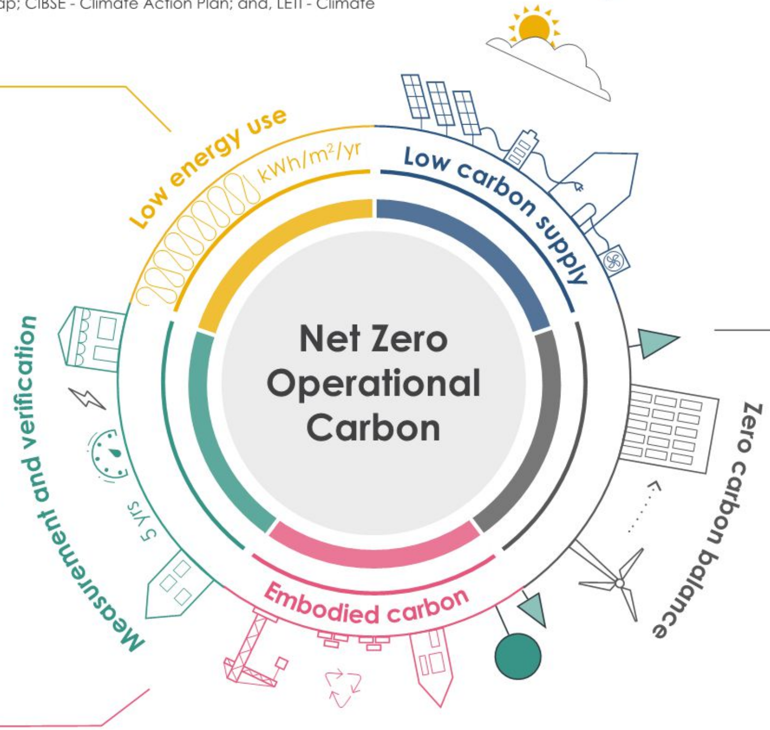
   For non-domestic buildings a minimum DEC B (40) rating should be achieved and/or an EUI equal or less than:
   - **65 kWh/m²/yr** (GIA) for schools[1]
   - **70 kWh/m²/yr** (NLA) or **55 kWh/m²/yr** (GIA) for commercial offices[1,2]
2. Building fabric is very important therefore space heating demand should be less than **15 kWh/m²/yr** for all building types.

Measurement and verification

3. Annual energy use and renewable energy generation on-site must be reported and independently verified in-use each year for the first 5 years. This can be done on an aggregated and anonymised basis for residential buildings.

Reducing construction impacts

4. Embodied carbon should be assessed, reduced and verified post-construction.[3]



Low carbon energy supply

5. **Heating and hot water should not be generated using fossil fuels.**
6. The average annual carbon content of the heat supplied (gCO_2/kWh) should be reported.
7. On-site renewable electricity should be maximised.
8. Energy demand response and storage measures should be incorporated and the building annual peak energy demand should be reported.

Zero carbon balance

9. A carbon balance calculation (on an annual basis) should be undertaken and it should be demonstrated that the building achieves a net zero carbon balance.
10. Any energy use not met by on-site renewables should be met by an investment into additional renewable energy capacity off-site OR a minimum 15 year renewable energy power purchase agreement (PPA). A green tariff is not robust enough and does not provide 'additional' renewables.

Notes:

Note 1 – Energy use intensity (EUI) targets
The above targets include all energy uses in the building (regulated and unregulated) as measured at the meter and exclude on-site generation. They have been derived from: predicted energy use modelling for best practice; a review of the best performing buildings in the UK; and a preliminary assessment of the renewable energy supply for UK buildings. They are likely to be revised as more knowledge is available in these three fields. As heating and hot water is not generated by fossil fuels, this assumes an all electric building until other zero carbon fuels exist. (kWh targets are the same as $kWh_{elec-eq}$). Once other zero carbon heating fuels are available this metric will be adapted.

Note 2 – Commercial offices
With a typical net to gross ratio, 70 kWh/m² NLA/yr is equivalent to 55 kWh/m² GIA/yr. Building owners and developers are recommended to target a base building rating of 6 stars using the BBP's Design for Performance process based on NABERS.

Note 3 – Whole life carbon
It is recognised that operational emissions represent only one aspect of net zero carbon in new buildings. Reducing whole life carbon is crucial and will be covered in separate guidance.

Note 4 – Adaptation to climate change
Net zero carbon buildings should also be adapted to climate change. It is essential that the risk of overheating is managed and that cooling is minimised.

Developed in collaboration with:

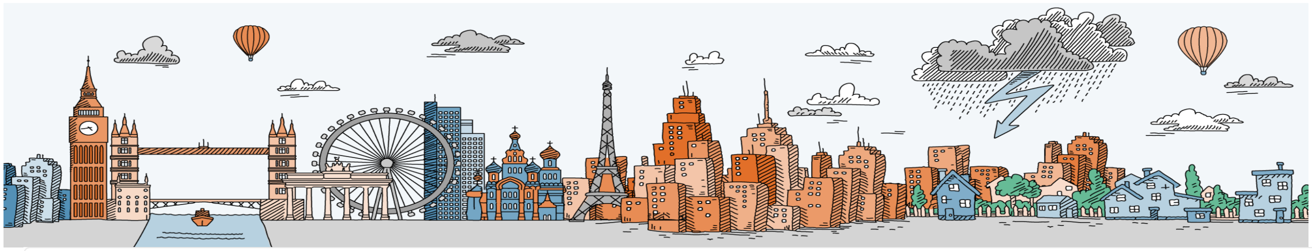
London Energy Transformation Initiative | UKGBC | BBP Better Buildings Partnership

Developed with the support of:

Good Homes Alliance | RIBA Architecture.com | CIBSE

MANCHESTER 1824
The University of Manchester

Tyndall°Centre for Climate Change Research



Setting Climate Committments for Cornwall

Quantifying the implications of the United Nations Paris Agreement for Cornwall

Date:	January 2021
Prepared By:	Dr Jaise Kuriakose, Dr Chris Jones, Prof Kevin Anderson, Dr John Broderick & Prof Carly McLachlan

NB: All views contained in this report are solely attributable to the authors and do not necessarily reflect those of the researchers within the wider Tyndall Centre.

Key Messages

This report presents climate change targets for Cornwall[i] that are derived from the commitments enshrined in the Paris Agreement , informed by the latest science on climate change and defined in terms of science based carbon setting . The report provides Cornwall with budgets for carbon dioxide (CO_2) emissions and from the energy system for 2020 to 2100.

The carbon budgets in this report are based on translating the “well below 2°C and pursuing 1.5°C” global temperature target and equity principles in the United Nations Paris Agreement to a national UK carbon budget [ii]. The UK budget is then split between sub-national areas using different allocation regimes . Aviation and shipping emissions remain within the national UK carbon budget and are not scaled down to sub-national budgets. Land Use, Land Use Change and Forestry (LULUCF) and non-CO_2 emissions are considered separately to the energy CO_2 budget in this report.

Based on our analysis, for Cornwall to make its ‘fair’ contribution towards the Paris Climate Change Agreement, the following recommendations should be adopted:

1. Stay within a maximum cumulative carbon dioxide emissions budget of 17.8 million tonnes ($MtCO_2$) for the period of 2020 to 2100. At 2017 CO_2 emission levels[iii], Cornwall would use this entire budget within 7 years from 2020.
2. Initiate an immediate programme of CO_2 mitigation to deliver cuts in emissions averaging a minimum of -13.4% per year to deliver a Paris aligned carbon budget. These annual reductions in emissions require national and local action, and could be part of a wider collaboration with other local authorities.
3. Reach zero or near zero carbon no later than 2041. This report provides an indicative CO_2 reduction pathway that stays within the recommended maximum carbon budget of 17.8 $MtCO_2$. At 2041 5% of the budget remains. This represents very low levels of residual CO_2 emissions by this time, or the Authority may opt to forgo these residual emissions and cut emissions to zero at this point. Earlier years for reaching zero CO_2 emissions are also within the recommended budget, provided that interim budgets with lower cumulative CO_2 emissions are also adopted.

Sections 1, 2 and 5 of this report - **Introduction, Methods and References** - can be found in the full print report

3. Results

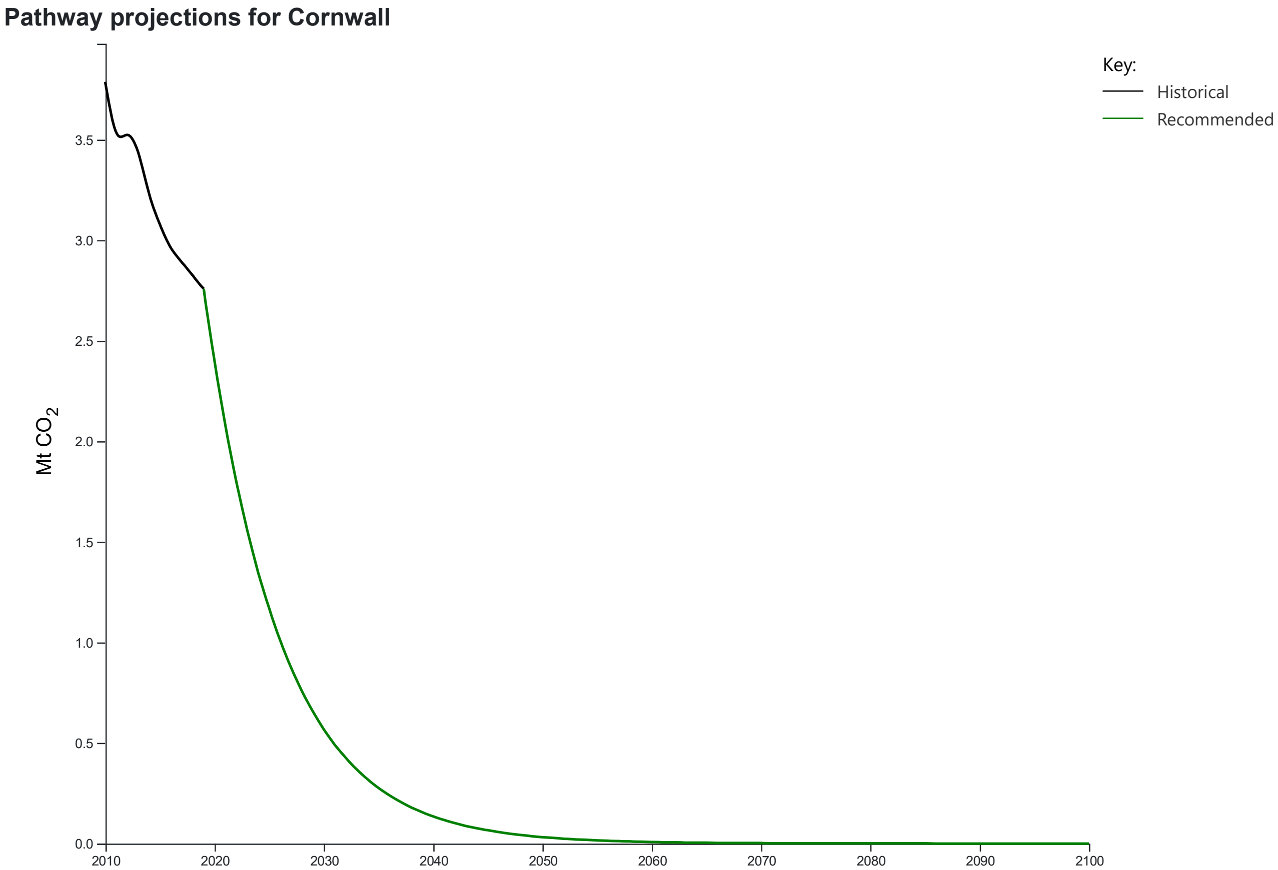
3.1 Energy Only Budgets for Cornwall

Following the Method the recommended energy only CO_2 carbon budget for the Cornwall area for the period of 2020 to 2100 is 17.8 $MtCO_2$. To translate this into near to long term commitments a CO_2 reduction pathway within the 17.8 $MtCO_2$ is proposed here. A consistent emissions reduction rate of -13.4% out to the end of the century is applied. In 2041

95% of the recommended carbon budget is emitted and low level CO2 emissions continue at a diminishing level to 2100.

Figure 1: *An interactive chart of Energy related CO_2 only emissions pathways (2010-2100) for Cornwall premised on the recommended carbon budget.*

Tracking your mouse over this chart will display the actual figures for each of the pathways, as well as for the lead-in historical values.



☐*Show alternative pathway projections (see below)*

Table 1 presents the Cornwall energy CO_2 only budget in the format of the 5-year carbon budget periods in the UK Climate Change Act. To align the 2020 to 2100 carbon budget with the budget periods in the Climate Change Act we have included estimated CO_2 emissions for Cornwall for 2018 and 2019, based on BEIS provisional national emissions data for 2018 and assuming the same year on year reduction rate applied to 2019. The combined carbon budget for 2018 to 2100 is therefore 23.4 $MtCO_2$.

Table 1: *Periodic Carbon Budgets for 2018 for Cornwall.*

Carbon Budget Period	**Recommended Carbon Budget (**Mt CO_2**)**
2018 - 2022	11.8
2023 - 2027	5.9
2028 - 2032	2.9
2033 - 2037	1.4
2038 - 2042	0.7
2043 - 2047	0.3
2048 - 2100	0.3

The recommended budget is the maximum cumulative CO_2 amount we consider consistent with Cornwall's fair contribution to the Paris Agreement. A smaller carbon budget, with accelerated reduction rates and an earlier zero carbon year, is compatible with this approach. It is however important that for an alternative zero carbon year the proposed 5 year budget periods are the same or lower that those specified in Figure 2. Furthermore meeting the budget must not rely on carbon offsets.

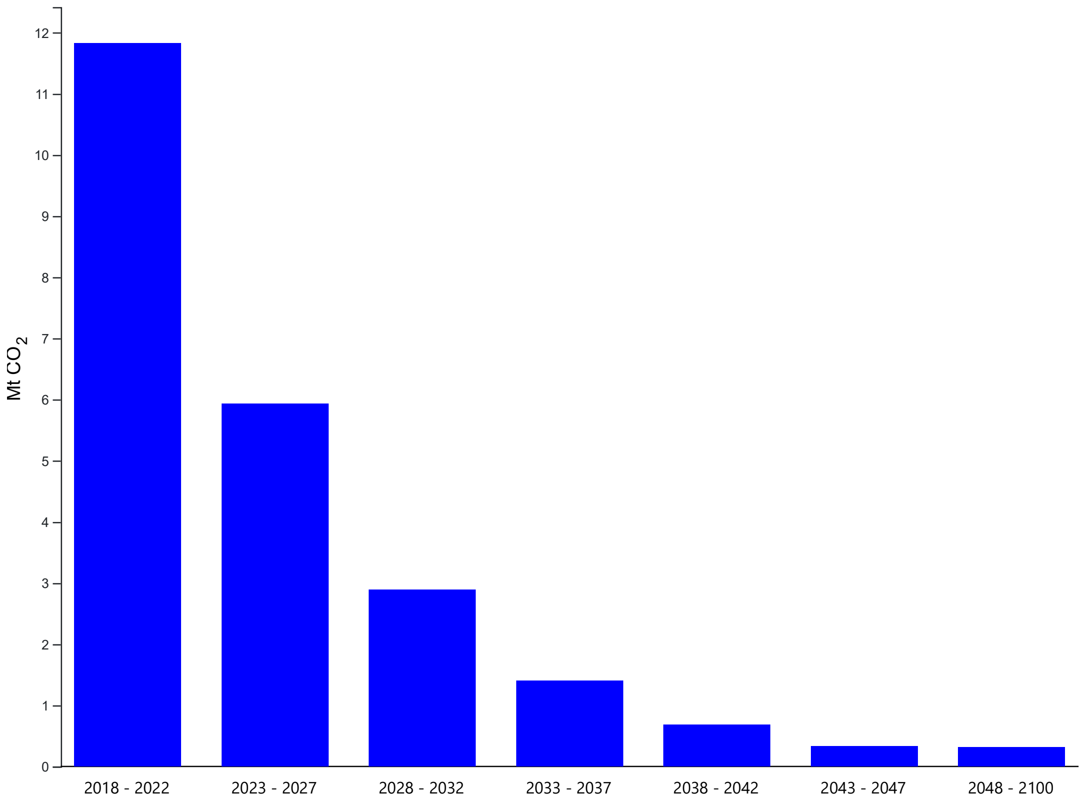


Figure 2: *Cumulative CO_2 emissions for budget period (based on Table 1) from 2018 to 2100 for Cornwall*

3.2 Recommended Allocation Regime for Carbon Budget

The recommended carbon budget is based on a grandfathering allocation regime for sub-dividing the UK sub-national energy only carbon budget. There are three distinct allocation regimes that can be applied to determine sub-national budgets. We have opted to recommend one common approach for allocating carbon budgets that can be applied to all Local Authority areas. This enables straightforward compatibility between carbon budgets set at different administrative scales. For example this makes it easier for individual Local Authorities to calculate their own carbon budgets that are compatible with a budget set at Combined Authority scale. It also means that under the recommended carbon budgets, all Authorities are contributing to a common total UK carbon budget. If for example all Authorities selected the allocation regime that offered them largest carbon budget the combined UK budget would not comply with the objectives of the Paris Agreement. The common approach to allocation we recommend therefore further assures that the carbon budget adopted is Paris Agreement compatible.

We have chosen a grandfathering as our common allocation approach because, based on our analysis, it is the most appropriate and widely applicable regime within the UK.

Population and Gross Value Added[iv] (GVA) are alternative allocation regimes. Population shares the carbon budget equally across the UK on a per capita basis. In this allocation regime the UK population is compared to that of Cornwall from 2011 to 2016. The carbon budget (2020-2100) for Cornwall is then apportioned based on its average proportion of the UK population for the period 2011-2016. For regions where per capita energy demand deviates significantly from the average (e.g. a large energy intensive industry is currently located there) the budget allocated may not be equitable for all regions, therefore it is not recommended as the preferred allocation. GVA is used as an economic metric to apportion carbon budgets. For example, the UK total GVA is compared to that of Cornwall from 2011 to 2016. The carbon budget (2020-2100) for Cornwall is then apportioned based on Cornwall's average proportion of UK GVA for the period 2011-2016. GVA can be useful as a proxy for allocation on economic value, however without an adjustment for the type of economic activity undertaken, areas with high economic 'value' relative to energy use can get a relatively large budget, while the inverse is true for areas with energy intensive industries, and/or lower relative economic productivity. We would therefore not recommend GVA as an appropriate allocation regime for all regions.

Table 2 presents the result outcomes for alterative allocation regimes – population and gross value added (GVA).

Table 2: *Energy only CO_2 budgets and annual mitigation rates for Cornwall (2020-2100) by allocation regime*

Allocation regime (% of UK Budget allocated to Cornwall	**UK Budget[v] ($MtCO_2$)**	**Cornwall Budget ($MtCO_2$)**	**Average Annual Mitigation Rate (%)**
Grandfathering to Cornwall from UK (0.8%)	2,239	17.8	-13.4%
Population split to Cornwall from UK (0.8%)	2,239	18.9	-12.7%
GVA split to Cornwall from UK (0.6%)	2,239	12.3	-18.3%

To view the pathways for the Population and GVA allocation regimes, select the checkbox under Fig. 1

3.3 Land Use, Land Use Change and Forestry emissions for Cornwall

Land Use, Land Use Change and Forestry (LULUCF) consist of both emissions and removals of CO_2 from land and forests. We recommend that CO_2 emissions and sequestration from LULUCF are monitored separately from the energy-only carbon budgets provided in this report. Cornwall should increase sequestration of CO_2 through LULUCF in the future, aligned with Committee on Climate Change's high level ambition of tree planting, forestry yield improvements and forestry management . Where LULUCF is considered, we recommend it compensate for the effects of non-CO_2 greenhouse gas emissions (within the geographical area) that cannot be reduced to zero, such as non-CO_2 emissions from agriculture.

3.4 Non-CO_2 Emissions

The IPCC SR1.5 report identifies the importance of non-CO_2 climate forcers (for instance methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), sulphur dioxide (SO_2) and black carbon) in influencing the rate of climate change. However, a cumulative emission budget approach is not appropriate for all non-CO_2 greenhouse gases, as the physical and chemical properties of each leads to differing atmospheric lifetimes and warming effects . There are also substantial relative uncertainties in the scale, timing and location of their effects.

We do not provide further analysis or a non-CO_2 emissions reduction pathway in this report. However the global carbon budget in the IPCC Special Report on 1.5ºC, that our analysis is based on, assumes a significant reduction in rate of methane and other non-CO_2 emissions over time. Therefore to be consistent with carbon budgets Cornwall should continue to take action to reduce these emissions.

The Department of Business Energy and Industrial Strategy's Local Authority emissions statistics do not at this time provide non-CO_2 emissions data at the regional level. Given the absence of robust non-CO_2 emissions data, any non-CO_2 emissions inventory by other organisations at scope 1 and 2 for Cornwall may form the basis of monitoring and planning for these emissions. We recommend considering the adoption of a LULUCF pathway that includes CO_2 sequestration sufficient to help compensate for non-CO_2 emissions within Cornwall's administrative area.

4. Conclusions

The results in this report show that for Cornwall to make its fair contribution to delivering the Paris Agreement's commitment to staying "well below 2°C and pursuing 1.5°C" global temperature rise, then an immediate and rapid programme of decarbonisation is needed. At 2017 CO_2 emission levels[vi], Cornwall will exceed the recommended budget available within 7 years from 2020. **To stay within the recommended carbon budget Cornwall will, from 2020 onwards, need to achieve average mitigation rates of CO_2 from energy of around -13.4% per year**. This will require that Cornwall rapidly transitions away from unabated fossil fuel use. For context the relative change in CO_2 emissions from energy compared to a 2015 Paris Agreement reference year are shown in Table 3.

Table 3: *Percentage reduction of annual emissions for the recommended CO_2-only pathway out to 2050 in relation to 2015*

Year	**Reduction in Annual Emissions (based on recommended pathway)**

Year	Reduction in Annual Emissions (based on recommended pathway)
2020	22.4%
2025	62.2%
2030	81.6%
2035	91.1%
2040	95.6%
2045	97.9%
2050	99.0%

The carbon budgets recommended should be reviewed on a five yearly basis to reflect the most up-to-date science, any changes in global agreements on climate mitigation and progress on the successful deployment at scale of negative emissions technologies.

These budgets do not downscale aviation and shipping emissions from the UK national level. However if these emissions continue to increase as currently envisaged by Government, aviation and shipping will take an increasing share of the UK carbon budget, reducing the available budgets for combined and local authorities. **We recommend therefore that Cornwall seriously consider strategies for significantly limiting emissions growth from aviation and shipping.** This could include interactions with the UK Government or other local authority and local enterprise partnership discussions on aviation that reflect the need of the carbon budget to limit aviation and shipping emissions growth.

CO_2 emissions in the carbon budget related to electricity use from the National Grid in Cornwall are largely dependent upon national government policy and changes to power generation across the country. **It is recommended however that Cornwall promote the deployment of low carbon electricity generation within the region and where possible influence national policy on this issue**.

We also recommend that the LULUCF sector should be managed to ensure CO_2 sequestration where possible. The management of LULUCF could also include action to increase wider social and environmental benefits..