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Rother District Council

Rother Climate Change Study

Net Zero Carbon Evidence Base Report

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Introduction and Purpose

Rother District Council (RDC) declared a Climate Emergency in 2019 and published its Environment Strategy for Rother 2020-2030 in September 2020. It includes pledges to incorporate planning policies in the new local plan which planning policy officers are drafting under a "Green to Core" vision which emphasizes three pillars:

1) "Living well" locally - managing development so as to reduce the need to use a car; to encourage walking and cycling and provide EV infrastructure.
2) Net Zero carbon standards – specific policy for new development
3) Renewable energy provision – planning for sustainable energy and supporting communities to develop local solutions.

These pledges for the new Local Plan contribute to the council's ambition for Rother to be net zero across the district by 2030. To support this vision, RDC has commissioned Arup to develop a Net Zero Carbon Evidence Base which will feed into the development of the new 2019-2039 Local Plan. This report sets out an assessment of the causes, effects, and future projections of sectoral carbon emissions which the Local Plan will need to address in order to achieve a sustainable and resilient future for Rother residents.

Key recommendations

Achieving significant carbon reductions in Rother will require coordination between not just ***how*** buildings are developed (as directed by planning policy) but ***where*** they are located and how they are grouped, as determined through local plan site allocations and growth scenarios. The key recommendations of this report address both aspects.

Recommendations for Growth Scenarios

The 'intensification of urban areas' option has shown the largest potential for sustainable growth. Intensification reduces gross floor area in residential development and in turn a reduced heating demand. Intensification also goes hand in hand with the assumptions of district heating to serve non-residential loads, and the intensification of urban areas would also reduce trip levels and mileage, encouraging a mode shift to EV uptake and active travel.

This option is beneficial as it allows local authorities to use the Local Plan to influence heating demand and look for ways to meet this sustainably through low-carbon heat networks. The installation of on-site PV is recommended because PV would minimise emissions associated with growth whilst creating opportunities to decarbonise existing stock. Battery storage and decentralised networks should be prioritised to optimise emissions savings and maximise cost benefits. PV initiatives have potential to benefit all three growth option scenarios.

The development of brownfield areas and the intensification of urban centres should be prioritised (although it is recognised that options are limited in Rother) and land with high sequestration potential is advised to be protected and enhanced wherever possible.

Recommendations for Local Plan policy

The table below sets out a summary of the recommended net zero policies. The full detail of the recommended policies is included in Chapter 10.

Table E1: Policy Recommendations

Policy area	Topic	Recommendation
Net zero building standards for minor and major residential development (including conversions)	Building performance standards for operational emissions	It is suggested that RDC require all residential development (including building conversions) to achieve the LETI Total Energy Use Intensity (TEUI) Target for Operational Energy of 35 kWh/m^2/year (GIA). To assure other factors contributing to high quality construction, it is proposed that residential development also attains: • For new builds, a 4-star Home Quality Mark (HQM) score; or • For conversions to residential development, a BREEAM ‘Excellent’ standard as minimum. It is not considered that an interim target is required for these thresholds, since they entail a holistic range of sustainability metrics and so are more accessible for developers to demonstrate compliance. Developer guidance: Developers could select one of BRE’s existing certification schemes to demonstrate compliance with both the LETI energy and carbon targets, and the quality of construction target guidance.
	Building performance standards for embodied emissions	To account for embodied carbon emissions, it is suggested that RDC tailor the maximum policy package threshold. Based on the joint Embodied Carbon Target Alignment guidance from LETI, RIBA and other industry organisations, current average building design achieves an E rating on the LETI carbon rating system, equating to 950 kgCO^2/m^2 upfront embodied carbon and 1400 kgCO^2/m^2 total embodied carbon. Additionally, our carbon specialists do not consider that the commercial construction supply chain can yet achieve the LETI 2030 Design Targets (an A rating on the LETI carbon rating system, equating to 350 kgCO^2/m^2 upfront embodied carbon and 530 kgCO^2/m^2 total embodied carbon). As such, a staggered approach is proposed to transition towards the LETI 2030 Design Targets, as included in the maximum policy scenario: • On adoption of the new Local Plan: Stipulate a LETI C rating, equating to 600 kgCO^2/m^2 upfront embodied carbon and 970 kgCO^2/m^2 total embodied carbon. The Embodied Carbon Target Alignment guidance has benchmarked these thresholds with projects that demonstrate good building design. By 2030: Stipulate the LETI A rating for residential development, equating to 300 kgCO^2/m^2 upfront embodied carbon and 450 kgCO^2/m^2 total embodied carbon. As above, these thresholds correspond with the LETI 2030 Design Targets.
	Energy statement requirements	To accompany all planning applications for residential development, it is recommended that developers are required to provide a detailed energy statement encompassing: • Demonstration of how the building performance standards will be met using the energy hierarchy in the design, construction, and operation phases[1]. This includes connecting with district heat networks and decentralised electricity networks. The requirements for heat networks are detailed below. • Evidence that high energy efficiency appliances are installed if these are included in the interior fit-out. For developments of more than 100 dwellings (or a lower threshold to capture a significant proportion of new dwellings in the district) it is suggested that developers show that whole life carbon analysis has been applied in designing their scheme, including optimising operational and embodied carbon and energy, as well as integrating Circular Economy principles (following current LETI and RIBA guidance[2]).
	Energy provision requirements	To attain the TEUI Target for Operational Energy of 35 kWh/m^2/year (GIA), a combination of energy demand reduction and efficiency measures will be required. It is proposed that RDC require both ASHP and rooftop solar PV systems with electricity storage provision to be installed in residential units (excluding flats) where there are unshaded roof areas with appropriate orientation and slope to make PV installation feasible. For flats, a requirement for building

[1] The energy hierarchy is defined by considering how to reduce operational energy use in the following order of priority: 1) Be lean – Use less overall energy; 2) Be clean – supply energy efficiency, cleanly and via local energy resources (such as secondary heat) where possible; and 3) Be green – use renewable energy.

[2] Guidance available at: LETI and RIBA (2021). Whole Life Carbon One-Pager. Available at: https://www.leti.uk/_files/ugd/252d09_c4aa3410d7614e8d8b524e87b1b8fd2a.pdf [Accessed on 19/01/2023]

		rooftop PV is suggested, alongside a feasibility statement to evidence if ASHP can practicably be installed to serve at unit or building level. The strength of these requirements is complemented by the updated Building Regulations which will require a combination of passive design, high building fabric performance, efficient electric heating, and hot water systems, mechanical or hybrid ventilation likely with heat recovery, and PV panels. Additionally, the UK Government have indicated an upcoming ban on natural gas boilers [2]. Based on the modelling, it is suggested that 2 – 3.6 kWp rooftop PV systems are installed since this will contribute to the reduction of overall household grid electricity consumption. This is considered a more robust approach than the originally proposed requirement for 10% of future energy use from on-site renewable generation in section 5.3. To accompany the solar PV systems, to attain the greatest benefits for energy efficiency, developers should provide battery storage commensurate with the quantum of development or contribute to the upgrade of existing battery storage systems. <u>Developer guidance</u>: Developers may need to consult the Distribution Network Operator prior to installation in line with Engineering Recommendation G99[3].
	Monitoring requirements	The requirement for monitoring regulated and unregulated emissions has been weighed up in the context of other additional costs to the developer (incurred by the other proposed requirements above) and the long-term benefits of data collection for Rother's residents and RDC net zero objectives. In comparison to the other proposed requirements, the benefits to emissions reduction through monitoring are more limited and so a targeted approach is proposed. This excludes unregulated emissions, given the Local Planning Authority does not hold any powers to control these. For implemented developments of more than 100 dwellings[4], it is proposed that monitoring of regulated operational emissions of a statistically significant representative sample of dwellings is required for a period of the first five years of occupation. The monitoring would be intended to inform net zero building policies for Rother's subsequent Local Plan, beyond the current emerging Plan. Post-occupancy evaluation (with thermal comfort) surveys could also provide valuable feedback and data to commission all systems appropriately and achieve comfort and satisfaction.
Net zero new building standards for minor and major non-residential development (including conversions)	Building performance standards for operational emissions	It is recommended that RDC require non-residential development (including building conversions and excluding industrial units) to achieve the LETI TEUI Target for Operational Energy of 65 kWh/m^2/year (GIA) for light industrial [and 55 for offices?]. In some cases, to achieve this target, it will be necessary to install extensive rooftop and/or on-site ground solar PV systems. For industrial units (including warehouses), a requirement for a feasibility statement is proposed to evidence a practicable TEUI Target for Operational Energy. This should demonstrate that the best energy efficiency outcomes have been achieved to serve the proposal, by maximising opportunities for on-site solar PV systems and optimising building fabric performance, heating and ventilation. It has not been possible to source a benchmarked TEUI threshold for this type of development. To assure other factors contributing to high quality construction, it is proposed that non-residential development also attains a BREEAM 'Outstanding' standard as a minimum. It is not considered that an interim target is required for these thresholds, since they entail a holistic range of sustainability metrics and so are more accessible for developers to demonstrate compliance. <u>Developer guidance</u>: Developers could select one of BRE's existing certification schemes to demonstrate compliance with both the LETI energy and carbon targets, and the quality of construction target guidance.
	Building performance standards for embodied emissions	To account for embodied carbon emissions, it is suggested that RDC tailor the maximum policy package threshold. Based on the joint Embodied Carbon Target Alignment guidance from LETI, RIBA and other industry organisations, current average building design achieves an E rating on the LETI carbon rating system, equating to 950 $kgCO_2/m^2$ upfront embodied carbon and 1400 $kgCO_2/m^2$ total embodied carbon. Additionally, our carbon specialists do not consider that the commercial construction supply chain can yet achieve the LETI 2030 Design Targets (an A rating on the LETI carbon rating system, equating to 350 $kgCO_2/m^2$ upfront embodied carbon and 530 $kgCO_2/m^2$ total embodied carbon). As such, a staggered approach is proposed to transition towards the LETI 2030 Design Targets, as included in the maximum policy scenario:

[3] Available here: Energy Networks Association (2020) Engineering Recommendation G99 Issue 1 – Amendment 6. Available at: https://www.energynetworks.org/assets/images/Resource%20library/ENA_EREC_G99_Issue_1_Amendment_6_(2020).pdf [Accessed on: 19/01/2023]

[4] Threshold to be reviewed once quantum of all allocations agreed. The intention of the requirement is for monitoring to be stipulated for a significant proportion of Plan allocations.

	• On adoption of the new Local Plan (scheduled for Q3 of the 2023/24 financial year): Stipulate a LETI C rating for office development, equating to 600 $kgCO_2/m^2$ upfront embodied carbon and 970 $kgCO^2/m^2$ total embodied carbon. The Embodied Carbon Target Alignment guidance has benchmarked these thresholds with projects that demonstrate good building design. • By 2030: Stipulate a LETI A rating for office development, equating to 350 $kgCO^2/m^2$ upfront embodied carbon and 530 $kgCO_2/m^2$ total embodied carbon. As above, these thresholds correspond with the LETI 2030 Design Targets.
Energy statement requirements	To accompany all planning applications for non-residential development, it is recommended that policy requires developers to provide a detailed energy statement encompassing: • Demonstration of how the building performance standards will be met using the energy hierarchy in the design, construction, and operation phases[5]. This includes using excess heat productively on-site or as part of a district heat network (as recommended in section 8.5.1). This includes connecting with district heat networks and decentralised electricity networks. The requirements for heat networks are detailed below. • Evidence that high energy efficiency appliances are installed, if these are included in the interior fit-out. For developments of more than 100 sqm, it is suggested that developers show that whole life carbon analysis has been applied in designing their scheme, including optimising operational and embodied carbon and energy, as well as integrating Circular Economy principles (following the LETI and RIBA guidance[6]).
Energy provision requirements	Given previous Government (formerly BEIS) reporting has shown Energy Use Intensity to be approximately 177 $kWh/m^2/year$ for non-residential development[7], substantial efforts will be required to attain a TEUI Target for Operational Energy of 65 $kWh/m^2/year$ (GIA). Our modelling assumes a 27% reduction in total energy demand for non-residential development (relative to Government Building Energy Efficiency Survey data), in alignment with the new Building Regulation requirements. This reduction would be achieved by developers through improvements to the efficiency of building fabric and services, and on-site renewable energy capacity. Considering renewable electricity generation, it is therefore proposed that, for all non-residential developments of 100 sqm, 20% of electricity consumption should be supplied via on-site solar PV systems. Large non-residential schemes can offer significant rooftop capacity for solar PV in comparison to residential developments, contributing to both lowering EUI of buildings and decarbonising the grid. To accompany the solar PV systems, and attain the greatest benefits for energy efficiency, developers should also allow for battery storage. Developer guidance: Developers may need to consult the Distribution Network Operator prior to installation in line with Engineering Recommendation G99[8]. [3].
Monitoring requirements	As above, the requirement for monitoring regulated and unregulated emissions has been weighed up in the context of other additional costs to the developer (incurred by the other proposed requirements above) and the long-term benefits of data collection for Rother's net zero objectives. For developments of more than 1,000 sqm[9], it is proposed that monitoring of regulated operational emissions of a statistically significant sample of buildings is secured by legal agreement with the developer for a period of five years. The monitoring would be intended to inform net zero building policies for Rother's subsequent Local Plan, beyond the current emerging Plan.

[5] The energy hierarchy is defined by considering how to reduce operational energy use in the following order of priority: 1) Be lean – Use less overall energy; 2) Be clean – supply energy efficiency, cleanly and via local energy resources (such as secondary heat) where possible; and 3) Be green – use renewable energy.

[6] Guidance available at: LETI and RIBA (2021). Whole Life Carbon One-Pager. Available at: https://www.leti.uk/_files/ugd/252d09_c4aa3410d7614e8d8b524e87b1b8fd2a.pdf [Accessed on 19/01/2023]

[7] Value calculated from the retail Energy Use Intensity data (for electricity and heat demand), from the Department for Business, Energy & Industrial Strategy (2015) Overarching report – Building Energy Efficiency Survey data 2014-2015, Figure 3.11. More recent equivalent data not available.

[8] Available here: Energy Networks Association (2020) Engineering Recommendation G99 Issue 1 – Amendment 6. Available at: https://www.energynetworks.org/assets/images/Resource%20library/ENA_EREC_G99_Issue_1_Amendment_6_(2020).pdf [Accessed on: 19/01/2023]

[9] Threshold to be reviewed once quantum of all allocations agreed. The intention of the requirement is for monitoring to be stipulated for a significant proportion of Plan allocations.

Heat network requirements for residential and non-residential development	Heat network requirements	For residential developments, the most favourable opportunities for establishing new district heat networks were mainly identified in Bexhill-on-Sea and the surrounding areas because of existing high building heat density and the presence of large, non-residential buildings with sufficient heat demand to act as anchor loads. The most favourable opportunities for large non-residential developments are in Bexhill-on-Sea, and Rye. To take an integrated approach to heat network establishment, it is proposed that all proposals of greater than 10 dwellings or 1,000 sqm are required to make developer contributions towards the establishment of a district heat network in Bexhill-on-Sea and Rye. On implementing new district heat networks in the named settlements, the Council should have regard for the outcomes of the Government (formerly BEIS) Heat Networks Zoning Pilot [1]. They should also seek to identify existing buildings and forthcoming schemes with heat demand greater than 500MWh/year which can act as anchor loads and play a significant role in stabilising the delivery of heat and guaranteeing economic and technical feasibility of a potential network. In particular, large non-residential developments with sufficient heat demand can act as anchor loads in areas identified as potential heat network zones. Potential anchor loads being developed around potential heat network zones that do not currently have anchor loads (such as those in Bexhill-on-Sea and most of the potential zones in Rye), have the potential to facilitate the increased viability of these potential zones. Once the district heat network has been established, all development proposals within the named settlements should connect to the district energy network, or an extension to that network.
Net zero refurbishment standards for minor and major residential and non-residential development	Energy statement requirements	All proposed refurbishment schemes should provide an energy statement which aligns with the six principles for best practice in LETI's Climate Emergency Retrofit Guide. It is also suggested that RDC, while engaging with applicants at the pre-application and/or application stage, highlight how to avoid poor indoor air quality and condensation. The Building Regulation Approved Document guidance and the Chartered Institution of Building Services Engineers (CIBSE) guides may be helpful in illustrating this.
	For decision-makers	It is suggested that the Council attribute significant weight to building retrofit proposals which result in considerable improvements to the energy efficiency and reduction in carbon emissions.

Underlying research for policy recommendations

Examining best practice and synthesising policy options

As a starting point for the final recommendations, potential policy options were initially prepared. These options have been considered with the technical evidence, to formulate the overall Rother policy recommendations.

To assist analysis of exemplar Local Plan policy, a review of leading industry standards on net zero buildings, renewable energy and policymaking was undertaken. Technical building assessment advice was reviewed from industry organisations including BRE, the UK Green Buildings Council (UKGBC), the Passive House Institute and LETI, along with Local Government Association guidance on renewable energy. On policymaking, a range of publications were reviewed including The New Homes Policy Playbook (UKGBC, 2021) and The Climate Crisis Guide (RTPI & TCPA, 2021)

In addition to examining the accreditation and guidance available, this evidence base also provides a review of planning policies which have been proposed and adopted in progressive local plans across the UK. The purpose of this review is to capture examples of how net zero standards can be built into planning policy and to identify trends which could be applicable for application in Rother. To this end, four plans were highlighted for further examination as case studies: Cornwall Council, Cornwall Climate Emergency Development Plan; Oxford City Council, Local Plan; Milton Keynes City Council, Plan: MK 2016-2031 and the West Berkshire, Local Plan Review 2020-2037.

Finally, the best practice review of Local Plan policies (along with the industry standards that they incorporated) were used to synthesize potential policy options, organised as minimum, medium, and maximum approaches based on Rother's baseline and policies adopted elsewhere. These policy options (or "packages") formed the basis of three scenarios for carbon modelling, described further below.

Rother's current baseline emissions

To test the impact of growth options, it was important to understand current emissions in Rother and assess different decarbonisation pathways.

Greenhouse gas (GHG) emissions accounting and reporting is essential for monitoring the effectiveness of policy and interventions, planning funding, and identifying priorities for cost-effective decarbonisation at pace. Emissions are categorised into Scope 1 to 3 estimated based on the selected boundaries of the report. This study's methodology aligns with the GHG Protocol for Cities and Communities[10], an internationally recognised standard for the monitoring and reporting emissions. The boundaries for the assessment are the boundaries of Rother DC and the emissions reported are the territorial emissions. Emissions data for the period 2015-2020 were collected by the Government formerly Department for Business, Energy & Industrial Strategy (formerly BEIS)[11] published datasets. The emissions have been aggregated and presented by sector (Table E2) using the BASIC method as set out in the GHG Protocol standard.

> Scope 1 emissions include emissions from gas and other fuels that have been consumed within the boundaries of Rother DC. Scope 2 emissions mainly represent emissions attributed to Rother due to electricity consumption.

The sector with the highest Scope 1 emissions is transportation – specifically due to road traffic. The second largest source of emissions is residential buildings due to heating demand and the use of boilers. Agriculture has a small but noticeable impact on emissions in comparison with the other sectors. The opportunities to reduce agricultural emissions might be limited because of the specialised vehicles used by this sector and the fuels these vehicles can currently use.

The main source of Scope 2 emissions from grid-supplied electricity are residential buildings, which is to be expected. Both domestic and commercial Scope 2 emissions show a strong declining trend, due to grid decarbonisation and a consequent decrease in electricity emissions intensity.

Table E2: Scope 1 & 2 emissions (kt CO_2e) of Rother according to the "BASIC" method as set out in the GHG Protocol for Communities.

Scope of emissions	Emissions category	Emissions ($ktCO_2e$) sources	2015	2016	2017	2018	2019	2020
Scope 1	Stationary	Domestic	118	121	117	118	115	117
		Commercial and industrial	70	85	86	89	69	68
		Agriculture	13	14	14	14	14	14
	Transportation	On-road	187	194	187	189	188	154
		Railways	2	2	2	2	2	2
	Waste	Emissions from waste disposal	3	3	3	3	4	4
		Scope 1 Total	393	420	409	415	392	358
Scope 2	Stationary	Domestic	72	56	51	46	41	39
		Commercial and industrial	54	44	39	37	32	25
		Agriculture	5	4	4	3	3	3
		Scope 2 Total	132	104	94	86	76	67

[10] Greenhouse Gas Protocol, Global protocol for Community-scale Greenhouse Gas Inventories. An Accounting and Reporting Standard for Cities. Available from: https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

[11] BEIS was split to form the Department for Energy Security and Net Zero, Department for Science, Innovation and Technology, and Department for Business and Trade in 2023.

These sectoral emissions for Rother were plotted over time (Figure E1) following the Department for Energy Security and Net Zero (DESNZ) (formerly BEIS) "Net Zero strategy" baseline scenario. This shows the trajectory of Rother's emissions according to the emissions change estimates for each sector based on existing legislation, policy, and commitments. According to this baseline scenario, Rother will not achieve the net zero targets without new interventions and policy ambition beyond and above current national policy and building regulations compliance.

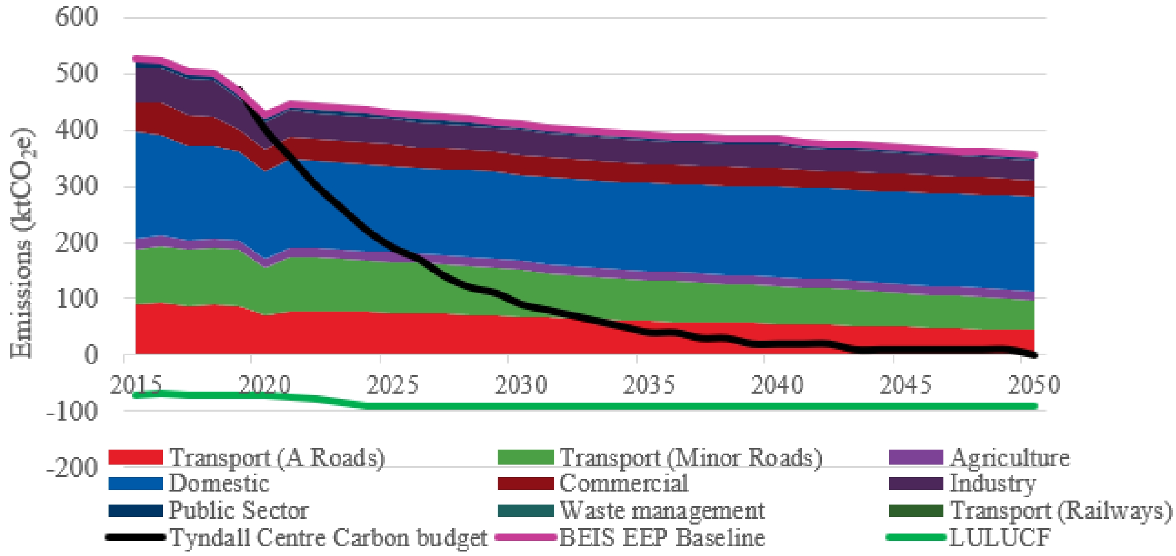

Figure E1: Rother baseline emissions projection according to the Department for Energy Security and Net Zero (DESNZ) (formerly BEIS) Net Zero Strategy Baseline trajectory.

By comparison, the science-based carbon budget trajectory for Rother, calculated by the Tyndall Centre, is shown with a black line in Figure E1. The carbon budgets of the local authority areas are aligned with the United Nations Paris Agreement "well below 2°C and pursuing 1.5°C" global temperature target and defined by science-based carbon budget setting [12]. This carbon budget is based on energy related CO_2 emissions only and is not directly comparable with the other scenarios. Nevertheless, it still highlights the challenge and need for policy to influence and support the private sector to retrofit existing housing stock and set aspirational energy performance and quality standards for new developments, which should not need to be retrofitted by 2050.

Rother's Current Baseline Carbon Sequestration

The land use, land-use change, and forestry (LULUCF) sector is representative of the total sequestration potential. These are emissions removed or released to the atmosphere through processes relating to land use and the natural environment. For example, urban land cover is considered to have neutral impact with 0 kt $CO_2e.yr^{-1}$ carbon flow. However, the change of woodland, which has a high sequestration potential, to urban land through planned development would likely result in reduction of the emissions removed from the atmosphere. The sequestration potential for Rother was estimated to be 106.1 kt $CO_2e.yr^{-1}$. The largest source of emissions is agricultural land (~10.3kt CO_2e yr^{-1}). The largest sinks of emissions were coniferous and non-coniferous trees, followed by the foreshore's natural environment, although it is recognised that this large area (4,269 ha) is outside Rother's jurisdiction. Figure E2 illustrates the carbon sequestration potential across Rother.

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[12] Tyndall Carbon Budget Reports - Quantifying the implications of the United Nations Paris Agreement for local areas. Available from: https://carbonbudget.manchester.ac.uk/

According to the greenhouse gas dataset for UK local authorities[13], in 2020 Rother had -70.8 kt CO_2e net (removal) LULUCF emissions (-0.73 kt CO_2e per capita). By comparison, Wealden had -135 kt CO_2e (-0.83 kt CO_2e per capita), Cornwall had -100.7 kt CO_2e (-0.18 kt CO_2e per capita) and Milton Keynes -11.6 kt CO_2e (-0.04 kt CO_2e per capita) respectively. In 2020 only 14% of the local authorities (53 of 374) in the UK showed a decrease in net emissions from LULUCF compared to 2019. Overall, the LULUCF sector in 2020 was a net source of 3.7 Mt CO_2e emissions[14] (0.05 kt CO_2e per capita).

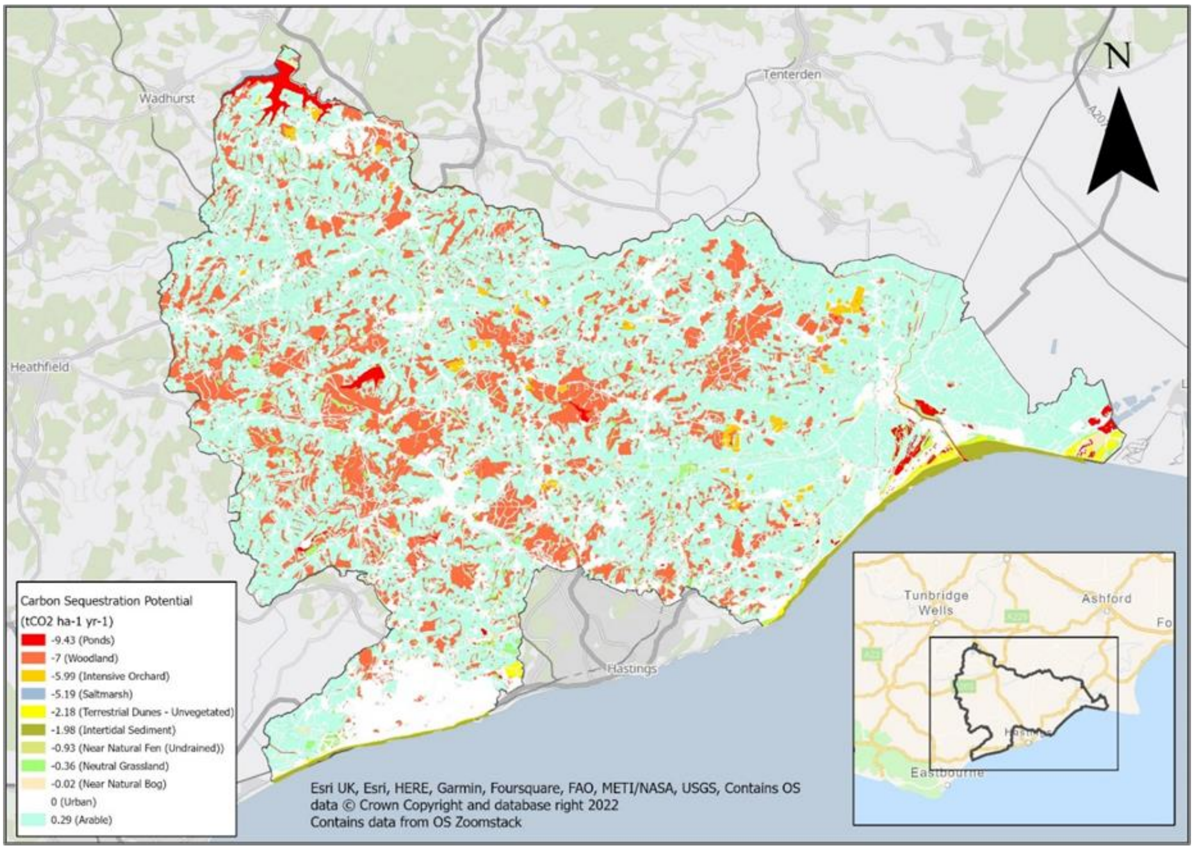

Figure E2. Land use type and carbon sequestration potential map (Detailed sub-regions map in Appendix 0)

Growth Scenarios

The following distinct and theoretical growth scenarios were used to model the carbon impacts of different approaches to development and settlement locations and density. The Local Plan's spatial strategy is likely to be a combination of all three scenarios.

Table E3: Summary of scenarios and main areas of development.

Growth Scenarios	Description	Development type / size	Employment land
G1 - Dispersed settlements	*Countryside living, Access to nature* New development is proportionally distributed based on the size of identified settlements.	450 dwellings per year proportionally distributed into the focus areas based on the status/size of the settlements.	Employment land growth focused on the settlements in the scenario.

[13] UK National Statistics, Combined land use and agricultural territorial greenhouse gas emissions estimates by UK region and local authority 2020. Available from

[14] UK National Statistics, DESNZ (formerly BEIS) (2022) UK local authority greenhouse gas emissions estimates 2020. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1086967/uk-local-regional-greenhouse-gas-emissions-2005-2020-release.pdf

Growth Scenarios	Description	Development type / size	Employment land
	Main transport option is private vehicles together with a limited bus network and cycling in low traffic roads. Surveys indicate that around 20% of Rother working population commutes to Hastings.	Higher ratio of semi-detached and detached to flats and terraced dwellings. 30 min rural community, Intergenerational Housing, Ageing community standard, Countryside living, Access to nature	Small shopping, small leisure.
G2-Clustered networks	*30 min rural community networks, Enhanced connections, and links with transport hubs* Villages and smaller settlements are closely linked with larger villages or towns by public transport to transport hubs. Four clusters have been identified in principle, centred around Rye, Battle, Bexhill and Hastings as key transport interchanges. Local economy growth, decentralised provision of services and goods. Main transport option still the private car but with greater opportunity for viable public transport and active modes of travel.	450 dwellings per year equally distributed into the four main identified clusters. Higher ratio of semi-detached and terraced to flats and detached dwellings. 30 min rural community, Intergenerational Housing, Ageing community standard, Family friendly, Sustainable living.	Employment land growth in the areas of the key transport hubs in each cluster. Small shopping, small office, leisure.
G3-Intensification of urban areas	*Rejuvenation of existing towns, active travel* Mixed use, master planned large developments within or on the edge of existing settlements' boundaries with focus on higher densities of current population centres. Radial development. Opportunities for better public transport, cycling and walking connections with town and local centres.	450 dwellings per year in the focus areas. Higher ratio of flats and terraced to semi-detached dwellings. 20 min neighbourhood, Intergenerational Housing, Family friendly, Hybrid working, Sustainable living, Affordable housing.	Development focused on Bexhill and Hastings Fringe. Office buildings, industrial, larger-scale shopping.

Carbon emissions and new buildings specifications

Three policy options (minimum, medium and maximum ambition) were developed to reflect the findings of the review of planning policy precedents and three modelling scenarios were developed to examine the impact, if any, from the implementation of high building performance standards beyond the current buildings' regulations compliance. These scenarios represent different levels of ambition on planning policy and different pathways regarding the implementation of key buildings energy policy requirements. Carbon modelling was undertaken of the three ambition scenarios to understand the impact of each approach upon future emissions.

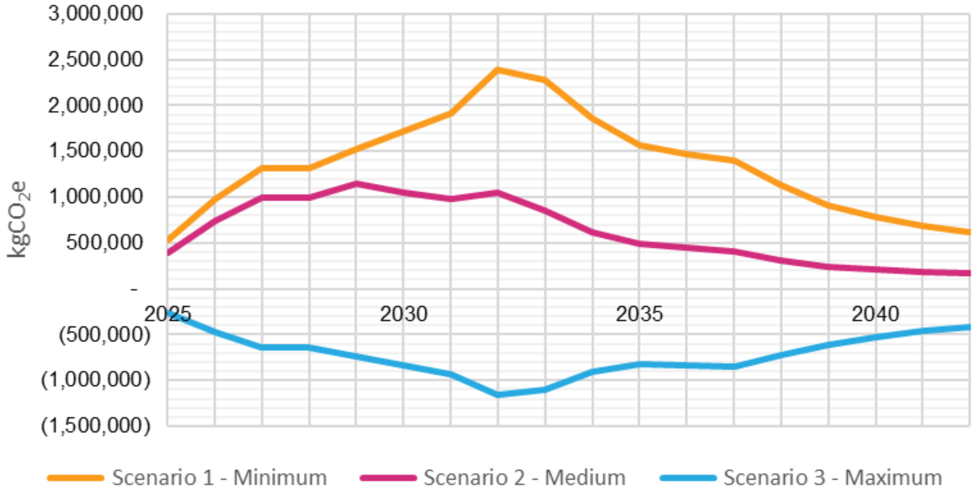

Figure E3: Net annual emissions (kg CO_2e) from residential buildings for different policy ambition (Includes PV electricity generation).

The Maximum Ambition scenario (Energy Use Intensity ~35kWh/m^2 in 2025, 3.6 kWp PV per dwelling, district heating in non-residential in 2030) will decisively lead to net zero residential development and in combination with an intensification focused growth strategy will reduce the impact of new development in Rother. New residential buildings are expected to be already built net zero ready or with near net zero emissions performance, mainly through reducing heating demand as much as possible and moving to fossil fuel-free homes. Future emissions from buildings will be relatively low in all scenarios. New development has emissions associated with other sectors such as transport, waste and commercial activities. As a result, the overall residual emissions will remain in similar levels across the different ambition scenarios if the emissions of other sectors cannot be effectively reduced (Figure E4-E5) such as in the case of buildings. This is further shown in the results of the growth scenario modelling (Figure E5).

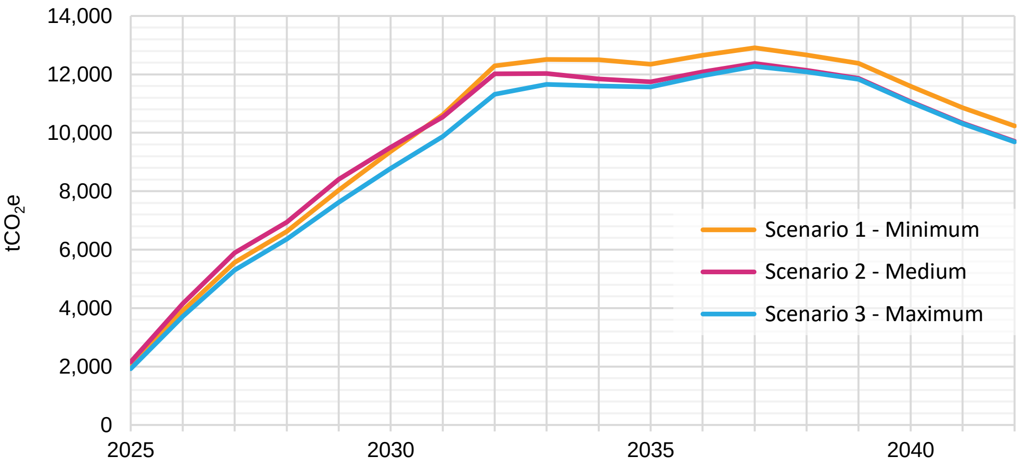

Figure E4: Annual emissions (t CO_2e) for three different levels of policy ambition in Rother.

Carbon emissions and growth

Three growth scenarios were evaluated to highlight the impact of different spatial strategies through changes in transport, travel modes, building types, employment land use classes and renewable energy generation. This modelling exercise aims to show how certain planning policy decisions can affect the journey of Rother to net zero emissions and the transition to sustainable growth. Figure E5, shows that overall, the Intensification scenario would result in the lowest total emissions, whereas the Dispersed and Clustered Network scenarios will both have similar impact on future emissions.

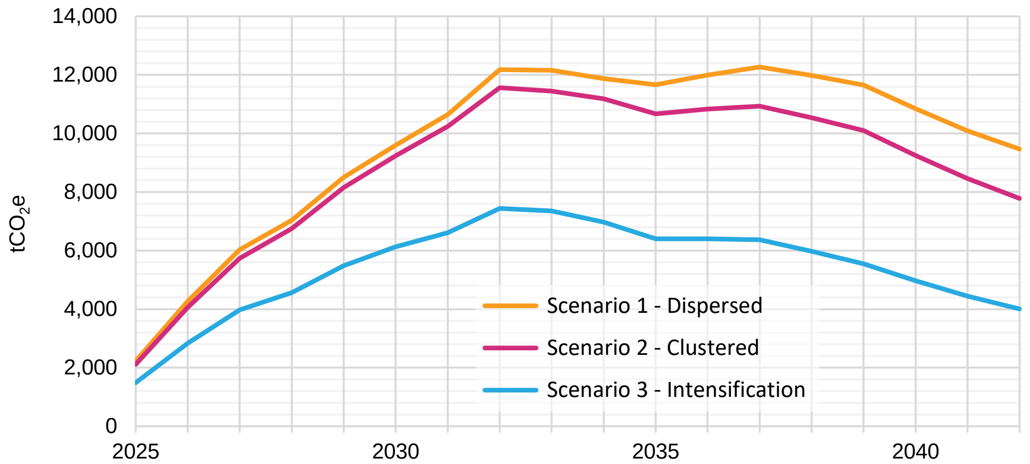

Figure E5: Annual emissions (tCO_2e) due to new development for the three growth scenarios in Rother.

The difference in annual emissions among the scenarios can be largely explained by transport emissions based on the assumptions for each scenario relating to commuting trips, travel modes and electrification rates of private vehicles and public transport. These findings indicate that measures focused only on buildings' performance will not be alone sufficient to reduce the emissions associated with growth to net zero. Early implementation of high building energy performance requirements, electrification of heat and increased renewable electricity generation will only be effective as part of an integrated strategy that aims to achieve net zero emissions for all sectors. This result should not be interpreted in a way that reduces policy ambition and supports a "do nothing" response. If the difference between the scenarios is small this is because all new construction will have higher energy performance than the existing building stock, and most importantly because the expected growth in terms of new residential and non-residential buildings is relatively small and similar among the scenarios. Potential for low-carbon heat networks and renewable generation

In addition to modelling the carbon impacts of the policy packages and growth scenarios, sites were also identified for potential future heat networks and renewable energy generation. The total heat demand by all identified potential district heat network zones across Rother accounts for 6% of Rother's baseline heat demand, with the most potential zones in Bexhill-on-Sea because of the area's higher density of buildings.

The Local Plan should encourage all new buildings to prioritise connection to existing or future district heat networks above alternative heating technologies to promote the viability of district heat networks, particularly for new developments within or surrounding Bexhill-on-Sea.

This report outlines the potential for renewable electricity generation in Rother. The Local Plan should encourage refurbishment of existing building stock to include proof of consideration of roof-mounted solar PV installations as well as set targets for rooftop PV installation in all new building.

The Local Plan should also consider the planning requirements to support the cost-effective development of ground-mounted solar farms, particularly in areas of high potential, but taking account of the protected landscape of the AONB. The Local Plan should consider the planning requirements to support the cost-effective development of onshore wind turbines, particularly in the ward of Catsfield & Crowhurst, which show favourable spatial characteristics.

Cost implications and financial feasibility

A comparative cost analysis was undertaken to determine the cost uplifts associated with adopting higher building standards for these building elements. The building elements with the most notable cost increase were glazing, PV installations and heat generation systems.

Costs were calculated for the following five interventions applied to five building typologies for Rother: flats/apartments, semi-detached houses, detached houses, offices and industrial.

- Insulation to external walls
- Glazing
- Roof Insulation
- PV Installations
- Heat Generation

The cost impacts for an 85sq.m. semi-detached house range from £10 / m^2 increase for the "advanced" insulated case (above building regulations) against an assumed baseline for regulations compliance, to £350 / m^2 increase for glazing systems respectively. Full costing tables looking at all five typologies are included in Section 8 of this report.

Financial feasibility will differ between developments and developers, and as such will be required to be considered on a case-by-case basis; however, initial findings suggest increased insulation (above building regulations compliance) to external walls and roofs, based on the same design and construction, yields minimal financial impact for flats, semi-detached and detached houses. Alternative construction methodologies designed to achieve similar emissions reductions for office and industrial buildings indicate a larger financial impact, though this would vary depending on the design of units.

1. Introduction

1.1 Scope and Purpose

Rother District Council (RDC) commissioned Arup to develop a Net Zero Carbon Evidence Base which will feed into the development of the new 2019-2039 Local Plan. RDC has a strong vision for the emerging plan to have an ambitious and decisive role in reducing emissions, supporting local communities to flourish, and enhancing sustainability with a place-based approach. As such, a robust and comprehensive assessment of the causes, effects and future projections of sectoral emissions is essential for understanding the scope for the emerging Local Plan to drive the change that new development must embrace to achieve a sustainable and resilient future for Rother residents.

RDC declared a Climate Emergency in 2019 and published its Environment Strategy for Rother 2020-2030 in September 2020. It includes pledges to incorporate planning policies in the new local plan which planning policy officers are drafting under a "Green to Core" vision which emphasizes three pillars:

1) "Living well" locally - managing development to reduce the need to use a car; to encourage walking and cycling and provide EV infrastructure.
2) Net Zero carbon standards – specific policy for new development.
3) Renewable energy supplies – planning for sustainable energy and supporting communities to develop local solutions.

The council's ambition is to be net zero by 2030.

1.2 Overview of Methodology and Workstreams

This project brings together inputs from Town Planning, Quantity Surveying and Climate and Sustainability specialists to present a multidisciplinary view of Rother's current context in terms of carbon emissions, sequestration, renewable energy, and planning policies. These workstreams fed into the modelling and analysis of carbon impacts of different spatial growth scenarios and net zero buildings measures, the detail of which is included in the methodology sections within the relevant chapters of this report. Finally, the workstreams fed into a series of policy recommendations which embed the findings of the carbon and renewable energy analysis and build upon examples of policy best-practice elsewhere.

1.3 Document Structure

This report is set out in the following sections:

- **Understanding Rother Today** which establishes the carbon emissions baseline and policy context for Rother
- **Examining Best Practice** identifies examples of measures which have been applied elsewhere including industry standards and policy case studies.
- **Synthesising Policy Options** assesses how the measures taken from best practice apply to Rother in three policy packages.
- **Carbon Impacts of Growth Scenarios** applies carbon modelling techniques to three spatial growth scenarios to guide development and transport throughout the district. This modelling indicates the relative performance of each scenario in terms of carbon emissions and sequestration.

- **Net Zero Buildings Analysis of Rother Typologies** builds upon the previous chapters to examine the potential impacts of building typologies in Rother on future carbon emissions and measures which may be implemented to improve efficiency.
- **Carbon Impacts of Policy Options** applies carbon modelling techniques to three policy packages to indicate relative performance of each package in terms of carbon emissions
- **Net Zero Buildings Feasibility and Costs** provides further detail of the feasibility and cost implications of implementing net zero building requirements
- **Renewable Energy and District Heat Network Analysis** sets out the opportunities and implications for renewable energy and district heat networks within Rother.
- **Net Zero Buildings Policy Recommendations** bring together the findings of the previous chapters into a series of policy recommendations based upon the results of the carbon analysis

2. Understanding Rother Today

This chapter examines Rother today, establishing the carbon emissions baseline and local planning context which will form the starting point for this study.

2.1 Carbon Emissions Baseline

2.1.1 Methodology

The first stage of work was to undertake baselining of carbon emissions and benchmark the results against the Government's legislated targets (78% reduction by 2035 (1990 base), net zero by 2050), the sixth Carbon Budget for the period 2033-2037, and the Climate Change Committee (CCC)'s 2022 progress report.

This carbon emissions baseline assessment is the first iteration of climate change evidence supporting the emerging Local Plan, setting the baseline for Rother, and identifying opportunities to embed climate change considerations into the local planning process. Providing a clear picture of the current state of play is an essential part of understanding the starting point, defining future targets, and setting the trajectory to achieve them. Although this report primarily aims to inform the next steps of the Local Plan preparation process, it can also support Rother's wider action on climate change, and contribute to achieving local, national, and international carbon reduction and climate resilience targets.

The methodology follows a quantitative approach to estimate sectoral emissions, report the results following recognised standards and discuss key findings within the context of Rother and scope of this report. The boundaries for the emissions baselining are set to include district-wide, total emissions of Rother as a whole.

The key steps in the methodology are:

- Collection and analysis of Government Department for Energy Security and Net Zero (DESNZ) (formerly BEIS)[15] sub-national datasets for Rother
- Accounting and reporting of Rother's Scope 1 & 2 emissions following the "BASIC" method as set out in the Greenhouse Gas Protocol for Communities
- Projections of the calculated baseline emissions according to national emissions scenarios
- Benchmarking of current emissions against Government's targets, the sixth Carbon Budget and CCC 2022 progress report

2.1.2 Resources and Assumptions

Main data sources for this analysis include:

- sub-national statistics published by Department for Energy Security and Net Zero (DESNZ) (formerly BEIS)
- additional local data, including housing and non-domestic building quanta and performance data (e.g. Strategic Housing Research Project by Opinion Research Services, 2018)
- transport and travel data

The projections of the baseline emissions according to the national committed policies are based on:

[15] BEIS was split to form the Department for Energy Security and Net Zero, Department for Science, Innovation and Technology, and Department for Business and Trade in 2023.

- Net Zero strategy, Reference Baseline and projections from the Department for Energy Security and Net Zero (DESNZ) (formerly BEIS) Energy and Emissions Projections, 'Net Zero Scenario' (AR5) baseline

Context and existing policies have been provided by Rother District Council and include:

- Copies of the current Development Plan, Proposals Map, and any necessary base maps, along with accompanying GIS files
- Details of current large-scale housing and non-residential commitments and allocations, as well as housing and non-residential data from Council monitoring reports
- Appendix A ESPH555 Rother Net Zero Base – Consultants Brief

The main assumptions made for the calculation of emissions:

- In recognition of the rural character of large parts of Rother and the potential for carbon abatement, the analysis has included greenhouse gas emissions and removals for the land use, land use change and forestry (LULUCF) sector.
- Current population growth is estimated at 2.8% and it was assumed that it will follow the national growth trends.
- Commercial and Public sectors were assumed to follow the 'Net Zero Scenario' (AR5) baseline and projections for Industry as there is not specific mention in the scenario, and they include mainly office buildings and spaces visited by the public.
- The DESNZ 'Net Zero Scenario' (AR5) projections for LULUCF indicate greater than 200% change for the UK. However, Rother already has a significant amount of carbon abatement due to relatively high levels of woodland. While there are opportunities for new woodland areas, the percentage increase is expected to be limited and significantly lower than the national rate. It was assumed that LULUCF follows the 'Net Zero Scenario' (AR5) projections to 2024, when it peaks and remains stable due to sustainable woodland management practices, sustainable farming, protection of the existing ecosystems and quality greenspace in cities.
- The emissions projections for the period 2040-2050 have been forecasted according to the trend from the period 2020- 2040.
- In the National Grid ESO Future Energy Scenarios [4] (FES) "Leading the Way" scenario it has been assumed that the projections of emissions from residential heat and electricity include the energy vector shift from moving to electric heating.
- In the National Grid ESO Future Energy Scenarios (FES) "Leading the Way" scenario LULUCF was assumed to be the same as the Net Zero Scenario.

2.1.3 Main sources of emissions

Greenhouse gas (GHG) emissions accounting and reporting is essential for monitoring the effectiveness of policy and interventions, planning funding, and identifying priorities for cost-effective decarbonisation at pace. Emissions are categorised into Scope 1 to 3 estimated based on the selected boundaries of the report. This study's methodology aligns with the GHG Protocol for Cities and Communities [5], an internationally recognised standard for the monitoring and reporting emissions. The boundaries for the assessment are the boundaries of Rother DC and the emissions reported are the territorial emissions. Emissions data for the period 2015-2020 were collected by the Government Department for Energy Security and Net Zero (DESNZ) (formerly BEIS) published datasets. The emissions have been aggregated and presented by sector (Table 1) based on the BASIC method as set out in the GHG Protocol standard. Scope 1 emissions include emissions from gas and other fuels that have been consumed within the boundaries of Rother DC. Scope 2 emissions mainly represent emissions accounted to Rother due to electricity consumption.

In terms of Scope 1 emissions, the sector with the highest emissions is transportation and specifically road traffic. The second largest source of emissions is residential buildings due to heating demand and the use of boilers. The reduction in emissions from transportation in 2020 can be explained by the COVID lockdowns in March 2020 and the impact of the pandemic. Agriculture has a small but noticeable impact on emissions in comparison with the other sectors. The opportunities to reduce agriculture emissions might be limited because of the specialised vehicles used by this sector and the fuels these vehicles can currently use.

In terms of Scope 2, electricity-related emissions, the main sources are, again, residential buildings, which is to be expected. Interestingly, both domestic and commercial Scope 2 emissions show a strong declining trend. This trend is mainly the result of grid decarbonisation and a consequent decrease of electricity emission factors from 0.367 kgCO_2e/kWh in 2015 to 0.162 kgCO_2e/kWh in 2020 (grid average, consumption-based, domestic sector. DESNZ, Green Book supplementary data tables 1 to 19).

Table 1: Scope 1 & 2 emissions (kt CO_2e) of Rother according to the "BASIC" method as set out in the GHG Protocol for Communities.

Scope of emissions	GPC emissions category	Emissions (ktCO_2e) sources	2015	2016	2017	2018	2019	2020
Scope 1	Stationary	Domestic	118	121	117	118	115	117
		Commercial and industrial	70	85	86	89	69	68
		Agriculture	13	14	14	14	14	14
	Transportation	On-road	187	194	187	189	188	154
		Railways	2	2	2	2	2	2
	Waste	Emissions from waste disposal	3	3	3	3	4	4
		Scope 1 Total	393	420	409	415	392	358
Scope 2	Stationary	Domestic	72	56	51	46	41	39
		Commercial and industrial	54	44	39	37	32	25
		Agriculture	5	4	4	3	3	3
		Scope 2 Total	132	104	94	86	76	67

2.1.4 Emissions projections to 2050

These sectoral emissions for Rother were plotted over time (Figure 1) following the DESNZ "Net Zero strategy" baseline "Do nothing" scenario. This scenario shows the trajectory of Rother's emissions according to the emissions change estimates for each sector under the government's Net Zero Strategy Baseline, energy, and emissions projections. Those projections show the current national pathway based on existing legislation, policy, and commitments. This baseline projection should be used to decide the policy measures required to achieve net zero by 2030. According to this trajectory, Rother will not achieve the Net Zero targets without new interventions and policy ambition beyond and above current relevant national policy and building regulations compliance.

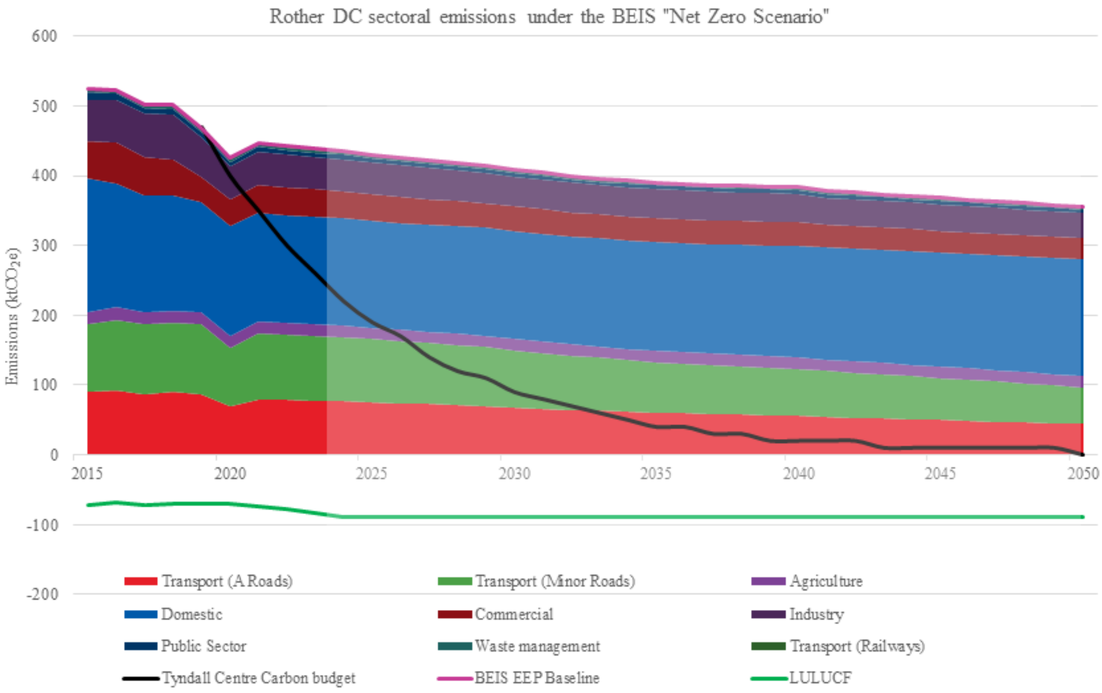

Figure 1: Rother baseline emissions projection according to the DESNZ (formerly BEIS) Net Zero Strategy Baseline trajectory.

By comparison, the science-based, recommended carbon budget pathway for Rother, calculated by the Tyndall Centre, is shown with a black line in Figure 1, Figure 2 and Figure 3. The Tyndall Carbon Budget is the recommended carbon emissions pathway for UK local authority areas. The carbon budgets of the local authority areas are aligned with the United Nations Paris Agreement "well below 2°C and pursuing 1.5°C" global temperature target and defined by science-based carbon budget setting [6]. This carbon budget is based on energy related CO_2 emissions only and it should not be directly compared with the other scenarios. Nevertheless, this points out the challenge and need for policy to influence and support the private sector to retrofit existing housing stock and set aspirational energy performance and quality standards for new developments, which should not need to be retrofitted by 2050.

The National Grid ESO Future Energy Scenarios [7] (FES) report proposes four credible pathways to Net Zero emissions by 2050. The scenarios focus on the energy system, supply and demand in the years to 2050. The Leading the Way (LTW) scenario used for the Rother emissions projections in this study (Figure 2) is the most ambitious scenario and the only which reaches Net Zero before 2050 (by 2047). It describes the fastest credible decarbonisation pathway, which is achieved through significant lifestyle changes, a mixture of hydrogen and electrification for heating, high consumer engagement and world leading technology and investment, along with a large increase in renewable energy capacity from wind and solar power.

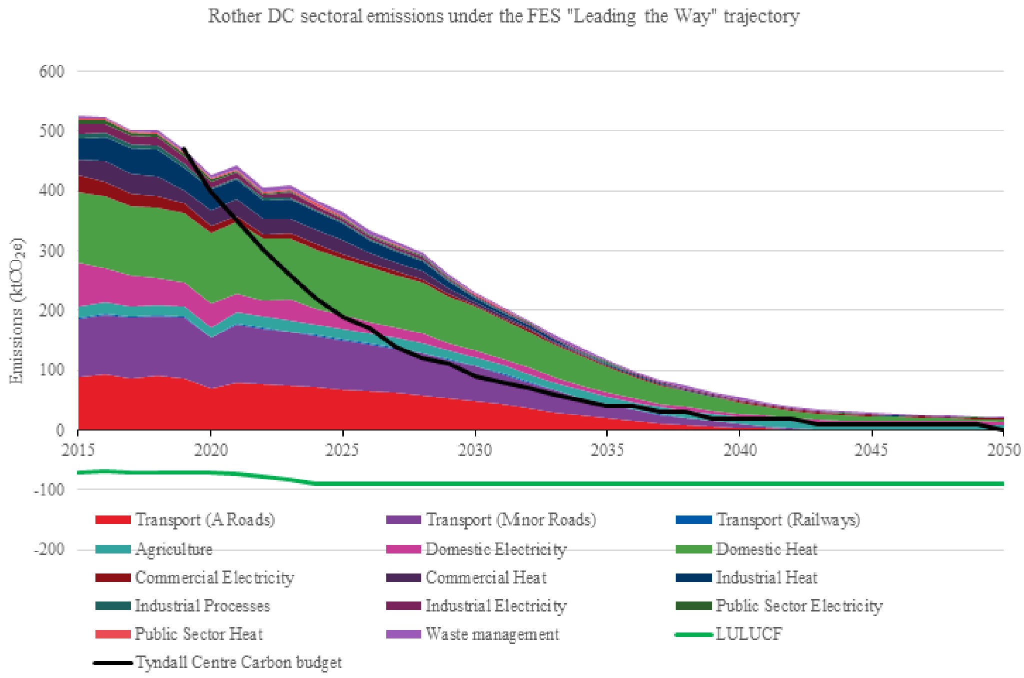

Figure 2: Rother baseline emissions projection under the Future Energy "Leading the Way" scenario trajectory.

Rother is expected to fall short of its Net Zero by 2030 target based on the FES "Leading the Way" trajectory. Despite modest carbon sequestration potential (shown by the LULUCF green line) in the district, in 2030 the residual emissions are still estimated to be 142 ktCO_2e (mainly from domestic heat and minor roads transportation) with Net Zero met in 2037. As it was discussed in the assumptions, the net LULUCF emissions removal were capped in the scenarios, and they do not follow the national increase rate as this was considered to result in very high levels of emissions removal from the atmosphere. Figure 3 shows Rother emissions trajectory based on the Climate Change Committee (CCC) Sixth Carbon Budget "CB6 – Balanced Net Zero" scenario [8]. This Sixth Carbon Budget report outlines potential pathways for the UK to achieve Net Zero emissions by 2050. The Sixth Carbon Budget advice includes four scenarios exploring different pace of emission reductions and possible variation between sectors. The scenarios have been used to identify a recommended Balanced Net Zero Pathway to 2050. This balanced pathway proposes a sensible pace for decarbonisation at an economy-wide level based on the latest evidence for the technology choices in each sector, a "highest possible ambition" regarding the timing of deployment and estimated costs for meeting the carbon budgets in each scenario.

Following this trajectory, Rother would meet the Net Zero target in 2038 (including an increased LULUCF sequestration trajectory in the scenario). Domestic heat emissions are shown to be the hardest to tackle in this scenario. The 6th Carbon Budget key recommendations are based on low-carbon, largely electric, heating and transport, achieving zero carbon electricity by 2035 through further increase in offshore wind generation and hydrogen replacing fuels for shipping, transport and in industry, reduction in demand and increase in efficiencies, with greenhouse gas removals increased through new woodland, some agricultural land shift to energy crops, and peatland restoration and sustainable management.

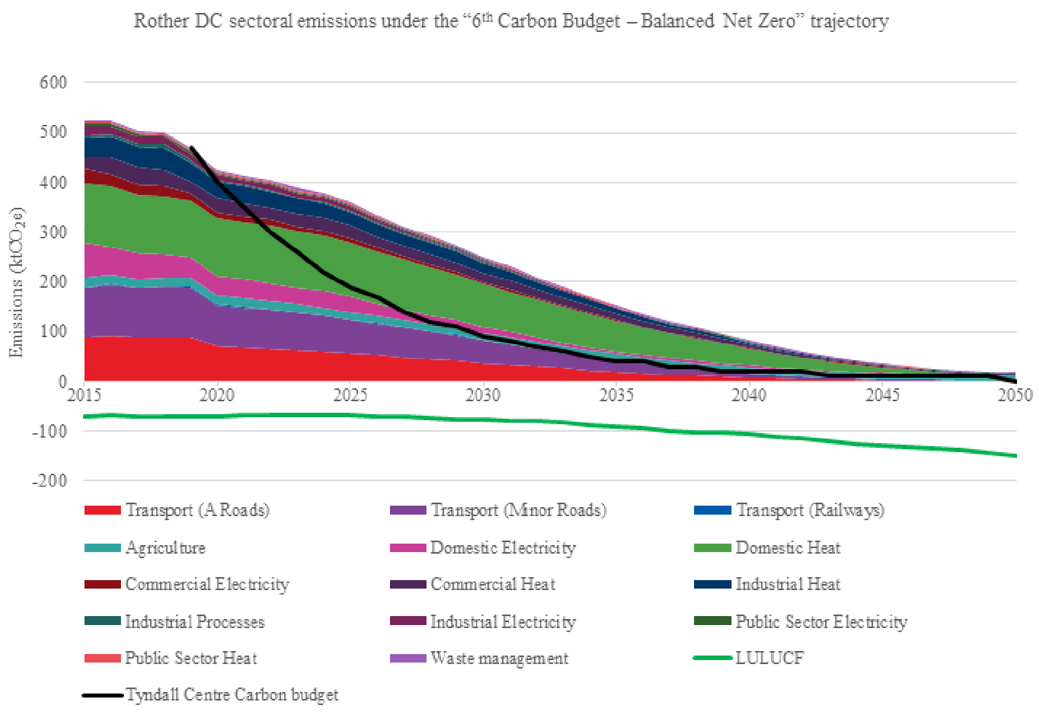

Figure 3: Rother baseline emissions projection based on to the 6th Carbon Budget trajectory.

2.1.5 Land-use carbon sequestration

Land use, land-use change, and forestry (LULUCF) sector is representative of the total sequestration potential. These are emissions removed or released to the atmosphere through processes relevant with land use and the natural environment. For example, urban land cover is considered to have neutral net emissions with 0 kt $CO_2e.yr^{-1}$ carbon flow (from the atmosphere to the land). However, the change of woodland, that has a high sequestration potential, to urban land through planned development would result in reduction of the emissions removed from the atmosphere. The sequestration potential for Rother was estimated to be 106.1 kt $CO_2e.yr^{-1}$. The largest source of emissions is agricultural land (~10.3kt CO_2e yr^{-1}). The largest sinks of emissions were coniferous and non-coniferous trees, followed by the foreshore's natural environment (although it is recognised that this large area (4,269 ha) is outside Rother's jurisdiction).

According to the greenhouse gas dataset for UK local authorities [9], in 2020 Rother had -70.8 kt CO_2e net LULUCF emissions (-0.73 kt CO_2e per capita), Wealden had -135 kt CO_2e (-0.83 kt CO_2e per capita), Cornwall had -100.7 kt CO_2e (-0.18 kt CO_2e per capita) and Milton Keynes -11.6 kt CO_2e (-0.04 kt CO_2e per capita) respectively. In 2020 only 14% of the local authorities (53 of 374) in the UK showed a decrease in net emissions from LULUCF compared to 2019. In overall, the LULUCF sector in 2020 was a net source of 3.7 Mt CO_2e emissions[16] (0.05 kt CO_2e per capita).

Recognising that Rother includes the High Weald AONB and woodland areas, the current land use was assessed based on the OS MasterMap Topography Layer. The total areas for each habitat type were matched with common habitat type descriptions associated with known carbon flux values taken from the Natural England Research Report [10] unless otherwise stated. The main steps in the methodology are:

- Geospatial assessment of baseline artificial and natural habitats on site.
- Calculation of the total area (ha) per habitat.

- Matching of baseline habitats with habitat types with known carbon sequestration potential.
- Calculation of the baseline annual carbon sequestration potential.

The full table of results is shown in Appendix A.2. Carbon sequestration potential is presented as tonnes of carbon dioxide equivalent per year ($tCO_2e\ yr^{-1}$) for the Rother area. The total Rother area was estimated to be 65,579 ha (larger than the 51,180ha cited in other sources) because of the inclusion of intertidal zones in the GIS data.

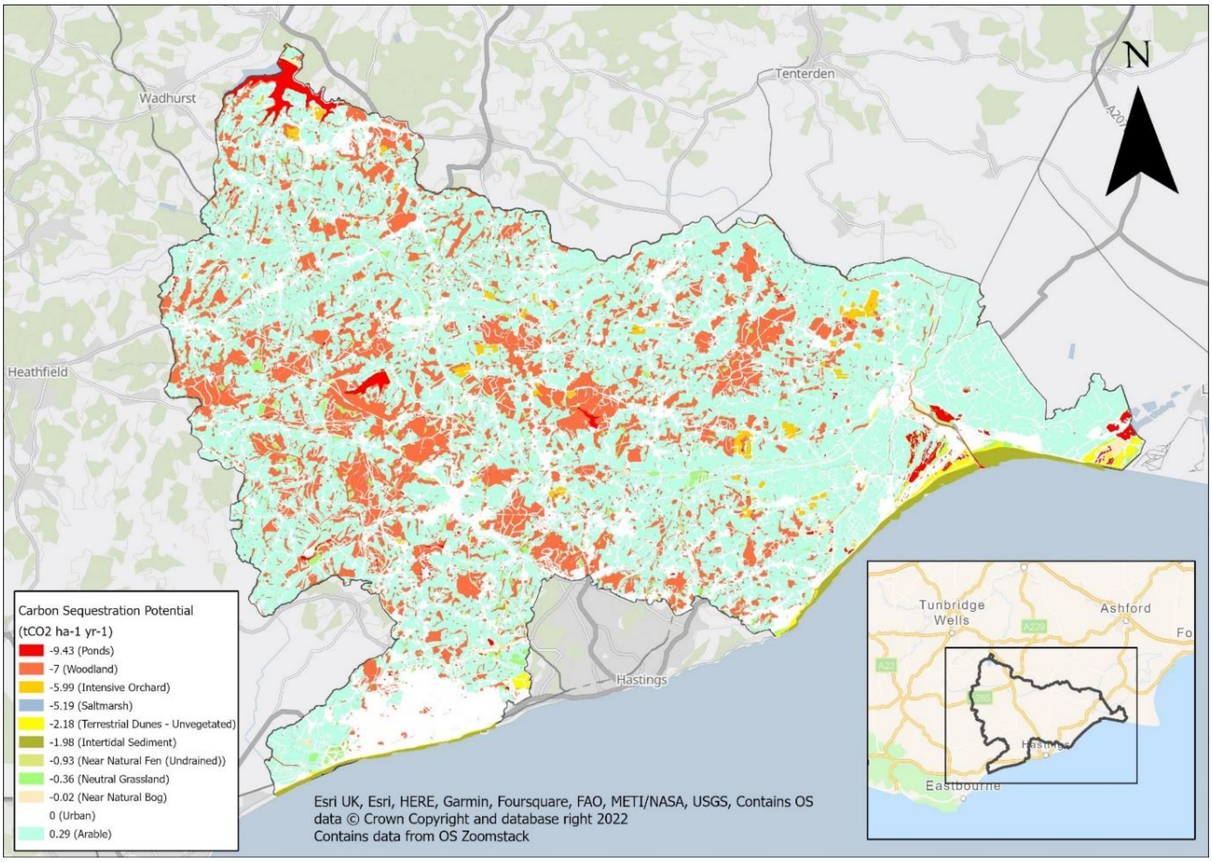

Figure 4. Land use type and carbon sequestration potential map (Detailed sub-regions map in Appendix 0).

Figure 4 shows a land use map of carbon sequestration potential for the Rother area. Detailed maps for sub-regions of Rother are available in Appendix 0. This information could be used to identify development areas and the extent of measures required to achieve positive net carbon sequestration after development.

2.2 Energy Demand and Supply Baseline

A baseline energy consumption analysis for heat and electricity was carried out across Rother. The electricity consumption was baselined according to the emissions modelling methodology described in this section. The heat baseline was conducted on a building-by-building baseline to enable more meaningful assessments of the district heat network potential in the district. Carbon emissions projections for Rother indicate that domestic heat will contribute approximately 50% of residual emissions in 2030, highlighting the importance of decarbonising Rother’s domestic heating load. To meaningfully assess the potential for renewable electricity generation and low-carbon district heat networks in Rother, it is important to conduct a baseline of existing low-carbon assets as well as identify any existing network constraints on future developments.

2.2.1 Baseline Heat Demand Characterisation

Individual building heating demand was calculated using benchmarks and Ordnance Survey (OS) data. Data, specifically the OS Topography Layer and OS AddressBase Premium datasets, was combined such that the corresponding building height (and subsequent number of storeys) as well as building floor area was mapped to each individual address. Where building height was not available, standard benchmarks were used to estimate the number of storeys in each building typology. In cases where multiple addresses exist in a single building, the total floor area of the full building was divided equally amongst the number of addresses it contained. By multiplying the floor area for each address by the number of storeys in the building, the total area corresponding to each address was calculated.

Every address is associated with an AddressBase Premium class code describing the purpose of the address. For non-residential address types, the heating benchmarks defined by the Building Energy Efficiency Survey (BEES) [11] conducted by Government (formerly BEIS) were used to calculate heating demand. The AddressBase class code for every non-residential address was mapped to a BEES subsector and the corresponding heating benchmark was mapped back to the address. The total heating demand for each non-domestic address was then calculated. Residential address types were classified as either 'Flats' or 'Non-Flats' (due to the similarity in square meter heating demand for residential properties which aren't flat blocks) and the heating benchmarks for each category were mapped accordingly. Addresses' demands were combined to obtain total individual building heating demand.

Table 2 Baseline heat demand per ward in Rother District

Ward	Heat Demand (MWh)
Bexhill Central	53376
Bexhill Collington	47256
Bexhill Kewhurst	46519
Bexhill Old Town & Worsham	35245
Bexhill Pebsham & St Michaels	38220
Bexhill Sackville	38291
Bexhill Sidley	40572
Bexhill St Marks	49616
Bexhill St Stephens	35851
Brede & Udimore	20414
Burwash & the Weald	45445
Catsfield & Crowhurst	23201
Eastern Rother	61064
Hurst Green & Ticehurst	41847
North Battle, Netherfield & Whatlington	43446
Northern Rother	45014
Robertsbridge	20881
Rye & Winchelsea	49677
Sedlescombe & Westfield	48995

Ward	Heat Demand (MWh)
South Battle & Telham	19134
Southern Rother	40904
Total	**844968**

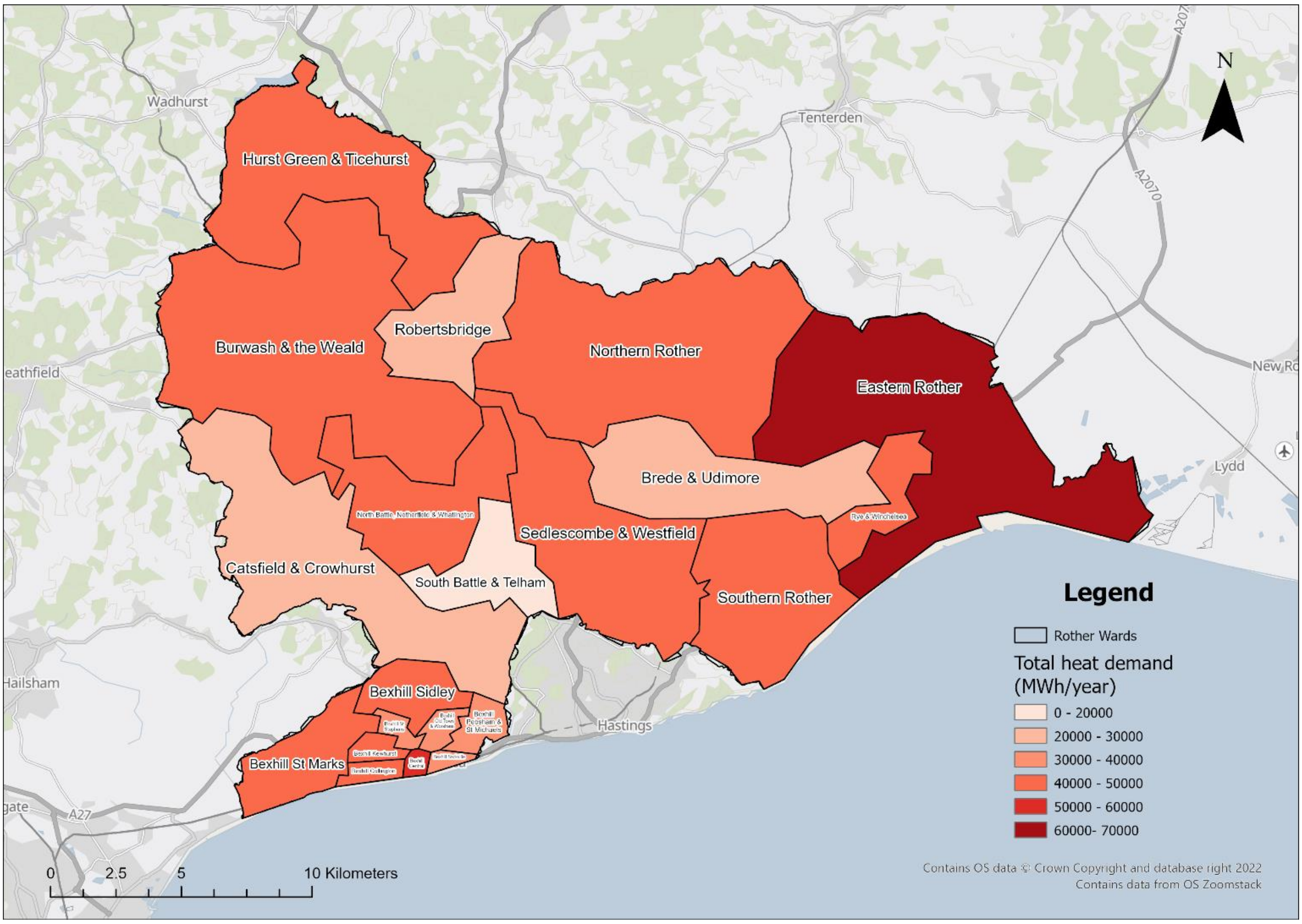

Figure 5: Baseline heat demand in the Rother District.

The baseline heat demand in Rother was calculated to be 845,000MWh/year. Most of the wards have a heating demand ranging from 30,000MWh/year – 50,000MWh/year, with Eastern Rother having the largest heat demand of 61,000MWh/year due to Eastern Rother's relatively large geographical footprint and the ward containing the greatest number of buildings compared to all other wards in Rother.

2.2.2 Baseline Electricity Consumption

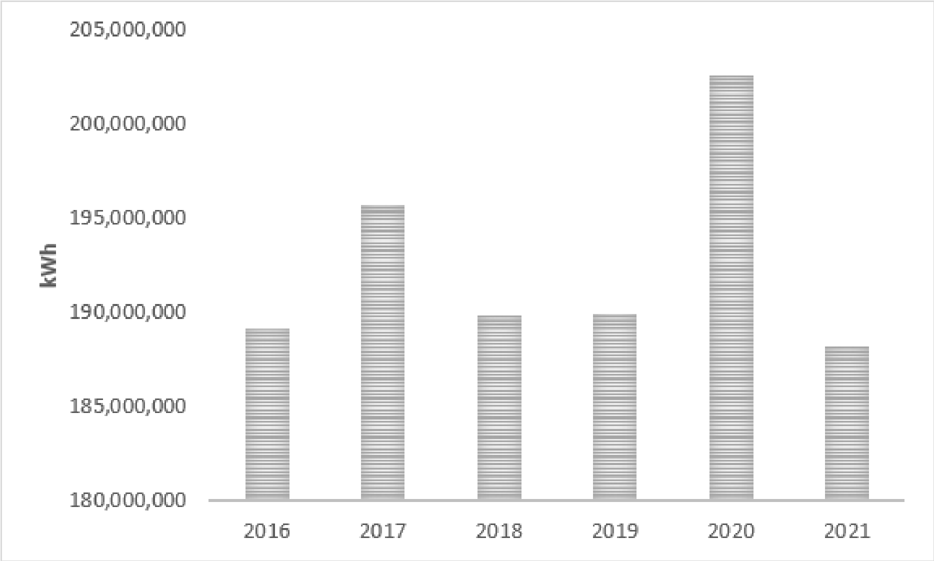

Figure 6. Annual, total domestic electricity consumption in Rother. (Source: DESNZ, Domestic electricity consumption by LSOA)

The total domestic electricity consumption for Rother was relatively similar in the last six years, with the increase in 2020 explained by the response to the COVID-19 pandemic. This also explains the reduction, as expected, in non-residential electricity consumption in 2020 (Figure 7). In 2021, non-residential consumption remained lower than the pre-pandemic levels, likely because of home working and the number of buildings with an office use in Rother in relation to the other non-residential uses.

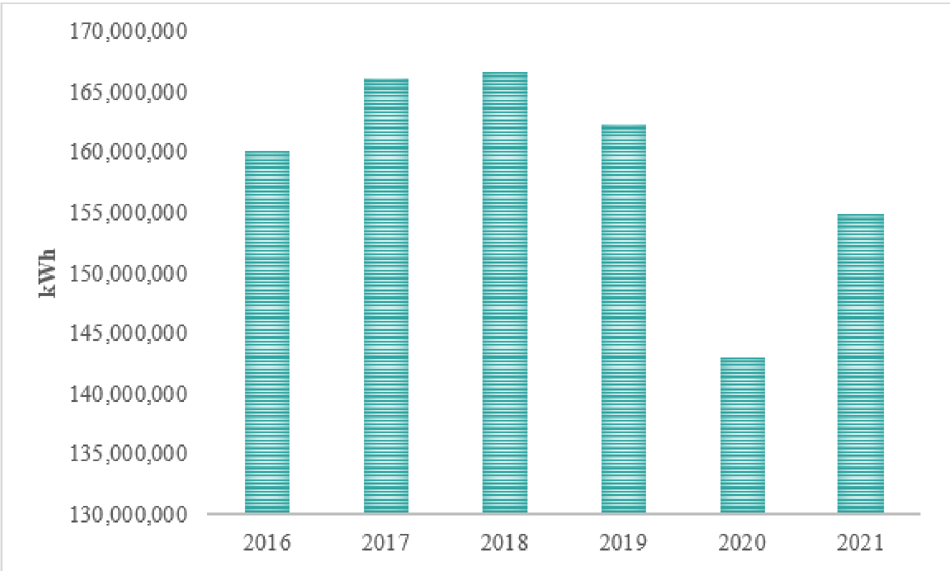

Figure 7. Annual, total non-residential electricity consumption of Rother (4,706 meters in 2021). (Source: DESNZ, Non-Domestic electricity consumption by MSOA)

Table 3 shows the median electricity intensity by building use as presented in the DESNZ Non-domestic National Energy Efficiency Data-Framework (ND_NEED) 2022.

Table 3 Non-domestic median (weighted) electricity intensity by building use, 2012-2020 (kWh / m^2). (Source: Table 9A. DESNZ, ND-NEED 2022)

Building use	2012	2013	2014	2015	2016	2017	2018	2019	2020
Arts, Community and Leisure	33	32	33	32	31	32	32	30	18
Education	65	63	65	64	62	62	60	58	51
Emergency Services	77	76	77	69	70	59	59	55	55
Factories	41	38	38	37	34	35	34	32	30
Health	100	99	100	98	95	94	91	89	81
Hospitality	197	196	203	200	187	196	195	187	111
Offices	97	91	91	88	84	85	81	76	59
Shops	160	150	153	146	141	141	134	126	84
Warehouses	35	33	33	32	30	31	31	29	27
Other	59	56	56	55	52	53	51	49	43
Total	84	79	80	77	73	74	70	67	50
Total excluding factories	99	93	94	90	86	86	83	78	56

2.2.3 Renewable Energy Generation Baseline

Existing and planned renewable energy sites in the Rother District were identified by auditing the Renewable Energy Planning Database[17] and UKPN's embedded capacity register. Only sites that were operational or had submitted planning permissions were included.

Table 4: Review of existing and planned renewable energy sites in the Rother District

Operator or Applicant	Site Name	Rother Ward	Technology Type	Storage Type	Installed Capacity (MWe)	Mounting Type for Solar	Development Status
Lightsource Renewable Energy	St Francis Farm	Catsfield & Crowhurst	Solar Photovoltaics		4.00	Ground	Operational
Iota Solar (OPDE)	Catsfield Solar Farm	Catsfield & Crowhurst	Solar Photovoltaics		12.00	Ground	Revised
Iota Solar (OPDE)	Catsfield Solar Farm	Catsfield & Crowhurst	Solar Photovoltaics		5.00	Ground	Revised
Statkraft UK Limited	Kilnwood Farm, Lunsford Cross –	Catsfield & Crowhurst	Battery	Stand-alone Storage			Application Submitted

[17] Extract taken from October 2022 quarterly update. See reference [124].

Operator or Applicant	Site Name	Rother Ward	Technology Type	Storage Type	Installed Capacity (MWe)	Mounting Type for Solar	Development Status
	Energy Storage						
Darvell Bruderhof Community	Darvell Bruderhof Community, Brightling Road – Solar Panels	Robertsbridge	Solar Photovoltaics		0.50	Ground	Application Submitted
Sunsave 26 (Pashley) Ltd	Pashley PV	Bexhill Sidley	Photovoltaic		10.125	Ground	Operational
CEMG EXPORT PORTFOLIO	Pebsham Landfill Site	Bexhill Pebsham & St Michaels	Gas turbine (OCGT) – biofuel landfill gas		1.00		Operational
Biffa Waste Services Ltd	Pebsham Landfill Site	Bexhill Pebshame & St Michaels	Gas turbine (OCGT) – biofuel landfill gas		1.40		Operational
Balanced Grid Solutions Ltd	Kilnwood Farm	Catsfield & Crowhurst	Battery		49		Accepted to connect
Balanced Grid Solutions	Olives Farm	North Battle, Netherfield & Whatlington	Battery		52.4		Accepted to connect

2.2.4 Review of previous studies

Previous local renewable electricity generation feasibility studies have shown potential to contribute towards Rother's 2030 net-zero target. A policy review was conducted to collate the outputs from previous studies and the results are summarised in Table 5.

Table 5 Review outlining the findings of previous renewable energy and district heat network feasibility studies.

Document description	Technology	Capacity	Outputs
Renewable Energy Background Paper (2016): Background paper for Rother's Local Plan (2019-2039). Builds on findings in 2010 background paper.	Wind	6MW	The following areas have potential based on wind speed maps: • Fairlight-Hastings-Heathfield Ridge • Bexhill Fringes Builds on 2010 study by excluding Rye due to presence of internationally protected sites, particularly Special Protection Areas for birds.
Wind Energy Feasibility Study (2021): Collaboration between Rother District Council and Energise Sussex Coast	Wind	25MW	Capacity based on estimated potential to be installed using 2.5MW wind turbines. Rye/Camber/Playden identified as having most potential for wind.

Document description	Technology	Capacity	Outputs
Site Solar assessed RDC sites (2018): Identifies buildings suitable for rooftop solar.	Rooftop solar PV	Not specified	All sites identified for further investigation are in Bexhill, Battle, Camber, or Rye.
Infraland Breadsell, Hastings Renewable Energy Report (2022): Feasibility assessment of a site at Breadsell Lane, St Leonards-On-Sea (near Hastings) for potential renewable development.	Ground-mounted solar + battery energy storage system (BESS)	20MW ground mounted solar + 38MW BESS	Portion of the site is in Rother boundary Identified as a Carbon Mitigation Zone in the Hastings consultation draft (Regulation 18) Local Plan.
RCEF Stage 1 Feasibility Study, RINA (2022): Part of the Warmer Crowhurst project, considers district heat network, heat pump and solar PV feasibility in Crowhurst. Undertaken by BHESCo and RINA.	Rooftop solar PV	0.50MW	Assumes village-wide rollout of rooftop domestic PV (excluding a few properties due to shading or Grade II listed status). 2kWp panels assumed for all domestic buildings.
RCEF Feasibility Study – Solar Farm, Energise Sussex: Part of the Warmer Crowhurst project. Collaboration between	Ground-mounted solar farm.	5.84MW	Solar farm proposed spans five fields in Swainham Lane. Solar farm could potentially fund the improvements to individual homes and the zero-carbon transition of the entire village.
RCEF Stage 1 Feasibility Study, RINA (2022): Part of the Warmer Crowhurst project, considers district heat network, heat pump and solar PV feasibility in Crowhurst. Undertaken by BHESCo and RINA.	District heat networks.	Total heat demand of all proposed networks: 2,662 MWh/yr	17 heat networks explored that would connect to around 67% of the properties in the village (166 out 251 of the total domestic properties connected). No non-domestic buildings included in heat networks due to small heat load or not being in clusters. BHESCo outlines financial model with the potential for a community heat offer, involving a community co-operative. Conclusion was that these schemes would only work in some cases.
Camber Heat Analysis, Buro Happold (2022) Interim heat demand analysis will form part of final feasibility study on renewables, energy efficiency and decarbonisation of heat in Camber and Rye Harbour.	District heat networks.	N/A	High level heat load assessment shows that there is not enough concentration of heat in Camber or Rye Harbour to look at a high-temperature district heating.

These outputs will be compared to the renewable energy and district heat network potential identified in the analysis performed in Section 9.

2.2.5 Constraints

A significant barrier to the uptake of renewable energy or electrified heating projects within Rother is constraints on the local grid. UKPN publishes its network development plan that lists the DNO's (Distribution Network Operator's) substation upgrade schedules; however, significant primary level substation upgrades have long timescales. The earliest completion date for upgrades to substations serving the Rother District is 2026 according to UKPN's Network Development Report (2022)[18]. Consequently, this barrier is predicted to continue to hinder the rapid deployment of large-scale renewable energy projects up until that date. However, UKPN has communicated interest in collaborating directly with local authorities to facilitate grid capacity increases to enable local renewable projects where feasible.

The cost to developers is an additional constraint to renewable energy project development. Where the renewable project places constraint on the network, be it at a high or lower voltage network, this significantly impacts the cost to the developer and needs to be considered at the feasibility study phase.

2.3 Key findings of Carbon and Energy Baselining

The emissions pathways show that Rother needs to be very ambitious to achieve its 2030 net-zero carbon targets. Rother needs to maintain and enhance its carbon sequestration potential, facilitate a transition to sustainable lifestyles for its residents and enable growth decoupled from energy use and carbon emissions.

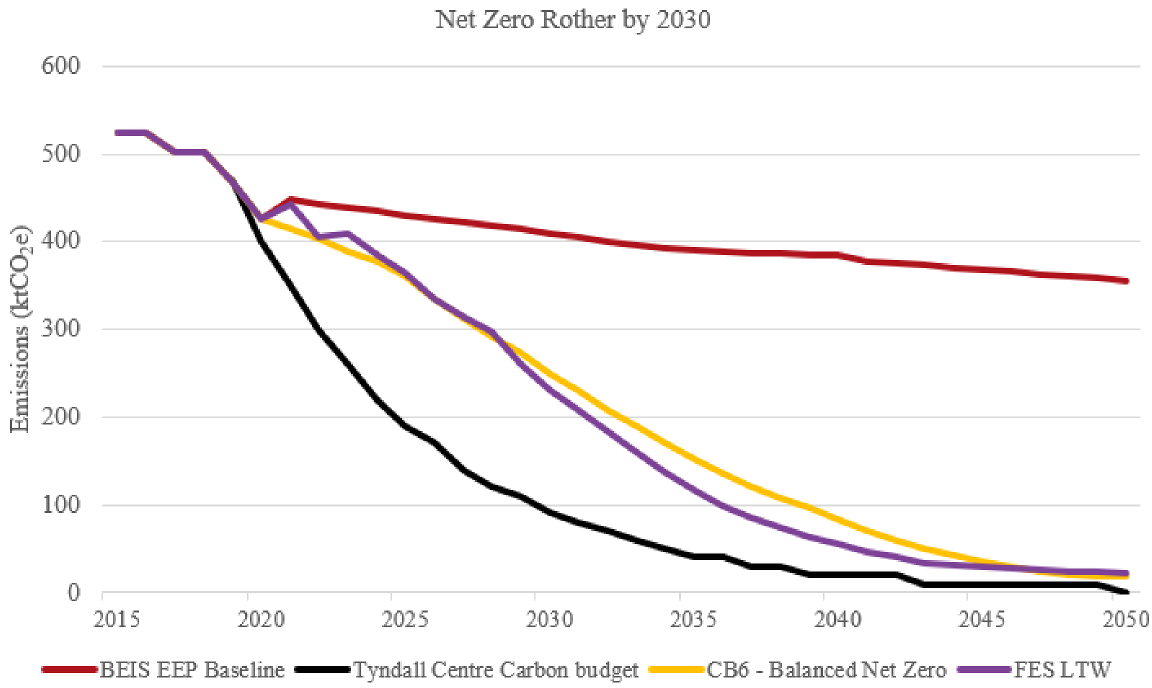

Figure 8. Rother emissions trajectory to achieve Net Zero under different scenarios of sectoral emissions transformation (Graph does not include LULUCF emissions removal).

A combination of measures and policies will be necessary to reduce emissions from domestic heating and transportation. Most importantly, regardless of any policy affecting new development, ambitious measures will be necessary to achieve rapid decarbonisation of the existing housing stock through retrofit at scale, investment in local renewable energy and enablement of street to neighbourhood level low carbon heat and electricity solutions. The development of brownfield

[18] UKPN's Network Development Report for the Southern Power Networks operational area (2022). Available here: https://ukpowernetworks.opendatasoft.com/pages/ltds_ndp_landingpage/

areas and the intensification of urban centres should be prioritised and land with high sequestration potential should be protected and enhanced wherever possible.

2.3.1 Implications for Local Plan

With focus on the Local Plan and its role in the future decarbonisation plans for Rother the main implications are:

- Land use changes should prioritise greenhouse gas removals with new woodland, some farmland shifting to energy crops, and sustainable management of woodlands, wetlands and arable lands.
- Local renewable electricity generation and low carbon heat will be key features of any new development. The Local Plan should consider the planning policies required to enable the cost-effective use of low carbon energy technologies.
- Planning requirements for new development should consider the sequestration potential of the selected sites, prioritise development in sustainable settlements and intensification, and require the maximisation of sequestration through design. Development should be avoided in areas with high carbon sequestration potential.
- Transportation has an important role due to the dispersed settlement pattern in Rother and poor shared and active transport options, particularly in its rural areas. Measures and policy should focus on 1) reduction of trip rates and miles, 2) zero emissions public transport, 4) electrification of private vehicles, and 5) incentives for visitors to use public transport instead of driving in the district.

2.4 Legislative and Policy Context

This section examines the current policy and legislative context for Rother, taking account of climate change and net zero building legislative requirements and national policy.

2.4.1 Legislative Requirements

Local planning authorities have a legal duty[19] to ensure that plan policy contributes to the mitigation of, and adaption to, climate change. This means that local plans have to demonstrate how policy contributes to the Climate Change Act 2008 target regime and that Local Plans have to set out their baseline carbon dioxide emissions and the actions needed to reduce emissions over time.

Building Regulations govern the legal standards for the design and construction of buildings to ensure the health and safety of individuals in and around these buildings. They also encompass requirements on the fuel usage and energy efficiency of buildings [12]. They therefore provide the legal minimum standards for energy and other sustainability performance metrics for buildings.

To initiate a net zero pathway towards Future Homes and Future Buildings Standards by 2025, there have been interim updates to the Building Regulations, following a recent Government consultation.

These interim updates entailed an ambitious increase in the energy efficiency of new homes through changes to Part F (Ventilation) of the Building Regulations and Part L (Conservation of fuel and power) [13]. The updates to Parts F and L came into force for developers who make a planning application on or after 15 June 2022. For developers who received planning permission before this date, the new requirements will not apply if they have already substantially started building works [14].

There were accompanying updates to statutory guidance including:

- Updates to Approved Documents L (Ventilation) and F (Conservation of fuel and power), and
- Introduction of new Approved Document O (Overheating) and Approved Document S (Infrastructure for charging electric vehicles) [15].

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[19] Section 19 of the Planning and Compulsory Purchase Act 2004, as amended by the Planning Act 2008; Climate Change Act 2008, Environmental Assessment Regulations 2004

A summary of each of these Documents is provided in the Appendix A1.

Ahead of establishing the Future Homes and Future Buildings Standards by 2025, the Government will hold another full technical consultation. The consultation will consider improvements to the energy efficiency of non-domestic buildings, alongside energy efficiency and overheating in new and retrofit homes [16].

2.4.2 National Planning Policy & Guidance

National policy[20] requires policies and decisions to be in line with the Climate Change Act 2008 and paragraph 152 expects the planning system to *'shape places in ways that contribute to radical reductions in greenhouse gas emissions'.*

Local Planning Authorities are permitted to set additional technical requirements for building energy performance, beyond those in Building Regulations, as per Planning Policy Guidance on 'Housing: optional technical standards' [17] and advice in a Written Ministerial Statement [18]. While the Government previously considered removing this ability from LPAs through amendments to the Planning and Energy Act 2008, it recently confirmed that this would not go ahead in the immediate term [19]. This advice is reiterated in National Planning Policy Framework (NPPF) (2021) paragraph 154b).

NPPF guidance on securing net zero new buildings is limited to paragraphs 154b) and 157b) – they advise that LPAs should support development that minimises energy consumption and greenhouse gas emissions, by considering the development location, orientation, massing, landscaping, and other factors.

The NPPF shows support at for proposals involving decentralised, renewable, and low energy generation (paragraphs 155 and 157 – 158), as long as their adverse impacts can be satisfactorily addressed. Paragraph 155 requires Local Plans to identify suitable areas for these energy generation proposals and consider opportunities for them to supply energy and heat to neighbouring development. Additionally, NPPF paragraph 157a) sets the expectation for developers to comply with any Local Plan policies requiring decentralised energy supply, unless it is not feasible or viable.

2.4.3 Adopted Local Policy

Rother's current Local Plan comprises the following:

- Core Strategy (CS) adopted in 2014,
- Development and Site Allocations Local Plan (DaSA) adopted in 2019, and
- Saved site specific policies in the Rother District Local Plan adopted in 2006 [20].

There are also four Supplementary Planning Documents (SPDs), including two site specific SPDs, one on Affordable Housing and another on Car Parking Standards.

Of these Local Plan documents, there are two key adopted policies related to net zero buildings:

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[20] Paragraph 153 of the NPPF; climate change section of the PPG; Climate Change Act (2050 Target Amendment) Order 2019

- CS Policy SRM1: Towards a low carbon future (excluding part (i))[21]

  This policy includes the following requirements:

  - All development should meet prevailing energy efficiency standards; developers are also encouraged to go beyond these standards (by considering low carbon or renewable energy generation), although this is caveated with consideration for viability.

  - Extension proposals are encouraged to reduce the carbon emissions of the entire building and secure improvements in energy efficiency.

  - Renewable and low carbon energy generation schemes are supported, as long as they do not adversely affect local amenities, ecology, heritage assets or landscape character.

- DaSA Policy DRM3: Energy Requirements

  This policy includes the following requirements:

  - For all developments, the degree of renewable and low carbon energy included in a proposal will be weighed favourably in decision-making.

  - For developments of more than 100 dwellings or 10,000 sqm of non-residential floorspace, applicants should demonstrate regard to energy efficiency (including through inclusion of renewable and low carbon energy) as part of their Design & Access Statement.

2.4.4 Implications for Study

In terms of legal requirements, the updated Building Regulations provide a thorough baseline position for any Local Plan policy. It standardises the expectations for achieving net zero carbon across all new building schemes, balancing competing considerations such as air tightness and indoor air quality. The upcoming Future Homes and Future Buildings Standards will strengthen this baseline position in 2025.

From a planning policy perspective, the relevant paragraphs of the NPPF are less specific, providing only general principles for achieving net zero carbon development.

On Rother's current adopted policies, CS Policy SRM1 and DaSA Policy DRM3 provide more specific considerations for developers on energy efficiency and renewable generation schemes. However, it is noted that the policies above do not currently contain numerical thresholds on energy or building performance. DaSA Policy DRM3 also removed the requirement for developers to provide energy strategies and assessments of CHP (Combined Heat & Power) generation potential, when it was adopted in 2019.

[21] For clarity, part (i) of CS Policy SRM1 was superseded by DaSA Policy DRM3 when adopted in 2019 - it was considered that the CS Policy SRM1 stipulated overly onerous requirements on developers in relation energy strategies and assessments of CHP (Combined Heat & Power) generation potential. See reference [123].

3. Examining best practice

This chapter examines best practice of what is being done in terms of net zero building standards and policies elsewhere. Understanding emerging industry standards and how net zero policies have been developed and applied elsewhere provides examples which may be applicable to Rother.

3.1 Technical Building Assessments

The following best practice standards have been reviewed on technical building assessments. For further details and references, see Appendix A.1.

3.1.1 BREEAM, BREEAM Infrastructure and HQM

BREEAM has been developed for assessing the sustainability of buildings and BREEAM Infrastructure for assessing the sustainability of civil engineering, infrastructure, landscaping, and the public realm works. The Home Quality Mark (HQM) was also developed by the Building Research Establishment (BRE) to help developers assess and provide assurance on the quality of new homes. The use of HQM as a 'preferred option' within Local Plans is growing. The Planning Practitioner Guidance report suggests Local Authorities should first understand the local area need and the viability of raising efficiency standards. Crucially, Authorities must ensure that their requirements for BREEAM, BREEAM Infrastructure and HQM are clearly outlined in the Local Plan, to prevent a potential challenge if these standards are conditioned in a permission.

3.1.2 UKGBC - Net Zero Carbon Buildings: A Framework Definition (UKGBC, 2019) & follow-up guidance (UKGBC, 2020 & 2021)

This Framework was published in 2019 to establish an industry definition of net zero carbon buildings and advises a 'reduction first' approach to achieving net zero carbon. The UKGBC have also produced a second document signposting best practice standards which includes input from the Low Energy Transformation Initiative (LETI) and Royal Institute of British Architects (RIBA), and they have produced guidance with additional technical requirements which, on some matters, supersede the original high-level guidance.

The UKGBC are now also involved in the development of a UK Net Zero Carbon Standard in conjunction with BRE, LETI and RIBA. This will provide a single method of verifying net-zero carbon status of buildings and is likely to supersede the 2019 Framework. Rother DC are a UKGBC member.

3.1.3 The Passivhaus Standard (Passive House Institute, 2022)

The Passivhaus Standard focuses on substantially reducing space heating and cooling requirements and establishing good indoor comfort levels, by adopting a fabric first approach and systems level ventilation. Passivhaus buildings achieve a minimum 75% reduction in space heating requirements, over standard UK new build practice.

Achieving Passivhaus Standard in the UK typically involves design modelling using Passive House Planning Package (PHPP) software, very high insulation levels, extremely high-performance windows with insulated frames, airtight building fabric, 'thermal bridge free' construction and a mechanical ventilation system with highly efficient heat recovery.

3.1.4 LETI Guidance

The Low Energy Transformation Initiative (LETI) have published several documents offering best practice guidance for Carbon Resilience. These are

- Defining and Aligning: Whole Life Carbon and Embodied Carbon

- Whole Life Carbon 'One-Pager'
- Embodied Carbon Target Alignment
- Embodied Carbon 'One-Pager'
- Climate Emergency Retrofit Guide

These documents set out a range of guidance and standards to aid the built environment industry reduce carbon emissions. Some principles set out are that: the built environment industry should only use the limited amount of carbon apportioned to it and incorporate low carbon and circular economy principles in materials and design. The documents also suggest buildings should all achieve LETI 2030 design target of 'A' rating and should follow the LETI elemental reduction strategies for reducing embodied carbon. Furthermore, LETI have published six principles for best practice in retrofit, meaning their documents cover all bases for new buildings as well as retrofit.

3.2 Renewable Energy

The following best practice standards have been reviewed on renewable energy:

- The Local Government Association's 'Renewable energy good practice guidance' is designed to help local Members and Council officers understand and manage the potential risks and benefits of siting and delivering large scale renewable schemes.

3.3 Advice for Local Policy-Makers

The following best practice standards have been reviewed on net zero local policymaking:

3.3.1 The New Homes Policy Playbook (UKGBC, 2021)

The UKGBC's Playbook (2021) seeks to push Local Authorities to go beyond national policy in setting sustainability policies. It proposes that Local Authorities match upcoming Building Regulations in carbon emissions targets and provides advice on net zero carbon, overheating, and assuring performance.

3.3.2 Planning for A Smart Energy Future (RTPI, 2019)

This report was produced for planning policy and decision makers to create future planning policy that can 'catch up' to the clean growth opportunities offered by smart energy. The report makes several recommendations including the need for more top-down leadership in planning to deliver transformational change and for Local Authorities to improve access to resources and training to stay up to date on new energy technologies.

3.3.3 'The Climate Crisis Guide' RTPI, TCPA (4th edition, 2023)

This guide focuses on the broad approaches to handling carbon reduction and climate adaptation through the planning system. It refers to the relationships between planning and other systems, such as building regulations, but focuses on the former. It highlights that the core purpose of planning is to create places that enable people to live happy and healthy lives and that it is not possible to achieve this aim without addressing both climate change mitigation and climate change adaptation. It sets out the legal and policy background; advises on collating an evidence base and policy approaches for plan-making; and offers advice on decision-making. It provides case studies and advice in relation to, amongst other issues, district heat networks in new developments and binding net-zero standards for new development. This guide also provides advice on setting requirements for sustainable buildings with reference to the BRE and PassivHaus standards.

3.3.4 Cracking the Code (RTPI, 2022)

To achieve net zero and nature recovery, the RTPI has prepared a guide on district and site level design codes. The advice builds on the National Model Design Code and was produced in collaboration with planning, climate and transport specialists, alongside the Royal Society for the Protection of Birds (RSPB).

This design code comprises a baseline carbon assessment, mapping of energy and potential energy sources, a high-level spatial vision for 2040, critical success factors for 2040 and lastly, design principles and core requirements for all types of allocations.

3.4 Review of Best Practice in Local Plan Policy

3.4.1 Purpose of review

Following the review of non-statutory net zero buildings standards (see section 3 and Appendix section A.1.3 – A.1.5), the study proceeded to look at how and where these standards and other metrics had been used in recent Local Plan policy.

The purpose of this review was to identify case studies of net zero building policies in recently adopted or proposed submission Local Plans to increase the Council's awareness of the lessons learned by other Local Planning Authorities (LPAs) and to inform the policy wording in their Local Plan (see section 5.3).

3.4.2 Case Studies of recent Local Plan policies

Methodology

This section presents key policy case studies arising from a comprehensive review of examples of best practice from other LPAs in England. The case studies set out the characteristics of each LPA and demonstrate their applicability to Rother District Council, break down key points from each policy, and illustrate the different standards they set for development proposals.

Case studies have been selected through a thorough review process, by which several policy examples were gathered, categorised and analysed for their applicability to different levels of climate resilience intervention and for their applicability to Rother as a Local Authority.

This process culminated in the selection of policy examples from Cornwall, Oxford, Milton Keynes and West Berkshire.

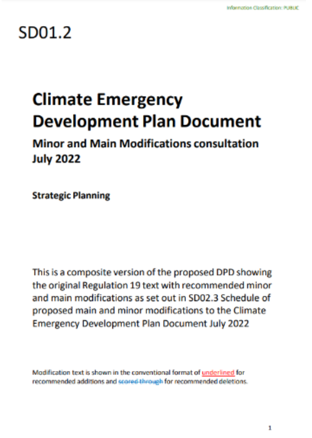
Overview of Case Studies

From each case study LPA in this section, the following policies have been considered:

- Cornwall – Climate Emergency Development Plan Document – Policy SEC1
- Oxford – Oxford Local Plan - Policy G8
- Milton Keynes – Plan:MK (Local Plan) - Policy SD1
- West Berkshire – Local Plan Review - Policy DC3 and Policy SD5

In addition to the examples listed above and detailed overleaf, please see Appendix A1 for a full record of the long list of policy examples.

Cornwall Council, Cornwall Climate Emergency Development Plan

Adopted February 2023	Climate Emergency Development Plan Document [21]
 SD01.2 **Climate Emergency Development Plan Document** **Minor and Main Modifications consultation July 2022** **Strategic Planning** This is a composite version of the proposed DPD showing the original Regulation 19 text with recommended minor and main modifications as set out in SD02.3 Schedule of proposed main and minor modifications to the Climate Emergency Development Plan Document July 2022 Modification text is shown in the conventional format of underlined for recommended additions and scored through for recommended deletions. 1	The Cornwall Climate Emergency Development Plan covers an area of 3,559 square kilometres with a population of 570,300 [22]. Cornwall's topography is characterised by 697km of coastline [23] including the most southwestern point of Great Britain at Land's End, along with inland areas of exposed upland including Bodmin Moor as well as pastoral farmland and wooded valleys near the south coast. Main settlements include Truro, Falmouth, Penzance, St. Ives, Padstow, St Austell and Newquay. Cornwall's economy is characterised by tourism, fishing, agriculture, mining and aerospace at Newquay airport.

Relevant Policies

Policy SEC1 – Sustainable Energy and Consumption

This policy requires proposals to embed the energy hierarchy within the design of buildings, with all major non-residential developments required to achieve BREAAM 'Excellent'. All new residential development will be required to achieve Net Zero Carbon and submit an 'Energy Statement' demonstrating how they will achieve: space heating demand less than 30kWh/m^2/annum, total energy consumption of less than 40kWh/m^2/annum, and onsite renewable energy generation to match total energy consumption, with a preference for roof-mounted solar PV.

In addition, this policy gives significant weight to considerable improvements to the energy efficiency and reduction in carbon emissions in existing buildings and states that the council will support domestic and non-domestic renewables, such as solar panels, where they require planning permission. This policy is caveated so that proposals that effect the significance of heritage assets and their settings must ensure.

- Not to cause harm to appearance or historic character.
- Require minimal intervention with the fabric of the building.
- And be easily reversible.

Relevant standards and best practice

This document uses the BREAAM standard by requiring major non-residential developments to achieve BREAAM excellent status.

In addition, this document cites the use of the Energy Hierarchy to reduce energy consumption through good design. All proposals no matter what typology should embed the Energy Hierarchy in their design, which means they must prioritise fabric first, orientation and landscaping to minimise energy demand (for heating, lighting, and cooling), and all proposals should consider opportunities for solar PV and energy storage.

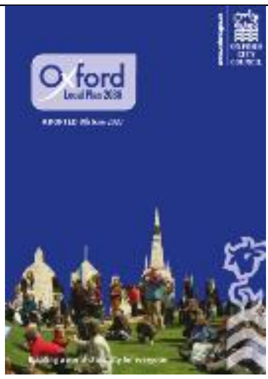
The policy utilises energy use intensity targets, requiring a space heating demand of less than 30kWh/m^2/annum, a total energy consumption of less than 40kWh/m^2/annum, and a requirement for onsite renewable energy generation to match total energy consumption.

Summary and applicability to Rother

This document shows an ambitious approach to implementing net zero building policies within a coastal environment, which provides a helpful benchmark to test applicability in Rother. Policies relating to application of BREAAM standards, residential efficiency requirements and supporting retrofit are all areas which could prove applicable in Rother.

The Plan has been examined and found sound by a Planning Inspector. He considered that the general approach and Policy C1 was a reasonable response to Cornwall’s declared climate emerge

Oxford City Council, Local Plan

Adopted June 2020	Oxford Local Plan [24]
	The Oxford Local Plan aims to determine the homes, jobs, communities, and facilities until 2036, and covers a total area of c.46sqkm and including a population of 162,100 [25]. Oxford is made up of several main 'centres' including the City Centre, Cowley, East Oxford-Cowley Road District, Headlington District, Summertown District, and the Blackbird Leys District. Around 27% of Oxford is in the Green Belt, and most of this land is flood plain [25].

Relevant Policies

Policy RE1 – Sustainable Design and Construction

Requires applicants to demonstrate the use of sustainable design and construction principles incorporating energy efficiency and the use of low carbon energy, water conservation and efficiency, use of recycled and recyclable materials and responsible sourcing, minimising waste and maximising recycling during construction and operation, minimising flood risk, adaptability and flexibility to future occupier needs and enhancing biodiversity. In addition, this policy requires the submission of an Energy Statement for residential and non-residential schemes over 1,000m^2.

This policy also requires at least a 40% reduction in carbon emissions from the 2013 building regulations, increasing to a 50% reduction from 31 March 2026 and increasing (for residential developments) to -'zero carbon' from 31 March 2030. Non-residential developments are required to meet BREEAM excellent standard.

The policy also states that the council will encourage the development of city-wide heat networks and that if a heat network exists in proximity to a scheme, it will be expected to connect to it.

Relevant standards and best practice

This document uses the BREEAM standard as a requirement for non-residential development, which will be required to demonstrate that they meet BREEAM 'excellent' standard.

This document also notes that the council will encourage residential schemes to use the Home Quality Mark (HQM) and Passivhaus standards to demonstrate energy efficient design.

Summary and applicability to Rother

This plan provides a useful case study for the integration of multiple building standards (BREEAM, HQM and Passivhaus) and the requirement for developments to demonstrate progressively more ambitious net zero targets over time, gradually transitioning to requiring all new residential developments to be net zero by 2030.

Milton Keynes City Council, Plan:MK 2016-2031

Adopted March 2019	Milton Keynes Local Plan, Plan:MK 2016-2031 [26]
	The Milton Keynes Local Plan covers the period up to 2031 and covers an area of approximately 310sqkm miles and a population of 275,000. Milton Keynes is a medium sized city characterised by a mix of land uses including higher education, a growing residential population and key employers including Amazon and Santander [27]. The vision of this plan sets out that Milton Keynes wants to remain "one of the 'greener' UK cities with high environmental standards" [26].

Relevant Policies

Policy SC1 – Sustainable Construction

This policy requires development proposals to demonstrate compliance with sustainable construction principles across the topics of materials and waste; energy and climate; water; and retrofitting. All non-residential developments of at least 1,000m^2 are required to achieve a BREEAM 'Outstanding' rating or meet the requirements below, which also apply to residential development.

In terms of materials and waste, the policy requires the reuse of land and buildings (wherever feasible); reuse and recycling of demolition and refurbishment materials; prioritising materials and construction techniques with smaller ecological and carbon footprints; green roofs and walls; consideration of the lifecycle of a building (including ease of adaption, modification and recycling at end of life); and space to foster greater levels of recycling of waste.

In terms of energy and climate, all development is required to implement the Energy Hierarchy; to review opportunities to provide energy storage and demand management; to design buildings and a built environment that is resilient to the predicted impacts of climate change. Developments of 11 or more dwellings or non-residential developments greater than 1,000m^2 are required to submit an Energy and Climate Statement demonstrating that the development will: achieve a 19% carbon reduction from the standards set within the 2013 Building Regulations Approved Document Part L; on-site renewable energy generation or connection to a community energy scheme that contributes to a further 20% reduction in residual carbon emissions; make financial contributions to the council's carbon offsetting fund to enable the residual carbon emissions to be offset by local initiatives; for dwellings, calculate indoor air quality and overheating risk; implement a recognised quality regime to ensure that 'as built' performance matches design calculations; and put in place a recognised monitoring regime to assess this performance for 10% of the dwellings for the first five years of occupancy.

This policy also considers retrofitting, noting that "Proposals which would result in considerable improvements to the energy efficiency, carbon emissions and/or general suitability, condition and longevity of existing buildings will be supported, with significant weight attributed to those benefits".

Policy SC2: Community Energy Networks and Large-Scale Renewable Energy Schemes

This policy attributes 'significant weight in their favour' to low carbon and renewable energy schemes where they will not have any significant negative impacts.

It also expects proposals for over 100 homes or non-residential developments of over 1,000 sqm to consider the integration of community energy networks; and for all new development in proximity to an existing or proposed combined heat and power station or local energy network to connect to the network, unless a better alternative for reducing carbon emissions can be achieved, the connection is not justified or unviable.

Policy SC3: Low Carbon and Renewable Energy Generation

This policy encourages low carbon and renewable energy developments that are led by, or meet the needs of, local communities.

Relevant standards and best practice

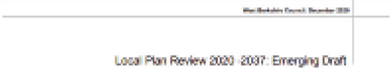
This plan requires a BREEAM 'outstanding' rating or demonstration of sustainable construction across 13 criteria for all non-residential development of at least 1,000m^2. All residential developments are required to meet the 13 criteria, with developments of 11 or more dwellings required to demonstrate 19% carbon reduction improvement on Part L 2013, a further 20% reduction through on-site renewable generation and carbon offset of the remainder of emissions through financial contributions to the Council's carbon offset fund.

Policy SC1 also requires developments to implement a 'recognised quality regime' to ensure 'as built' performance matches calculated design performance; however it does not specify any specific regime requirements.

Summary and applicability to Rother

This plan sets out a comprehensive policy covering expectations for strategic development and includes policies which also consider the wider benefits delivered from climate resilience measures. The requirement to demonstrate benchmarked carbon reductions shows an ambitious carbon mitigation approach, which also includes contributions to the council's offsetting fund and support for retrofitting measures. This plan also covers transport solutions associated with strategic development, and the fact these must also feed into the sustainability agenda of the Council.

West Berkshire, Local Plan Review 2020-2037

Proposed Submission (Regulation 19) version published January 2023	West Berkshire Local Plan Review 2020-2039 [28]
 Local Plan Review 2020 -2037: Emerging Draft	West Berkshire's Local Plan covers the period up to 2039 and spans an area which is predominantly rural in character (90%) and of which 74% is within the AONB of the North Wessex Downs [28]. West Berkshire's population is 161,400 and key settlements include Newbury and Thatcham, Tilehurst, Purley on Thames and Calcot. West Berkshire is part of the Thames Valley and has good road connections to Reading, Oxford, Swindon, Basingstoke, and London [28].

Relevant Policies

Policy DM 4: Building Sustainable Homes and Businesses

This policy requires new development on one or more dwelling, and/ or non-residential floorspace of more than 100sqm to achieve net zero operational carbon emissions by implementing the energy hierarchy and should demonstrate this through an Energy Statement or a detailed energy section within the Sustainability Statement. This statement must demonstrate how minimum construction standards are achieved to the 'greatest extent feasible and viable'.

All residential development must achieve the carbon target emission rate set by the Future Homes Standard, once confirmed, and in the meantime achieve 63% reduction compared to Part L 2021 (SAP 10.2) by on-site measures. This reduction is to be achieved before the addition of on-site renewable electricity generation; it must also have a space heat demand of equal or less than 15kWh/M^3/year.

Residential refurbishment developments of 10 dwellings or more must meet BREEAM Domestic Refurbishment Excellent, as a minimum.

Non-residential development of 100sqm or more must demonstrate a percentage reduction in energy emissions using a nationally recognised standard; and achieve BREEAM Excellent.

All residential development and non-residential over 100sqm is required to achieve net zero operational energy on site through zero and low carbon energy technologies.

Where development cannot demonstrate that it is net-zero, it is required to provide a financial contribution in lieu, calculated based on emissions over a 30-year timeframe from completion.

Policy SP 5 – Responding to Climate Change

All development is required to embed the principles of climate mitigation and adaptation into new development and tod contribute to the District's becoming and staying carbon neutral by 2030. Development is expected to demonstrate that they have taken advantage of latest low and zero carbon technologies and innovations, including digital tools; achieve net zero carbon development by applying the energy hierarchy, achieving the highest levels viable levels of energy efficiency, generating and supplying renewable, low and zero carbon energy and, as a last resort carbon offsetting; and that they achieve the highest viable levels of energy efficiency.

It also requires development to generate and supply renewable, low and zero carbon energy for its own use and/or local distribution networks; provide for sustainable forms of vehicular and personal transport; enable recycling and waste reduction during construction and occupation; manage and conserve water resources; provide green infrastructure to detain water run-off and absorb carbon emissions; improve wildlife habitat; and improve the energy performance of heritage assets without compromising their significance.

Proposals should be accompanied by a Sustainability Statement which demonstrates how these principles have been embedded into the development.

Relevant standards and best practice

Proposals for residential development will meet the following minimum standards of construction:

- 63% reduction in carbon emissions compared to Part L 2021 and the Future Homes Standard once this is confirmed and space heat demand of equal or less than 15kWh/M^2/year

Residential Refurbishment [10+ dwellings] BREEAM Domestic Refurbishment Excellent

Proposals for non-residential development must meet BREEAM excellent as a minimum and demonstrate a percentage reduction in energy carbon emissions

Summary and applicability to Rother

This proposed submission local plan includes ambitious policies which emphasise requirements as a minimum, and expects development to exceed these requirements, and also requires net-zero through the use of on-site materials and a financial contribution if net-zero cannot be achieved. The standards have been amended since an emerging draft local plan was published for consultation, with the removal of a scaled approach and the use of HQM, and the introduction of energy use intensity measures.

It should be noted that this plan has not yet been the subject of public examination.

4. Synthesising policy options from best practice review

The best practice review of Local Plan policies (along with the industry standards that they incorporate) were used to synthesise potential policy options. Organised as minimum, medium, and maximum, these options informed the technical evidence and carbon modelling to formulate overall Rother policy recommendations in Section 10.

4.1 Methodology

First, a long list of net zero building policies was collated from both recently adopted and emerging Local Plans in England. It is highlighted that the number of relevant Local Plans for this process was impacted by the small (albeit growing) number of LPAs incorporating net zero policies into their Plans. This long list was then organised by level of stringency of net zero building standards.

For the minimum policy scenario, it was determined that this should equate to the current adopted Rother Local Plan policies. It therefore comprised the requirements of adopted Core Strategy (CS) Policy SRM1: Towards a low carbon future (parts (ii) to (viii)) and the adopted Development & Site Allocations (DaSA) Policy DRM3: Energy Requirements (further details of both policies in section 2.4.3).

For the medium and maximum policy options, these were developed based on the following principles:

- Going beyond the current and upcoming Building Standards. This is driven by UKGBC advice for Local Authorities seeking to reach their climate emergency targets [29] and by the need to future proof Rother's planning policies against further advancements in Building Standards beyond the Future Homes and Future Buildings Standards.

- Incorporating use of Energy Use Intensity (EUI) targets (as used in Cornwall's adopted policy and West Berkshire's proposed submission local plan policy). As advised by LETI, these are more robust measures of building performance, since they are solely determined by a building's in-use performance, and not carbon emissions which would reflect the carbon intensity of the grid [30].

- Accounting for a broader range of key building performance metrics with impacts on net zero. This was achieved by identifying types of metrics from industry best practice standards (see section 4) and the long list of net zero planning policies. It resulted in embodied carbon and whole life carbon being included in the package options.

To differentiate from the medium policy option, we sought to ensure that the maximum option encompassed the most ambitious and innovative policy exemplars, based on industry advice. As a result, off-site measures, which are lower on the UKGBC's carbon reduction hierarchy [31], were not included in the maximum policy package option.

4.2 Overview of results from the Residential Net Zero Buildings Policy Options review

	Minimum policy option	Medium policy option	Maximum policy option
Requirements		**Minor residential development**	
Legal	• Current Building Regulations (Parts L[26] [32], F [27] [33]and O [28] [34])	• Current Building Regulations (Parts L[26] [32], F [27] [33]and O [28 [34])	• Current Building Regulations (Parts L[26] [32], F [27] [33]and O [28 [34])
Retrofit	• CS Policy SRM1(v) on encouraging reduction of carbon emissions when altering existing buildings [35][29]	• Future Homes Standard (FHS) 2025 [36][30] • Provision for carbon offset fund, if permitted by FHS 2025 • No gas or oil boilers?	• FHS 2025 [36][30] • Significant weight attributed to schemes that considerably improve energy efficiency & carbon reduction [31] [37], [15] • Alignment with the six principles for best practice in LETI's Climate Emergency Retrofit Guide [32]
Non-statutory best practice	• CS Policy SRM1(ii) on achieving current energy efficiency standards and encouraging high standards [35][29]	• FHS 2025 [36][30] • 3-star Home Quality Mark (HQM) score [38][33] • LETI Target for Operational Energy - Total Energy Use Intensity (EUI) of 35 kWh/m2 /yr (GIA) [39][34] • 10% of future energy use from renewables [40] [35]	• FHS 2025 [36][30] • 4-star HQM score [33] [38] for new builds or BREEAM 'Excellent' standard for conversion to residential development [36] [41]. • LETI Target for Operational Energy - Total Energy Use Intensity (EUI) of 35 kWh/m2 /yr (GIA) [39] [34] • 20% of future energy use from renewables [35]
Energy strategy	• No existing policies	• No proposed policies	• Demonstrate regard to energy hierarchy in design [42]
Embodied & whole lifecycle carbon assessment	• No existing policies	• LETI 2020 Design Target for residential development (C rating for upfront embodied carbon and total embodied carbon) [43][38]	• LETI 2030 Design Target for residential development (A rating for upfront embodied carbon and total embodied carbon) [43] [38]
Requirements		**Major residential development**	
Legal	• Current Building Regulations (Parts L[26] [32], F [27] [33]and O [28] [34])	• Current Building Regulations (Parts L[26] [32], F [27] [33]and O [28] [34])	• Current Building Regulations (Parts L[26] [32], F [27] [33]and O [28] [34])
Retrofit	• CS Policy SRM1(v) on encouraging reduction of carbon emissions in buildings [35][29]	• FHS 2025 [36][30] • Provision for carbon offset fund, if permitted by FHS 2025	• FHS 2025 [36][30] • Significant weight attributed to schemes that considerably improve energy efficiency & carbon reduction [31] [37], [15] [21]. • Alignment with the six principles for best practice in LETI's Climate Emergency Retrofit Guide [44].[31]
Non-statutory best practice	• CS Policy SRM(ii) on meeting prevailing energy efficiency standards and encouraging high standards [35][29] • CS Policy SRM(iv) on achieving high levels of energy performance at Bexhill development & renewables/ CHP [35][20]	• FHS 2025 [36][30] • 3-star HQM score [38][33] • LETI Target for Operational Energy - Total Energy Use Intensity (EUI) of 35 kWh/m2 /yr (GIA) [39][34] • 20% of future energy use from renewables [35]	• FHS 2025 [36][30] • Detailed energy statement to show how net-zero carbon target will be met using energy hierarchy ([37], [31], [39]), decentralised energy provision and residual met through on-site or community renewables scheme ([31], [40]) • 4-star HQM score for new build [38] or BREEAM 'Excellent' standards for major conversions to residential development [41][36]. • LETI Target for Operational Energy - Total Energy Use Intensity (EUI) of 35 kWh/m2 /yr (GIA) [39][34]/ • Estimate and minimise unregulated carbon emissions [42][37] • Monitoring of key metrics for first five years of occupation [31] [37]. • Use latest net zero technology, including digital [22] [28]. • Financial contribution to off-setting fund if not met on-site
Energy strategy	• DaSA Policy DRM3 on due regard to energy efficiency, including renewables, as part of Design & Access Statement [41] [45].	• Detailed energy strategy to demonstrate how net-zero carbon target would be met, in accordance with the energy hierarchy ([37], [31], [39] [46]).	• Detailed energy strategy to demonstrate how net-zero carbon target would be met, in accordance with the energy hierarchy ([37], [31], [39] [46]).
Embodied & whole lifecycle carbon assessment	• No policies	• LETI 2020 Design Target for residential development (C rating for upfront embodied carbon and total embodied carbon) [38] [43].	• LETI 2030 Design Target for residential development (A rating for upfront embodied carbon and total embodied carbon) [38] [43]. • Provide details of whole life-cycle carbon emissions, if >100 dwellings [37] [42].

4.3 Overview of Non-Residential Net Zero Buildings Policy Options

	Minimum policy option	Medium policy option	Maximum policy option
Requirements		**Minor non-residential development**	
Legal	• Current Building Regulations (Parts L [42] [47] and F [48][43])	• Current Building Regulations (Parts L [42] [47] and F [48][43])	• Current Building Regulations (Parts L [42] [47] and F [48][43])
Retrofit	• CS Policy SRM1(v) on encouraging reduction of carbon emissions when altering existing buildings [35][29]	• Future Buildings Standard (FBS) 2025 [49][44] • Provision for carbon offset fund, if permitted by FHS 2025	• FBS 2025 [49][44] • Significant weight attributed to schemes that considerably improve energy efficiency & carbon reduction [37][31], [15]. • Alignment with the six principles for best practice in LETI's Climate Emergency Retrofit Guide [32] [44].
Non-statutory best practice	• CS Policy SRM1(ii) on meeting prevailing energy efficiency standards and encouraging high standards [35][29]	• FBS 2025 [49][44] • BREEAM 'Very Good' standard as a minimum ([36] [41], [39] [46]). • LETI Target for Operational Energy - Total Energy Use Intensity (EUI) of 65 kWh/m2 /yr (GIA) [39][34] • 10% of future energy use from renewables [40] [35]	• FBS 2025 [44] [49] • BREEAM 'Excellent' standard as a minimum [41] [36] • LETI Target for Operational Energy - Total Energy Use Intensity (EUI) of 65 kWh/m2 /yr (GIA) [39][34] • Residual future energy use from renewables [40] [35]
Energy hierarchy	• No existing policies	• No proposed policies	• Demonstrate regard to energy hierarchy in design [42].
Embodied & whole lifecycle carbon assessment	• No existing policies	• LETI 2020 Design Target for retail development (C rating for upfront embodied carbon and total embodied carbon) [38] [43].	• LETI 2030 Design Target for retail development (A rating for upfront embodied carbon and life cycle embodied carbon) ([37], [41]) [42, 50].
Requirements		**Major non-residential development**	
Legal	• Current Building Regulations (Parts L [42] [47] and F [48][43])	• Current Building Regulations (Parts L [42] [47] and F [48][43])	• Current Building Regulations (Parts L [42] [47] and F [48][43])
Retrofit	• CS Policy SRM1(v) on encouraging reduction of carbon emissions when altering existing buildings [35][29]	• FBS 2025 [49][44] • Provision for carbon offset fund, if permitted by FHS 2025	• FBS 2025 [49][44] • Significant weight attributed to schemes that considerably improve energy efficiency & carbon reduction [37] [37][31], [15]. • Alignment with the six principles for best practice in LETI's Climate Emergency Retrofit Guide [32]
Non-statutory best practice	• CS Policy SRM(ii) on meeting prevailing energy efficiency standards and encouraging high standards [35][29] • CS Policy SRM(iv) on achieving high levels of energy performance at Bexhill development & renewables/ CHP [35][29[	• FBS 2025 [49][44] • LETI Target for Operational Energy - Total Energy Use Intensity (EUI) of 65 kWh/m2 /yr (GIA) [39] [34] • BREEAM 'Very Good' standard as a minimum ([41][36], [39] [46]). • 20% of future energy use from renewables [40][35]	• FBS 2025 [49][44] • Detailed energy statement to show how net-zero carbon target will be met using energy hierarchy ([42][37], [31], [39]), decentralised energy provision and residual met through on-site or community renewables scheme ([31] [37], [40] [51]). • BREEAM 'Excellent' standard as a minimum [41][36] • LETI Target for Operational Energy - Total Energy Use Intensity (EUI) of 65 kWh/m2 /yr (GIA) for retail and light industrial, 55kW/m2/year for offices [34] • Excess heat used productively on-site or for district network [52] [46] • Estimate and minimise unregulated carbon emissions [42][37] • Use latest "net zero" technology, including digital [28][22] • Financial contribution to off-setting fund if not met on-site
Energy hierarchy	• DaSA Policy DRM3 on due regard to energy efficiency, including renewables, as part of Design & Access Statement [41] [45].	• Detailed energy strategy to demonstrate how net-zero carbon target would be met, in accordance with the energy hierarchy ([37] [42], [31], [39] [46]).	• Detailed energy strategy to demonstrate how net-zero carbon target would be met, in accordance with the energy hierarchy ([37] [42], [31], [39] [46]).
Embodied & whole lifecycle carbon assessment	• No existing policies	• LETI 2020 Design Target for retail development (C rating for upfront embodied carbon and total embodied carbon) [38] [43].	• LETI 2030 Design Target for retail development (A rating for upfront embodied carbon and life cycle embodied carbon) ([37], [41]) [42, 50]. • Provide details of whole life-cycle carbon emissions, if >100 sqm (GIA) [42][37].

5. Carbon Impacts of Growth Scenarios

This study has used Arup's operational carbon models to assess carbon emissions at a strategic level for three main growth scenarios (G1-G3) and three different levels of ambition in relation to building specifications (S1-S3 in Section 6). Each growth option is modelled as a scenario where various factors and parameters reflect different policy, urban design decisions and housing industry trends.

The spatial development options have been agreed with Rother and they have been developed in scenarios to depict three distinct theoretical strategies for growth. It is expected that there will be a combination of locations and aspects from all strategies in the Council's new Local Plan spatial strategy. The important consideration in this analysis is not the absolute number of emissions but the scale of impact from future development and the comparison among key differentiators. These differentiators are 1) building performance, 2) electrification of vehicles (including refuse collection and public buses), 3) size of employment land and land use classes mix, and 4) local rooftop PV capacity.

5.1 Growth Scenario description

Table 6 provides an overview of the main characteristics for each growth scenario and a high-level comparison of the differences in growth option model inputs, that explain the differences in emissions over time. The ratios of open space and habitat creation for each scenario are based upon precedent established in the Warwick Open Space SPD which has been adapted to apply to Rother using professional judgement and analysis of Rother's context.

Table 6: Main characteristics of the growth scenarios (G1-G3) and their interpretation in modelling parameter.

Growth Scenarios	Buildings	Transport
Dispersed settlements	Decarbonisation of heating in line with national policies. Carbon sequestration in line with local policy. Public open space (POS) allocation rate assumed: 5.47 ha/1000 people (residential) 2.50 ha/1000 employees (non-residential) New habitats creation associated with residential development (POS): 17% Amenity green space (heathland, grassland), 35% Parks and gardens (heathland, grassland), 35% Natural areas including urban woodland (Mixed native broadleaved woodland), 7% Allotments, community gardens and urban farms (Mixed native broadleaved woodland), 6% Children/Youth areas. New habitats creation associated with non- residential development (POS): 20% Amenity green space (heathland, grassland), 40% Parks and gardens (heathland, grassland), 40% Natural areas including urban woodland (Mixed native broadleaved woodland) Higher on-site renewables. Housing Mix: Semi-detached 60%, detached 15%, terraced 20%, flats 5%	Lowest reduction in long car trips. Lower uptake of 20-minute neighbourhoods / 30-min communities. Low uptake of EVs. Low reduction in car use expected. Main travel mode: private car with limited bus services viable
Clustered networks	Decarbonisation of heating in line with national policies. Carbon sequestration in line with local policy. Public open space (POS) allocation rate assumed: 5.47 ha/1000 people (residential)	Low reduction in long car trips. Good reduction in short car trips.

Growth Scenarios	Buildings	Transport
	2.50 ha/1000 employees (non-residential) New habitats creation associated with residential and non-residential development (POS): Same with Dispersed settlements scenario High on-site renewables, opportunities for street scale low carbon energy technologies. Housing Mix: Semi-detached 50%, detached 5%, terraced 25%, flats 20%	Best uptake of 30-min communities High uptake of EVs. Big opportunities for active travelling for short to long trips. Main travel model: Local bus or private car to transport hubs / rail to London/Bexhill/Hastings / pedal/e- cycle
Intensification of urban areas	Decarbonisation of heating in line with national policies. Carbon sequestration in line with local policy. Public open space (POS) allocation rate assumed: 5.47 ha/1000 people (residential) 2.50 ha/1000 employees (non-residential) New habitats creation associated with residential and non-residential development (POS): Same with Dispersed settlements scenario Lower on-site renewables, opportunities for neighbourhood scale low carbon energy technologies. Housing Mix: Semi-detached 25%, detached 0%, terraced 25%, flats 50%	Highest reduction in long car trips. Low reduction in short car trips (assumed low already). Best uptake of 20-min neighbourhoods. High uptake of EVs. Highest uptake of active travel modes. Main travel mode: Rail to London, pedal/e- cycle, walk

All scenarios are based on an annual growth of 450 new dwellings and 0.7 ha of employment land for the period from 2025 to 2040. A description of each growth scenario along with some key considerations is presented in Table 7.

Table 7. Description of scenarios and main areas of development.

Growth Scenarios	Description	Focus areas	Development type / size	Employment land
G1 - Dispersed settlements	*Countryside living, Access to nature* New development is proportionally distributed based on the size of identified settlements. Main transport option is the private car with a limited bus network and cycling in low traffic roads. Surveys indicate that around 20% of Rother working population commutes to Hastings.	All. Proportionally distributed growth.	450 dwellings per year proportionally distributed based on the /size of all settlements. Higher ratio of semi-detached and detached to flats and terraced dwellings. Retains existing settlement pattern. Still opportunities for rural community, Intergenerational Housing, Ageing community standard, Countryside living, Access to nature	Employment land growth focused on the settlements in the scenario. Small shopping, small leisure.
G2-Clustered networks	*30 min rural communities, Enhanced connections, and links with transport hubs* Villages and smaller settlements are closely linked with larger villages or towns by public transport to transport hubs. Four clusters have been identified in principle, centred around Rye,	Rye, Battle, Bexhill, Hastings Clusters	450 dwellings per year equally distributed into the four main identified clusters. Higher ratio of semi-detached and terraced to flats and detached dwellings. 30 min rural community, Intergenerational Housing, Ageing community standard,	Employment land growth in the areas of the key transport hubs in each cluster. Small shopping, small office, leisure.

Growth Scenarios	Description	Focus areas	Development type / size	Employment land
	Battle, Bexhill and Hastings as key transport interchanges. Local economy growth, decentralised provision of services and goods. Main transport option still the private car, but with greater opportunity for viable public transport and active modes of travel.		Family friendly, Sustainable living.	
G3-Intensification of urban areas	*Rejuvenation of town centres, active travelling* Mixed use, master planned large developments within existing settlements' boundaries with focus on higher densities of current population centres. Radial development. Opportunities for better public transport, cycling and walking connections with town and local centres.	Bexhill, Hastings Fringes	450 dwellings per year in the focus areas. Higher ratio of flats and terraced to semi-detached dwellings. 20 min neighbourhood, Intergenerational Housing, Family friendly, Hybrid working, Sustainable living, Affordable housing.	Development focused on Bexhill and Hastings. Office buildings, industrial, large-scale shopping.

Table 8 gives an overview of the main assumptions and scenario parameters. The assumptions are based on projection trends, industry insights and previous experience. The main intention is to show the impact of specific decisions and policies and facilitate comparison and discussion.

Table 8. Main input parameters and assumptions for the growth scenario modelling.

Growth scenario parameters	G1-Dispersed Settlements	G2-Clustered Networks	G3-Intensification of urban areas
On-site rooftop PV capacity deployment (2025 -2040)	1188 kW(p) / year: 330 dwellings x 3.6kW	900 kW(p) / year: 250 dwellings x 3.6 kW	360 kW(p) / year: 100 dwellings x 3.6 kW
Building efficiency standard required for new residential development	LETI guidance	LETI guidance	LETI guidance
Housing mix	Semi-detached 60%, detached 15%, terraced 20%, flats 5%	Semi-detached 50%, detached 5%, terraced 25%, flats 20%	Semi-detached 25%, detached 0%, terraced 25%, flats 50%
House types (where B=Bedrooms and P=People)	Flats: 1B2P 15%, 2B3P 30%, 2B4P 25%, 3B4P 30% Houses: 2B3P 25%, 3B4P 50%, 4B6P 25%	Flats: 1B2P 20%, 2B3P 30%, 2B4P 30%, 3B4P 20% Houses: 2B3P 35%, 3B4P 45%, 4B6P 20%	Flats: 1B2P 25%, 2B3P 40%, 2B4P 25%, 3B4P 10% Houses: 2B3P 50%, 3B4P 35%, 4B6P 15%
Energy use intensity of new residential development (EUI, kWh / m^2 per year)	35	35	35
Heating demand of new residential development (kWh / m^2 per year)	15	15	15

Growth scenario parameters	G1-Dispersed Settlements	G2-Clustered Networks	G3-Intensification of urban areas
New non-residential development heating systems (Includes hotels and caring homes)	Electric boiler in 2030	District heating in 2032	District heating in 2032
Embodied Carbon reduction of new residential development (kg CO_2e / m^2 GIA)	30% reduction by 2030	30% reduction by 2030	30% reduction by 2030
Percentage reduction in overall trips (2035)	5%	10%	15%
Private EVs in 2035 (% of all private vehicles)	30%	40%	50%
Year buses assumed to be EV buses	2040	2035	2030
Working from Home – Percentage reduction in commuter trips	30%	20%	10%
Employment Land Use Class	Industrial / Storage (B1/B2/B8) 30% Hotels, residential care homes, colleges (C1/C2) 20% Retail, food, offices, recreation (E) 30% Libraries, community halls (F1/F2) 20%	Industrial / Storage (B1/B2/B8) 40% Hotels, residential care homes, colleges (C1/C2) 20% Retail, food, offices, recreation (E) 20% Libraries, community halls (F1/F2) 20%	Industrial / Storage (B1/B2/B8) 15% Hotels, residential care homes, colleges (C1/C2) 15% Retail, food, offices, recreation (E) 50% Libraries, community halls (F1/F2) 20%

5.2 Emissions of Growth Scenarios (G1-G3)

This section presents results from the growth scenario modelling. The analysis and discussion of the results follows in the next section.

Table 9 shows the emissions results from the modelling of the three growth scenarios in Rother. The G1-Dispersed settlements scenario resulted to the largest annual and cumulative emissions, whereas the G3-intensification scenario had the least emissions, as expected.

Table 9. Annual and cumulative emissions for the three growth scenarios in Rother.

Growth scenario	Cumulative emissions for the period of the Local Plan (2025-2040) (tCO_2e)	Additional* annual emissions in 2030 (tCO_2e)	Additional annual emissions in 2040 (tCO_2e)	Additional population in 2040 (based on housing growth)
G1-Dispersed Settlements	154,918	9,593	10,841	28,411
G2-Clustered Networks	142,800	9,239	9,244	26,325
G3-Intensification of urban areas	88,514	6,125	4,968	23,220

*The additional emissions are representative of the emissions associated with new development only and not the existing, baseline emissions and their future trajectory.

The emissions for the scenarios shown in Figure 9 include all final emissions from residential, non-residential and transport sectors, including PV generation but excluding embodied carbon emissions. Only emissions associated with new development are shown here.

The difference in estimated emissions between the G1-Dispersed and G2-Clustered scenarios is relatively small until 2030. The emission increase rate is lower for the G3-Intensification scenario which differentiates from the beginning to remain the scenario with lowest emissions through the modelled period.

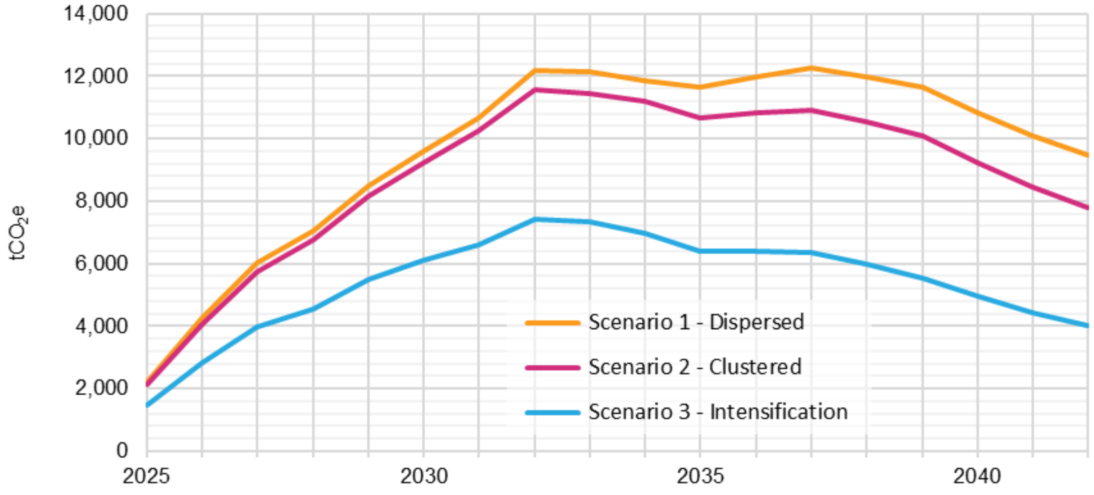


Figure 9. Annual emissions (tCO_2e) due to new development for the three growth scenarios in Rother.

The increase rate of annual emissions associated with the projected development reduces drastically in 2032 to peak by 2037 for the G1-Dispersed and G2-Clustered scenarios.

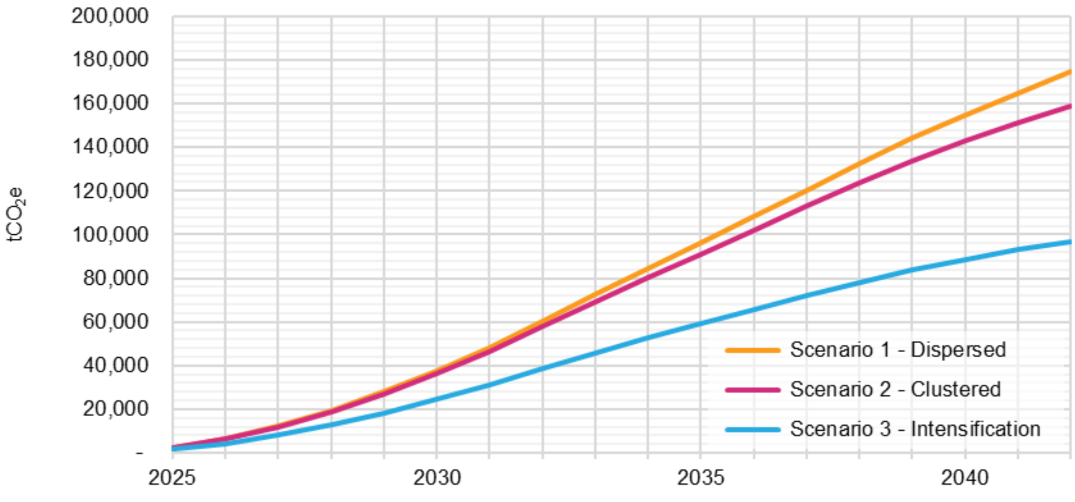


Figure 10. Cumulative, additional emissions (tCO_2e) under the growth scenarios for Rother (excluding embodied emissions)

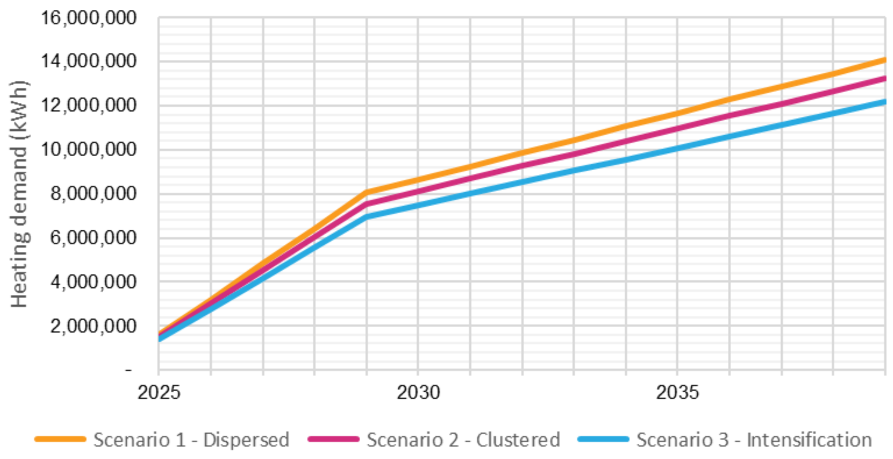


Figure 11. Comparison of residential, cumulative heating demand (kWh) among the growth scenarios.

The heating demand of new dwellings shows a lower growth rate after 2029 due to the introduction of high energy performance building (in alignment with current LETI guidance) standards from 2030. Electricity demand follows a similar pattern with heating demand.

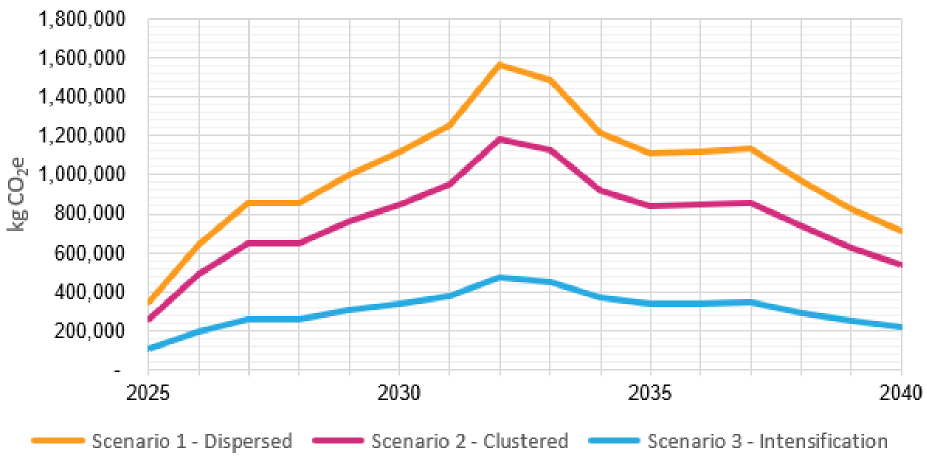


Figure 12. Avoided emissions by annual local PV generation at new residential development sites (residential rooftop PV).

Rooftop PV generation has an important role to play in the reduction of energy demand and the final emissions of new development. The avoided emissions are estimated based on the assumption that the electricity generated by the PV systems is used locally, offsetting demand from the grid. All years are modelled to have the same electricity generation. The grid emissions factors varied based on the grid carbon intensity projections. Figure 12 shows that the emissions avoidance potential peaks in 2032 and then the avoided emissions follow the UK grid decarbonisation trend. The substantial rooftop PV capacity assumed in the G1-Dispersed scenario had less impact on overall emissions than the emissions reductions achieved from transport, housing and use class mix and total floor areas in theG2-Clustered and G3-Intensification scenarios.

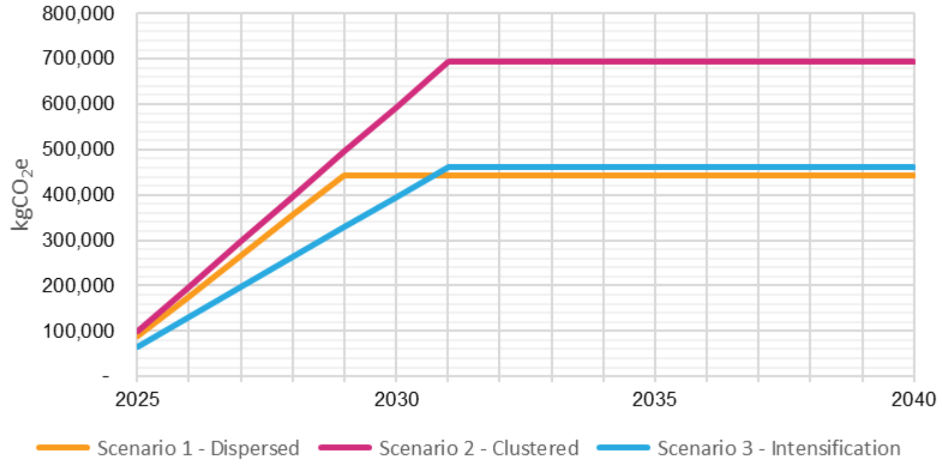


Figure 13. Cumulative non-residential emissions (kg CO_2e) from gas consumption.

The emissions from gas consumption in the non-residential buildings sector peaks in 2029 for the G1-Dispersed scenario (Figure 13) when the new build non-residential development is assumed to adopt electric boilers. In the other two scenarios the transition to electric heating takes place with two years delay, in 2032, when it is assumed that new non-residential development is connected to a low-carbon district heating system. That can also be seen in the emissions from electricity use (Figure 14) in the non-residential buildings. The main difference in the emissions between the G1-Dispersed growth and the other two scenarios is the selection of electric heating and hot water system. In G1-Dispersed scenario the heat demand is served with electric boilers (CoP 1), whereas the other two scenarios (G2-G3) show the efficiency gains from district heating systems (CoP 4). The other factor that differentiates the scenarios is the mix of non-residential building use-classes.

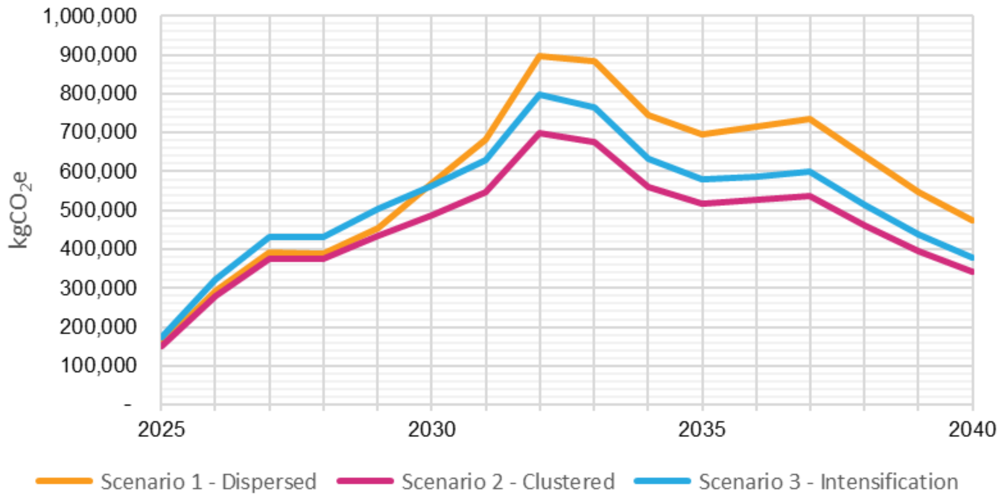


Figure 14. Annual emissions (kg CO_2e) from electricity consumption in new non-residential development.

The modelled transport sector emissions are mainly affected by the year and percentage of electric vehicle uptake. This includes private vehicles, but also public bus service and refuse collection vehicles (which has a large impact on waste emissions reduction). This is shown in Figure 15, with the modelled emissions differentiating from the beginning due to lower population growth initially for the G3-Intensification scenario, and in 2030 due to electrification of public buses in the G3-Intensification scenario (2035 for the G2-Clustered, and 2040 for the G1-Dispersed respectively). The location of development influences the trip destinations, mode of transport and reduction in commuting trips and mileage. In 2035, there is a reduction assumed in overall trips (G1-5% reduction, G2-10% reduction, G3-15% reduction), but farther reductions are achieved with the electrification of private vehicles (G1- EVs are 30% of total vehicles, G2-40% , G3-50% respectively).

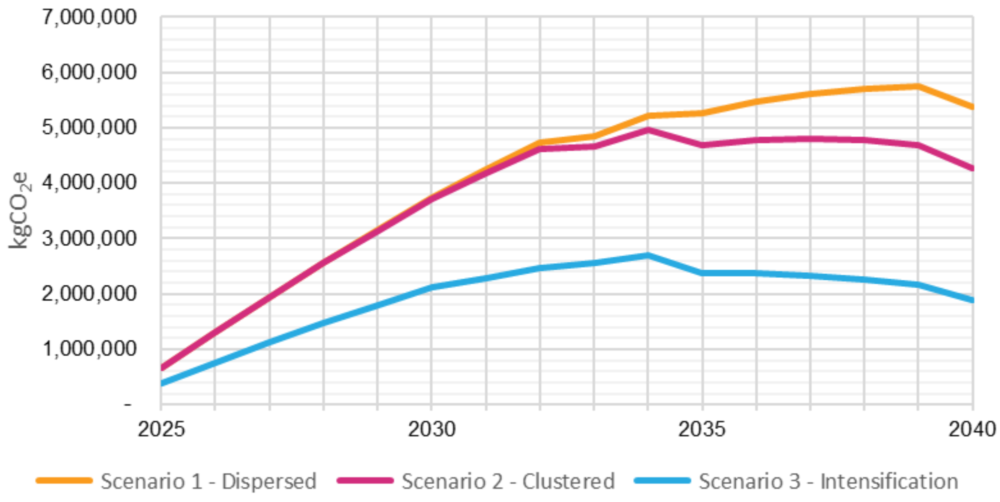


Figure 15. Emissions (kg CO_2e) associated with residential transport for the different growth scenarios.

All scenarios have similar number of trips with a small difference explained by the cumulative population projection associated with new housing and employment land.

In overall, promotion of intensification is likely to lead to significantly less carbon emissions from the transport sector, which is one of the main carbon emissions sources in Rother.

5.3 Discussion of growth scenarios

The modelling results identify specific areas and sectors that influence emissions and should be carefully considered during stakeholder engagement and policy making.

In general, the intensification scenario shows the largest potential for sustainable growth. This is an outcome of less gross floor area for residential development, less heating demand, the assumption of district heating to serve non-residential loads, a reduction on trips and mileage that could encourage a mode shift to active travel and support private EV uptake.

It is expected that development will follow a hybrid/mixed approach that combines all the potential growth scenarios. The important implication for the Local Plan is to promote development and solutions that can add-on by optimising the type and size of development according to a site’s potential and local community opportunities to decarbonise the system as a whole.

5.3.1 Housing mix choices

The overall estimated emissions remain relatively similar between the Dispersed and Clustered scenarios until 2030, indicating that housing mix is not the primary driver of emissions in this case. This is mainly a result of the small size of annual development (450 dwellings per year), the expectation for fossil fuel-free dwellings in combination with low carbon intensity of the grid, and rather small differences in floor area between different house types. The differentiation of the Intensification scenario emissions is explained by less heating demand due to high number of flats in comparison with semi-detached and detached houses that were assumed to have larger floor areas. Lower population growth as the model assumes population increase as a function of house types, and most importantly less transport emissions.

It is however important to consider that as the scale of development may increase, the impact the housing mix has on population, heating demand and electricity consumption, waste and transport emissions will increase proportionally too. The housing mix can be directly affected by the Local

Plan and its final impact on the emissions is indicative of the level of uncertainty in the future outcome of all energy related trajectories. For example, slower electrification of residential heating, higher than projected grid carbon intensity and higher heating demand due to less ambitious building performance standards will eventually impact the emissions growth proportionally with the gross floor area and population growth. This applies to the embodied carbon emissions too that in the case of Rother (Figure 16) and under current energy decarbonisation trajectories they have a significantly larger impact than the operational emissions (Figure 13).

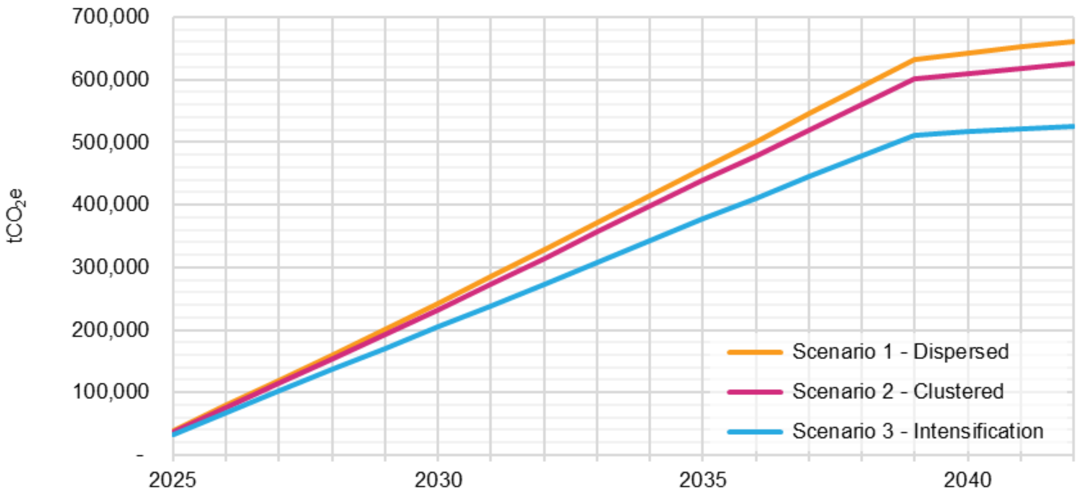


Figure 16. Cumulative, additional emissions (tCO_2e) under the growth scenarios for Rother (including embodied carbon emissions).

When the embodied carbon emissions due to new buildings are considered in the analysis, the cumulative additional emissions in 2040 are almost 4 times higher than the operational emissions alone. Continuous increases in building energy performance, the decrease of grid carbon emissions factor and consequent decrease in operational emissions will eventually result to the embodied carbon emissions being considerably higher than the operational emissions. The Local Plan will need to adopt policy from the beginning to effectively reduce the impact of embodied carbon emissions associated with new development and building extensions and alterations (retrofits).

5.3.2 The role of grid decarbonisation to net zero development

Current projections of UK grid emissions indicate a large reduction in grid carbon intensity around 2032. This can be seen in all modelling results, and it is a key reason why annual emissions (including avoided emissions) peak and start reducing after 2037 despite the continuous annual development and steady growth. The other reasons mainly being the reduction in residential heating demand from 2030 and the electrification of heating in non-residential buildings (especially with highly efficient district heating networks in 2032).

Emissions avoided by local PV electricity generation will also be affected, as expected, by the low carbon intensity of the grid. This will result in a substantial increase on additional local PV capacity required to offset the remaining emissions after all efficiency improvements. The marginal abatement cost of carbon with PV may increase but investment is necessary to achieve the projected grid decarbonisation and consequent reduction of emissions.

5.3.3 Timing of introduction of measures/high performance buildings guidance

Timing of the implementation of measures is very important for the reduction of total emissions during the Local Plan period. In general, requirements for high efficiency building fabric should be introduced at the earliest possible time in terms of feasibility. A very high-performance fabric approach is the only certain way forward to reduce emissions and running costs, regardless of any uncertainties with fuel costs and grid carbon intensity. Technical feasibility is not expected to be an issue as the buildings are new build (not retrofitted). The viability of development, supply chain, and availability of skilled workforce concerns should ideally be addressed as soon as possible with local policy initiatives and a strong focus on building local capacity to facilitate sustainable growth.

Based on the modelled growth scenarios, and within the limitations and uncertainty of the model, it is likely that an interim update will be required in 2030 and most of the development should take place as later as possible to benefit from economies of scale, advances in materials and electric vehicles technology, the decarbonisation of UK grid, and an equitable transition to more sustainable lifestyles. The Local Plan and policy decisions at all levels will have an imperative role in the timely development of the necessary conditions to achieve "net zero" development and sustainable growth.

5.3.4 Non-residential sector and employment land use classes

The model groups development in four use classes (i.e. E, B1/B2/B3, C1/C2, F1/F2) but it does not distinguish within the classes, such as between hotels and residential institutions within use class C, or among offices, storage and general industrial within use class B. The mix of employment land use classes and the size of the developments is very important as these buildings typically have a larger gross floor area and energy use intensity than residential buildings. The selection of electric boilers as a heating system in 2030 under the G1-Dispersed scenario had marginal impact on the total emissions of the scenarios because the efficiency of gas and electric boilers is comparable, and electricity and gas carbon emissions factors do not have a large difference yet. The connection to district heating in 2032 as modelled in the G2-Dispersed and G3-Intensification scenarios has noticeable impact on emissions, mainly under the assumption that the low-carbon district heating system is designed with very high performance (CoP 4). While it is not realistic to supply all non-residential new builds with district heating, the results show the benefits which can be achieved with careful planning of heat loads and provision for neighbourhood to district scale energy systems.

Employment land will have a larger impact to overall energy demand and emissions than residential housing development. New non-residential developments should be prioritised in locations that they can be part of low-carbon district heating networks, or where there is an opportunity to develop district heating networks for the surrounding community based. Those areas should be prioritised for development and subsequent residential and non-residential development should be planned for locations that can connect and enable the expansion of such networks.

5.3.5 Decarbonisation of transport and reduction of total trips

In the modelled scenarios the critical turning points in emissions are the electrification of buses, the electrification of refuse collection vehicles and reduction of collection trips, high uptake of private EVs and reduction in commuter and overall trips in general.

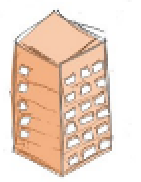
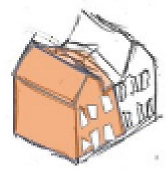
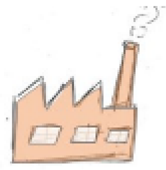
Decarbonisation of public transport will need investment in electric buses, charging infrastructure and route planning. Uptake of EVs is likely a combination of cost, availability, ease of use (e.g. charging, range). The reduction of trips and a mode shift away from cars is directly influenced by selection of development locations, work trends, travel options, cost, and convenience of these scenarios.

6. Net Zero Building Analysis of Rother Typologies

6.1 Typologies in Rother

Five typologies were identified as typical in Rother: flats, semi-detaches houses, detached houses, offices and industrial. The purpose of the typologies is to model the impacts of potential building interventions upon carbon emissions and to understand potential outcomes within Rother of different policy levers.

This study focuses on three residential house typologies and two non-residential. Typical characteristics for these typologies in the UK are shown below. For comparison, the Valuation Office Agency (VOA) in the UK [53] suggests that the median floor area space for all properties in Rother is 96 m^2, for flats the floor space area is 48 m^2, for houses 109 m^2 and for bungalows 94 m^2.

Flats/Apartments	Semi Detached Houses	Detached Houses	Offices (Private)	Industrial
				
Floor Area: 55 m^2 **Bedrooms**: 2 **Occupancy (persons):** 3	**Floor Area**: 93 m^2 **Bedrooms**: 3 **Occupancy (persons):** 4	**Floor Area:** 152 m^2 **Bedrooms**: 4 **Occupancy (persons):** 5	**Floor Area:** 2,000 m^2 **Bedrooms**: N/A **Occupancy (persons):** N/A	**Floor Area**: 10,000 m^2 **Bedrooms**: N/A **Occupancy (persons):** N/A

*For warehouses, evidence suggests that the average size of units has increased to 31,500 m^2 which exceeds the annual employment land development as assumed for Rother regions. Therefore, this typology was capped to 10,000 m^2.

6.2 Modelling the impact of building energy system choices

This section presents a summary of key findings, full details of the worked example and commentary on net zero building measures can be found in Appendix A3.

Subnational consumption data from Rother has been used to provide context on the changes required in buildings specification to achieve the “net-zero for new developments” aspiration in the Local Plan.

Developers are required to show compliance with building regulations by comparing the new dwellings in design stage, and after the completion of works, against a “notional” building that represents the minimum standard of energy performance accepted by the regulations. The “notional” dwelling has the same size and form with the “actual” building. Its specifications and the calculation methodology are defined in Part L and the Government’s Standard Assessment Procedure (SAP 10 currently). The energy performance of the “notional” dwelling is described with three metrics [54]:

1. The target primary energy rate (TPER), in kWh_{PE}/m^2 per year: this is influenced by the fabric and fuel.
2. The target emission rate, in $kgCO_2/m^2$ per year: this is influenced by the fabric and fuel.
3. The target fabric energy efficiency rate, in kWh/m^2 per year: this is influenced by the fabric only.

The SAP has recently been updated from the previous SAP 12 approach. The recent changes in the regulations and the consequent SAP update have updated the carbon emissions factor for electricity and the primary energy factors (PEF) for fuel used in buildings (Table 10).

Table 10 Comparison of key factors between current (SAP 10) and previous (SAP 12) building regulation.

	Unit price, p/kWh	Emissions $kgCO_2/kWh$	Primary energy factor (PEF) kWh/kWh
SAP 12 (previous)			
Grid electricity	13.19	0.519	3.07
Mains gas supply	3.48	0.216	1.22
SAP 10 (current)			
Grid electricity	16.49	0.136	1.501
Mains gas supply	3.64	0.210	1.13

The key changes are: 1) the carbon emission intensity of grid electricity was reduced largely, and it is now lower than the carbon intensity of mains gas, 2) the primary energy factor of grid electricity was also reduced from 3.07 to 1.501 but this is still higher than the 1.13 PEF value for mains gas, 3) unit prices have been adjusted in the current SAP but this adjustment did not capture the recent inflation impact on energy prices, with unit prices now being on average at 34p/kWh and 10.3 p/kWh for electricity and gas respectively.

These changes have a direct impact on the decisions for heating systems, renewable electricity generation, air tightness and insulation levels in new residential and non-residential developments.

A series of worked examples (A.3.3 Net zero buildings) was developed to support the arguments for high energy performance targets for new dwellings (and non-residential buildings) and demonstrate the implications of the compliance calculations methodology (SAP) on building design decisions. The worked examples (details see Appendix A.3.3) are based on simplified calculations and assumptions to facilitate discussion. This discussion is presented in the form of questions and answers in the following subsections. An overview of the estimated metrics and the comparison among energy system design choices is shown in Table 10 Comparison of key factors between current (SAP 10) and previous (SAP 12) building regulation.

The "notional" building energy performance metrics in SAP are a function of several design aspects and have not been calculated for the building typologies in Rother as part of this report. The modelling set out below is based off a notional semi-detached house as identified as one of the key typologies in Rother.

Solar panels as a term are used interchangeably with PV systems. Solar thermal systems have not been considered in the examples, but they are part of the alternative renewable energy technologies that may be suitable for some developments. Any results and conclusions are generic and transferable to non-residential buildings. The estimated costs for heating in the case studies do not include the standing charges and are based on the unit price in the previous and current versions of SAP. The actual cost is calculated based on an average unit price assumption for England in December 2022.

Table 11 Overview of the impact of design choices to energy metrics in the worked examples*

	Gas boiler, no PV (House A)	Heat pump, no PV (House B)	Electric panels, no PV (House C)	Gas boiler, 3.1 kWp PV (House D)	Heat pump, 2.9kWp PV (House E)
Floor space area, m^2	93	93	93	93	93
Heating demand, kWh/year	8,200	8,200	8,200	8,200	8,200
Energy Use Intensity (EUI), kWh/m^2	136	69	126	117	35
Total Primary Energy, kWh_{PE} /year	15,549	9,649	17,562	12,105	4,818
Electricity generation (local use), kWh/year	0	0	0	1721	3220
Electricity generation (export), kWh/year	0	0	0	1721	0
Total emissions (energy related), tCO_2e	2.4	0.9	1.6	1.9	0.4
SAP Cost for heating (consumption based), £/year	£332	£483	£1,352	£332	£438
Actual Cost estimate for heating (consumption based) £/year	£938	£996	£2,788	£938	£996

*The worked examples are based on a new semi-detached house with $93m^2$ floor area. The heating demand was assumed to be 8,200kWh , annual electricity consumption of 3,500kWh and estimated energy use intensity (EUI)=~$136kWh/m^2$. Detailed description and calculations are available in Appendix A.3.3.

6.2.1 Evidence for a shift to fossil fuel-free buildings.

The comparison of the case studies in this section shows that the new metrics and factors used for compliance with building regulations are in favour of electric heat pumps, which can achieve very high efficiencies in comparison to gas boilers and electric panel heaters.

In terms of energy related emissions, new dwellings with air source heat pumps (ASHP) are expected to have ~60% less emissions than dwellings with gas boilers. The use of electric panel heaters will result in higher emissions in comparison with ASHP but will still perform better (regarding emissions) than gas boilers.

Energy Use Intensity (EUI) calculations are not required for compliance, but it is a metric that allows direct comparison of the energy performance between different building systems. (i.e. fabric + services). EUI represents the total energy consumption of the dwelling, including unregulated energy use (e.g. from appliances). Recommended EUI for net-zero dwellings is in the range of 35-40 kWh/m^2. In the examples in this section, it is only House E with the ASHP, solar panels and battery storage that has an EUI value near this level. Note that a 30% reduction in heating demand has already been assumed for the new dwellings against the historical observations for Rother.

The total primary energy, which is required for compliance, is again lower with the use of ASHP systems than gas boiler heating systems. Electric panel heaters perform worse than gas boilers but the results between the two heating systems are comparable. Further arguments in favour of this approach are provided in the discussion and recommendations from the growth and policy scenario analysis (see Implications for Local Plan).

Concluding on the results, a shift to fossil fuel-free buildings (residential and non-residential) with high efficiency electric heating systems (heat pumps, low-carbon district heating) would be justifiable and recommended from the onset of the Local Plan.

6.2.2 Cost implications of a transition to Air Source Heat Pumps

The installation cost of an ASHP is assumed £13,000 [55] (without considering economies of scale, trade discounts etc). The installation cost of a gas boiler is assumed £2,000. The cost will also depend on house size, heating and hot water demand, climate (for heat pumps) etc.

The increase in the unit price of electricity in the current SAP10 version is larger than the unit price increase for gas. It should be noted that the SAP10 unit prices for both electricity and gas are still much lower than the actual prices in December 2022.

According to current SAP fuel price factors, heating the new dwelling in the example with a gas boiler (~£330/year) would cost considerably less than heating the same house with an ASHP (~£480/year). However, when the actual prices are considered, the cost is rather comparable. This can be explained by 1) the actual unit price for gas being almost 2.8 times higher than the SAP gas unit price, 2) the actual unit price of gas still being three times lower than actual electricity unit price, and 3) the ASHP having a three times higher efficiency than the gas boiler.

If the electricity price remains connected with the gas price, and the gas to electricity cost ratio is 1:3, the cost for heating between a new house with gas boiler and ASHP will stay comparable.

The heating cost for House C with electric panel heaters (or electric boilers) will be considerable higher than the other cases in the example with both SAP and actual unit prices for fuel. This is a result of a heating fuel consumption like House A (gas heating), but three times higher unit price (five times in SAP) for electricity than gas. Compared with House B (ASHP, e- heating), the unit price is the same, but the ASHP is almost three times more efficient that electric panel heaters. It should be noted though that electric panel heaters are usually installed in mid- to high-rise buildings with flats that will typically have less heating demand than other house types (due to less external walls/ceiling/floor surface, less window surface area, simpler form, and newer construction specifications). In new developments of buildings with flats, the opportunities for ASHP and decentralised low-carbon heating (in building, street, or district scale) should be considered to avoid unnecessarily high heating costs for residents of flats.

The capital cost for the developers will increase as ASHP are generally more expensive systems than gas boilers. Market price trends are demand driven and it is hard to predict their evolution.

House A (gas heating) and House B (ASHP) have comparable actual heating costs. House B will have 5,900 kWh_{PE} less primary energy consumption than House A (same floor surface area). House B will also have 1.5 tCO_2e less emissions than House A in the example.

Depending on the heating and hot water demand of non-residential buildings, especially in the case of energy intensive industrial processes, heat pumps might not be suitable for such use. In such cases, heat pumps with top-up boilers, electric boilers, or a combination of district heating with top up boilers and immersion heaters (ideally combined with on-site PV and/or solar thermal capacity) are likely to be needed to serve the heat demand. It is not expected though that heavy industrial zones will be part of the future zoning in Rother.

6.2.3 The role of solar panels (PV systems) in new buildings development.

The "notional" building specification includes a PV system; for houses the nominal installed capacity (kWp) should be 40% of ground floor area including unheated areas / 6.5. For flats the nominal installed capacity is 40% of dwelling floor area / (6.5 x number of floors in block).

In this example, the "notional" semi-detached dwelling would include a PV system of (0.40 x 50 m^2) / 6.5 = 3.1 kWp installed capacity.

The performance metrics for House D (gas heating + PV) would change as shown inTable 11. For simplicity, it has been assumed that the PV generation is not used to displace loads from the gas boiler (e.g. there is not a hot water storage tank with immersion heaters or secondary electric heating and hot water systems). It is assumed that the smart export guarantee (SEG) tariff rate is 5.5 p/kWh exported to the grid. It is also assumed that there is no battery storage (local or communal), and half of the electricity generated by PV is used locally with the other half being exported to the grid.

This example shows the role that building regulations will have into the electrification of heating in new buildings. House D in this example (gas heating + PV) will still have higher energy use intensity, primary energy consumption and carbon emissions than House B (ASHP, no PV). Assuming the House D performance as shown above has the same performance with the notional building, House B with the ASHP in the example would achieve a 20% reduction in the total primary energy consumption without any PV systems. In terms of emissions, House B (ASHP) will also achieve a 55% reduction in comparison with House D emissions.

The inclusion of the PV system in the "notional" building in combination with the building fabric performance specification means that new buildings with gas heating systems will either need to have some renewable energy capacity installed or the developers will have to reduce the primary energy demand rate by further reducing the heating demand, through additional air tightness, design and better performing than the minimum specification building elements. This will also make the economic case for ASHP stronger, as any cost avoided with the selection of a gas boiler instead of a ASHP will likely have to be invested in other measures.

Regarding running costs, SAP cost factors indicate that the cost for heating will be lower for House D (gas heating + PV) than House B (ASHP, no PV). However, the actual cost for heating based on market prices in December 2022 was found to be similar between the two case studies. A 3.1 kWp PV system in Bexhill, Rother could potentially generate 3,440 kWh electricity annually, which is almost equal to the assumed total electricity consumption of House D. Such PV system would require ~16 m^2 of unshaded roof area with southeast-southwest orientation (15deg azimuth angle, and 35deg roof angle assumed). At £2,000 for 1 kWp installed, the total capital cost would be around £6,200 per dwelling (without including economies of scale, trade discounts and developer's subcontractor pricing etc).

As it was discussed in the growth scenario analysis, non-residential buildings will have an important contribution to the overall emissions. On-site PV generation should be a requirement for all such industrial development to mitigate the impact of industrial emissions.

6.2.4 Benefits from investing in local or communal battery storage for PV systems. "Are there benefits from investing in local or communal battery storage for PV systems?"

The biggest benefits from investing in local or communal battery storage are the sharing of capital and operational costs, space saving in the houses, easy access for maintenance and scalability of the system. Opportunities should be explored for public-private partnerships with community participation that will allow investment to local low-carbon electricity and heat generation.

Insights from the case studies indicate that sufficient battery storage capacity (House E case study) would further reduce the primary energy consumption and overall emissions of the building and increase savings for residents, as the current unit price of electricity is significantly higher than the smart export guarantee tariff.

Large non-residential development could create opportunities for large scale battery storage and private grids that could help optimise savings, efficiency, and cost of large renewable energy systems.

6.2.5 New residential developments that achieve an EUI = 35-40 kWh/m^2 "What an EUI =35-40 kWh/m^2 mean for new residential developments?"

The worked example for the dwelling with the ASHP and without any PV generation (EUI = 69 kWh/m^2) shows that the EUI could be reduced almost by 50% with the transition from gas boilers (EUI = 136 kWh/m^2) to heat pumps, assuming better building fabric performance as specified by the 2023 update on current building regulations. It is assumed that local PV generation used in the dwelling is included in the EUI calculation, whereas electricity export to the grid is excluded. It is noted that LETI guidance excludes renewable energy contribution from the EUI targets, whereas RIBA 2030 Challenge targets include both grid and renewable electricity consumption. The semi-detached in the example has a floor area of 93m^2. To reduce the EUI from 69 kWh/m^2 to 35 kWh/m^2, additional electricity consumption reductions of around 34 kWh/m^2 x 93m^2 = 3,200 kWh electricity would be needed. In Rother, assuming optimum azimuth and slope of the panels, the 3,200 kWh could be generated by a 2.9 kW PV system, with an approximate roof surface requirement for installation of 15m^2 and a cost of around £6,000.

House E in Table 11 shows the results for the case study with ASHP + solar panels and local use of the PV output. In reality, the generated electricity will not match the household demand for large periods of time. The PV output can be directed to a hot water cylinder (typically installed with the heat pump), to a battery in the house or to a decentralised energy system with demand variation and local/communal storage.

To achieve an EUI= 35 kWh/m^2 the solution promoted is to install ASHP, and ~3kW PV capacity with battery storage of sufficient capacity to store the excess electricity and use it in the house when required, for example during peak demand periods. All buildings will still be connected to the grid, for example with grid-tie island battery systems that can manage the loads with the use of the grid, local generation, or the battery and charge the battery with excess electricity from the PV when available or by the grid where unit prices are preferable. Such type of systems will increase the CAPEX considerably more than the £6,000 cost for the PV panels alone.

6.2.6 Achieving net-zero (ready) for non-residential buildings "How could net-zero (ready) be achieved for non-residential buildings?"

This is a complex issue with multiple pathways to explore. The first consideration is the selection of use classes, the size of development and the locations with employment land. The second consideration is the building specifications and the heating, cooling, and hot water systems, in terms of technology selection but also the cost and who pays the bill.

The scenario analysis concluded that the choice of use classes, the size and location of development will significantly affect the overall emissions associated with new employment land. It was assumed that by the end of the Local Plan period, there will be 10 ha of additional non-residential buildings. Based on the modelling results, the total electricity consumption could be in the range of 10 GWh. A 20% replacement of that usage from the grid with on-site PV generation would require the installation of around 2.6ha of PV arrays. The scale of investment and required infrastructure intensifies the need to plan according to the energy hierarchy.

The Local Plan needs to carefully identify the scale and type of non-residential development needed in Rother (avoid unnecessary development) and define zones in locations with opportunities to reduce energy demand for transport, achieve high efficiency of buildings and services, and provide large available areas for installation of PV systems, electricity, and hot water storage.

Office buildings should aim for EUI=55 kWh/m^2/yr (RIBA 2030 Climate Challenge). Retail and light industrial buildings should aim for EUI=65 kWh/m^2/yr, by maximising the renewable energy use, simple forms that optimise passive design, efficient ventilation strategies, and a "fabric first" approach to minimise heating and cooling demand. For medium to large scale developments, the most efficient solution with multiple opportunities for nearby communities (regarding heat decarbonisation) would likely be low carbon district heating networks but these will likely require

Summary

- A shift to fossil fuel-free buildings (residential and non-residential) with high efficiency electric heating systems (heat pumps, low-carbon district heating) and PV generation would be justifiable and recommended from the onset of the Local Plan.
- If the electricity price remains connected with the gas price, and the gas to electricity cost ratio is 1:3, the cost for heating between a new house with gas boiler and ASHP will stay comparable.
- The capital cost for the developers will increase as ASHP are generally more expensive technology than gas boilers. Market price trends are demand driven and it is hard to predict their evolution.
- The inclusion of the PV system in the "notional" building in combination with the building fabric performance specification means that new buildings with gas heating systems will either need to have some renewable energy capacity installed or the developers will have to reduce the primary energy demand rate by further reducing the heating demand, through additional air tightness, design and better performing than the minimum specification building elements. This will also make the economic case for ASHP stronger, as any cost avoided with the selection of a gas boiler instead of a ASHP will likely have to be invested in other measures.
- The worked examples show that sufficient battery storage capacity would further reduce the primary energy consumption and overall emissions of the building and increase savings for residents, as the current unit price of electricity is significantly higher than the smart export guarantee tariff.
- The Local Plan needs to carefully identify the scale and type of non-residential development needed in Rother (avoid unnecessary development) and define zones in locations with opportunities to reduce energy demand for transport, achieve high efficiency of buildings and services, and provide large available areas for installation of PV systems, electricity, and hot water storage.

public investment and public-private sector partnerships to fund and deliver the necessary infrastructure at pace and scale.

6.3 Building performance metrics for Rother typologies

The following metrics for each typology are recommended based on the findings of the modelling of carbon emissions as standards to help reduce overall emissions and improve efficiency.

Building with flats

RIBA 2030 challenge

EUI = 35 kWh/m^2.yr (including renewable energy contribution)
Potable water : <75 l/p/day

LETI guidance

EUI = 35 kWh/m^2.yr (excluding renewable energy contribution)
Space Heating demand: 15 kWh/m^2.yr
Hot water demand : 10 kWh/m^2.yr

RIBA Good Practice (2021)/ Reference

EUI = 60 kWh/m^2.yr (including renewable energy contribution)
Potable water : 110 l/p/day

Typical types and GIA

1 Bedroom (1-2 people) 50 - 65 m^2
2 Bedroom (2-4 people) 65 – 80 m^2
3 Bedroom (4-6 people) 85 – 110 m^2

Design measures

Maximise renewables so that 100% of annual energy requirement is generated on-site (where feasible)

Passive design in the first stages of site development.
Site layout to optimise potential for daylight, natural ventilation, renewables

Form factor <1.7 – 2.5

New dwelling specification comparison

	Notional building (Part L, 2021 update)	Limiting (max) values (Part L, 2021 update)	LETI guidance
External Walls	U = 0.18 W/(m^2.K)	U = 0.26 W/(m^2.K)	U = 0.13 – 0.15 W/(m^2.K)
Floors	U = 0.13 W/(m^2.K)	U = 0.18 W/(m^2.K)	U = 0.08 – 0.10 W/(m^2.K)
Roofs	U = 0.11 W/(m^2.K)	U = 0.16 W/(m^2.K)	U = 0.10 – 0.12 W/(m^2.K)
Windows	U = 1.2 W/(m^2.K)	U = 1.6 W/(m^2.K)	U = 0.8 W/(m^2.K)
Doors	U = 1.0 W/(m^2.K)	U = 1.6 W/(m^2.K)	U = 1.0 W/(m^2.K)
Air tightness (@50Pa)	5.0 m^3/(h.m^2)	8.0 m^3/(h.m^2)	<1.0 m^3/(h.m^2)

Semi – Detached/Terraced houses

RIBA 2030 challenge
EUI = 35 kWh/m^2.yr (including renewable energy contribution)
Potable water : <75 l/p/day

RIBA Good Practice (2021)/ Reference
EUI = 60 kWh/m^2.yr (including renewable energy contribution)
Potable water : 110 l/p/day

LETI guidance
EUI = 35 kWh/m^2.yr (excluding renewable energy contribution)
Space Heating demand: 15 kWh/m^2.yr
Hot water demand : 10 kWh/m^2.yr

Typical types and GIA

2 Bedroom (2-4 people) 65 – 80 m^2
3 Bedroom (4-6 people) 85 – 110 m^2
4 Bedroom (5-7 people) 120 – 125 m^2

Design measures

Maximise rooftop PV capacity installation where feasible.
Rooftop PV >2.0kWp installed (where feasible)

Passive design in the first stages of site development.
Site layout to optimise potential for daylight, natural ventilation, renewables

Form factor <0.8 – 1.5

New dwelling specification comparison

	Notional building (Part L, 2021 update)	Limiting (max) values (Part L, 2021 update)	LETI guidance
External Walls	U = 0.18 W/(m^2.K)	U = 0.26 W/(m^2.K)	U = 0.13 – 0.15 W/(m^2.K)
Floors	U = 0.13 W/(m^2.K)	U = 0.18 W/(m^2.K)	U = 0.08 – 0.10 W/(m^2.K)
Roofs	U = 0.11 W/(m^2.K)	U = 0.16 W/(m^2.K)	U = 0.10 – 0.12 W/(m^2.K)
Windows	U = 1.2 W/(m^2.K)	U = 1.6 W/(m^2.K)	U = 1.0 W/(m^2.K)
Doors	U = 1.0 W/(m^2.K)	U = 1.6 W/(m^2.K)	U = 1.0 W/(m^2.K)
Air tightness (@50Pa)	5.0 m^3/(h.m^2)	8.0 m^3/(h.m^2)	<1.0 m^3/(h.m^2)

Detached houses

RIBA 2030 challenge
EUI = 35 kWh/m^2.yr (including renewable energy contribution)
Potable water : <75 l/p/day

RIBA Good Practice (2021)/ Reference
EUI = 60 kWh/m^2.yr (including renewable energy contribution)
Potable water : 110 l/p/day

LETI guidance
EUI = 35 kWh/m^2.yr (excluding renewable energy contribution)
Space Heating demand: 15 kWh/m^2.yr
Hot water demand : 10 kWh/m^2.yr

Typical types and GIA

3 Bedroom (4-6 people) 85 – 110 m^2
4 Bedroom (5-7 people) 120 – 125 m^2
5 Bedroom (5+ people) >135 m^2

Design measures

Maximise rooftop PV capacity installation where feasible.
Rooftop PV >2.6kWp installed (where feasible)

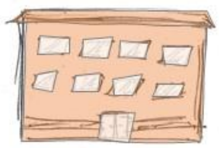
Passive design in the first stages of site development.
Site layout to optimise potential for daylight, natural ventilation, renewables

Form factor <0.8 – 1.5

New dwelling specification comparison

	Notional building (Part L, 2021 update)	Limiting (max) values (Part L, 2021 update)	LETI guidance
External Walls	U = 0.18 W/(m^2.K)	U = 0.26 W/(m^2.K)	U = 0.13 – 0.15 W/(m^2.K)
Floors	U = 0.13 W/(m^2.K)	U = 0.18 W/(m^2.K)	U = 0.08 – 0.10 W/(m^2.K)
Roofs	U = 0.11 W/(m^2.K)	U = 0.16 W/(m^2.K)	U = 0.10 – 0.12 W/(m^2.K)
Windows	U = 1.2 W/(m^2.K)	U = 1.6 W/(m^2.K)	U = 1.0 W/(m^2.K)
Doors	U = 1.0 W/(m^2.K)	U = 1.6 W/(m^2.K)	U = 1.0 W/(m^2.K)
Air tightness (@50Pa)	5.0 m^3/(h.m^2)	8.0 m^3/(h.m^2)	<1.0 m^3/(h.m^2)

Small Offices – General Office space



GIA <1,000m²

RIBA 2030 challenge
EUI = 55 kWh/m².yr (including renewable energy contribution)
Potable water : <10 l/p/day

RIBA Good Practice (2021)/ Reference
EUI = 90 kWh/m².yr (including renewable energy contribution)
Potable water : 16 l/p/day

LETI guidance
EUI = 55 kWh/m².yr (excluding renewable energy contribution)
Space Heating demand: 15 kWh/m².yr
Current Avg. ~160 kWh/m².yr

Design measures

Maximise renewables to generate the annual energy requirement for at least two floors of the development on-site (where feasible)

Passive design in the first stages of site development.
Site layout to optimise potential for daylight, natural ventilation, renewables

Form factor 1.0 – 2.0

New dwelling specification comparison

	Notional building (Part L, 2021 update)	Limiting (max) values (Part L, 2021 update)	LETI guidance
External Walls	U = 0.18 W/(m².K) (side-lit/unlit) / 0.26 (top-lit)	U = 0.26 W/(m².K)	U = 0.12 – 0.15 W/(m².K)
Floors	U = 0.15 W/(m².K) (side-lit/unlit) / 0.22 (top-lit)	U = 0.18 W/(m².K)	U = 0.10 – 0.12 W/(m².K)
Roofs	U = 0.15 W/(m².K) (side-lit/unlit) / 0.22 (top-lit)	U = 0.18 W/(m².K) (flat) / U = 0.16 W/(m².K) (pitched)	U = 0.10 – 0.12 W/(m².K)
Windows	U = 1.4 W/(m².K)	U = 1.6 W/(m².K) (or Rated Band B)	U = 1.0 - 1.2 W/(m².K)
High-usage entrance Doors	U = 1.9 W/(m².K)	U = 3.0 W/(m².K)	U = 1.2 W/(m².K)
Air tightness (@50Pa)	3.0 m³/(h.m²) (side-lit/unlit) / 5.0 (top-lit)	8.0 m³/(h.m²)	<1.0 m³/(h.m²)

Light Industrial

GIA ~1,000m²

RIBA 2030 challenge
EUI = 55 kWh/m².yr (including renewable energy contribution)
Potable water : <10 l/p/day

RIBA Good Practice (2021)/ Reference
EUI = 90 kWh/m².yr (including renewable energy contribution)
Potable water : 16 l/p/day

GBC – Paris Proof targets
EUI = 80 kWh/m².yr (with cooling)
EUI = 50 kWh/m².yr (without cooling)

Design measures

Maximise renewables to generate the annual energy requirement for at least two floors of the development on-site (where feasible)

Passive design in the first stages of site development.
Site layout to optimise potential for daylight, natural ventilation, renewables

Form factor 1.0 – 2.0

New dwelling specification comparison

	Notional building (Part L, 2021 update)	Limiting (max) values (Part L, 2021 update)	LETI guidance
External Walls	U = 0.18 W/(m².K) (side-lit/unlit) / 0.26 (top-lit)	U = 0.26 W/(m².K)	U = 0.12 – 0.15 W/(m².K)
Floors	U = 0.15 W/(m².K) (side-lit/unlit) / 0.22 (top-lit)	U = 0.18 W/(m².K)	U = 0.10 – 0.12 W/(m².K)
Roofs	U = 0.15 W/(m².K) (side-lit/unlit) / 0.22 (top-lit)	U = 0.18 W/(m².K) (flat) / U = 0.16 W/(m².K) (pitched)	U = 0.10 – 0.12 W/(m².K)
Windows	U = 1.4 W/(m².K)	U = 1.6 W/(m².K) (or Rated Band B)	U = 1.0 - 1.2 W/(m².K)
High-usage entrance Doors	U = 1.9 W/(m².K)	U = 3.0 W/(m².K)	U = 1.2 W/(m².K)
Air tightness (@50Pa)	3.0 m³/(h.m²) (side-lit/unlit) / 5.0 (top-lit)	8.0 m³/(h.m²)	<1.0 m³/(h.m²)

7. Carbon impacts of potential policy options

The building specifications case studies (S1-S3) explore the different impacts on emissions when high performance building fabric and fossil-free building services are adopted, guided by year of adoption.

This Section selectively tests key metrics which could be used in planning policy. It builds upon the principles of the policy options in section 5, adapting them for application to carbon modelling methodologies which will feed into the overall policy recommendations in Section 10.

The aim of this research is to showcase outcomes of high building performance requirements at different timescales, by modelling buildings within three case study settings and with different energy performance metrics and energy sources. These are named S1 to S3, with increasing stringency in energy performance and thus ambition.

Arup's operational carbon models have been used to assess carbon emissions at a strategic level. The background growth scenario will not affect the outcomes as it is the same across the three case studies, namely the G1-Dispersed growth option (detailed in Section 5). Any differences will be due the controlled parameters in Table 12. The Dispersed scenario was selected as the background option because it results in a larger floor area (more detached dwellings, less flats) and therefore higher population growth than the other scenarios to enable comparisons among the case studies. The estimated emissions are meaningful for the comparison between different options in scenarios and should only be considered as indicative within the context of the modelling assumptions and limitations.

The main differences in metrics between case studies are:

1) the year residential developments adopt the LETI guidance specifications, and
2) the heating system type and year of installation in non-residential new development.

All residential buildings are assumed to be built at Part L 2021 standard, until the year when LETI specifications are implemented in the case studies. All residential buildings have ASHP, as construction start is assumed for 2025 when gas and oil boilers will likely be no longer allowed in new build dwellings.

Non-residential buildings specifications are representative of the Part L 2021 requirements. Non-residential buildings do not adopt LETI guidance or similar high-performance specifications. They are built with gas boilers as standard until the year electric boilers or district heating are installed as defined for each case study.

Table 12 Key parameters and assumptions in the building case studies.

Buildings' case study settings	S1 Case Study Metrics	S2 Case Study Metrics	S3 Case Study Metrics
Housing mix	Semi-detached 60%, detached 15%, terraced 20%, flats 5%	Semi-detached 60%, detached 15%, terraced 20%, flats 5%	Semi-detached 60%, detached 15%, terraced 20%, flats 5%
Efficiency standard introduced for developers	LETI guidance from 2035	LETI guidance from 2030	LETI guidance from 2025
All residential new builds' heating systems	ASHP from 2025	ASHP from 2025	ASHP from 2025

Buildings' case study settings	S1 Case Study Metrics	S2 Case Study Metrics	S3 Case Study Metrics
Total on-site rooftop PV capacity deployment (2025 - 2040)	450 kWp / year (1kWp per dwelling) 6,750 kWp total	900 kWp / year (2 kWp per dwelling) 13,500 kWp total	1,600 kWp / year (3.6 kWp per dwelling) 24,300 kWp total
All non-residential new builds' heating systems	Electric boilers from 2035	Electric boilers from 2030	District heating from 2030
Employment Land Use Class & Transport options	See G1-Dispersed settlements	See G1-Dispersed settlements	See G1-Dispersed settlements
Transport related input	See G1-Dispersed settlements	See G1-Dispersed settlements	See G1-Dispersed settlements

7.1 Emissions of different levels of policy ambition

This section shows the results from the case studies modelled with focus on buildings' performance ambition levels.

Table 13 Annual and cumulative emissions for the three buildings case studies in Rother

Buildings' case study	Cumulative emissions for the period of the Local Plan (2025-2040) (tCO_2e)	Additional* annual emissions in 2030 (tCO_2e)	Additional annual emissions in 2040 (tCO_2e)
S1-Minimum ambition	157,980	9,359	11,588
S2-Medium ambition	154,784	9,502	11,067
S3-Maximum ambition	148,914	8,784	11,040

*The additional emissions (population) are representative of the emissions (population) associated with new development only and not the existing, baseline emissions and their future trajectory.

The annual emissions estimated for the policy scenarios have a similar trend with the growth scenario analysis. The S3-Maximum ambition case study shows that emissions have a lower growth rate than the other case studies. The emissions growth rate starts effectively reducing around 2032 across all cases, when new non-residential buildings have been connected to district heating networks. The S2-Medium ambition case study (LETI standard in 2030, 2 kWp PV capacity per dwelling, electric boilers in non-residential in 2030) emissions reach similar levels in 2035 with the S3-Maximum ambition scenario (LETI standard in 2025, 3.6 kWp PV capacity per dwelling, district heating in non-residential in 2030).

The case study results in Figure 18 show that the S3-Maximum ambition case study (3.6 kWp per dwelling) will effectively deliver residential developments with net zero emissions. This result should be interpreted in combination with the PV generation expectations in each scenario (Figure 17). The annual emissions avoided with PV generation will be directly affected by the grid carbon intensity, with the expectation of a decrease in the effect of PV systems on annual emissions accounting.

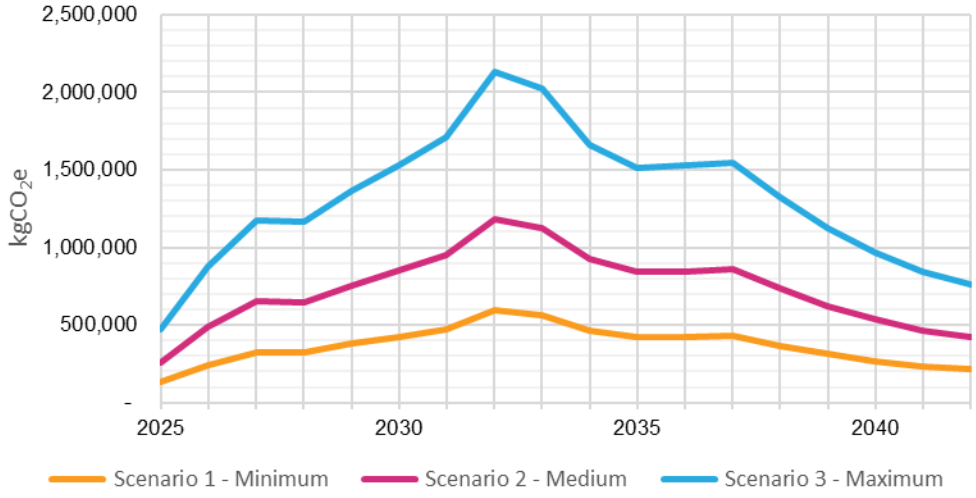


Figure 17. Annual emissions (kg CO_2e) avoided with local PV generation in each case study.

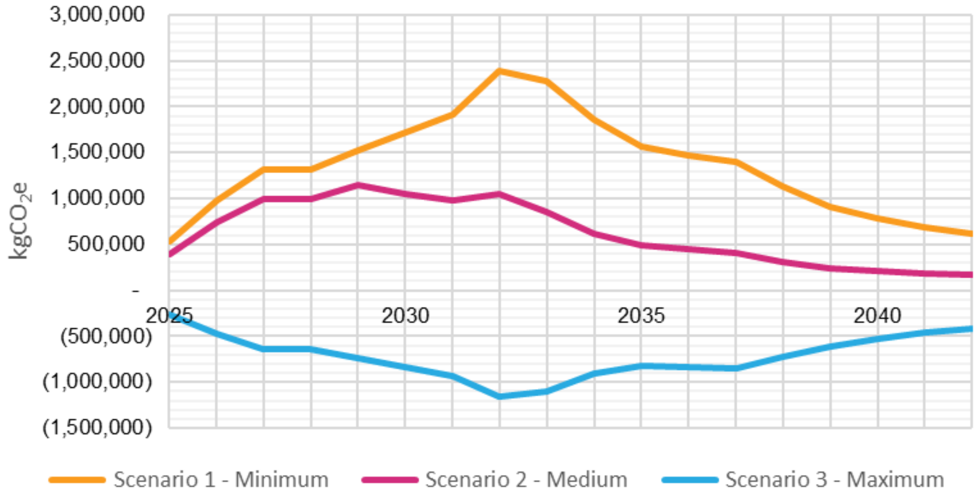


Figure 18. Net annual emissions (kg CO_2e) from residential buildings for different policy ambition(Includes PV electricity generation).

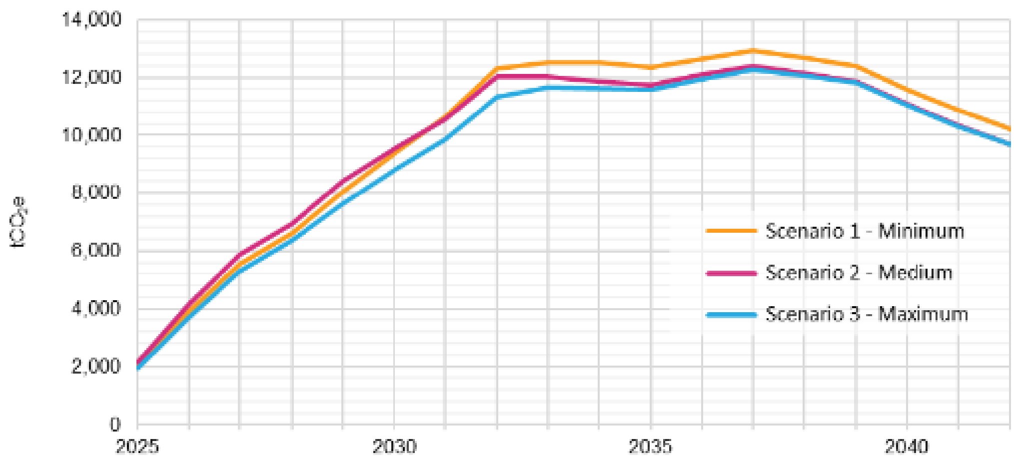


Figure 19. Annual emissions (tCO_2e) for three different levels of policy ambition in Rother.

Despite the Maximum policy ambition delivering net zero residential development, the impact on the overall emissions associated with growth is relatively small (Figure 19). These findings indicate that measures focused only on buildings' performance will not be alone sufficient to reduce the emissions associated with growth to net zero. Early implementation of high building energy performance requirements, electrification of heat and increased renewable electricity generation will only be effective as part of an integrated strategy that aims to net zero emissions for all sectors. This result should not be interpreted in a way that reduces policy ambition and supports a "do nothing" response. If the difference between the scenarios is small this is because all new construction will have higher energy performance than the existing building stock, and most importantly because the expected growth in terms of new residential and non-residential buildings is relatively small and similar among the scenarios.

7.2 Adoption of ambitious building performance standards

The discussion in this section focuses on two main findings: firstly, the effect of timing building performance strategy and secondly the importance of PV generation in achieving net zero development.

7.2.1 Time of adoption

In Rother, within the context of expected new residential development (~450 dwellings/year) and emissions accounting (i.e. not considering futureproofing, running costs and comfort), the early adoption of high-performance standards alone has a marginal effect on reducing the overall emissions. Transport and the residual emissions from buildings define the emissions pathway because 1) the current building regulations (2021 update) are leading towards highly insulated housing with efficient electric heating systems, and 2) transport emissions are almost half of the annual total emissions.

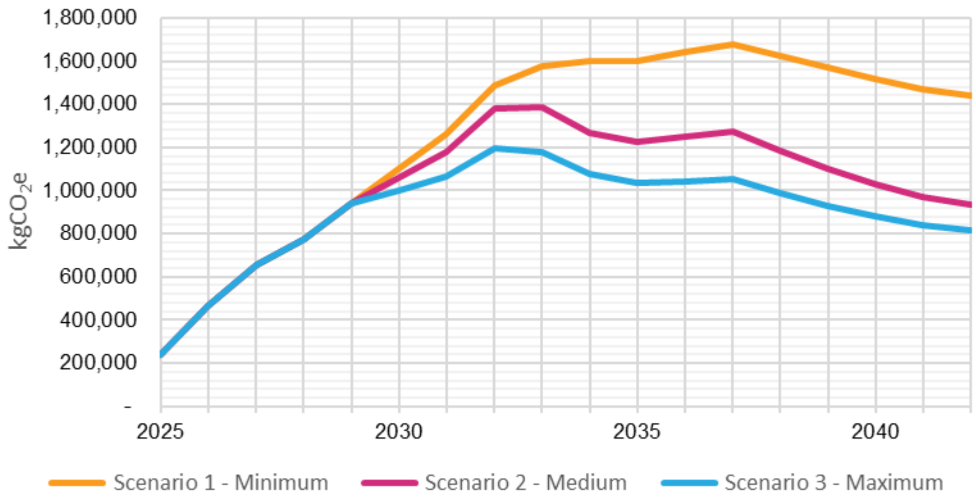


Figure 20. Net annual emissions (kg CO_2e) from non-residential buildings for different policy ambition.

It is noted that the energy demand of non-residential buildings has already been adjusted to represent the impact of new building regulations, but the baseline was high and the grouping of buildings in broad use classes does not allow for additional granularity in the results. Despite the impact this might have on final levels of emissions, the important findings here are:

1. The significance to prioritise use classes mix and enable the use of low-carbon efficient heating systems in non-residential buildings,
2. The careful consideration on the size of non-residential development,
3. The need for high performance requirements in non-residential buildings where possible and

4. The requirement for significant on-site renewable electricity and heat generation. As it has been discussed this should be holistically approached to allow for solutions that add-on and create opportunities for decentralised networks and district heating that can benefit businesses and local communities alike.

7.2.2 PV electricity generation and net zero buildings

The results show the significant contribution that local PV generation can have on achieving net zero emissions for new development. There are however some simplifications in the modelling of the scenarios that need to be noted. The model does not consider the matching of demand with generation. While on average the S3 Maximum ambition would likely result in net zero residential housing development, this can only be possible with significant investment in battery storage systems and smart networks in order to use generation locally where and when is needed, in office and school buildings during the working day for example.

PV generation in non-residential development has not been included in the modelling, this was mainly for simplification of the calculations and due to uncertainty on the use classes and building types. Policy ambition should be maximised for on-site PV generation and the use of highly efficient electric heating options in combination with energy demand reduction in non-residential buildings.

7.3 Implications for Local Plan

The modelling results and the discussion around the growth options support the argument that successful decarbonisation at pace of future development is a systemic challenge. Policy levers are key to enable reduction of overall emissions while delivering societal and economic benefits.

All scenarios and trajectories rely on the rapid decarbonisation of the national grid. The modelling at this stage has not considered the utility bill costs associated with heat electrification. There are currently plans for a gas/oil boiler ban in new build residential dwellings from 2025 onwards. If this ban is enforced as planned, then the Local Plan should include provisions that encourage local PV generation and local electricity storage to help alleviate any large increases of electricity costs.

7.3.1 Timing of introduction of measures/high performance buildings guidance

Timing of the implementation of measures is very important for the reduction of total emissions. In general, requirements for high efficiency building fabric should be introduced at the earliest possible time in terms of feasibility. Despite the small impact on emissions shown in the modelling results, a very high-performance fabric approach is the only certain way forward to reduce emissions and running costs, regardless of any uncertainties with fuel costs and grid carbon intensity. Technical feasibility is not expected to be an issue as the buildings are new build (not retrofit). The viability of development, supply chain, and availability of skilled workforce concerns should ideally be addressed as soon as possible with local policy initiatives and a strong focus on building local capacity to facilitate sustainable growth.

PV generation will also be an important element of achieving net zero residential development. Battery storage and decentralised networks will be necessary to maximise cost benefits for residents and optimise energy and emissions savings. For PV generation to be a feasible and effective solution to decarbonise dwellings in the long term, the residual emissions need to be as low as possible by minimising heating, hot water and unregulated electricity consumption which will likely require very high building fabric performance. The implications of those considerations in achieving compliance and low energy use intensity are discussed with some worked examples in the Net Zero Building Analysis section.

8. Net Zero Buildings Feasibility and Costs

8.1 Introduction and methodology

In line with the carbon modelling detailed in this report, costings have been calculated for the five archetypes: flats, semi-detached housing, detached housing, offices, and industrial units. The purpose of these costings is to provide comparison of baseline build to interventions reflective of the advanced planning policies required to tackle climate change.

Costs have been calculated using industry published data and internal benchmarked data of projects of a similar nature. The feasibility nature of this study means the feasibility design detail is equivalent to RIBA Stage 0 Strategic Definition. It is prudent to allow an estimate sensitivity tolerance of +/- 50%. The nature of this report is such that influencing cost factors cannot be fully accounted for including time of construction, economies of scale, procurement route and construction contract. Costs are inclusive of main contractor preliminaries, overheads and profits and include an element of risk allowance. Contractor development costs will vary depending on numerous factors including but not exclusive to; businesses, development size, site location, market conditions and building methodology. Costs have been made based on new build developments only and are not applicable in alternative scenarios. These costs should not be used during procurement or tendering activities or to determine project or business commercial targets.

To allow cost comparison, assumptions have been made regarding the unit sizes, solid:glazed ratios of external walls, heating output requirements and PV solar potentials. It is the case that these assumptions will not be reflective of all developments and therefore, costs are to be considered as an indicative guide only for discussions around the design development in relation to planning scenarios. For example, where heat generation for apartment buildings has been costed on the basis of individual heat pumps, alternative more centralised methods may be used depending on the development design.

Of further note, costs relating to flats should be considered as a partial representation. It is notable that costs per apartment would be calculated across a wider development in real terms. This would significantly impact the cost per m² as shown. Furthermore, in the instance of heat generation, it is likely that more development centralised systems may be used as an alternative to individual ASHP's. This would also impact the cost per kW requirement.

Typology 4 (Office) has been based on a design reflective of a standalone, single storey building. Costs relating to Typology 5 (Industrial) have also been built-up on a similar basis. It should be noted the construction methodology utilised will vary between developments due to locality, purpose and design preference. The construction methodology will impact the extent of each intervention and therefore, costs per m² / kW.

Typology and intervention-specific commentary regarding the methodology of the cost build up is provided within the full Order of Cost Estimate summary table in Appendix A4.

8.2 Feasibility Findings

Feasibility findings will differ between developments and developers, and as such will be required to be considered on a case-by-case basis. Initial findings suggest enhanced insulation to external walls and roof -based on the same design and construction yields minimal financial impact for typologies 1 – 3. Alternative construction methodologies designed to achieve relevant u-values for typologies 4 – 5 indicate a larger financial impact, though this would vary depending on the design of units.

Glazing upgrades assume an upgrade from double to triple glazing to achieve improved u-values. The resultant cost impact reflects increased material costs associated with glazing improvements. The impact of this on the feasibility of projects would vary from design and developments across the archetypes, depending on project values and glazing proportions.

The most significant impact on feasibility can be seen on the PV installations and heat generation. PV panels are compared against no installations and therefore demonstrate a more significant impact. Heat generation for dwellings has been assessed on ASHP compared to the installation of electric boilers on typologies 4 and 5. The perceived value will be dependent on the purpose of the development and the ownership of operational costs. Initial findings suggest PV installations and alternative heat generation will have the most significant impacts on feasibility.

8.3 Cost Findings

The tables below set out the cost findings of the proposed interventions. Costs should be read in conjunction with the corresponding comments shown within the full tables in Appendix A4 and the cost assumptions and exclusions in Appendix A5.

Table 14 Intervention costs, Typology 1.

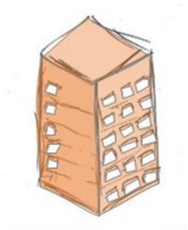
			Typology 1 – Flats and Apartments			
			**41 m² Assumed external wall area (m²) per flat (2,550m² per block)** **14 m² Assumed glazing area (m²) per flat (224m² per block)** **70 m² Assumed roof area (m²) per flat (289m² per block)** **70 m² Assumed GIA (m²) per flat** **753 ft² Assumed GIA (ft²) per flat** **1 block with12 flats in 4 floors (3 flats per floor) assumed.** **17m length x 17m width block assumed**			
Ref	Description	Unit	Cost per 'Unit' Baseline [£ GBP]	Total (building) [£ GBP]	Cost per 'Unit' Advanced [£ GBP]	Total (building) [£ GBP]
1.	Insulation to external walls	m²	520	1,326,000	530	1,351,500
2.	Glazing	m²	850	190,400	1,200	268,800
3.	Roof insulation	m²	330	95,370	350	101,150
4.	PV installations	kW	2,000 (13kWp)	26,000	2,000 (40kWp)	80,000
5.	Heat generation	kW	230 (24kW)	66,240	1,900 (5kW)	108,000
	Totals			1,704,010		1,909,450
Cost uplift for each block: ~12%, £205,440 per block, £17,120 per flat or £245 per m² GIA						

Table 15 Intervention costs, Typology 2.

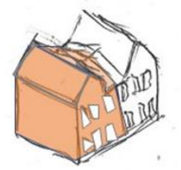
		Typology 2 – Semi-detached houses				
			**72 m² Assumed external wall area (m²)** **17 m² Assumed glazing area (m²)** **52 m² Assumed roof area (m²)** **85 m² Assumed GIA (m²)** **915 ft² Assumed GIA (ft²)**			
Ref	Description	Unit	Cost per 'Unit' Baseline [£ GBP]	Total (building) [£ GBP]	Cost per 'Unit' Advanced [£ GBP]	Total (building) [£ GBP]
1.	Insulation to external walls	m²	520	37,440	530	38,160
2.	Glazing	m²	850	14,450	1,200	20,400
3.	Roof insulation	m²	390	20,282	490	25,480
4.	PV installations	kW	0	0	2,000 (3kWp)	6,000
5.	Heat generation	kW	200 (30kW)	6,000	1,600 (7kW)	11,200
	Totals			78,172		101,240
Cost uplift for each house: ~30%, £23,000 per house or £271 per m² GIA						

Table 16 Intervention costs, Typology 3.

		Typology 3 – Detached houses				
			**152 m² Assumed external wall area (m²)** **25m² Assumed glazing area (m²)** **76 m² Assumed flat roof area (m²)** **125 m² Assumed GIA (m²)** **1,345 ft² Assumed GIA (ft²)**			
Ref	Description	Unit	Cost per 'Unit' Baseline [£ GBP]	Total (building) [£ GBP]	Cost per 'Unit' Advanced [£ GBP]	Total (building) [£ GBP]
1.	Insulation to external walls	m²	520	79,040	530	80,560
2.	Glazing	m²	850	21,250	1,200	30,000
3.	Roof insulation	m²	380	28,880	490	37,240
4.	PV installations	kW	0	0	2,000 (3kWp)	6,000
5.	Heat generation	kW	190 (35kW)	6,650	1,300 (9kW)	11,700
	Totals			135,820		165,500
Cost uplift for each house: ~22%, £30,000 per house or £238 per m² GIA						

Table 17 Intervention costs, Typology 4.

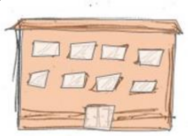
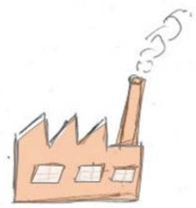
			Typology 4 – Office			
			**68 m^2 Assumed external wall area (m^2)** **22m^2 Assumed glazing area (m^2)** **54 m^2 Assumed flat roof area (m^2)** **54 m^2 Assumed GIA (m^2)** **581 ft^2 Assumed GIA (ft^2)**			
Ref	Description	Unit	Cost per 'Unit' Baseline [£ GBP]	Total (building) [£ GBP]	Cost per 'Unit' Advanced [£ GBP]	Total (building) [£ GBP]
1.	Insulation to external walls	m^2	460	31,280	510	34,680
2.	Glazing	m^2	860	18,920	1,230	27,060
3.	Roof insulation	m^2	410	22,140	440	23,760
4.	PV installations	kW	0	0	2,000 (3kWp)	6,000
5.	Heat generation	kW	240 (24kW)	5,760	1,000 (4.5kW)	4,500
	Totals			78,100		96,000
Cost uplift for each office unit: ~23%, £18,000 per unit or £331 per m^2 GIA						

Table 18 Intervention costs, Typology 5.

			Typology 5 – Industrial			
			**120 m^2 Assumed external wall area (m^2)** **30 m^2 Assumed glazing area (m^2)** **54 m^2 Assumed flat roof area (m^2)** **54 m^2 Assumed GIA (m^2)** **581 ft^2 Assumed GIA (ft^2)**			
Ref	Description	Unit	Cost per 'Unit' Baseline [£ GBP]	Total (building) [£ GBP]	Cost per 'Unit' Advanced [£ GBP]	Total (building) [£ GBP]
1.	Insulation to external walls	m^2	450	54,000	510	61,200
2.	Glazing	m^2	850	25,500	1,200	36,000
3.	Roof insulation	m^2	410	22,140	420	22,680
4.	PV installations	kW	0	0	2,000(3kW)	6,000
5.	Heat generation	kW	220 (30kW)	6,600	900 (12kW)	10,800
	Totals			108,240		136,680
Cost uplift for each industrial unit: ~26%, £28,0440 per unit or £527 per m^2 GIA						

9. Renewable Energy and District Heat Network Methodology and Findings

The high-level technical capacity for onshore renewable energy across Rother has been estimated using benchmarks and geospatial data for the area. The analysis at this stage will provide an indication of potential capacity across the district and a more detailed feasibility and techno-economic assessment as well as a consideration of grid connections will be needed for any specific sites. Following the assessment of total technical capacity for each technology, the existing, installed capacity will be subtracted to assess the overall potential for additional generation.

9.1 Methodology

9.1.1 Roof-mounted Solar PV

Estimations regarding the building rooftop types and angles across Rother were determined using OS data and a selection of high-level assumptions. The data contained in the OS Topography Layer includes building floor area and building height, allowing for the calculation of the number of storeys for each building. Using the address classifications contained in the OS AddressBase Premium database, buildings were classified as either residential, mixed-use, or non-residential. Based on a cursory manual review of buildings in each category, the following assumptions were defined:

- Non-residential buildings are assumed to have flat rooftops, with solar panels angled at the optimal 15°
- Residential and mixed-use buildings are assumed to have rooftops sloped at approximately 30°- unless the building has more than four storeys, in which case the building is designated as having a flat rooftop, with solar panels angled at the optimal 15°

Using these rooftop classifications and floor area for each building, the rooftop area for each building was estimated. The rooftop area available for solar PV was determined by eliminating a portion of both sloped and flat rooftops. An additional reduction was included for flat rooftops to account for the shading of adjacent solar panels. Based on the remaining rooftop area available for solar PV and assuming a standard panel area of 1.7m^2, the total number of panels that could be installed on each rooftop was calculated. Using a standard panel rating of 340W_p/panel, the total potential installed capacity was determined.

The open-source Photovoltaic Geographical Information System (PV-GIS) was used to produce kWh/kWp benchmarks based on annual solar radiation data for the Rother District. A kWh/kWp value was produced for South, West and East facing solar panels. Assuming a distribution of 50% South-facing panels, 25% East-facing panels and 25% West-facing panels, the total installed capacity was converted to estimated annual energy generation from roof-mounted solar PV. It is noted again that this assessment is high-level and estimates the theoretical potential capacity based on the roof area available for rooftop solar PV. Economic considerations such as connection costs are not included in this estimation.

9.1.2 Ground-mounted Solar PV

The area of land available for ground-mounted solar PV was calculated based on the area of open spaces (crops, grass, shrub, bare ground) identified by the geospatial analysis for the Rother District. Ground solar PV panels are normally installed within a buffer of 5-10m from the edge of each site, to avoid shading from any perimeter borders such as trees or hedges and to allow access. The following criteria were used to exclude areas from the assessment:

- The following designations: Agricultural land category class Grade 1-3a, Ancient Woodland, England Green Belt, Heritage Assets and Historic Environment, RAMSAR, Local Nature Reserves and Flood Map zones for rivers and seas (zones 1-3).
- Any land areas which are less than 3,000m^2 (and therefore unlikely to have a viable area more than 10m away from the perimeter of the land).

It is noted that land within the High Weald Area of Outstanding Natural Beauty (AONB) is included in the potential land assessment for ground-mounted solar PV as this designation covers 83% of the Rother District.

The buffer rule noted above leads to a net availability of around 77% of the total potential land area. This area was multiplied by a standard industry assumption of an installed capacity factor of 0.7 MW/ha.

9.1.3 Onshore Wind

To identify opportunities for onshore wind turbines in Rother, the number of wind turbines that could reasonably fit within the available area was estimated. These estimations were based on the industry standard turbine size for planning applications, as defined in the previous Wind Energy Feasibility Study referenced in Section 2.2.3 as a 2.5MW turbine. The available land was approximated by excluding the restricted or occupied land areas as described in the ground-mounted solar PV analysis, in addition to excluding the Area of Outstanding Natural Beauty. Land in proximity to major settlements was also excluded using a buffer distance of 600m away from settlement areas as defined in the Wind Energy Feasibility Study referenced in Section 2.2.3.

The reference turbines have a rotor diameter of 100m. Onshore wind turbines are optimally spaced between 7 and 15 rotor diameters apart. Assuming a spacing of 10 rotor diameters means each turbine requires a 1000m x 1000m (1.0 km2) footprint. The available land area was overlayed with a 1.0 km2 grid which indicated the approximate number of turbines which could fit into the area. Therefore, the maximum potential capacity for onshore wind in the Rother District was determined. The potential electricity generation was calculated using a 10-year average (2010-2020) load factor of 26.6% [56] for onshore wind in the UK.

9.1.4 District Heat Network

The potential for district heating networks was evaluated at a high-level across Rother using the linear heat density method. The baseline individual building heat demand calculated through the energy baselining process outlined in Section 3 was mapped spatially. All buildings with demand of less than 73MWh/year were eliminated from consideration as it is likely the heat demand is too low to support the cost of the infrastructure required. An annual linear heat density value of 4000kWh/yr/m was taken from industry standards as a benchmark appropriate for capturing opportunities in more rural local authority areas.

It should be noted that the linear heat density value used is based on cost of pipework and anticipated revenue from energy and, due to the volatile nature of both supply chains and energy markets, this value can change considerably. Using this linear heat density benchmark, the individual building heat demand was converted into a buffer around each building. Areas where buffers overlap indicated opportunities for connecting properties as part of the district heat network. Analysis of buffer overlaps was therefore used to determine heat network opportunity areas. Anchor loads are defined as buildings with large heating loads and offer resilience to a network through potential economic viability. Loads that were greater than 500MWh/year were classified as anchor loads and the district heat networks that included anchor loads were identified.

9.1.5 Energy Demand Forecast

The electricity and heat demand were forecasted based on the Growth Scenarios identified in Section 5. The main modelling assumptions used to forecast the electricity and heat demand resulting from new builds. The national energy consumption trends outlined in DESNZ' Energy and emissions projections: Net Zero Strategy baseline[22] were taken as an indication of the energy consumption changes due to retrofit of existing building stock. Changes to energy demand for residential and non-residential sectors were forecasted for each year considering both the additional energy demand for new builds and changes to existing stock's energy demand due to retrofit.

9.2 Electricity Use Forecast

New development (and population growth) in conjunction with electrification of transport and heating is expected to result in an increase to electricity consumption under all scenarios. The residential electricity consumption (7 to 9 GWh) is relatively less than the non-residential electricity use (10 to 13 GWh). The total electricity consumption forecast is shown in Figure 21. For reference, the total domestic electricity consumption in Rother in 2021 was 188 GWh (46,323 meters, DESNZ Domestic electricity consumption by LSOA). The total non-residential consumption in 2021 was around 155 GWh (4,706 meters, DESNZ Non-domestic electricity consumption by MSOA).

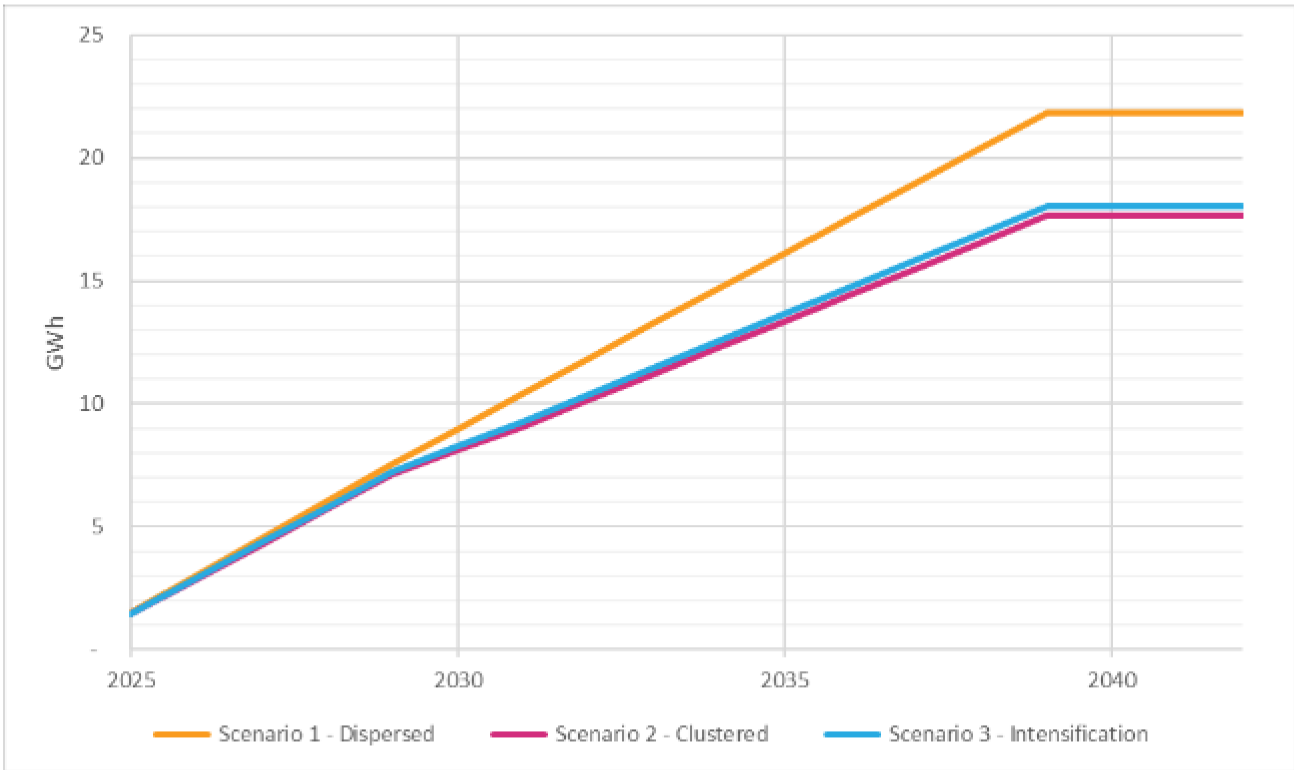


Figure 21: Electricity consumption projections for the modelled residential and non-residential growth scenarios (excluding PV electricity generation).

9.3 Renewable Electricity Generation Potential

Roof-mounted solar PV potential was estimated using building-by-building floor area and high-level assumptions to determine roof area available for PV. The total potential installed capacity is approximately 210MW, amounting to 1.5% of the UK's total PV installed capacity. This is an

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[22] https://www.gov.uk/government/publications/energy-and-emissions-projections-net-zero-strategy-baseline-partial-interim-update-december-2021

estimated figure based entirely on roof availability and not accounting for grid constraints, economic viability or required planning permission.

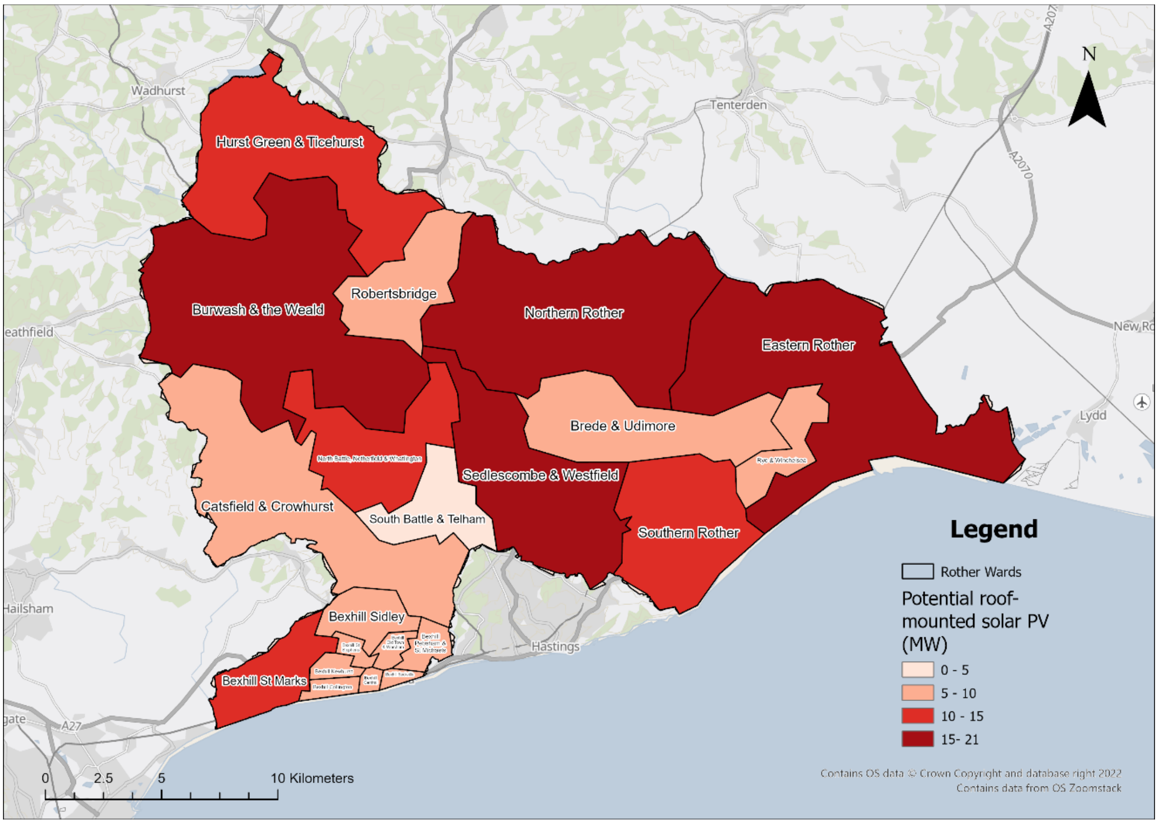


Figure 22: Potential roof-mounted solar PV capacity in Rother's wards.

The total potential ground-mounted solar PV capacity that could be installed in the Rother District is 16GW. However, this is assuming that the entirety of the available 299km^2 land identified as being technically suitable for ground-mounted solar PV is developed into solar farms. Actual solar farm development is contingent on site-specific planning considerations of landscape significance and community and decarbonisation benefits in addition to economic viability and grid constraints, which have not been considered in this analysis. However, this initial estimate indicates that the Rother District has favourable geospatial characteristics for ground-mounted solar, with the total potential installed capacity based on a purely geospatial analysis in Northern Rother alone amounting to 17% of the UK's total solar PV installed capacity in 2022.

In addition, opportunities to install ground mounted solar PV would be limited for wards that are within the High Weald Area of Outstanding Natural Beauty. The previous feasibility studies considering ground-solar farm development are site-specific and could be motivated by the interest of stakeholders in the area rather than purely a high-level geospatial analysis as performed above. It is noted that both potential sites outlined in the RCEF Feasibility Study – Solar Farm, Energise Sussex and the Infraland, Breadsell, Hastings Renewable Energy Report (2022) do correspond with the land available for ground-mounted solar farms. However, more detailed feasibility and techno-economic assessment as well as a consideration of grid connections will be needed to fully guarantee the viability of both sites.

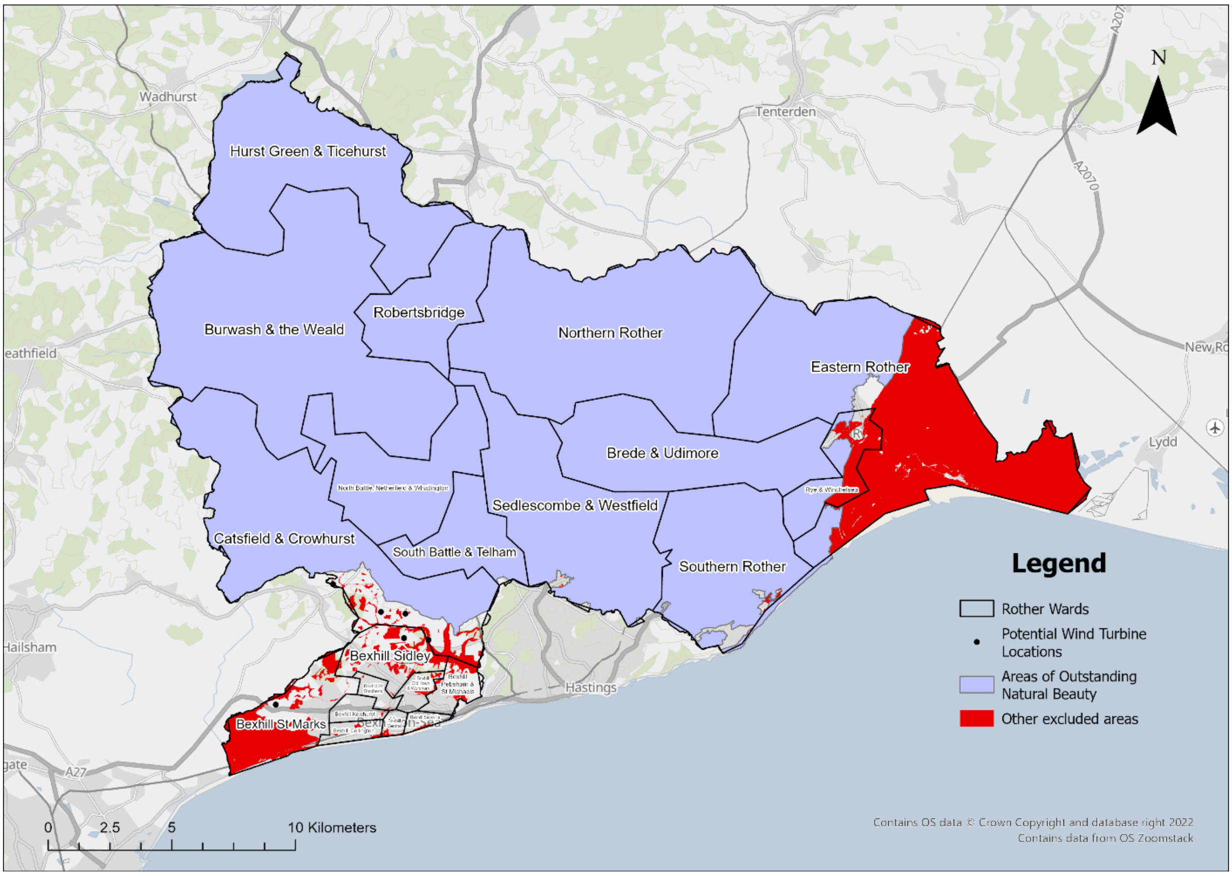


Figure 23: Potential onshore wind turbine placement in Rother's wards.

The potential wind turbine locations illustrated in Figure 23 partially corroborates the findings of previous wind feasibility studies outlined in Table 3. The Renewable Energy Background Paper (2016) concluded that the Fairlight-Hastings-Ridge and Bexhill-Fringes were favourable for wind turbines due to high wind speeds. The geospatial analysis performed above excludes most of the areas along the Fairlight-Hastings-Ridge as these areas are within the High Weald Area of Outstanding Natural Beauty. One turbine in Bexhill-St-Marks corresponds with the Bexhill-Fringes areas cited as having favourable wind speeds. Catsfield & Crowhurst was found to be the ward with the most favourable conditions spatial conditions for wind turbines, with 4 wind turbines being feasible within the ward.

It is recommended that more up to date wind speed data is layered on top of the geospatial analysis performed in this study to further corroborate the feasibility of onshore wind electricity generation in the locations identified in Figure 22. The Wind Energy Feasibility Study (2021) suggests that the Rye/Camber/Playden area has the most potential for onshore wind electricity generation. The geospatial analysis performed above excludes the majority of land in this area due the land falling into one of the following classifications: RAMSAR, Sites of Special Scientific Interest and Flood Map zones for rivers and seas (zone 3).

9.4 Heat Demand Forecast

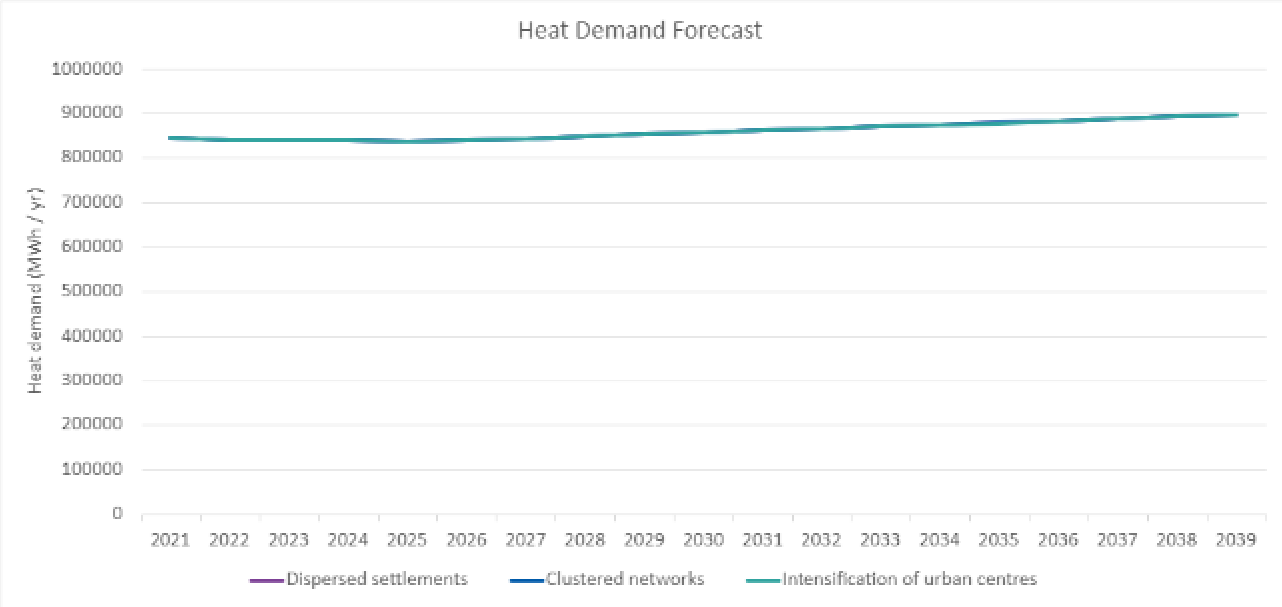


Figure 21: Heat demand forecast across all three growth scenarios, including a forecast of heat demand in existing building stock.

The heat demand forecast for all three growth scenarios is shown in Figure 21. The heating demand across all three growth scenarios follows the same trend of decreasing until 2024 due to retrofit interventions implemented in existing building stock and increasing thereafter as the development of the new builds defined for the different growth scenarios begins. The final heat demand achieved in 2039, the end of the modelled growth period, is highest for the dispersed settlements scenario, because of this scenario having the highest relative percentage of semi-detached new builds. All growth scenarios achieve a relatively similar 2039 heating demand due to the small variations in the typology of new-builds and the constant new-build heating demand of 15kWh/m^2. The final 2039 heating demand are: 898,601 MWh/year for the dispersed settlements scenario, 897,997 MWh/year for the clustered networks scenario and 897,331 MWh/year for the intensification of urban centres scenario. In summary, Rother's heating demand is forecasted to increase by approximately 50 000MWh/year or 6% of the district's baseline heating demand from 2021-2039 across all three growth scenarios.

9.5 District Heat Network Potential

9.5.1 Identified Potential District Heat Network Zones

The total heat demand by all identified potential district heat network zones across Rother accounts for 6% of Rother's baseline heat demand, with 5% of this demand attributed to the potential zones in Bexhill-on-Sea, and 4.5% of the worst-case forecasted heat demand in 2039. However, this final percentage has the potential to be higher depending on the location of the new developments in Bexhill-on-Sea. The majority of the identified potential district heat network zones are in Bexhill-on-Sea because of the area's high density of buildings. It is noted that more detailed techno-economic feasibility and grid constraint analyses are required to confirm the viability of any specific site identified below.

Table 19 Summary of potential district heat network locations across Rother.

Cluster ID	Number of buildings	Total heat demand of buildings in cluster (MWh/year)	Number of anchor loads	Total anchor load heat demand (MWh/year)	Anchor load heat demand relative to total heat demand of buildings (%)	Location
1	98	23071	9	9475	41	Bexhill-On-Sea
2	15	3616	0	1065	29	Bexhill-On-Sea
3	16	3302	1	786	24	Bexhill-On-Sea
4	7	3121	0	0	0	Bexhill-On-Sea
5	11	2997	1	867	29	Bexhill-On-Sea
6	11	2369	0	0	0	Rye
7	11	2134	1	831	39	Bexhill-On-Sea
8	9	1633	0	0	0	Bexhill-On-Sea
9	5	1548	0	777	50	Bexhill-On-Sea
10	5	1296	1	834	64	Rye
11	4	1286	0	0	0	Rye
12	7	979	0	0	0	Rye
13	3	928	0	0	0	Bexhill St Marks
14	5	872	2	0	0	Bexhill St Marks
Total	**207**	**49152**	**15**	**14635**	**276**	**-**

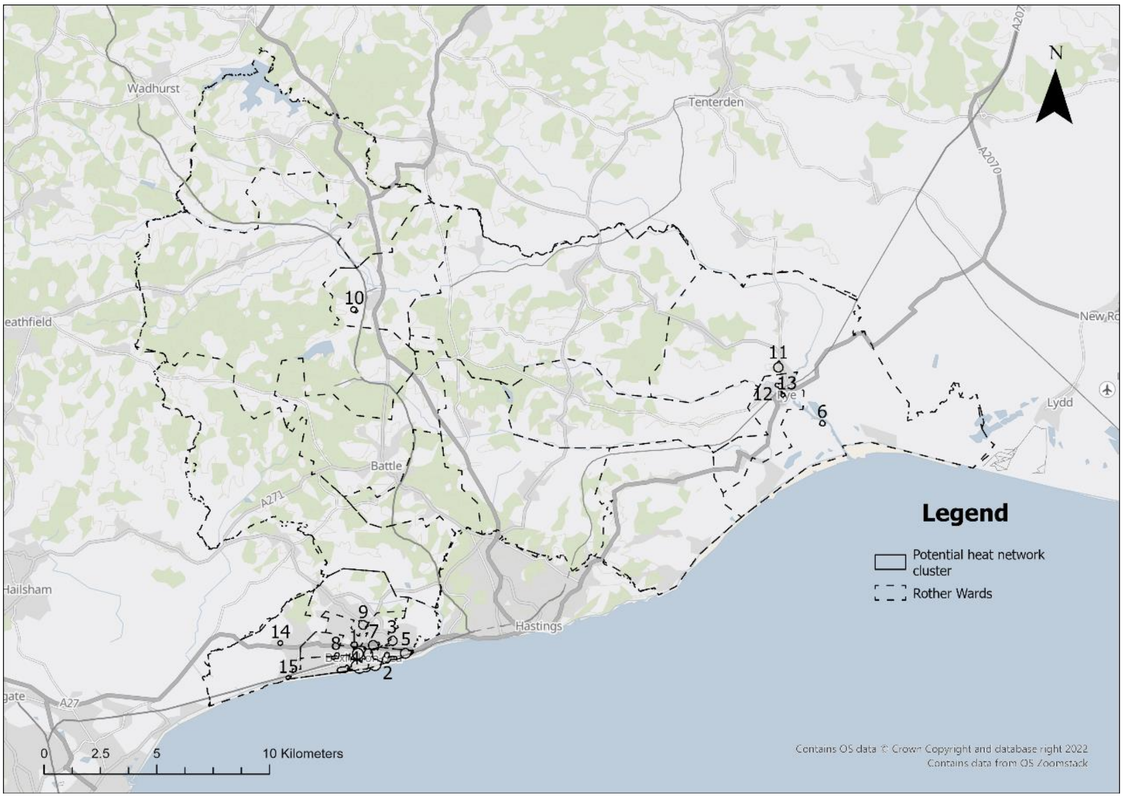


Figure 24: Overview of potential district heat network locations across Rother.

The district heat networks identified in Figure 22 shows the theoretical and technical potential at a strategic level for district heat connections in Rother. The annual building heat demand and linear heat density thresholds described in Section 9.1.4 were chosen to eliminate buildings with insufficient heat demand to support the cost of the district heat network infrastructure. In addition, anchor loads, defined as buildings with large heating loads that offer technical and economic resilience to a network, are also shown as red dots in subsequent more detailed figures as a high-level indicator as to the viability of potential networks. However, site-level feasibility studies considering a more detailed techno-economic analysis and the consideration of non-technical factors, such as community support and building ownership, is required before committing to the development of any particular network and confirm economic viability. The LHEES methodology used in this report considers the potential for 4th generation district heat networks- meaning, district heat networks with a central energy centre, usually a heat pump supplied, low carbon network. However, it is noted that the potential district heat networks might be suitable as 5th generation networks (5th generation being defined as ambient loop supply at lower temperatures and including building-level generation equipment) but the feasibility for these technologies is not considered in this analysis and would require further investigation.

The previous district heat network study outlined in the RCEF Stage 1 Feasibility Study RINA (2022) is dependent on site-specific analyses as opposed to high-level heat demand analyses performed above. The Camber Heat Analysis (2022) stated that high level heat load assessments shows that there was not enough concentration of heat demand in Camber or Rye to consider a high-temperature district heat network.

However, the heat demand analysis performed in this report identifies several suitable zones in Rye as shown in Figure **27**. Potential district heat networks were also identified at the Rosewood Park development in Little Common and at Cooden Beach (both in Bexhill St Marks) and within the Darvell Community in Robertsbridge, however, no anchor loads were identified in these clusters which negatively impacts the viability and economic feasibility of the potential networks. As illustrated in Figure 25 most potential heat network zones are in Bexhill-on-Sea or the surrounding areas as a result of high heat density and the presence of large, non-residential buildings to act as anchor loads.

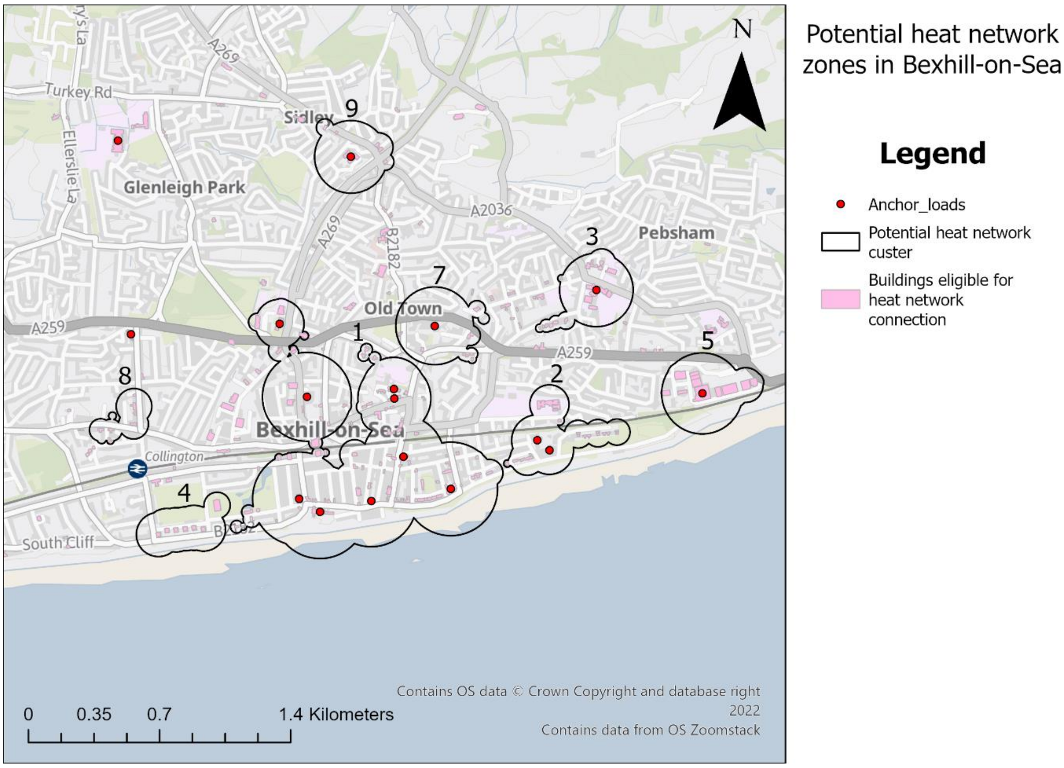


Figure 25: Overview of potential district heat network locations in Bexhill-on-Sea.

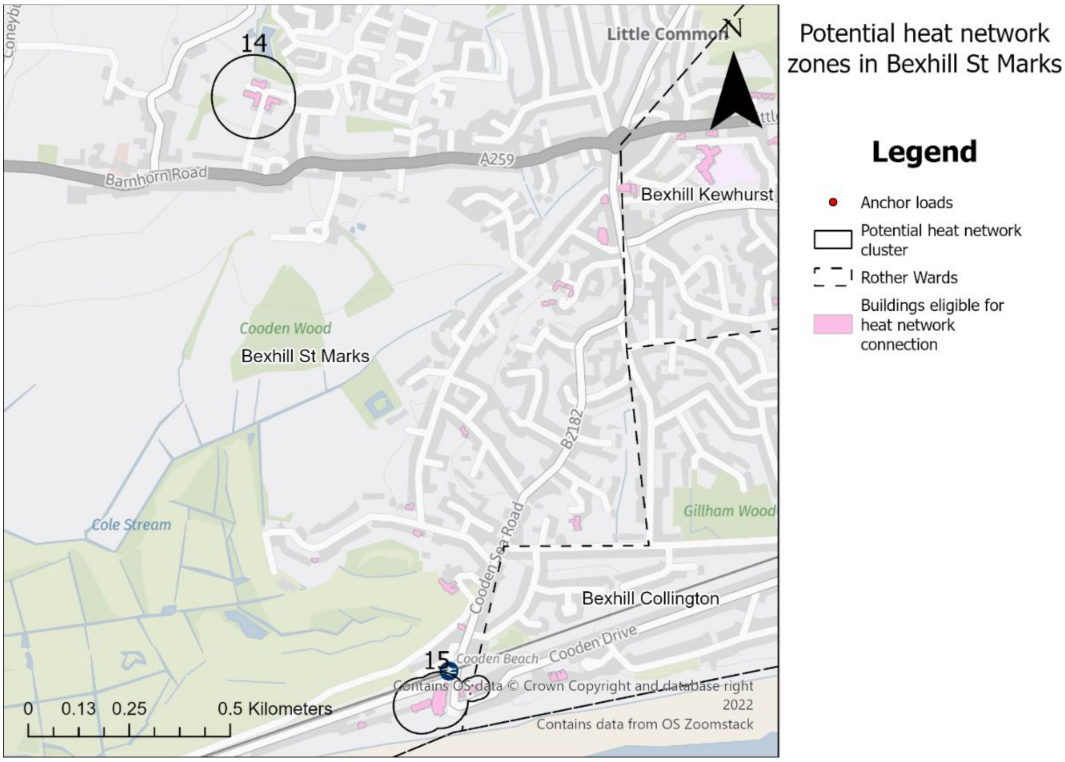


Figure 26: Overview of potential district heat network locations in Bexhill St Marks

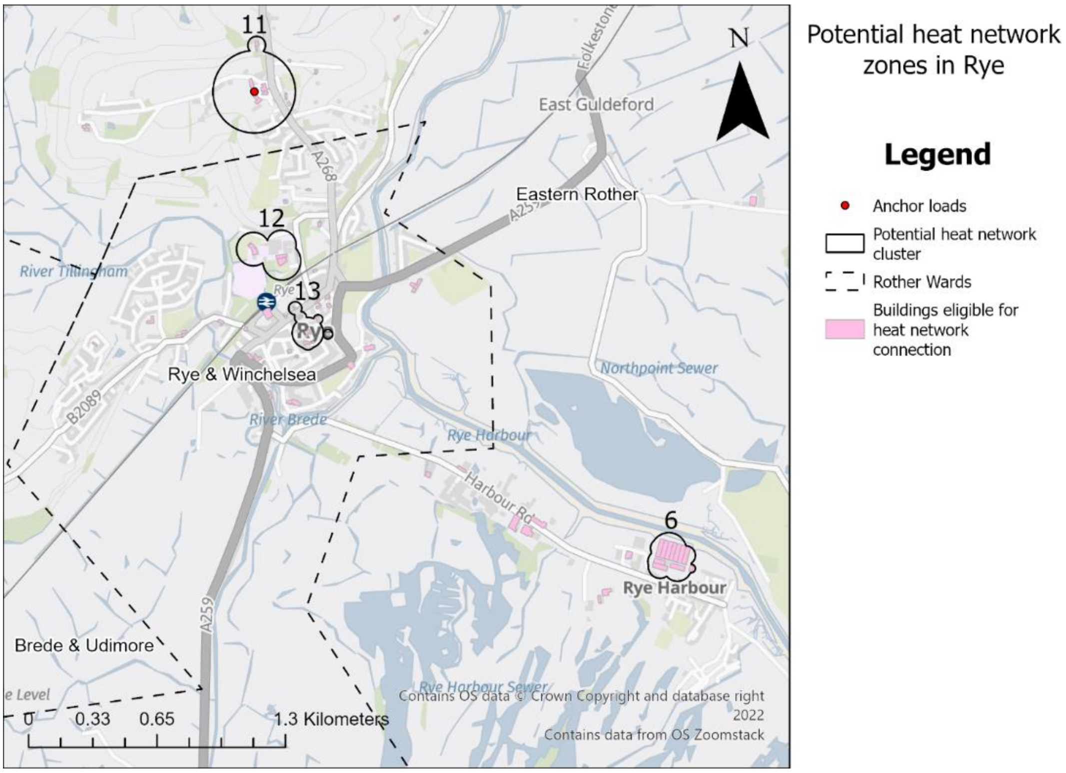


Figure 27: Overview of potential district heat network locations in Rye.

9.6 Implications for Local Plan

With focus on the Local Plan and its role in the future decarbonisation plans for Rother the main implications are:

- The heat and electricity demand in Rother is forecast to increase significantly across all potential growth scenarios. In the context of reaching Rother's 2030 net-zero goal, the Rother's District Council should establish clear renewable electricity generation and low carbon heating targets for all new developments.
- There is the significant potential to decarbonise the Rother District's heating system through the development of district heat networks. As illustrated in Figure 20 most potential heat network zones are in Bexhill-on-Sea or the surrounding areas as a result of high heat density and the presence of large, non-residential buildings to act as anchor loads. The Local Plan should encourage all new-builds to prioritise connection to existing/future district heat networks above alternative heating technologies to promote the viability of district heat networks, particularly for new developments within/surrounding Bexhill-on-Sea.
- Table 21 outlines the potential for renewable electricity generation to contribute meaningfully to local renewable generation in Rother, leading to the following implications for the Local Plan:
  - The Local Plan should encourage refurbishment of existing building stock to include proof of consideration of roof-mounted solar PV installations as well as set targets for rooftop PV installation for all new-builds The Local Plan should consider the planning requirements to support the cost-effective development of ground-mounted solar farms, particularly in highlighted areas of high ground-mounted solar PV potential, but taking account of the protected landscape of the High Weald AONB, the Local Plan should consider the planning requirements to support the cost-effective development of onshore wind turbine/farm, particularly in Catsfield & Crowhurst, which shows favourable spatial characteristics for onshore wind turbines.

10. Rother Net Zero Policy Recommendations

This section provides recommendations and considerations for Local Plan policy, by building on the findings of the baseline assessment, best practice review and the modelling of different policy and spatial scenarios. These are intended to assist the Council in developing the emerging Local Plan and should be considered in conjunction with the other evidence base documents.

These recommendations are intended to assist RDC's aspiration to be net zero by 2030 and to reduce carbon emissions to address the projections set out in section 2. By taking a holistic and wide-ranging approach to reducing carbon (through identifying appropriate locations and densities of growth, implementing sustainable building practices for new development and retrofitting existing stock) RDC's policies will support opportunities to reduce embodied and operational carbon at multiple stages in the development lifecycle.

10.1 Recommendations for growth scenarios

This section of the report will evaluate the benefits of different growth scenarios (Dispersed settlements, Clustered Networks, Intensification of Urban Areas) for energy and carbon performance. As noted previously, the expectation is that future development will follow a hybrid/mixed approach which combines parts of all scenarios in light of limited land availability, housing and economic need, building types, locations and uses. By showcasing the benefits and drawbacks of each scenario and its potential options, the Local Plan can promote 'add-on' solutions for development to improve the certainty of a net-zero future.

10.1.1 Intensification

The 'intensification of urban areas' option has shown the largest potential for sustainable growth – intensification reduces gross floor area in residential development and in turn a reduced heating demand. Intensification also goes hand in hand with the assumptions of district heating to serve non-residential loads, and the intensification of urban centres would also reduce trip levels and mileage, encouraging a mode shift to EV uptake and active travel. Moreover, intensification would encourage the transport sector to take measures in pushing travel mode shift away from the use of private vehicles and instead towards more active and sustainable travel solutions.

10.1.2 Non-residential development and heat networks

Non-residential building typologies will typically have a larger energy demand and larger gross floorspace than residential uses, which means new non-residential developments would be most efficient when placed in areas where they can benefit from low-carbon district heating networks or feed into the provision and development of district heating networks to extend the breadth of community benefit.

10.1.3 Solar

Current plans for a ban on gas/oil boilers in new residential buildings from 2025 onwards means that local authorities should plan for new ways for homes to generate electricity. One of these alternatives is the use of local PV generation and local energy storage. This option is beneficial as it allows local authorities to use the Local Plan to influence heating demand and look for ways to meet this sustainably through clustered heat networks and intensification of urban centres. The installation of on-site PV is recommended because PV would minimise emissions associated with growth whilst creating opportunities to decarbonise existing stock. Battery storage and decentralised networks should be prioritised to optimise emissions savings and maximise cost benefits. PV initiatives have potential to benefit all three growth option scenarios.

10.1.4 Transport

The transport sector has huge potential for decarbonisation which would complement the decarbonisation of residential and non-residential development. Intensification with parallel investment in decarbonising public transport and encouraging active travel will minimise emission output parallel to population growth and associated increase in trips.

10.1.5 Carbon Sequestration

Carbon sequestration potential is also assessed in this work. The development of brownfield areas and the intensification of urban centres should be prioritised and land with high sequestration potential is advised to be protected and enhanced wherever possible.

10.2 Recommendations for Local Plan policy

The updated Building Regulations provide a thorough baseline position for any Local Plan policy. It standardises the expectations for achieving net zero carbon across all new building schemes, balancing competing considerations such as air tightness and indoor air quality. The upcoming Future Homes and Future Buildings Standards will likely strengthen this baseline position when they come to force.

Rother's current adopted policies on energy efficiency and renewable energy do not contain any minimum thresholds on energy or carbon building performance nor include any requirements for the preparation of whole life carbon statements. As such, the policy recommendations seek to go beyond the current and upcoming Building Standards, incorporate the use of Energy Use Intensity (EUI) targets in alignment with current industry best practice guidance and account for a broader range of key building performance metrics to enable the transition towards net zero buildings and lifestyles.

The technical analysis in this study demonstrates the scale of potential additional carbon emissions associated with each of the growth scenarios. In order to minimise these emissions as far as possible, it is proposed that RDC predominantly adopt and, where techno-economically feasible, strengthen the requirements by using the maximum policy packages.

These requirements are summarised in Table 22 below. They follow the Energy Hierarchy by favouring a "fabric first" approach through setting minimum targets for operational and embodied carbon emissions to drive improvements in building construction and fabric, as informed by the best practice review and technical modelling.

While LETI encourage prioritising low energy passive design over renewable generation [57], in view of the carbon emissions currently arising from average building design (see Table 23 below for details), renewable systems are still considered key to improving building carbon and energy performance.

As such, to mitigate operational emissions from new development, it is also proposed that RDC adopt a robust approach to installation of roof-based solar photovoltaic panels on new development, especially for non-residential development where there is greatest roof capacity.

The policy recommendations omit any allowance to carbon offsetting, so that carbon emissions are minimised on-site and directly in association with development.

Table 20 Policy Recommendations

Policy area	Topic	Recommendation
Net zero building standards for minor and major residential development (including conversions)	Building performance standards for operational emissions	It is suggested that RDC require all residential development (including building conversions) to achieve the LETI Total Energy Use Intensity (TEUI) Target for Operational Energy of 35 kWh/m^2/year (GIA). To assure other factors contributing to high quality construction, it is proposed that residential development also attains: • For new builds, a 4-star Home Quality Mark (HQM) score; or • For conversions to residential development, a BREEAM 'Excellent' standard as minimum. It is not considered that an interim target is required for these thresholds, since they entail a holistic range of sustainability metrics and so are more accessible for developers to demonstrate compliance. Developer guidance: Developers could select one of BRE's existing certification schemes to demonstrate compliance with both the LETI energy and carbon targets, and the quality of construction target guidance.
	Building performance standards for embodied emissions	To account for embodied carbon emissions, it is suggested that RDC tailor the maximum policy package threshold. Based on the joint Embodied Carbon Target Alignment guidance from LETI, RIBA and other industry organisations, current average building design achieves an E rating on the LETI carbon rating system, equating to 950 kgCO^2/m^2 upfront embodied carbon and 1400 kgCO^2/m^2 total embodied carbon. Additionally, our carbon specialists do not consider that the commercial construction supply chain can yet achieve the LETI 2030 Design Targets (an A rating on the LETI carbon rating system, equating to 350 kgCO^2/m^2 upfront embodied carbon and 530 kgCO^2/m^2 total embodied carbon). As such, a staggered approach is proposed to transition towards the LETI 2030 Design Targets, as included in the maximum policy scenario: • On adoption of the new Local Plan: Stipulate a LETI C rating, equating to 600 kgCO^2/m^2 upfront embodied carbon and 970 kgCO^2/m^2 total embodied carbon. The Embodied Carbon Target Alignment guidance has benchmarked these thresholds with projects that demonstrate good building design. By 2030: Stipulate the LETI A rating for residential development, equating to 300 kgCO^2/m^2 upfront embodied carbon and 450 kgCO^2/m^2 total embodied carbon. As above, these thresholds correspond with the LETI 2030 Design Targets.
	Energy statement requirements	To accompany all planning applications for residential development, it is recommended that developers are required to provide a detailed energy statement encompassing: • Demonstration of how the building performance standards will be met using the energy hierarchy in the design, construction, and operation phases[23]. This includes connecting with district heat networks and decentralised electricity networks. The requirements for heat networks are detailed below. • Evidence that high energy efficiency appliances are installed if these are included in the interior fit-out.

[23] The energy hierarchy is defined by considering how to reduce operational energy use in the following order of priority: 1) Be lean – Use less overall energy; 2) Be clean – supply energy efficiency, cleanly and via local energy resources (such as secondary heat) where possible; and 3) Be green – use renewable energy.

		For developments of more than 100 dwellings (or a lower threshold to capture a significant proportion of new dwellings in the district)it is suggested that developers show that whole life carbon analysis has been applied in designing their scheme, including optimising operational and embodied carbon and energy, as well as integrating Circular Economy principles (following current LETI and RIBA guidance[24]).
	Energy provision requirements	To attain the TEUI Target for Operational Energy of 35 kWh/m^2/year (GIA), a combination of energy demand reduction and efficiency measures will be required. It is proposed that RDC require both ASHP and rooftop solar PV systems with electricity storage provision to be installed in residential units (excluding flats) where there are unshaded roof areas with appropriate orientation and slope to make PV installation feasible. For flats, a requirement for building rooftop PV is suggested, alongside a feasibility statement to evidence if ASHP can practicably be installed to serve at unit or building level. The strength of these requirements is complemented by the updated Building Regulations which will require a combination of passive design, high building fabric performance, efficient electric heating, and hot water systems, mechanical or hybrid ventilation likely with heat recovery, and PV panels. Additionally, the UK Government have indicated an upcoming ban on natural gas boilers [2]. Based on the modelling, it is suggested that 2 – 3.6 kWp rooftop PV systems are installed since this will contribute to the reduction of overall household grid electricity consumption. This is considered a more robust approach than the originally proposed requirement for 10% of future energy use from on-site renewable generation in section 5.3. To accompany the solar PV systems, to attain the greatest benefits for energy efficiency, developers should provide battery storage commensurate with the quantum of development or contribute to the upgrade of existing battery storage systems. Developer guidance: Developers may need to consult the Distribution Network Operator prior to installation in line with Engineering Recommendation G99[25] [3].
	Monitoring requirements	The requirement for monitoring regulated and unregulated emissions has been weighed up in the context of other additional costs to the developer (incurred by the other proposed requirements above) and the long-term benefits of data collection for Rother's residents and RDC net zero objectives. In comparison to the other proposed requirements, the benefits to emissions reduction through monitoring are more limited and so a targeted approach is proposed. This excludes unregulated emissions, given the Local Planning Authority does not hold any powers to control these. For implemented developments of more than 100 dwellings[26], it is proposed that monitoring of regulated operational emissions of a statistically significant representative sample of dwellings is required for a period of the first five years of occupation. The monitoring would be intended to inform net zero building policies for Rother's subsequent Local Plan, beyond the current emerging Plan. Post-occupancy evaluation (with thermal comfort) surveys could also provide valuable feedback and data to commission all systems appropriately and achieve comfort and satisfaction.

[24] Guidance available at: LETI and RIBA (2021). Whole Life Carbon One-Pager. Available at: https://www.leti.uk/_files/ugd/252d09_c4aa3410d7614e8d8b524e87b1b8fd2a.pdf [Accessed on 19/01/2023]

[25] Available here: Energy Networks Association (2020) Engineering Recommendation G99 Issue 1 – Amendment 6. Available at: https://www.energynetworks.org/assets/images/Resource%20library/ENA_EREC_G99_Issue_1_Amendment_6_(2020).pdf [Accessed on: 19/01/2023]

[26] Threshold to be reviewed once quantum of all allocations agreed. The intention of the requirement is for monitoring to be stipulated for a significant proportion of Plan allocations.

Net zero new building standards for minor and major non-residential development (including conversions)	Building performance standards for operational emissions	It is recommended that RDC require non-residential development (including building conversions and excluding industrial units) to achieve the LETI TEUI Target for Operational Energy of 65 kWh/m^2/year (GIA) for light industrial [and 55 for offices?]. In some cases, to achieve this target, it will be necessary to install extensive rooftop and/or on-site ground solar PV systems. For industrial units (including warehouses), a requirement for a feasibility statement is proposed to evidence a practicable TEUI Target for Operational Energy. This should demonstrate that the best energy efficiency outcomes have been achieved to serve the proposal, by maximising opportunities for on-site solar PV systems and optimising building fabric performance, heating and ventilation. It has not been possible to source a benchmarked TEUI threshold for this type of development. To assure other factors contributing to high quality construction, it is proposed that non-residential development also attains a BREEAM 'Outstanding' standard as a minimum. It is not considered that an interim target is required for these thresholds, since they entail a holistic range of sustainability metrics and so are more accessible for developers to demonstrate compliance. Developer guidance: Developers could select one of BRE's existing certification schemes to demonstrate compliance with both the LETI energy and carbon targets, and the quality of construction target guidance.
	Building performance standards for embodied emissions	To account for embodied carbon emissions, it is suggested that RDC tailor the maximum policy package threshold. Based on the joint Embodied Carbon Target Alignment guidance from LETI, RIBA and other industry organisations, current average building design achieves an E rating on the LETI carbon rating system, equating to 950 kgCO_2/m^2 upfront embodied carbon and 1400 kgCO_2/m^2 total embodied carbon. Additionally, our carbon specialists do not consider that the commercial construction supply chain can yet achieve the LETI 2030 Design Targets (an A rating on the LETI carbon rating system, equating to 350 kgCO_2/m^2 upfront embodied carbon and 530 kgCO_2/m^2 total embodied carbon). As such, a staggered approach is proposed to transition towards the LETI 2030 Design Targets, as included in the maximum policy scenario: • On adoption of the new Local Plan (scheduled for Q3 of the 2023/24 financial year): Stipulate a LETI C rating for office development, equating to 600 kgCO_2/m^2 upfront embodied carbon and 970 kgCO^2/m^2 total embodied carbon. The Embodied Carbon Target Alignment guidance has benchmarked these thresholds with projects that demonstrate good building design. • By 2030: Stipulate a LETI A rating for office development, equating to 350 kgCO^2/m^2 upfront embodied carbon and 530 kgCO_2/m^2 total embodied carbon. As above, these thresholds correspond with the LETI 2030 Design Targets.
	Energy statement requirements	To accompany all planning applications for non-residential development, it is recommended that policy requires developers to provide a detailed energy statement encompassing: • Demonstration of how the building performance standards will be met using the energy hierarchy in the design, construction, and operation phases[27]. This includes using excess heat productively on-site or as part of a district heat network (as recommended in section 8.5.1). This includes connecting with district heat networks and decentralised electricity networks. The requirements for heat networks are detailed below. • Evidence that high energy efficiency appliances are installed, if these are included in the interior fit-out.

[27] The energy hierarchy is defined by considering how to reduce operational energy use in the following order of priority: 1) Be lean – Use less overall energy; 2) Be clean – supply energy efficiency, cleanly and via local energy resources (such as secondary heat) where possible; and 3) Be green – use renewable energy.

		For developments of more than 100 sqm, it is suggested that developers show that whole life carbon analysis has been applied in designing their scheme, including optimising operational and embodied carbon and energy, as well as integrating Circular Economy principles (following the LETI and RIBA guidance[28]).
	Energy provision requirements	Given previous DESNZ (formerly BEIS) reporting has shown Energy Use Intensity to be approximately 177 kWh/m^2/year for non-residential development[29], substantial efforts will be required to attain a TEUI Target for Operational Energy of 65 kWh/m^2/year (GIA). Our modelling assumes a 27% reduction in total energy demand for non-residential development (relative to current DESNZ Building Energy Efficiency Survey data), in alignment with the new Building Regulation requirements. This reduction would be achieved by developers through improvements to the efficiency of building fabric and services, and on-site renewable energy capacity. Considering renewable electricity generation, it is therefore proposed that, for all non-residential developments of 100 sqm, 20% of electricity consumption should be supplied via on-site solar PV systems. Large non-residential schemes can offer significant rooftop capacity for solar PV in comparison to residential developments, contributing to both lowering EUI of buildings and decarbonising the grid. To accompany the solar PV systems, and attain the greatest benefits for energy efficiency, developers should also allow for battery storage. Developer guidance: Developers may need to consult the Distribution Network Operator prior to installation in line with Engineering Recommendation G99[30] [3].
	Monitoring requirements	As above, the requirement for monitoring regulated and unregulated emissions has been weighed up in the context of other additional costs to the developer (incurred by the other proposed requirements above) and the long-term benefits of data collection for Rother's net zero objectives. For developments of more than 1,000 sqm[31], it is proposed that monitoring of regulated operational emissions of a statistically significant sample of buildings is secured by legal agreement with the developer for a period of five years. The monitoring would be intended to inform net zero building policies for Rother's subsequent Local Plan, beyond the current emerging Plan.
Heat network requirements for residential and non-residential development	Heat network requirements	For residential developments, the most favourable opportunities for establishing new district heat networks were mainly identified in Bexhill-on-Sea and the surrounding areas because of existing high building heat density and the presence of large, non-residential buildings with sufficient heat demand to act as anchor loads. The most favourable opportunities for large non-residential developments are in Bexhill-on-Sea, and Rye. To take an integrated approach to heat network establishment, it is proposed that all proposals of greater than 10 dwellings or 1,000 sqm are required to make developer contributions towards the establishment of a district heat network in Bexhill-on-Sea and Rye. On implementing new district heat networks in the named settlements, the Council should have regard for the outcomes of the DESNZ (formerly BEIS) Heat Networks Zoning Pilot [1]. They should also seek to identify existing buildings and forthcoming schemes with heat demand greater than 500MWh/year which can act as anchor loads and play a significant role in stabilising the delivery of heat and guaranteeing economic and technical feasibility of a potential network. In particular, large non-residential developments with sufficient heat demand can act as anchor loads in areas identified as potential heat network zones. Potential anchor loads being developed around potential heat network zones that do not

[28] Guidance available at: LETI and RIBA (2021). Whole Life Carbon One-Pager. Available at: https://www.leti.uk/_files/ugd/252d09_c4aa3410d7614e8d8b524e87b1b8fd2a.pdf [Accessed on 19/01/2023]

[29] Value calculated from the retail Energy Use Intensity data (for electricity and heat demand), from the Department for Business, Energy & Industrial Strategy (2015) Overarching report – Building Energy Efficiency Survey data 2014-2015, Figure 3.11. More recent equivalent data not available.

[30] Available here: Energy Networks Association (2020) Engineering Recommendation G99 Issue 1 – Amendment 6. Available at: https://www.energynetworks.org/assets/images/Resource%20library/ENA_EREC_G99_Issue_1_Amendment_6_(2020).pdf [Accessed on: 19/01/2023]

[31] Threshold to be reviewed once quantum of all allocations agreed. The intention of the requirement is for monitoring to be stipulated for a significant proportion of Plan allocations.

		currently have anchor loads (such as those in Bexhill-on-Seaand most of the potential zones in Rye), have the potential to facilitate the increased viability of these potential zones. Once the district heat network has been established, all development proposals within the named settlements should connect to the district energy network, or an extension to that network.
Net zero refurbishment standards for minor and major residential and non-residential development	Energy statement requirements	All proposed refurbishment schemes should provide an energy statement which aligns with the six principles for best practice in LETI's Climate Emergency Retrofit Guide. It is also suggested that RDC, while engaging with applicants at the pre-application and/or application stage, highlight how to avoid poor indoor air quality and condensation. The Building Regulation Approved Document guidance and the Chartered Institution of Building Services Engineers (CIBSE) guides may be helpful in illustrating this.
	For decision-makers	It is suggested that the Council attribute significant weight to building retrofit proposals which result in considerable improvements to the energy efficiency and reduction in carbon emissions.

10.3 Further Considerations

From the research undertaken for this study, there are several wider factors for Rother District Council to account for as they prepare their other Local Plan evidence base documents and policies. Approaches to decarbonisation and climate change mitigation will always inter-connect, and a joined-up approach to climate resilience is important.

10.3.1 Carbon Sequestration

Carbon sequestration should be considered as part of the preparation of Rother District Council's evidence base for the Local Plan. Although carbon sequestration is mentioned in this study and does have some impact on the growth scenarios, it should be noted that this study has not undertaken a holistic evaluation of the benefits and feasibility of carbon sequestration as an initiative for decarbonisation on a district scale. Meanwhile, further research into sequestration, its benefits and its feasibility for Rother District Council could be undertaken as part of other Local Plan evidence bases relating to ecology and biodiversity.

10.3.2 EV Charging

EV charging and EV policy will also be important for consideration when developing the Local Plan evidence base to feed into future policies. This work has set out that transport mode shift will be of paramount importance in the decarbonisation journey of Rother District Council, but this consideration will perhaps sit in the Council's transport policy work. Meanwhile, it should be maintained that EV policy needs to complement renewable energy, climate change and decarbonisation policy. A joined-up approach will ensure any forthcoming EV policy does not impact negatively on wider energy consumption targets.

10.3.3 Costings

The costing considerations presented in this report are extremely high level and should be used primarily to determine feasibility. It is recommended that Rother District Council undertake more in-depth costing analysis.

Appendices

A.1 Review of Legislative Requirements & Best Practice

A.1.1 Introduction

A review of legislative requirements and best practice has been undertaken relevant to embedding climate change and renewable energy considerations into local planning. Its aim is to highlight potential policy opportunities for greatest ambition with regards to climate change. The review of local authority policies is ordered by theme, recognizing that different local authorities are showing leadership in different areas to address climate change, e.g. sustainable building design, low carbon transport and renewable energy.

The best practice guidance is sourced from Government Ministries and the below organisations:

- Building Research Group (BRE): BRE is a 'profit-for-purpose' organisation comprising scientists, engineers and technicians seeking to raise standards in the built environment sector. By undertaking independent research, BRE continue to set and enhance industry standards, products and qualifications [58].
- UK Green Building Council (UKGBC): The UKGBC is a membership organisation formed in 2007 which aims to radically transform the way that the built environment in the UK is planned, designed, constructed, maintained and operated, in order to build more sustainable buildings [59].
- Passive House Institute (PHI): The PHI (a UK affiliate of the International Passivhaus Association) promotes the adoption of the Passivhaus standard and methodology [60].
- London Energy Transformation Initiative (LETI): Established in 2017, LETI has published key reports on supporting the UK's path to a zero-carbon future through the built environment.
- Royal Institute of British Architects (RIBA): RIBA is an international professional membership body, seeking to promote excellence in architecture through providing advice and guidance [61].
- The Royal Town Planning Institute (RTPI): The RTPI is an international professional body of town planners, responsible for setting and enhancing standards in the sector, such as by providing courses and publications [62].
- Town and Country Planning Association (TCPA): The TCPA are an independent association of town and country planners in the UK whose work involves campaigning, publishing research, providing training and influencing policy and decision makers on planning matters [63].
- Centre for Sustainable Energy (CSE): The CSE is a charity which aims to share knowledge and practical experience on sustainability, by providing advice and training, managing innovative energy projects, and undertaking research [64].
- Energy Systems Catapult (ESC): ESC was established to accelerate the UK energy system's transition to decarbonisation and ensure that the economic benefits of clean growth are also captured [65].

A.1.2 Legislative requirements

A.1.2.1 UK Building Regulations & associated Approved Documents (Department of Levelling Up, Housing & Communities, 2022)

Building Regulations govern the legal standards for the design and construction of buildings to ensure the health and safety of individuals in and around these buildings. They also encompass requirements on the fuel usage and energy efficiency of buildings [66].

To initiate a net zero pathway towards Future Homes and Future Buildings Standards by 2025, there have been interim updates to the Building Regulations, following a recent Government consultation

These interim updates to Building Regulations involved an ambitious increase in the energy efficiency of new homes through changes to Part F (Ventilation) of the Building Regulations [67] and Part L (Conservation of fuel and power). This resulted in changes to Approved Documents L and F, alongside the introduction of Approved Document O (Overheating) and Approved Document S (Infrastructure for charging electric vehicles) in June 2022 [68].

These Documents came into force for developers who make a planning application on or after 15 June 2022. For developers who received planning permission before this date, the new requirements will not apply unless they have already substantially started building works [69].

The Government's next step is to update the Building Regulations in 2025, following a full technical consultation. The consultation will consider improvements to the energy efficiency of non-domestic buildings, alongside energy efficiency and overheating in new and retrofit homes [70].

Updates to Approved Document F (Ventilation)

The updated Approved Document F (ADF) (Volume 1 for dwellings) comprises the following key changes:

- Introduction of a requirement for highly airtight dwellings to install continuous mechanical extraction ventilation systems [33, p. 17]. While highly airtight dwellings are energy efficient, the Government's consultation document highlighted that they could result in poorer air quality [33, p. 21].
- Introduction of more stringent air quality and ventilation standards for homes, including air flow rate testing of mechanical ventilation fans [71, p. 33] and higher threshold requirements for background ventilators per mm^2 equivalent area.

ADF Volume 2 for non-domestic buildings stipulates similar approaches and standards to ventilation and air quality. It also contains a new requirement for monitoring of air quality in occupiable rooms (such as by using a CO_2 monitor or other air quality sensor) [48].

Updates to Approved Document L (Conservation of fuel and power)

The updated Approved Document L (ADL) (Volume 1 for dwellings) comprises the following key changes:

Overall approach

- The new ADL emphasizes early consideration of designing a dwelling or group of dwellings at a systems level, by analysing the technical, environmental, and economic feasibility of using high-efficiency alternative systems.
- It is advisable to consider the interdependency between the new ADL and the other Approved Document requirements, given that there are more stringent requirements between energy, overheating and ventilation [72, p. 4].

More stringent compliance standards

The new ADL has:

- Increased minimum standards of dwelling fabric thermal performance by 13% (known as the Target Fabric Energy Efficiency Rate (TFEER))
- Removed the ability to compensate a lower fabric energy efficiency rate with another measure (such as the additional of on-site renewables)
- Reduced overall dwelling carbon emissions performance by 31% (known as Target Emission Rate (TER))
- Altered the carbon factors used to calculate carbon emission performance. The carbon factors are governed by the dwelling's primary fuel source (such as electricity and heat networks, alongside gas, liquid and solid fuel sources [73, p. 189]), as set out in the updated Standard Assessment Procedure (SAP) [73], and is measured in kilograms of carbon dioxide equivalent per Kilowatt Hours (or Emissions kg CO_2e per kWh) [73, p. 189].
- Established a new metric, the Target Primary Energy Rate (TPER). This is a measure of maximum primary energy use for the dwelling in a year – it is calculated by applying a factor (in Kilowatt Hours per square metre per year (or $kWh_{PE}/(m^2 \cdot year)$) [32, p. 76] according to the dwelling's primary fuel source [74].
- A new requirement for 'as built' photographic evidence of key energy efficiency elements of dwellings (such as insulation, and ventilation systems) [33, p. 79]. This evidence would also be

provided to the new occupier, as assurance, alongside a standardised user guide on using the building services efficiently.

The following real-world impacts are expected as a result of the new ADL:

- The carbon factor (for calculating carbon emissions performance) for electricity is now lower than gas, in anticipation of the electricity grid being decarbonised. This will therefore mean electrically heated buildings will more easily comply with Regulations [74].
- Mainstreaming the use of energy efficiency measures (such as heat pumps, photovoltaic panels and electric vehicle charging) will require greater grid infrastructure capacity, and connections to the grid [72].
- As lower fabric efficiency rates can no longer be compensated with other measures (such as renewables), it is anticipated that there will be a shift to thicken external walls and install high performance (and potentially smaller) windows [74].

ADL Volume 2 for non-domestic buildings also introduces a TPER metric, alongside the TER. On building fabric, while Volume 2 does not stipulate an equivalent TFEER, it introduces new minimum efficiency standards for new and replacement thermal elements [75] (such as a wall, floor or roof [47, p. 90]).

Approved Document O (Overheating)

The new Document O arose from an inquiry into heatwaves (conducted by the Environmental Audit Committee) which recommended new regulations to mitigate the overheating of new buildings [76, p. 15].

Document O is only applicable to new residential buildings [34, p. 1]. It includes:

- Limits to glazing to reduce unwanted solar gain [34, pp. 5-6]
- Requirements for shading in locations at high risk of overheating [34, p. 6]
- Standards for cross ventilation in order to remove excess heat [34, pp. 6-7]

To demonstrate compliance with Document O, developers can either use the 'Simplified method' (with threshold reference values) or a dynamic thermal modelling method to account for the site-specific circumstances [34, p. 8].

Approved Document S (Infrastructure for charging electric vehicles)

The new Document S sets out the electric vehicle charging and cable route requirements for:

- New residential and non-residential buildings.
- Changes of use.
- Major renovations to existing residential and non-residential buildings; and
- Mixed use buildings undergoing relevant building work [77].

The number of charging points or cable routes is dependent on the number of units arising from development, and the associated number of parking spaces [77].

A.1.3 Best Practice Guidance: Technical Building Assessments

A.1.3.1 BREEAM, BREEAM Infrastructure & HQM

As established by BRE, the BRE Environmental Assessment Method (BREEAM) and BREEAM Infrastructure are technical standard assessment methodologies to promote sustainability in the built environment. They are commonly used as tools to drive best practice and increasingly commonly seen as requirements in planning decision-making.

BREEAM has been developed for assessing the sustainability of buildings (incorporating net zero and health metrics) [78] and BREEAM Infrastructure for assessing the sustainability of civil engineering, infrastructure, landscaping and the public realm works (incorporating climate change and resilience metrics) [79]. BRE has produced a suite of guidance documents for local authorities to promote these standards within Local Plans.

Home Quality Mark (HQM), also developed by BRE, has been created to help developers assess and provide assurance on the quality and performance of all types of new-build homes, which can easily be communicated to buyers, financers, and the wider sector [38]. The assessment framework was recently revised, and now considers new dwellings against 39 assessment issues, encompassing its environs, quality of indoor living environment and construction quality. For each issue, assessors determine an appropriate number of credits to grant, depending on performance against specified criteria [80, p. 4].

While HQM is not currently as widely adopted as BREEAM or BREEAM Infrastructure, its use as a ‘preferred option’ within Local Plans is growing.

To ensure robust integration into the Local Plan, the Planning Practitioner Guidance report suggests the local authorities must first understand the local area need and the viability of raising efficiency standards. Local authorities should look to neighbouring authorities to define levels that complement their ambitions.
Other local authority approaches have set different requirements by development type and/or local priority. It may be appropriate to increase requirements through the Local Plan period, as standards generally increase nationally.

Crucially, Authorities must ensure that their requirements for BREEAM, BREEAM Infrastructure and HQM are clearly outlined in the Local Plan, to prevent a potential challenge if these standards are conditioned in a permission.

A.1.3.2 Net Zero Carbon Buildings: A Framework Definition (UKGBC, 2019) & follow-up guidance (UKGBC, 2020 & 2021)

The Framework was originally published in 2019 to establish an industry definition of net zero carbon buildings, accounting for both construction and operational energy. The Framework defined:

- Achieving net zero carbon for building construction as, “When the amount of carbon emissions associated with a building’s product and construction stages up to practical completion is zero or negative, through the use of offsets or the net export of on-site renewable energy” [31, p. 6]
- Achieving net zero carbon for building operations as, “When the amount of carbon emissions associated with the building’s operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset” [31, p. 6].

The Framework goes on to advise on a 'reduction first' approach to achieving net zero carbon, by following the carbon reduction hierarchy in Figure 28 below [81].

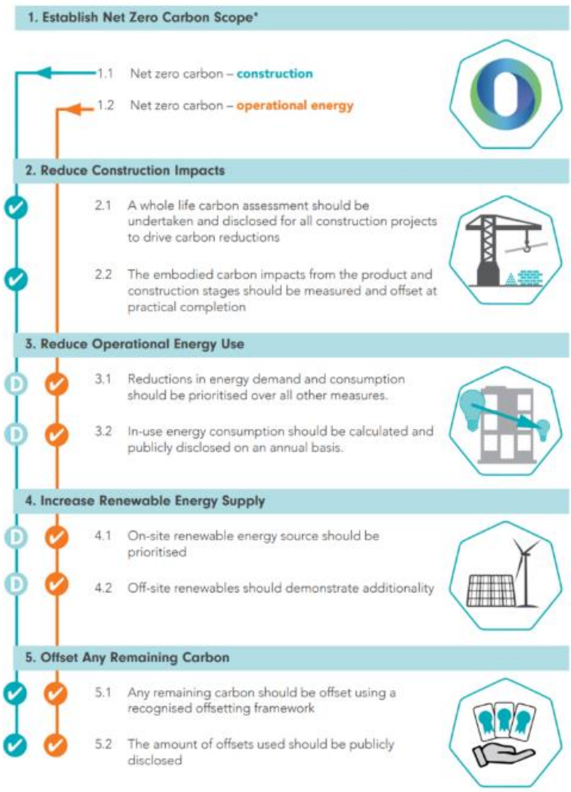


Figure 28: Carbon reduction hierarchy to achieve net zero carbon buildings [81]

To achieve each element of the 'carbon reduction hierarchy', the UKGBC have now produced a document to signpost relevant best practice standards, produced in-house and by other organisations [82]. This includes LETI's Climate Emergency Design Guide (see section A.1.4.5) and the RIBA 2030 Climate Challenge (see section A.1.3.6).

The UKGBC have also produced guidance with additional technical requirements which, on some matters, supersede the original high-level guidance. This includes operational energy performance standards for residential and non-residential buildings [83] [84], renewable energy procurement and carbon offsetting

Going forward, the UKGBC are now involved in developing a UK Net Zero Carbon Standard with several other industry leading organisations such as BRE, LETI and RIBA. This is intended to establish a single and comprehensive method of verifying the net zero carbon status of buildings, in line with the nation's climate targets and so is likely to supersede the 2019 Framework Definition [81].

A.1.3.3 The Passivhaus Standard (Passive House Institute, 2022)

The Passivhaus Standard focuses on substantially reducing space heating and cooling requirements and establishing good indoor comfort levels, by adopting a fabric first approach and systems level ventilation [85]. Passivhaus buildings achieve a minimum 75% reduction in space heating requirements, over standard UK new build practice [86].

A Passivhaus building is one in which thermal comfort can be achieved solely by post-heating or post-cooling the fresh air flow required for a good indoor air quality, without the need for additional recirculation of air [87].

The Passivhaus certification is a quality control process that aims to ensure that buildings will perform as designed. It provides performance certification for the following: products/components, designers/ consultant, tradespeople/installers and buildings [88].

Achieving Passivhaus Standard in the UK typically involves design modelling using Passive House Planning Package (PHPP) software, very high insulation levels, extremely high-performance windows with insulated frames, airtight building fabric, 'thermal bridge free' construction and a mechanical ventilation system with highly efficient heat recovery [88].

A.1.3.4 LETI Client Guide (LETI) [30]

This document pulls together key details from numerous documents and publications with the aim of mitigating climate risks. It also provides case studies of model development. Page 92 of this document onwards provides an extensive summary of sustainability assessment and certification, some of which are included in the review of best practice section of this document.

A.1.3.5 Defining and Aligning: Whole Life Carbon & Embodied Carbon [89]

LETI have worked with a number of industry groups to align definitions, scopes, measurement methodologies and targets. As part of this work, LETI have pulled together a suite of documents intended for reading in conjunction with one another to aid understanding of operational, embodied and Whole Life Carbon and of how to achieve a net zero 'Paris-Proof' [90] approach. This dictates that the built environment industry should only use the limited amount of carbon apportioned to it in order for the UK economy to reach net zero emissions by 2050.

A.1.3.6 Whole Life Carbon one-pager (LETI, 2021)

In a one-pager produced in collaboration with RIBA and the Whole Life Carbon Network (WLCN), LETI defines Whole Life Carbon emissions – their definition encompasses the sum of all asset-related GHG emissions and removals, encompassing both the operational and embodied carbon of an asset over its life cycle, including its disposal. Overall, Whole Life Carbon asset performance includes separately reporting the potential benefit from future energy recovery, reuse, and recycling.

To reduce Whole Life Carbon, LETI advises to:

1. Define the energy and embodied carbon targets, as well as the WLC measurement and verification process at project conception and track throughout. Formal disclosure should be made at post-completion and then annually.
2. Use WLC analysis during design to optimise embodied carbon, reduce operational energy and integrate Circular Economy[32] principles. For example, testing energy reductions, increased envelope specification or calculating carbon payback periods for Mechanical, Electrical & Plumbing (MEP) equipment or renewables.
3. Address upfront embodied carbon emissions (A1-5 in A.1.3.6) by using minimal material.
4. Consider the carbon cost/ benefit between upfront carbon, operational carbon, and life cycle carbon due to replacement cycles.
5. At each replacement cycle, prioritise low carbon materials and Circular Economy principles to reduce WLC emissions.
6. Operational energy loads must be minimised and meet local energy targets, such as LETI Energy Usage Intensity (EUI) targets. A future decarbonised grid depends on reducing overall energy requirements. A further effect of grid decarbonisation is to make embodied carbon an even larger proportion of WLC.
7. Utilise Circular Economy principles at the beginning and end of the building and component life cycle. This includes retrofit, re-use of materials, recycled materials and design for future adaptability. Project end-of-life scenarios and quantify the potential future carbon benefits.

[32] A circular economy aims to maintain the value of products, materials and resources for as long as possible by returning them into the product cycle at the end of their use, while minimising the generation of waste. The fewer products we discard, the less materials we extract, the better for our environment [125]

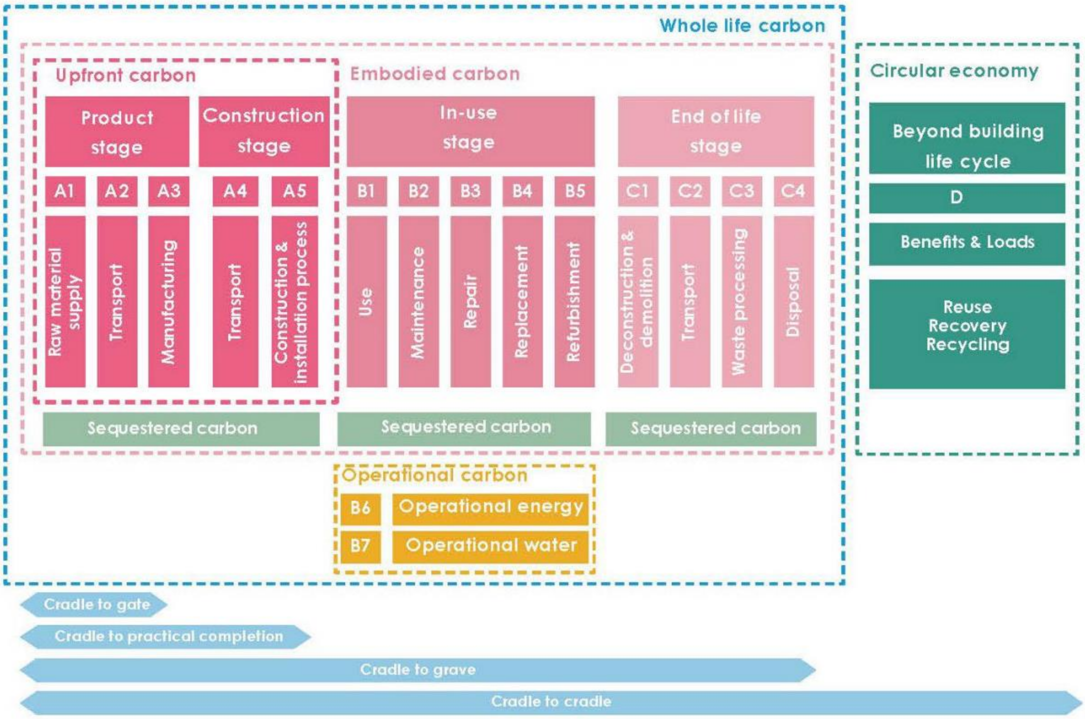


Figure 29: Life Cycle Stages [defined by BS EN 15978:2011]

A.1.3.7 Embodied Carbon Target Alignment (2021)

In LETI's 2021 guidance, it defines a letter banding scale (similar to the EPC band scale) for rating embodied carbon targets across typologies. Letter banding for a building is determined according to two thresholds in $kgCO^2/m^2$ [91, p. 3]: the upfront embodied carbon involved in construction (Greenhouse Gas emissions associated with materials and construction processes); and the total embodied carbon (Greenhouse Gas emissions over lifecycle, excluding disposal) [92].

On LETI's scale, average buildings in the design stage currently achieve an 'E' rating, good design can achieve a 'C' rating, and the LETI 2030 design target for embodied carbon would achieve an 'A' rating [45]

A.1.3.8 Embodied Carbon one-pager (LETI, 2021) [93]

This document defines embodied carbon emissions as the GHG[33] emissions and removals associated with materials and construction processes throughout the whole life cycle of an asset. It presents a hierarchy for reducing embodied carbon which is shown in A.1.3.6.

LETI also present a series of Elemental reduction strategies in order of highest to lowest for reducing embodied carbon:

- Structure: Options should be compared at an early stage, review loadings and rationalize or reduce structural grids and consider basement omission or test ground conditions.
- Façade and roof: Options should be compared at an early stage, and consideration should be given to the effect of replacement cycles.
- Mechanical, Electrical and Plumbing (MEP): Interrogate comfort metrics, avoid the over-provision of plant, and reduce duct-runs and consider natural ventilation as this can reduce upfront carbon, maintenance burden and energy use. Specification of refrigerants with low GWP and consideration of leakage in analysis and design for easy access through finishes, recycling and deconstruction as MEP is regularly replaced.

[33] Greenhouse Gas

- Finishes, furniture, and fitting: eliminate materials where possible and utilise self-finishing surfaces with low maintenance, ensure replacement cycles are considered from the outset (especially on loose items and high footfall areas) and replacement cycles should generally be reduced where possible.

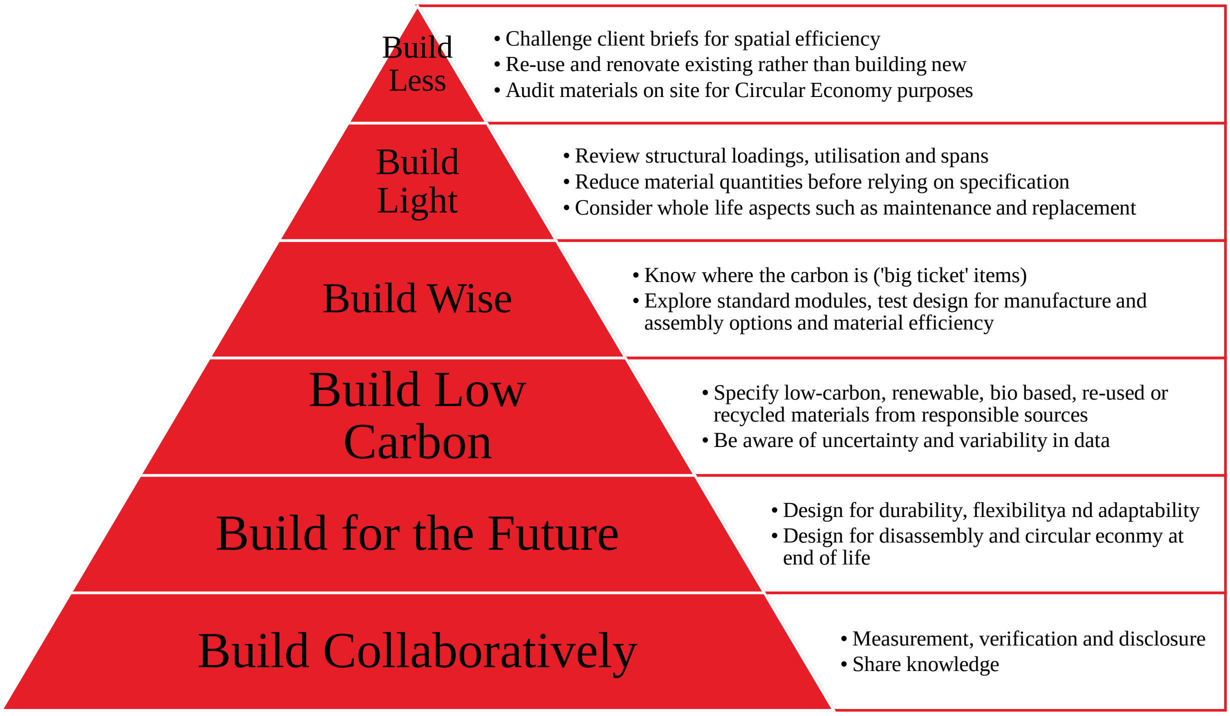


Figure 30: LETI Hierarchy for Embodied Carbon Reduction

A.1.3.9 Climate Emergency Retrofit Guide (LETI, 2021) [44]

This guide follows from the LETI Climate Emergency Design Guide [94] which was published in 2020 and provides guidance on defining good design in the context of the climate emergency for new buildings. This guide makes clear that retrofit should focus on reducing energy demands of homes specifically, but references heat sources as a critical part of this plan.

They have introduced six principles for best practice in building retrofit:

1. Reduce energy consumption
2. Prioritise occupant and building health
3. Have a whole building retrofit plan
4. Measure the performance
5. Think big
6. Consider impact on embodied carbon

LETI also emphasise the importance of tailoring retrofit to the property type and determining whether or not properties are constrained (by factors such as heritage asset, form factor and space) and

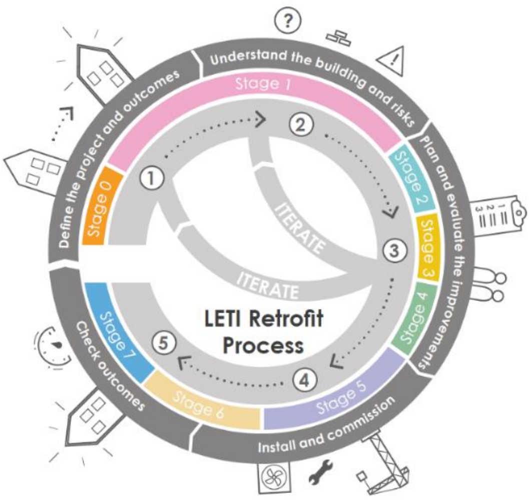


Figure 31: LETI Retrofit Process (LETI, 2021)

unconstrained (all other homes).

A.1.3.10 2030 Climate Challenge (RIBA, 2021)

After declaring a climate emergency in 2019, RIBA established a 2030 Climate Challenge in 2021 for chartered architectural practices to sign up [95].

RIBA developed the challenge, by first identifying nine of the seventeen UN Sustainable Development Goals relevant to the design of buildings. On this basis, RIBA established a framework of sustainable outcomes (including on climate action, and clean water and sanitation) for architects. These outcomes are linked with the development design stages so that architects can integrate sustainable outcomes throughout the design process, through goal and strategy creation, monitoring and learning from experience [95].

RIBA has also set quantitative targets for building design, based on the latest recommendations from the Green Construction board. These targets encompass operational energy, embodied carbon, potable water use and health and wellbeing [95].

A.1.4 Best Practice Guidance: Strategy development

A.1.4.1 The Climate Crisis (RTPI & TCPA, 2021), Place-Based Approaches to Climate Change (RTPI, 2021)

The RTPI and TCPA jointly released The Climate Crisis in 2021, as a guide for Local Authorities to plan for climate change mitigation and adaptation. The guide first provides context on the urgency of addressing climate change, and existing law and policy across the four nations within the UK [96, pp. 1-23].

The guide goes on to advise on incorporating climate change mitigation and adaptation for plan-making in six sequential steps:

1. Unlock the potential of the Local Plan, by placing the community at the heart of the process and by securing it as a key corporate priority and tool for responding to the climate crisis
2. Understand the legal and policy obligations for climate change, including how national Government targets apply to actions that are controlled or influenced locally

3. Collate a comprehensive evidence base on:
    - Climate mitigation, in order to set local carbon reduction targets in the Local Plan; and
    - Climate adaptation over 100-year time horizon
4. Apply evidence to prepare policies that are consistent with carbon reduction targets, and would credibly help adapt to worst-case scenarios for climate change impacts
5. Monitor the effectiveness of the policies, on an annual basis at minimum
6. Ensure that planning decisions fully assess the climate impacts of proposed developments, and do not exceed established carbon budgets or climate change impacts [96, p. 26].

The guide provides advice on how to complete each of these steps, and signposts best practice tools and existing Local Plans [96, pp. 24-55].

The RTPI's Place-Based Approaches to Climate Change research paper (2021) proposes similar approaches to the above. It also highlights specific opportunities for Local Government departments to take positive decisions and undertake activities to benefit climate mitigation.

The research paper also recommends taking a place-based systems approach "within social and planetary boundaries". A 'systems approach' means gathering and finding solutions at a "bigger picture" level so that an integrated, cross-sector approach can be taken to solving the climate crisis; a 'place-based approach' means forging clear links between local plans and the national net zero agenda.

Additionally, the paper also details several practical case study examples, including on supplementary planning guidance; implementation and monitoring policies and siting; and siting low carbon infrastructure [97].

A.1.4.2 Rising to the climate change challenge: The role of housing and planning within local councils (TCPA, 2022) [98]

This report considers the important role local authorities need to play in relation to planning and housing for low or zero carbon communities, and climate change resilience.

The report makes a number of recommendations for national governments so that we can unlock more urgent action at a local level:

- Local authorities must be sufficiently resourced, so they are able to undertake planning functions and transform places holistically
- Governments need to prioritise and support the development of skills (both within local authorities and relevant industries) to enable the creation of new regeneration of existing places that meet the needs of communities and are future-proofed
- Governments should issue guidance in some specific areas to support planning for climate change
- As is being seen in Scotland, national planning frameworks need to be established that bring together thematic and spatial policies
- Mitigating and adapting to climate change needs to be embedded in the priorities of the Planning Inspectorate in England and Wales, the Planning and Environmental Appeals Division in Scotland and the Planning Appeals Commission in Northern Ireland.
- The role of local authorities in relation to housing and planning needs to be recognised at both the national and local levels as central to the levelling up agenda and supported as such.
- In England, powers that have been removed through the expansion of permitted development rights must be restored to local authorities.

To conclude, this document states that ambitious action is required by all local planning authorities, multi-level action and collaboration is vital to this action, and there must be a consistent and collaborative approach to the climate crisis.

A.1.4.3 Joint Statement: Planning for the climate crisis (TCPA, 2021) [99]Joint Statement: Planning for the climate crisis (TCPA, 2021) [99]

This collaborative statement sets out responsibilities of the planning industry in tackling the climate crisis, which include:

- Planning for renewable energy and controlling the extraction of fossil fuels. In practice, this means seeking to locate and design new development to achieve multiple low carbon outcomes such as sustainable travel.
- Adapting to climate change by locating development to avoid flood risk from rivers and the predicted 1.5m of sea level rise expected by the end of this century. In practice, this will involve planning for key design elements such as natural flood defences, sustainable urban drainage systems and green infrastructure. All of these elements are vital to urban cooling and flood resilience.
- Giving local communities a voice in decisions surrounding the local climate solutions which will ultimately impact their future health and safety.

The report continues to set out major flaws in the planning system which prevent it from delivering the crucial solutions to climate change we need:

- Provisions of the Planning Act 2008 [100] and the Climate Change Act 2008 [101] need to be better integrated with one another ~~connected~~ before the planning system can be more direct in its contribution to delivering major emissions reductions. Strengthening policy guidance to introduce a legal framework around planning and climate change would function as a 'net-zero' test on development proposals, enabling policy to better deliver climate change solutions.
- The National Planning Policy Framework (NPPF) does not prioritise climate change in the way scientific evidence demands. The most significant part of national policy on climate change is included as a footnote, which is not enough to deal with the climate crisis. Although it includes detailed methodologies for forecasting many issues like housing, waste and aggregates, there is no such guidance for climate reduction.
- Changes in permitted development rights have meant that planning authorities no longer have a way of ensuring the climate emergency is reflected in all decisions. The current prior approval process does not allow local authorities to consider the impact of development on carbon emissions or overheating.

A.1.4.4 Mapping a Route to Local Clean Growth: Clearing the Path to Net Zero (Localis, 2022) [102]

Localis' recent report, 'Mapping a Route to Local Clean Growth', seeks to provide practical examples and policy pathways to action for all types of local authority across five key sectors: Housing and the built environment, energy, manufacturing, transport & infrastructure and land management. The report recommends that the government must fully recommit to net zero and produce a derailed strategy for achieving decarbonisation of the economy. It also recommends that net zero standards are raised in the NPPF amongst other suggestions.

A.1.4.5 Embodied Carbon Primer [103] (LETI, 2020) and Embodied Carbon Target Alignment [91] (LETI, 2022)

The Embodied Carbon Primer was published by LETI to help the built environment industry deliver net zero carbon new buildings. This document supplements the LETI Climate Emergency Design Guide and offers additional guidance to those interested in exploring embodied carbon in more detail. This arose due to a lack of knowledge in the built environment industry surrounding embodied carbon reduction strategies and calculations.

The Primer report critiques the built environment industry along with current regulations and practices for lagging behind the carbon trajectory that is required for protecting life on earth. The document concludes that the solution to meeting climate change targets must be:

1. Scalable – energy consumption targets are set so that there is enough renewable energy to power all buildings in the UK

2. Achievable – A comprehensive modelling study has been undertaken and in-use data from buildings analysed, so that the targets, while ambitious to achieve, are deemed achievable for most projects

3. Verifiable – Targets are measured in-use

4. Whole Life – Embodied Carbon and operational carbon must both be considered

The Embodied Carbon Target Alignment paper summarises the following key points:

- The industry must push for Embodied Carbon reporting on all projects
- A rating system should be introduced to allow quick comparison of ambition across various typologies and portfolios
- There are now established targets for industry including: total embodied carbon targets (including a consistent metric between LETI and RIBA); and targets for retail.
- Data disclosure and breakdowns are key to ensuring reporting is valid and comparable.
- There are two scopes that should be reported against: Upfront Carbon modules (A1-5, excluding sequestration, and total embodied Carbon (A1-5, B1-5, C1-4, including sequestration)

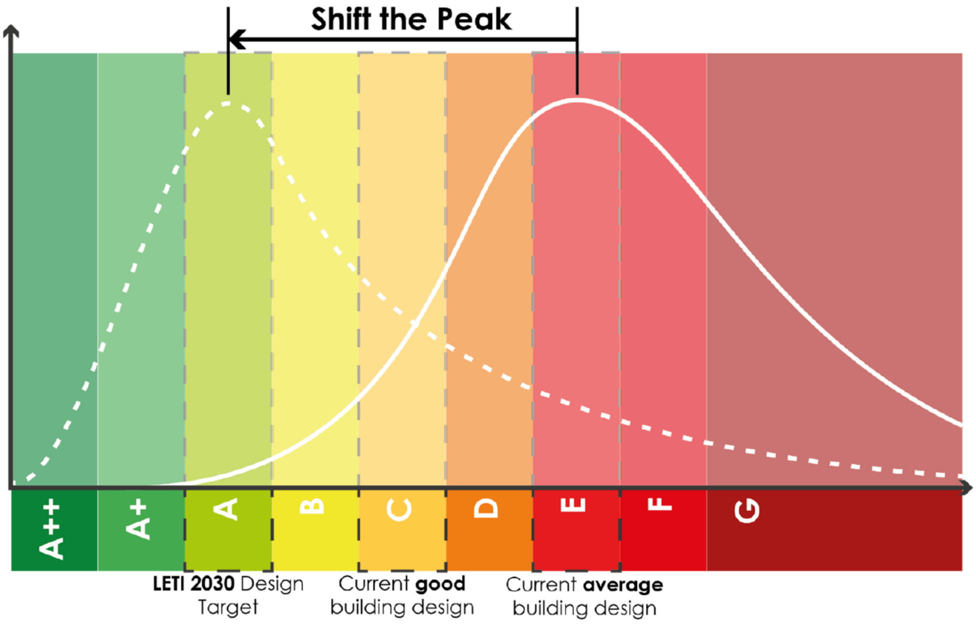


Figure 32: Graphic to show the range of performance based on benchmarked projects, and the need to improve the average (LETI, 2022)

The Target Alignment document concludes that we are in a climate emergency, and to achieve the development of all new buildings performing at net-zero carbon by 2030, we must ensure that by 2025 100% of all new buildings must be designed to deliver net zero carbon. The document sets out key actions to drive change, that sit within various roles including the client/ developer (decision making process), the Policymaker (strategy process), and the designer (implementation process).

A.1.4.6 Local Sustainable Energy Assessment Matrix (CSE, 2017) [104]

The CSE's Local Sustainable Energy Assessment Matrix sets out a simple proforma for Local Authorities to assess their area's current performance on sustainable energy delivery, based on the current extent and quality of local energy activity and opportunities for improvement.

For five key aspects of the energy sector, the assessment provides a five-point scoring scale of weak to excellent performance (with example qualifying criteria for each score). The five key aspects of the sector are: domestic sector energy; commercial sector energy; fuel poverty and affordable warmth; low carbon energy infrastructure and markets; and institutional ecosystem and resourcing.

A.1.4.7 Tackling fuel poverty and cutting carbon emissions (CSE, 2018) [105]

In a report titled 'Tackling fuel poverty, reducing carbon emissions and keeping household bills down: tensions and synergies', four high level principles are explained to aid policymaking in tackling fuel poverty and cutting carbon emissions:

- 'Choose the sweet spot' of policies that can tackle both fuel poverty and carbon emissions. This will require more routine assessments of both fuel poverty and carbon emission causes and impacts to find possible overlaps to target. This principle would target the energy performance of homes, particularly through better insulation, and encourage better targeting of energy subsidies.
- Ensure that short-term plans lay the foundations for longer-term targets. An example would be to meet future energy efficiency targets that are already currently known, thereby realising the benefit of making investments sooner rather than later.
- Clarify policy choices, to be clear who will pay for these policies, who is to gain, and why these decisions have been made. Policies generally garner more public support if they demonstrate fairness and effectiveness, supporting those in need without generating costs for those who can't afford them or have no responsibility to pay.
- Regularly review implemented policies against a set of carbon emission and fuel poverty indicators, to increase their effectiveness in the long-term.

A.1.4.8 Heat Networks guidance (Department for Business, Energy & Industrial Strategy, 2022)

The Department for Energy Security and Net Zero (formerly known as BEIS) hosts a repository of guidance documents to promote the establishment of heat networks by Local Authorities [106].

For strategy and policy formulation, the following guidance is relevant:

- Stakeholder Engagement in Heat Networks (BEIS & the Carbon Trust, 2018) [107]: Provides mini-guides on how and when stakeholder engagement should be undertaken in the stages of plan-making (including mapping and masterplanning).
- Creating a Standardised Due Diligence Set for Heat Networks [108]: Sets out a standard methodology of the full range of considerations for establishing heat networks, including gaining planning permission and other consents, alongside legal, financial and procurement matters.

A.1.4.9 Local Area Energy Planning (Energy System Catapult, 2022)

In 2020, the Centre for Sustainable Energy (CSE) and the Energy System Catapult (ESC) jointly published a new method for Local Area Energy Planning (LAEP) [109] to support local authorities, distribution network operators, businesses and communities to prepare spatial masterplans for a cost-effective transition to net zero. The method set out four key elements for preparing an LAEP, with qualifying criteria for success.

These elements include:

- Use of robust technical evidence and data (with an understanding of its limitations), which considers the whole energy system
- Assessment of wider non-technical factors necessary to secure change
- Well-considered stakeholder engagement process
- Credible and sustained approach to governance and delivery

Building on this, ESC produced updated guidance in 2022 [110] addressing the gap in providing a standard methodology and template for preparing Local Area Energy Plans. This is intended to assist Local Authorities, achieve efficiencies in LAEP preparation and allow for comparability between Local Authority areas.

The guidance provides standardised processes for stakeholder mapping and involvement, establishing a local energy system baseline, agreeing future scenarios and modelling approaches, and determining priorities.

A.1.5 Best Practice Guidance: Advice for local policymakers

A.1.5.1 The New Homes Policy Playbook (UKGBC, 2021) [111]

The UKGBC's Playbook (2021) seeks to push Local Authorities to go beyond national policy in setting sustainability policies.

The Playbook proposes that Local Authorities:

- Match the upcoming Building Regulation in carbon emissions targets.
- Require that all new homes are constructed to EPC Band C by 2028, in line with the Climate Change Committee recommendation.
- Propose that Authorities apply an ambitious set of energy use intensity, energy efficiency and operational energy targets.

It also provides advice on:

- Net zero carbon: Proposes that all new homes and buildings are net zero carbon emissions by 2030 at the latest. This could be achieved by setting requirements for modelling of 'whole life' carbon impacts for new developments and for monitoring energy performance of major new developments for the first years of operation.
- Overheating risk: Proposes that Authorities develop an overheating risk framework including mitigation for overheating, making sure new developments follow the cooling hierarchy and utilise an early screening assessment of risk to over-heating.
- Assuring performance: Suggests that Authorities commit to introducing a system of in-use testing and reporting on construction matters such as energy performance, indoor air quality and thermal comfort for a set period of time after occupation.

A.1.5.2 Planning for A Smart Energy Future (RTPI, 2019)

This report was produced for planning policy and decision makers to create future planning policy that can 'catch up' to the clean growth opportunities offered by smart energy.

The report's key findings and recommendations were:

- Given the longevity of development, nothing should be planned without having successfully demonstrated it is fit to take its place in a net-zero emissions future. This is to save costly retrofitting down the line
- Planning will require more top-down leadership from both local and national actors to break out of the 'business as usual' mould and deliver transformational change. Collaboration is essential between all actors involved in new development, including local authorities, councillors, developers and communities
- Local authorities must improve access to resources and training to properly keep up with the pace of existing and emerging energy technologies and whether these meet energy standards set in policy
- Local Enterprise Partnerships (LEPs) can work with local authorities, and central Government to more closely align spatial goals and by jointly seeking available funding

For planners, this means that smart energy should be central and inseparable from the process, from new homes to employment, transport and infrastructure. Embedding smart energy objectives across a range of local authority functions has proven effective. Businesses, communities and distribution network operators are keen to work with local authorities to unlock evidence and resources, as well as supporting innovative business models based on smart technology.

On setting specific requirements in planning policy, the RTPI and TCPA's 'The Climate Crisis' guide (2021) [96, pp. 38-47] advises Local Authorities on:

- District heat networks in new developments
- Binding net-zero standards for new development
- Setting requirements for sustainable buildings, with reference to the BRE and PassivHaus standards (as detailed at sections A.1.3.1 and A.1.3.3 respectively)

A.1.5.3 Cracking the Code (RTPI, 2022) [112]

To achieve net zero and nature recovery, the RTPI has prepared a guide on District and site level design codes. The advice builds on the National Model Design Code [113] and was produced in collaboration with planning, climate and transport specialists, alongside the Royal Society for the Protection of Birds (RSPB).

The District level design code guide is provided in the form of a real-world design code (albeit for a fictious area), prepared with real-world data, and comprises:

1. Baseline carbon assessment, including the calculation of emissions per person in the District (and comparison with national average) and the maximum carbon budget for District.
2. Mapping of energy and potential energy sources; natural assets (including habitats and water resources); local urban and rural character areas; and transport connections.
3. High-level spatial vision for 2040, guided by making space for renewable energy; zero carbon mobility; nature recovery; maintaining settlement character; and fluvial flooding.
4. Critical Success Factors for 2040, which are presented as written outcome statements that tie in with the UN Sustainable Development Goals.
5. Design Principles and Core Requirements for all types of allocations, linking back to the Critical Success Factors for 2040 [114].

A.1.6 Renewable energy good practice guidance: Risks and opportunities in large scale wind and solar energy generation [115] (LGA and Local Partnerships, 2020)

This document was commissioned to help members and officers within councils who are considering asset ownership to understand the potential risks and benefits and how these can be managed. The document provides a table which sets out the main considerations for councils to observe when deciding on ways forwards within their authorities.

Option	Potential Advantages	Things to consider
Self-develop on your own land	• No rental payments • No need to acquire land rights and establish clean title • No onerous restrictions or lease end date • Likely to be within the geographical boundary of the authority	• Do you have a site which is suitable in terms of size, location and planning policy? • Will you be forgoing an existing income stream? • Do you have another use for the site? • Is a suitable grid connection available? • Reputational issues if the site is in proximity to housing or has been promised for another use • Do you have the skills and capacity for the development? • Are you prepared to risk the development costs? • Design, procurement and construction risks to be managed

Develop a site on third party land	• Identify site for its suitability (both size and location) rather than its ownership • Wider search area and therefore more chance of finding a viable grid connection or private wire	• Viability model will need to account for landowner rent • Capacity to acquire the site on appropriate terms for the development • Time constraints introduced through the land acquisition period (for example option periods) • Asset lifespan limited by lease arrangements • Do you have the skills and capacity for the development? • Are you prepared to risk the development costs? • Design, procurement and construction risks to be managed
Acquire project rights from a third party	• Removes development risk, avoiding potentially abortive costs and providing certainty • Land rights, accepted grid offer, and planning consent will be in place significantly reducing capacity required in the authority to deliver the project	• Viability model will need to account for the landowner rent and for costs of acquiring the project rights • Asset lifespan limited by lease arrangements • Design, procurement and construction risks still to be managed • Project rights are well sought after in a competitive market. A local authority can potentially lack credibility as a purchaser compared to a financial institution who has undertaken several similar transactions • Rights are unlikely to be available at a scale or location which is preferable to the authority (bear in mind for example managing construction of a project several hundred miles away) and flexibility may be required
Acquire a completed project from a third party	• Removes development and construction risks, avoiding potentially abortive costs and providing certainty • Land rights, accepted grid offer, planning consent and functioning asset will be in place significantly reducing capacity required in the authority to deliver the project • Private sector developers often prefer to sell post construction and commissioning • Private sector contractors can procure more freely and consequently often build at a price significantly lower than the public sector. Quality may also be higher due to ongoing relationships with construction companies	• Viability model will need to account for the landowner rent and for costs of acquiring the project – although this may be less than the combined cost of acquiring project rights and constructing the asset through public procurement • Asset lifespan limited by lease arrangements • Projects are well sought after in a competitive market. A local authority can potentially lack credibility as a purchaser compared to a financial institution who has undertaken several similar transactions • Authorities will only have the ability to bid on existing projects and cannot therefore drive scale or location

The document concludes that a number of councils have already successfully invested in renewable energy generating assets and there are opportunities for other councils to follow suit. Councils should assess their own available opportunities and respond to their individual challenges meaning there is no 'one-size fits all' approach. The report summarises that the opportunities most likely to be successful for Councils are commercial scale solar PV, either smaller schemes with a direct private wire to a customer, or larger schemes of 20 MW or more. It advises authorities to balance financial returns with schemes' potential to offset the authorities' carbon emissions when considering where is best to sell power generated, and authorities that have developed or purchased assets advise that good quality external advice should be sought, no matter the route taken [115, p. 7].

A.1.7 Precedent from planning decisions

Inspector examinations of policy

- Inspector decision on West Oxfordshire DC Area Action Plan for Salt Cross Garden Village [116] (PINS/D3125/429/7) [117] – Did not find net zero carbon development policies to be consistent with national policy or justified

Energy & carbon performance achieved in recent DM decisions

- Blackfriars, Battle (LPA ref: RR/2019/604/P): Approved in Apr 21; 200 dwellings; Applicant – Rother DC. The development goes beyond policy, with some Passivhaus dwellings, some earth-sheltered dwellings and the remainder with a 31% reduction over Part L 2013 and other measures to 'future-proof' the transition to net zero. This is a large development site for Rother. Battle is our second biggest town, but only 6,000 pop and in the High Weald AONB. Energy and Sustainability Statement attached.
- The Paddock, Northiam (LPA ref: RR/2019/2738/P): Approved in Nov 21; 34 dwellings.
    - Meet current Building Regs standards (not Future Homes Standard) for emissions performance, through a fabric first approach
- Preston Hall Farm, Sidley, Bexhill (LPA ref: RR/2017/2441/P): Approved in Aug 18; 139 dwellings.
    - Meet superseded 2013 Building Regs standards for emissions performance, through insulation enhancement and improvement of U-values
- Buckholt Lane, Bexhill (LPA ref: RR/2017/2181/P):
    - Approved in May 2018, major commercial site.
    - Provides low proposed U-values - however, there are no explicit commitments to energy and carbon performance targets (such as Target Fabric Energy Efficiency Rate (TFEE) or Target Emission Rate (TER).
    - On renewables, only considering air source heat pumps for smaller units.

A.2 Land Use carbon sequestration potential in Rother

Table 21 Carbon sequestration factors used in the assessment.

Habitat description	(tCO_2e ha-1 yr-1)	References
Urban	0	Assumed negligible
Woodland	-7	Natural England 2021 report which references Woodland Carbon Code 2021 Thomas and others 2011 Poulton and others 2003 Ashwood and others 2019 Rates averaged over 100 years
Arable	0.29	Natural England 2021 Report which references Muhammed and others (2018)
Improved Grasslands	-0.36	Natural England 2021 Report which references Soussana and others (2010)
Ponds	-16.12	Natural England 2021 Report which references Taylor and others (2019); Ockenden and others (2014); Gilbert and others (2014)
Terrestrial – Dunes - Unvegetated	-2.18	Natural England 2021 report which references Jones and others (2008); measurements were made in Anglesey, Wales. No data available for England.
Intertidal Sediment	-1.98	Natural England 2021 Report which references Adams and others (2012) measured values for the Ouse estuary, England
Intensive Orchard	-5.99	Natural England 2021 report which references Robertson and others 2012
Neutral grassland	-0.36	Natural England 2021 report which references Soussana and others (2010)
Near Natural Bog	-0.02	Natural England 2021 Report which references 2021 update to the Emissions Inventory for UK Peatlands
Near Natural Fen	-0.93	Natural England 2021 Report which references 2021 update to the Emissions Inventory for UK Peatlands
Saltmarsh	-5.19	Natural England 2021 Report which references Beaumont and others 2014. based on previous assessments by Cannell and others 1999; Chmura and others (2003 and Adams and others (2012). Estimates are for the whole of the UK.

** Negative carbon flux values indicate net sequestration from atmosphere (carbon savings), positive values show emissions to atmosphere.

Table 22: Results of the land use carbon sequestration potential analysis for Rother

Land Use OSMM category	Area (ha)	Carbon flux ($tCO_2e\ ha^{-1}\ yr^{-1}$)	Carbon flux ($tCO_2e\ yr^{-1}$) **
General Surface	2910.81	0	0
Roadside	466.51	0	0.00
Building	661.86	0	0.00

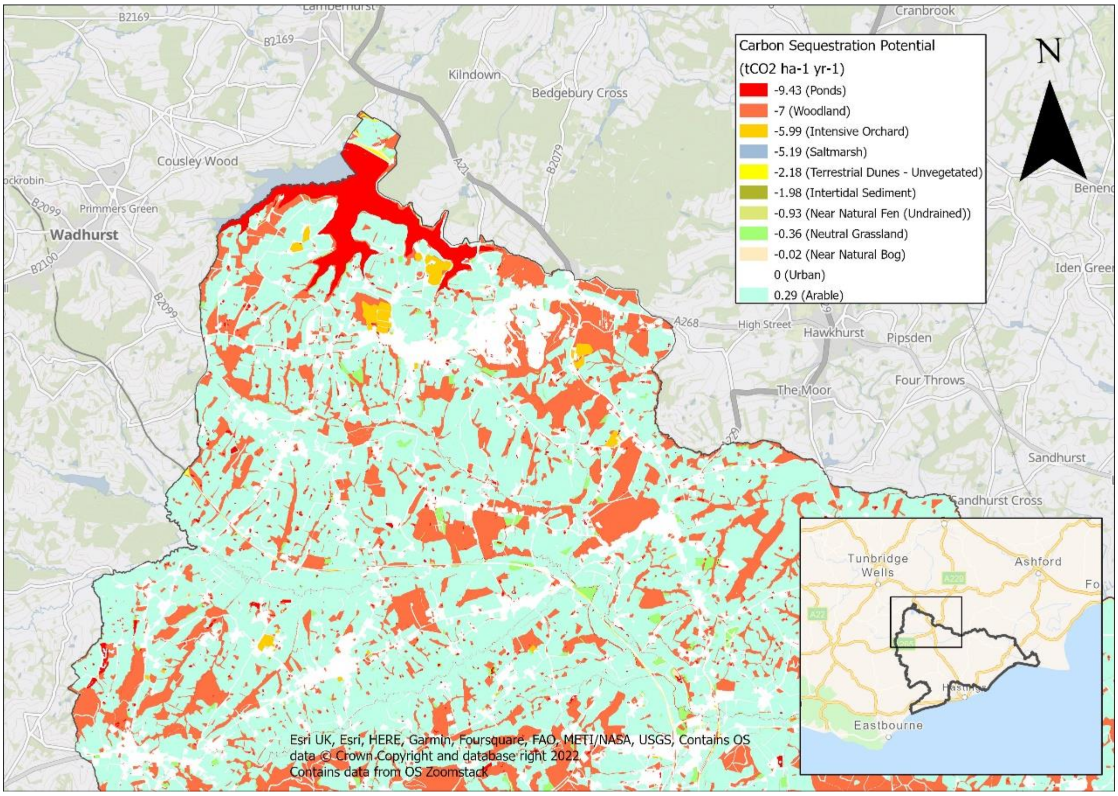
Land Use OSMM category	Area (ha)	Carbon flux ($tCO_2e\ ha^{-1}\ yr^{-1}$)	Carbon flux ($tCO_2e\ yr^{-1}$) **
Natural Environment_Coniferous Trees	3684.60	-7	-25792.20
General Surface_Multi Surface	2648.14	0	0.00
General Surface_Agricultural Land	35537.30	0.29	10305.82
Inland Water_Drain	199.32	0	0.00
Road Or Track	716.46	0	0.00
Path	41.58	0	0.00
Natural Environment_Nonconiferous Trees	8516.83	-7	-59617.80
Natural Environment_Rough Grassland	576.30	-0.36	-207.47
Inland Water_Static Water	598.97	-9.43	-5648.31
Road Or Track_Track	291.60	0	0.00
General Surface_Electricity Sub Station	0.86	0	0.00
Landform_Slope	319.79	-2.18	-697.15
Natural Environment_Shingle	1205.56	-2.18	-2628.13
Inland Water_Watercourse	249.18	-9.43	-2349.80
Rail	132.29	0	0.00
Road Or Track_Bridge	1.28	0	0.00
Structure_Tank	1.31	0	0.00
Structure	2.88	0	0.00
Natural Environment_Foreshore	4268.82	-1.98	-8452.27
Natural Environment_Orchard	552.02	-5.99	-3306.58
Path_Footbridge	0.87	0	0.00
Natural Environment_Scrub	606.23	-0.36	-218.24
Inland Water_Lock	0.02	0	0.00
Natural Environment_Marsh	252.52	-0.02	-5.05
Building_Archway	0.34	0	0.00
Inland Water_Reeds	12.31	-0.93	-11.45
General Surface_Foreshore	3.46	-1.98	-6.86
Natural Environment_Nonconiferous Trees (Scattered)	229.39	-7	-1605.72
Building_Tank	0.44	0	0.00
Natural Environment_Coppice Or Osiers	112.40	-7	-786.76

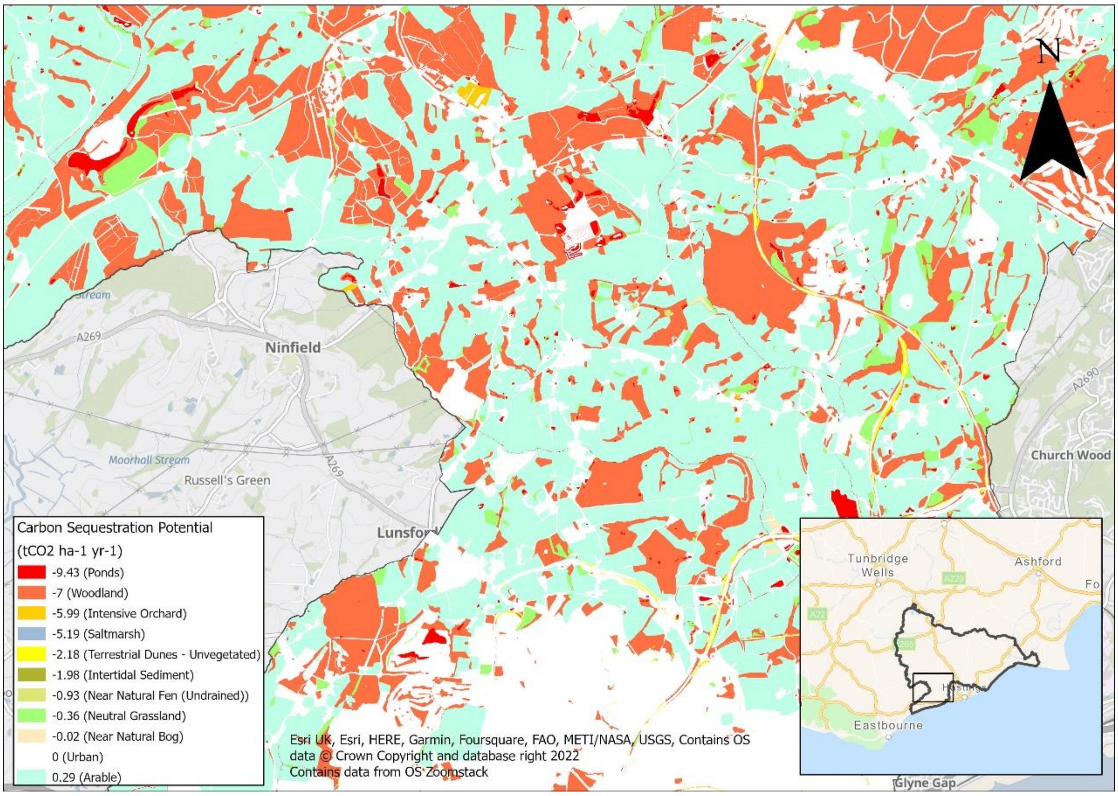
Land Use OSMM category	Area (ha)	Carbon flux ($tCO_2e\ ha^{-1}\ yr^{-1}$)	Carbon flux ($tCO_2e\ yr^{-1}$) **
General Surface_Step	0.32	0	0.00
Structure_Pylon	2.46	0	0.00
Unclassified	40.28	0	0.00
Inland Water_Weir	0.03	-9.43	-0.23
Building_Public Convenience	0.17	0	0.00
Building_Gas Governor	0.03	0	0.00
Building_Electricity Sub Station	0.19	0	0.00
General Surface_Bridge	0.63	0	0.00
Inland Water_Ford	0.01	-9.43	-0.06
Landform_Cliff	37.10	-2.18	-80.88
Rail_Level Crossing	0.32	0	0.00
Natural Environment_Coniferous Trees (Scattered)	22.30	-7	-156.13
General Surface_Sloping Masonry	1.50	0	0.00
Roadside_Bridge	0.29	0	0.00
General Surface_Mineral Workings	54.11	0	0.00
Building_Conveyor	0.78	0	0.00
Inland Water_Sinks	0.001	-9.43	-0.01
Road Or Track_Traffic Calming	0.55	0	0.00
Rail_Bridge	0.31	0	0.00
Path_Step	0.14	0	0.00
Glasshouse	1.07	0	0.00
Natural Environment_Mineral Workings (Inactive)	10.35	0	0.00
Inland Water_Swimming Pool	0.18	0	0.00
Inland Water_Spring	0.05	-9.43	-0.51
Inland Water	4.21	-9.43	-39.71
General Surface_Slipway	0.11	0	0.00
Path_Foreshore	0.01	0	0.00
Landform	18.09	-2.18	-39.43
Building_Well	0.001	0	0.00
Natural Environment_Saltmarsh	14.39	-5.19	-74.67

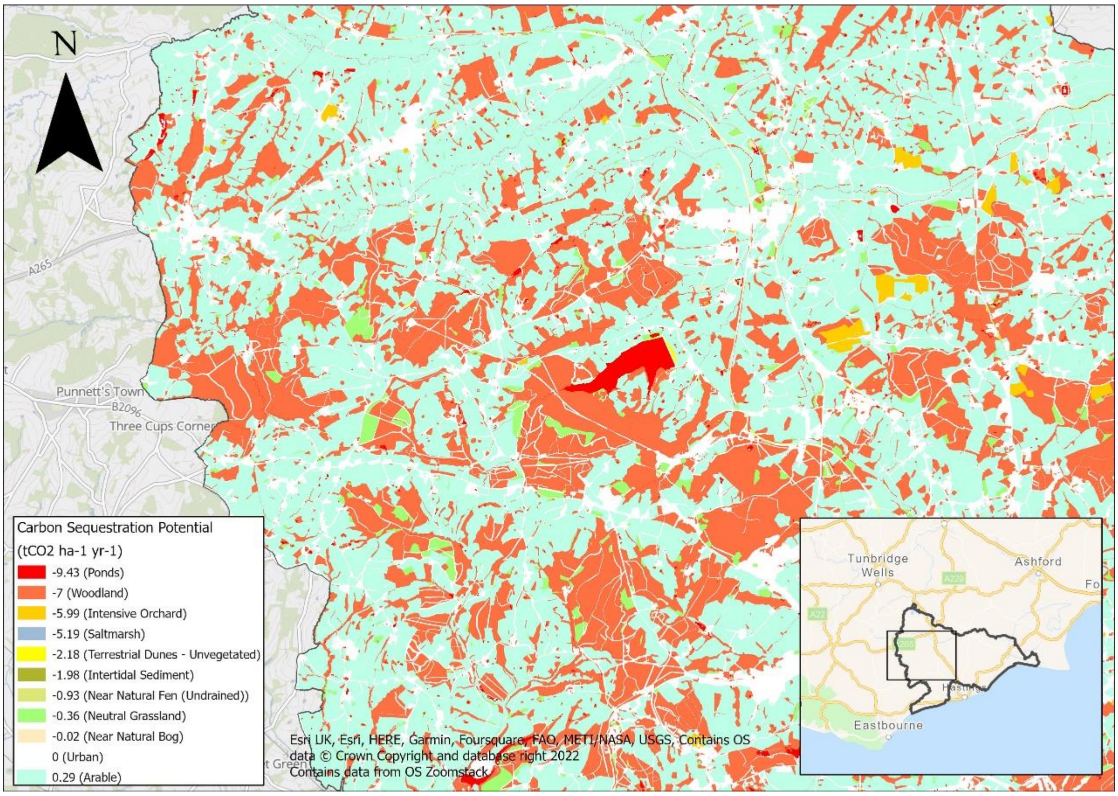
Land Use OSMM category	Area (ha)	Carbon flux ($tCO_2e\ ha^{-1}\ yr^{-1}$)	Carbon flux ($tCO_2e\ yr^{-1}$) **
Natural Environment_Boulders	18.17	-2.18	-39.61
Historic Interest_Slope	0.34	-2.18	-0.74
Path_Public Convenience	0.003	0	0.00
Structure_Telecommunications Mast	0.002	0	0.00
Structure_Groyne	0.04	0	0.00
Inland Water_Mill Leat	0.65	-9.43	-6.11
Inland Water_Well	0.01	-9.43	-0.09
Inland Water_Canal	12.88	-9.43	-121.43
Structure_Foreshore	0.05	0	0.00
General Surface_Sand	0.58	-2.18	-1.26
Path_Electricity Sub Station	0.004	0	0.00
Inland Water_Tank	0.01	-9.43	-0.10
Building_Chimney	0.00	0	0.00
Inland Water_Reservoir	424.94	-9.43	-4007.17
General Surface_Landfill (Inactive)	35.64	-2.18	-77.69
Tidal Water	42.81	-9.43	-403.71
Natural Environment_Sand	19.80	-2.18	-43.16
Structure_Conveyor	0.02	0	0.00
Natural Environment_Rock	10.96	-2.18	-23.89
Structure_Conduit	0.002	0	0.00
General Surface_Footbridge	0.01	0	0.00
Building_Footbridge	0.001	0	0.00
Roadside_Footbridge	0.001	0	0.00
General Surface_Gas Governor	0.29	0	0.00
Rail_Sand	0.003	-2.18	-0.01
Building_Signal	0.002	0	0.00
Tidal Water_Foreshore	0.001	-1.98	0.00
Inland Water_Waterfall	0.002	-9.43	-0.02
Path_Bridge	0.008	0	0.00
Structure_Gas Governor	0.000	0	0.00

Land Use OSMM category	Area (ha)	Carbon flux ($tCO_2e\ ha^{-1}\ yr^{-1}$)	Carbon flux ($tCO_2e\ yr^{-1}$) **
Path_Gas Governor	0.03	0	0.00
Natural Environment_Mud	0.02	-1.98	-0.04
Total	65579.50		- 106,145

A.2.1 Detailed maps showing the land use type and corresponding carbon sequestration potential.






N
Carbon Sequestration Potential
(tCO2 ha-1 yr-1)
-9.43 (Ponds)
-7 (Woodland)
-5.99 (Intensive Orchard)
-5.19 (Saltmarsh)
-2.18 (Terrestrial Dunes - Unvegetated)
-1.98 (Intertidal Sediment)
-0.93 (Near Natural Fen (Undrained))
-0.36 (Neutral Grassland)
-0.02 (Near Natural Bog)
0 (Urban)
0.29 (Arable)
Punnett's Town
Three Cups Corner
Tunbridge Wells
Ashford
Eastbourne
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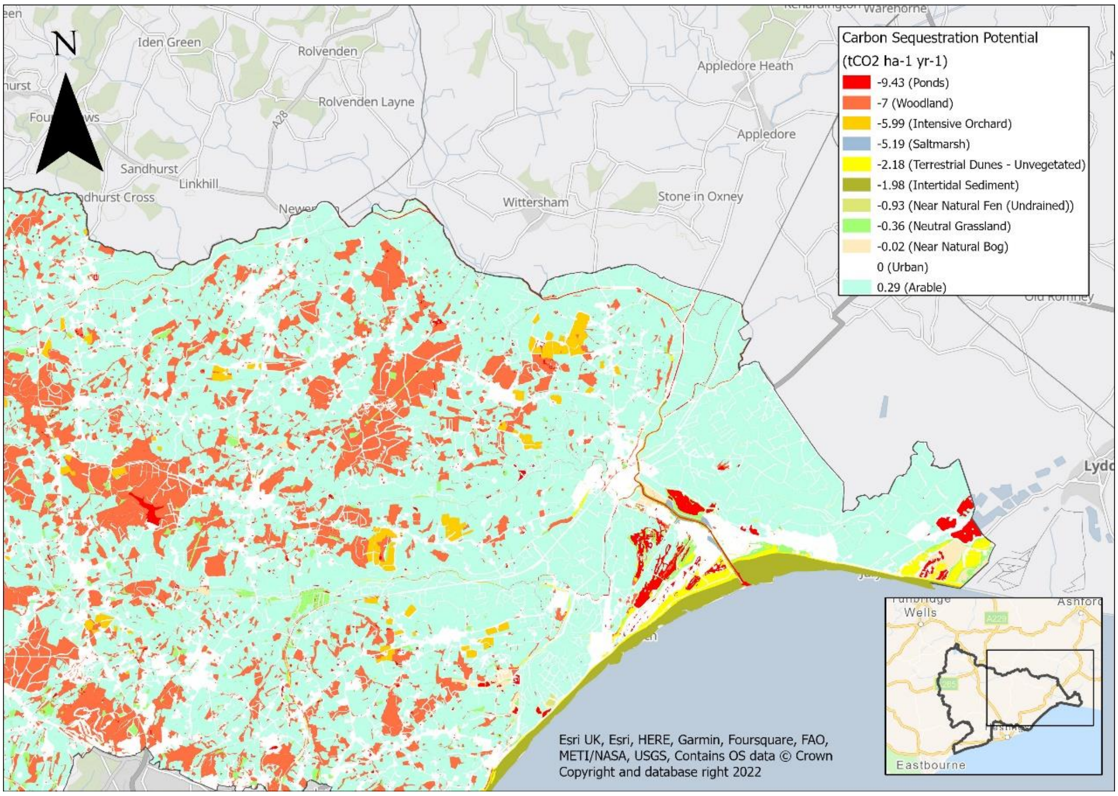
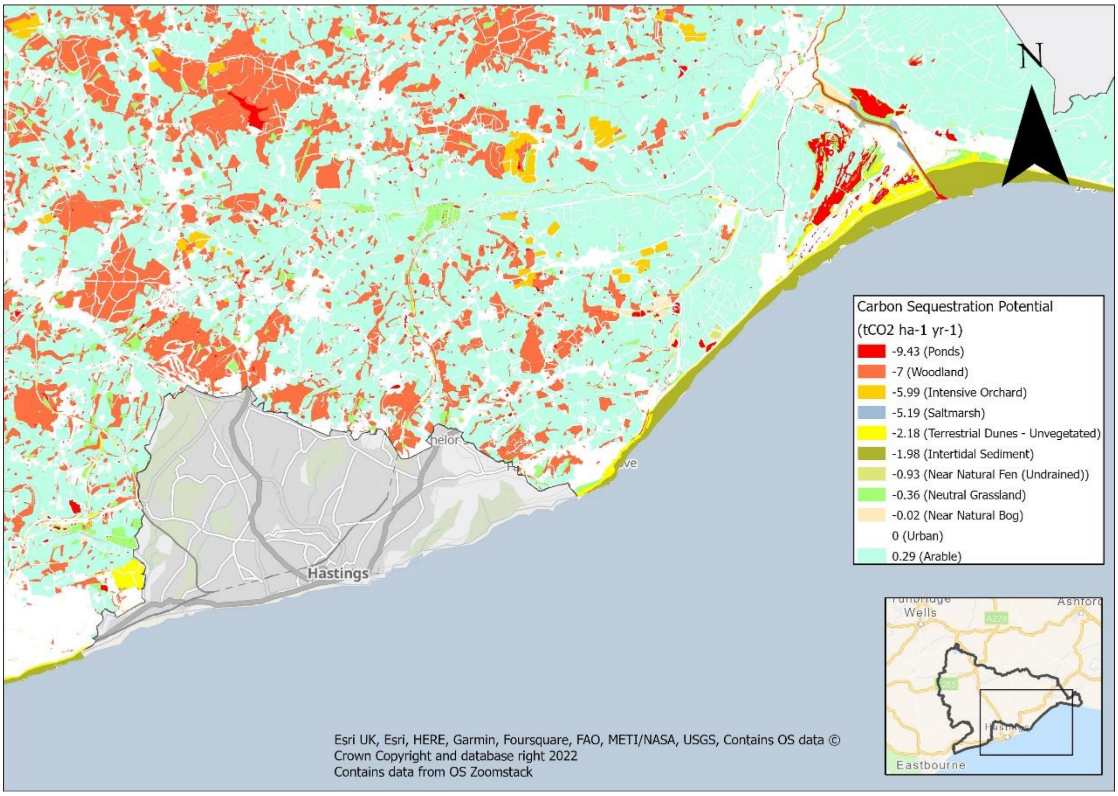
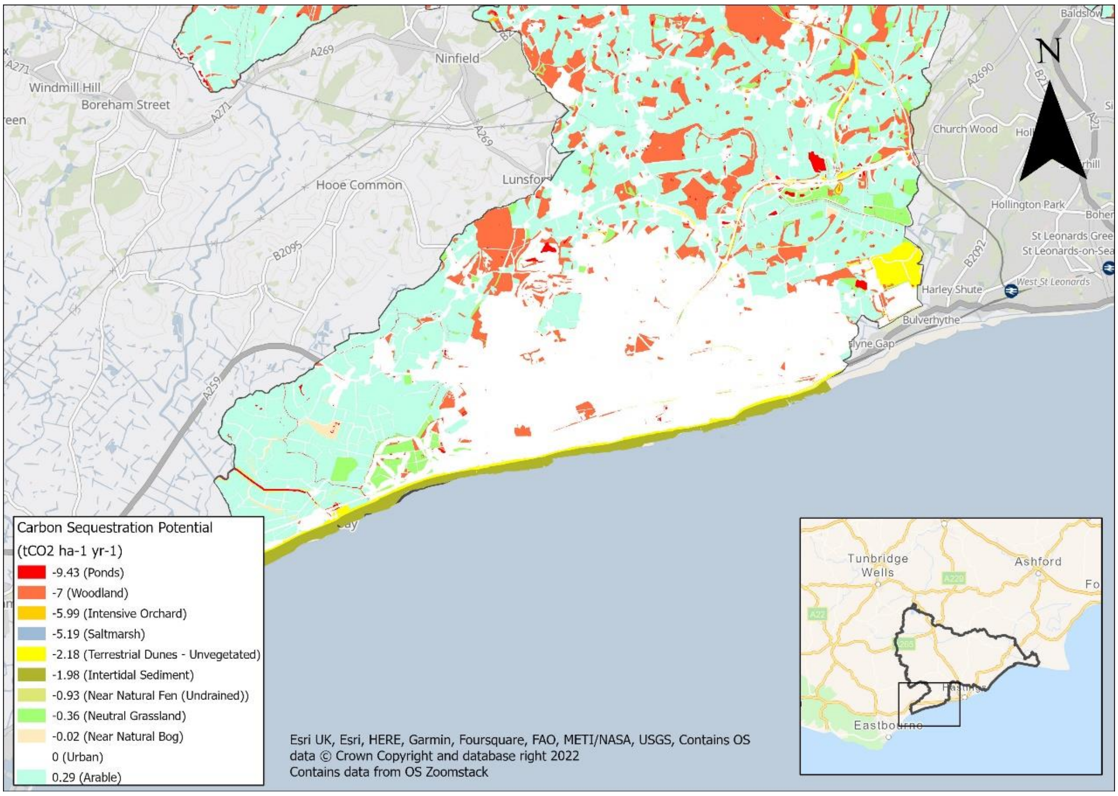
Contains data from OS Zoomstack


N
Iden Green
Rolvenden
Appledore Heath
Rolvenden Layne
Appledore
Sandhurst
Wittersham
Stone in Oxney
Carbon Sequestration Potential
(tCO2 ha-1 yr-1)
-9.43 (Ponds)
-7 (Woodland)
-5.99 (Intensive Orchard)
-5.19 (Saltmarsh)
-2.18 (Terrestrial Dunes - Unvegetated)
-1.98 (Intertidal Sediment)
-0.93 (Near Natural Fen (Undrained))
-0.36 (Neutral Grassland)
-0.02 (Near Natural Bog)
0 (Urban)
0.29 (Arable)
Eastbourne
Esri UK, Esri, HERE, Garmin, Foursquare, FAO, METI/NASA, USGS, Contains OS data © Crown Copyright and database right 2022


N
Hastings
Carbon Sequestration Potential
(tCO2 ha-1 yr-1)
-9.43 (Ponds)
-7 (Woodland)
-5.99 (Intensive Orchard)
-5.19 (Saltmarsh)
-2.18 (Terrestrial Dunes - Unvegetated)
-1.98 (Intertidal Sediment)
-0.93 (Near Natural Fen (Undrained))
-0.36 (Neutral Grassland)
-0.02 (Near Natural Bog)
0 (Urban)
0.29 (Arable)
Wells
Eastbourne
Esri UK, Esri, HERE, Garmin, Foursquare, FAO, METI/NASA, USGS, Contains OS data © Crown Copyright and database right 2022
Contains data from OS Zoomstack

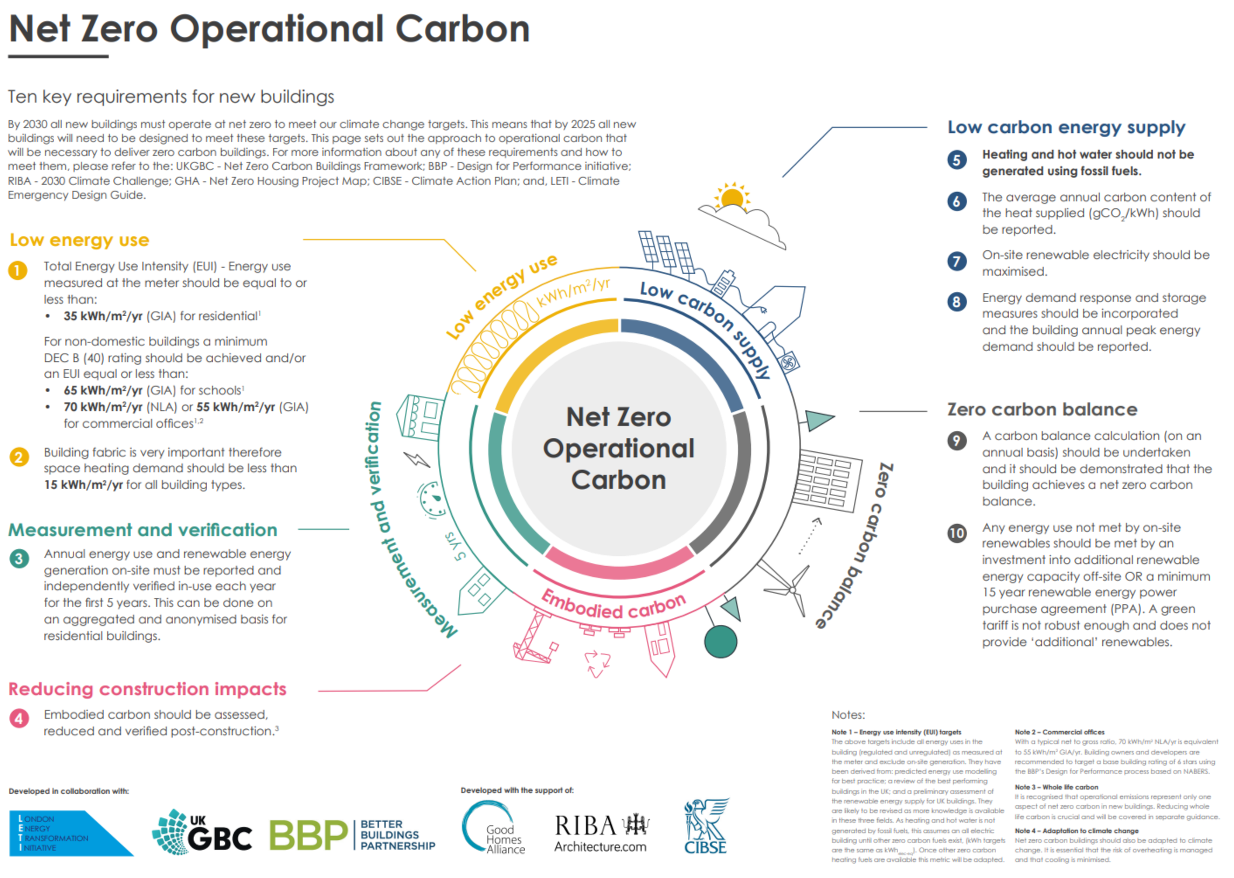

N
Windmill Hill
Boreham Street
Ninfield
Hooe Common
Church Wood
Hollington Park
St Leonards-on-Sea
Harley Shute
Bulverhythe
Carbon Sequestration Potential
(tCO2 ha-1 yr-1)
-9.43 (Ponds)
-7 (Woodland)
-5.99 (Intensive Orchard)
-5.19 (Saltmarsh)
-2.18 (Terrestrial Dunes - Unvegetated)
-1.98 (Intertidal Sediment)
-0.93 (Near Natural Fen (Undrained))
-0.36 (Neutral Grassland)
-0.02 (Near Natural Bog)
0 (Urban)
0.29 (Arable)
Tunbridge Wells
Ashford
Eastbourne
Esri UK, Esri, HERE, Garmin, Foursquare, FAO, METI/NASA, USGS, Contains OS data © Crown Copyright and database right 2022
Contains data from OS Zoomstack

A.3 Net Zero Buildings Analysis

A.3.1 Building regulations and industry trends

The residential buildings sector is the second highest source of emissions in Rother, behind only on-road transportation. Whereas a combination of electrification of transport and mode shift towards active travelling can reduce transportation emissions, residential buildings emissions are a systemic challenge that requires behaviour shift, support of supply chains, public engagement and innovative financing mechanisms based on public-private investment partnerships. Despite the challenge, there are big opportunities for building local capacity, and developing skills networks, alleviating fuel poverty, and enhancing the resilience of communities.

There are two main aspects in the decarbonisation of residential housing stock; 1) Operational emissions that occur from the operation of building services with the focus being on space heating, 2) Construction emissions that refer to the embodied carbon of building materials and the end-of-life treatment of materials and waste. In general, decisions early on the design process of buildings projects offer more opportunities to reduce embodied carbon and optimise the design for passive solar gains, shading in summer, use of renewable energy systems and reduction in the heating demand.



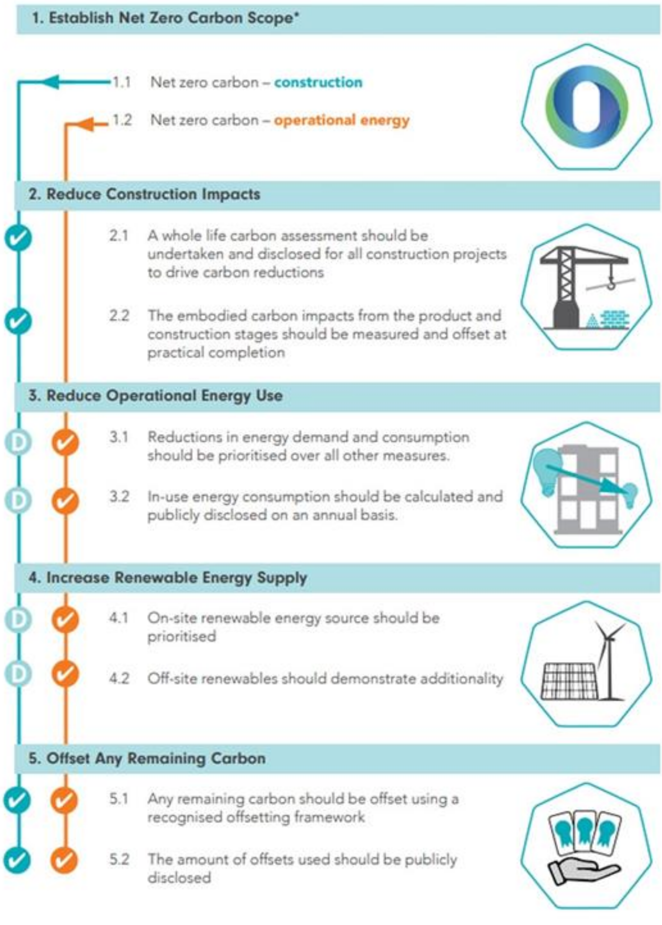
Ten key requirements for new buildings to achieve net zero carbon in operation [31].

Current UK industry trends are calling for a whole-building approach considering all stages of the life cycle of buildings and setting ambitious targets for energy use intensity (EUI, kWh/m^2/yr), space heating demand and low-carbon energy supply with on-site renewable energy systems. UK Green Building Council (UK GBC) has published a Net Zero Carbon Building framework [31] that sets out priorities for the buildings sector following a whole life approach with the consideration of both operational and embodied emissions.

According to resiliency based, “no regrets” approaches, the priority should be the reduction of energy demand and consumption. This shall ensure that there are no utility bills’ cost increases, comfort and indoor environmental quality are achieved to support health and wellbeing of the residents. The “no regrets” approach is consequently interpreted into a “fabric first” approach with focus on construction elements and design strategies to reduce heat losses as much as possible. The technology, knowledge and materials largely exist but cost and budget considerations are important to achieve optimum results and maximise the benefits/energy use reduction within any additional costs margins.

The expectations are that building regulations will progressively lead to new buildings being highly energy performing and achieving net zero emissions. High performance buildings will still require energy to heat and operate. This is where the “Net Zero ready” specifications and building design need to be complemented by technology and building services that are future proof in terms of changing between heating fuels and supporting on-site renewable power generation. For example, if for the next 2 years new buildings are still connected to the gas grid, there should be an inherent capability to change to heat pumps without extensive retrofit requirements.

Towards this direction, changes have been recently introduced to the approved documents for building regulations, in particular the Part L regulations on thermal efficiency, Part F on building ventilation and the newly introduced Part O on overheating mitigation. The Part O responds to concerns about overheating because of highly insulated, ait tight buildings that may risk failing to cool effectively in summer under hot weather conditions. The main changes have been discussed in the policy case studies and the typology analysis in this report. At the same time, it is widely accepted that new residential buildings should avoid using mechanical cooling, but it is recognised that under climate change impacts there might be a future need for hybrid ventilation and cooling strategies, utilising both natural and mechanical systems. Fabric first and net zero ready approach calls for taking all measures possible to achieve comfort with natural means before resorting to any mechanical cooling (i.e. reduce as much as possible by design any cooling demand).



UKGBC Net Zero Carbon Building framework that sets out priorities for the buildings sector following a whole life approach [29]

The success of many building strategies is interrelated with and relies on different local and national systems. Natural ventilation potential and openable windows will require good air quality and cooler ambient air temperatures than the interior to be effective. That means developments should consider landscape materials, density and layout of houses, location of windows and cross-ventilation strategies. The open space and materials selection will also affect the embodied carbon of the project, the carbon sequestration potential, biodiversity, and rainwater drainage. Thinking of net zero emissions, rapid uptake of solar panels and electrification of heating and transport may require grid strengthening, local electricity storage and maybe small, decentralised, development focused/street scale networks of renewable electricity and low-carbon heat.

It should also be noted that projected development in Rother is relatively small (~450 dwellings per year). The new buildings will have a marginal impact on Rother emissions in comparison with the existing housing stock. The residential emissions of existing buildings will continue to be a substantial part of the district’s total emissions. It is recognised that a Local Plan cannot directly affect retrofit plans at scale and pace to achieve regional net zero targets. The Local Plan though can set the example and level of ambition, showcase the benefits for high energy performance housing, and facilitate the transition to sustainable living for all, though active travelling opportunities, mixed use, sustainable density, employment and recreation opportunities and healthy, aspirational living. The correct level of ambition and aspirations could instigate behaviours, investment and policy that will enable retrofits at scale and pace, enhance the green infrastructure and ecosystem services, and unlock community led initiatives and funding.

To this direction, the following sections outline key principles for five common building typologies and discuss the implications for Rother Local Plan.

A.3.2 Net Zero for Rother building typologies

Subnational consumption data from Rother has been used to provide context on the changes required in buildings specification to achieve the “net-zero for new developments” aspiration in the Local Plan.

Descriptive statistics of the domestic electricity and gas consumption in Rother.

Rother (2020, E07000064) [118]	Mean (kWh per meter)	Median (kWh per meter)
Electricity (All domestic)	4,401	3,183
Gas (All domestic)	14,235	12,558

The results for 2019 were similar to 2020 and there was not a noticeable variation in consumption due to COVID 19, considering the high-level scope and accuracy for this analysis. It is also noted that the highest proportion (43.7%) of the existing housing stock is in EPC Band D (score 55-68), and a large percentage of dwellings is in Bands E to G (~27%) [119].

This study focuses on three residential house typologies and two non-residential. Typical characteristics for these typologies in the UK are shown below. For comparison, the Valuation Office Agency (VOA) in the UK [53] suggests that the median floor area space for all properties in Rother is 96 m^2, for flats the floor space area is 48 m^2, for houses 109 m^2 and for bungalows 94 m^2.

Main characteristics of the assessed building typologies in Rother.

Building typology	Floor area (m^2)	Layout (bedrooms / units)	Occupancy (persons)	Source
Flats / apartments	55	2	3	EHS [120] / Arup database
Semi-detached houses	93	3	4	EHS / Arup database
Detached houses	152	4	5	EHS / Arup database
Offices (Private)	2,000	NA	40	Assumption based on BEES from DESNZ [121]
Industrial*	10,000	NA	NA	Savills [122]

*For warehouses, evidence suggests that the average size of units has increased to 31,500 m^2 which exceeds the annual employment land development as assumed for Rother regions. Therefore, this typology was capped to 10,000 m^2.

A.3.3 Net zero buildings

A.3.3.1 Building Regulations – Part L 2021

Developers are required to show compliance with building regulations by comparing the new dwellings in design stage, and after the completion of works, against a "notional" building that represents the minimum standard of energy performance accepted by the regulations. The "notional" dwelling has the same size and form with the "actual" building. Its specifications and the calculation methodology are defined in Part L and the Government's Standard Assessment Procedure (SAP 10 currently). The energy performance of the "notional" dwelling is described with three metrics [54]:

- The target primary energy rate (TPER), in kWh_{PE}/m^2 per year: this is influenced by the fabric and fuel.
- The target emission rate, in $kgCO_2/m^2$ per year: this is influenced by the fabric and fuel.
- The target fabric energy efficiency rate, in kWh/m^2 per year: this is influenced by the fabric only.

The recent changes in the regulations and the consequent SAP update have updated the carbon emissions factor for electricity and the primary energy factors (PEF) for fuel used in buildings. An overview of the carbon emissions factors and the PEF is provided below.

The changes are: 1) the carbon emission intensity of grid electricity was reduced largely, and it is now lower than the carbon intensity of mains gas, 2) the primary energy factor of grid electricity was also reduced from 3.07 to 1.501 but this is still higher than the 1.13 PEF value for mains gas, 3) unit prices have been adjusted in the current SAP but this adjustment did not capture the recent inflation impact on energy prices, with unit prices now being on average at 34p/kWh and 10.3 p/kWh for electricity and gas respectively.

Comparison of key factors between current (SAP 10) and previous (SAP 12) building regulation.

	Unit price, p/kWh	Emissions $kgCO_2/kWh$	Primary energy factor (PEF) kWh/kWh
SAP 12 (previous)			
Grid electricity	13.19	0.519	3.07
Mains gas supply	3.48	0.216	1.22
SAP 10 (current)			
Grid electricity	16.49	0.136	1.501
Mains gas supply	3.64	0.210	1.13

These changes have a direct impact on the decisions for heating systems, renewable electricity generation, air tightness and insulation levels in new residential and non-residential developments.

The following examples aim to support the arguments for high energy performance targets for new dwellings (and non-residential buildings) and demonstrate the implications of the compliance calculations methodology (SAP) on building design decisions. The "notional" building energy performance metrics in SAP are a function of several design aspects and have not been calculated for the building typologies in Rother as part of this report. The following case studies are based on simplified calculations and assumptions to facilitate discussion. Solar panels as a term are used interchangeably with PV systems. Solar thermal systems have not been considered in the examples, but they are part of the alternative renewable energy technologies that may be suitable for some developments. Any results and conclusions are generic and transferable to non-residential buildings.

The estimated costs for heating in the case studies do not include the standing charges and are based on the unit price in the previous and current versions of SAP. The actual cost is calculated based on an average unit price assumption for England in December 2022.

Case Study (House A): Semi Detached with gas boiler for heating system, no solar panels.

- Current building regulations for domestic buildings are aiming to a 31% decrease to emissions against the previous targets.
- A semi-detached house in Rother has a floor space area of 93 m^2 and a gas consumption (heating only) of 13,000 kWh. The annual electricity consumption is 3,500 kWh (without heating or cooling).
- A new semi-detached, House A has a gas boiler of 90% efficiency (current standard practice). Let's assume that a 30% reduction of heating demand was achieved due to better thermal performance of the fabric. The heating demand of House A would be (13,000 kWh x 0.90) x (1-0.30) = 11,700 kWh x 0.7 = 8,200 kWh.
- The Energy Use Intensity would be ((8,200/0.90) kWh + 3,500 kWh) / 93 m^2 = ~136 kWh/m^2
- The primary energy associated with heating will be (8,200 kWh / 0.90) x 1.13 (gas PEF) = 10,300 kWh_{PE}
- The primary energy associated with electricity will be 3,500 kWh x 1.501 (grid PEF) = 5,250 kWh_{PE}
- The total energy related emissions will be 9,110 kWh (gas) x 0.216 + 3,500 (kWh e-) x 0.136 = 2,390 $kgCO_2e$
- The cost for heating will be 9,110 kWh (gas) x 3.64 p/kWh = £332 per year

Example of energy performance metrics for a simplified new dwelling with gas heating.

Semi-detached House A, gas boiler, no PV	SAP 10 (current)	SAP 12	Actual cost
Floor space area, m^2	93	93	
Heating demand, kWh/year	8,200	8,200	
Energy Use Intensity (EUI), kWh/m^2	136	136	
Total Primary Energy, kWh_{PE} /year	15,549	21,861	
Electricity generation (local use), kWh/year	0	0	
Electricity generation (export), kWh/year	0	0	
Total emissions (energy related), tCO_2e	2.4	3.8	
Cost for heating (consumption based), £/year	332	317	938

This case study shows the impact from the update of the emissions and primary energy use factors for fuel between the previous and current regulations. The gas heated; semi-detached house of the example would achieve a 35% reduction of emissions based on current SAP against the calculations with the previous SAP version.

Case Study (House B): Semi Detached with air source heat pump (ASHP) for heating system, no solar panels.

- House B has an air source heat pump with a CoP (efficiency factor) of 2.8. It is fossil-fuel free.
- It has the same heating demand of 8,200 kWh with House A.

Example of energy performance metrics for a simplified new dwelling with air source heat pump.

Semi-detached House B, heat pump, no PV	SAP 10 (current)	SAP 12	Actual cost
Floor space area, m^2	93	93	
Heating demand, kWh/year	8,200	8,200	
Energy Use Intensity (EUI), kWh/m^2	69	69	
Total Primary Energy, kWh_{PE} /year	9,649	19,736	
Electricity generation (local use), kWh/year	0	0	
Electricity generation (export), kWh/year	0	0	
Total emissions (energy related), tCO_2e	0.9	3.3	
Cost for heating (consumption based), £/year	483	386	996

Case Study (House C): Semi Detached with electric panels heating system, no solar panels.

- House C is heated with electric panel heaters that have an efficiency of 100%.
- It has the same heating demand with the previous examples.

Example of energy performance metrics for a simplified new dwelling with electric panel heaters.

Semi-detached House C, electric panels heating, no PV	SAP 10 (current)	SAP 12	Actual cost
Floor space area, m^2	93	93	
Heating demand, kWh/year	8,200	8,200	
Energy Use Intensity (EUI), kWh/m^2	126	126	
Total Primary Energy, kWh_{PE} /year	17,562	35,919	
Electricity generation (local use), kWh/year	0	0	
Electricity generation (export), kWh/year	0	0	
Total emissions (energy related), tCO_2e	1.6	6.1	
Cost for heating (consumption based), £/year	1,352	1,082	2,788

Case Study (House D): Semi Detached with gas boiler for heating system, and solar panels.

- House D is heated with a gas boiler with an efficiency factor of 0.9.
- It has the same heating demand of 8,200 kWh with House A.

The performance metrics for House A (gas heating + PV) would change as shown below. For simplicity, it has been assumed that the PV generation is not used to displace loads from the gas boiler (e.g. there is not a hot water storage tank with immersion heaters or secondary electric heating and hot water systems). It is assumed that the smart export guarantee (SEG) tariff rate is 5.5 p/kWh exported to the grid. It is also assumed that there is no battery storage (local or communal), and half of the electricity generated by PV is used locally with the other half being exported to the grid.

Example of energy performance metrics for a simplified new dwelling with gas boilers and PV system as specified for the "notional" building in SAP10.

Semi-detached House D, gas boiler, 3.1 kWp PV	SAP 10 (current)	SAP 12	Actual cost
Floor space area, m^2	93	93	
Heating demand, kWh/year	8,200	8,200	
Energy Use Intensity (EUI), kWh/m^2	117	117	
Total Primary Energy, kWh_{PE} /year	12,105	11,297	
Electricity generation (50% local use), kWh/year	1720.5	1720.5	
Electricity generation (50% export), kWh/year	1720.5	1720.5	
Total emissions (energy related), tCO_2e	1.9	2.0	
Cost for heating (consumption based), £/year	332	317	938
Cost heating fuel +electricity	529	325	1449

Case Study (House E): Semi Detached with air source heat pump (ASHP) for heating system, and solar panels (assumed battery storage).

- House E has an air source heat pump with a CoP (efficiency factor) of 2.8. It is fossil-fuel free.
- It has the same heating demand of 8,200 kWh with House A.

Example of energy performance metrics for a simplified "net zero ready" new dwelling with ASHP and 2.9 kWp PV system.

Semi-detached House E, heat pump, 2.9 kWp PV	SAP 10 (current)	SAP 12	Actual cost
Floor space area, m^2	93	93	
Heating demand, kWh/year	8,200	8,200	
Energy Use Intensity (EUI), kWh/m^2	35	35	
Total Primary Energy, kWh_{PE} /year	4,818	9,853	
Electricity generation (local use), kWh/year	3219	3219	
Electricity generation (export),), kWh/year	0	0	
Total emissions (energy related), tCO_2e	0.4	1.7	
Cost for heating (consumption based), £/year	483	386	996
Cost heating fuel +electricity	529	423	1091

A.4 Order of Cost Estimate

Rother - Climate Change Study
Order of Cost Estimate
January 2023

ARUP
Job Number: 292439-00

Archetype 1 - Apartment					
			41 m2	Assumed external wall area (m²)	
			14 m2	Assumed glazing area (m²)	
			70 m2	Assumed flat roof area (m²)	
			70 m2	Assumed GIA (m²)	
			753 ft2	Assumed GIA (ft²)	

Ref.	**Description**	**Unit**	**Cost per '*Unit*'** ***Baseline*** [£ GBP]	**Cost per '*Unit*'** ***Advanced*** [£ GBP]	**Comments**
1.	Insulation to external walls	m²	520	530	Works have been built up based on a single apartment considered as part of a wider development. For both scenarios, wall build up's are on the basis of cavity walls with single leaf blockwork and single leaf brick work. Insulation to the advanced scenario is increased to improve u-value's. Costs include for materials and labour of installing and applying brickwork and insulation for an apartment. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
2.	Glazing upgrades	m²	850	1,200	Baseline costs include for the installation of double glazing achieving u-value of approximately 1.2. The advanced scenario considers triple glazing installations to achieve an approximate u-value of 0.9. Costs include for materials and labour of installing new windows, per apartment based on approximate glazing area. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
3.	Roof insulation	m²	330	350	Works have been built up based on a single apartment considered as part of a wider development. It should be considered that the nature of the apartment buildings would mean the costs per m² will vary depending on the number of units in a development. For both scenarios, a flat roof has been assumed and costs include for the build up of roof structure. Insulation in the advanced scenario is increased to improve u-value's. Costs include for materials and labour of installing the roof for one apartment. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8% .It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
4.	PV installations	kW	0	3,200	Baseline scenario assumes no installation of PV panels. For the advanced scenario, the PV capacity has been assumed at 1.4kW based on a single apartment. Output will vary depending on development design, which will impact both CAPEX and £/kW. Costs include for materials and labour of installing and applying to the roof for an apartment. No allowance for the inclusion of battery storage has been made. Costs of main contractor preliminaries and OH&P have been included within supply and installation rates. An allowance has been made for access for the advanced scenario.
5.	Heat generation	kW	230	1,900	Costs compare installation of gas boiler for the baseline and individual ASHP in the advanced scenario. These have been assumed 1nr to each apartment. It should be noted the practicalities will vary between developments and therefore different systems and efficiencies may be realised. This will have a cost impact. Costs noted are inclusive of materials and installation of heat pump to external wall only. Further consideration to the heat emission system would be required and will impact build costs; for example use of radiators compared to underfloor heating system. Costs are on the basis of an assumed output requirement of 5kW. It is assumed no additional electrical capacity would be required to the building compared to baseline build. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.

Archetype 2 - Semi-detached house			72 m2	Assumed external wall area (m²)
			17 m2	Assumed glazing area (m²)
			52 m2	Assumed pitched roof area (m²)
			85 m2	Assumed GIA (m²)
			915 ft2	Assumed GIA (ft²)

Ref.	Description	Unit	Cost per '*Unit*' *Baseline* [£ GBP]	Cost per '*Unit*' *Advanced* [£ GBP]	Comments
1.	Insulation to external walls	m²	520	530	For both scenarios, wall build up's are on the basis of cavity walls with single leaf blockwork and single leaf brick work. Insulation to the advanced scenario is increased to improve u-value's. Costs include for materials and labour of installing and applying brickwork and insulation. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
2.	Glazing upgrades	m²	850	1,200	Baseline costs include for the installation of double glazing achieving u-value of approximately 1.2. The advanced scenario considers triple glazing installations to achieve an approximate u-value of 0.9. Costs include for materials and labour of installing new windows, based on approximate glazing area. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
3.	Roof insulation	m²	390	490	For both scenarios, a 35 degree pitched roof has been assumed and costs include for the build up of roof structure. Insulation in the advanced scenario is increased to improve u-value's. Costs include for materials and labour of installing the roof. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
4.	PV installations	kW	0	3,000	Baseline scenario assumes no installation of PV panels. For the advanced scenario, the PV capacity has been assumed at 2kW. Output will vary depending on development design and site orientation, which will impact both CAPEX and £/kW. No allowance for the inclusion of battery storage has been made. Costs include for materials and labour of installing and applying to the roof. Costs of main contractor preliminaries and OH&P have been included within supply and installation rates. An allowance has been made for access for the advanced scenario.
5.	Heat generation	kW	200	1,600	Costs compare installation of gas boiler for the baseline and individual ASHP in the advanced scenario. Costs noted are inclusive of materials and installation of heat pump only. Further consideration to the heat emission system would be required and will impact build costs; for example use of radiators compared to underfloor heating system. Costs are on the basis of an assumed output requirement of 7kW. It is assumed no additional electrical capacity would be required to the building compared to baseline build. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.

Ref.	Description	Unit	Cost per '*Unit*' ***Baseline*** [£ GBP]	Cost per '*Unit*' ***Advanced*** [£ GBP]	Comments
Archetype 3 - Detached houses				152 m2	Assumed external wall area (m²)
				25 m2	Assumed glazing area (m²)
				76 m2	Assumed pitched roof area (m²)
				125 m2	Assumed GIA (m²)
				1,345 ft2	Assumed GIA (ft²)
1.	Insulation to external walls	m²	520	530	For both scenarios, wall build up's are on the basis of cavity walls with single leaf blockwork and single leaf brick work. Insulation to the advanced scenario is increased to improve u-value's. Costs include for materials and labour of installing and applying brickwork and insulation. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
2.	Glazing upgrades	m²	850	1,200	Baseline costs include for the installation of double glazing achieving u-value of approximately 1.2. The advanced scenario considers triple glazing installations to achieve an approximate u-value of 0.9. Costs include for materials and labour of installing new windows, based on approximate glazing area. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
3.	Roof insulation	m²	380	490	For both scenarios, a 35 degree pitched roof has been assumed and costs include for the build up of roof structure. Insulation in the advanced scenario is increased to improve u-value's. Costs include for materials and labour of installing the roof. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
4.	PV installations	kW	0	2,400	Baseline scenario assumes no installation of PV panels. For the advanced scenario, the PV capacity has been assumed at 3.6kW. Output will vary depending on development design and site orientation, which will impact both CAPEX and £/kW. No allowance for the inclusion of battery storage has been made. Costs of main contractor preliminaries and OH&P have been included within supply and installation rates. An allowance has been made for access for the advanced scenario.
5.	Heat generation	kW	190	1,300	Costs compare installation of gas boiler for the baseline and individual ASHP in the advanced scenario. Costs noted are inclusive of materials and installation of heat pump only. Further consideration to the heat emission system would be required and will impact build costs; for example use of radiators compared to underfloor heating system. Costs are on the basis of an assumed output requirement of 9kW. It is assumed no additional electrical capacity would be required to the building compared to baseline build. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.

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Archetype 4 - Office					
			90 m2	Assumed external wall area (m^2)	
			22 m2	Assumed glazing area (m^2)	
			54 m2	Assumed flat roof area (m^2)	
			54 m2	Assumed GIA (m^2)	
			581 ft2	Assumed GIA (ft^2)	

Ref.	Description	Unit	Cost per '*Unit*' ***Baseline*** [£ GBP]	Cost per '*Unit*' ***Advanced*** [£ GBP]	Comments
1.	Insulation to external walls	m^2	450	510	The baseline scenario has been costed on the basis of a timber frame cavity wall, with external facing bricks and insulated plasterboard. The advanced scenario is costed on the basis of cavity walls with single leaf blockwork and single leaf brick work. The advanced scenario has been costed to a design to improve the u-value. Costs include for materials and labour of installing and applying brickwork and insulation. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
2.	Glazing upgrades	m^2	850	1,200	Baseline costs include for the installation of double glazing achieving u-value of approximately 1.2. The advanced scenario considers triple glazing installations to achieve an approximate u-value of 0.9. Costs include for materials and labour of installing new windows, based on approximate glazing area. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
3.	Roof insulation	m^2	410	440	For both scenarios, a flat roof has been assumed and costs include for the build up of roof structure. Insulation in the advanced scenario is increased to improve u-value's. Costs include for materials and labour of installing the roof. It has been assumed the office building is a stand-alone building. This may vary between developments, influencing the costs. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
4.	PV installations	kW	0	2,300	Baseline scenario assumes no installation of PV panels. For the advanced scenario, the PV capacity has been assumed at 4kW. Output will vary depending on development design and site orientation, which will impact both CAPEX and £/kW. No allowance for the inclusion of battery storage has been made. Costs of main contractor preliminaries and OH&P have been included within supply and installation rates. An allowance has been made for access for the advanced scenario.
5.	Heat generation	kW	240	1,000	Costs compare installation of gas boiler for the baseline and electric boiler in the advanced scenario. Outputs are assumed at 4.5kW. Costs noted are inclusive of materials and installation of electric boiler only. Further consideration to the heat emission system would be required and will impact build costs; for example use of radiators compared to underfloor heating system. Costs include for the upgrade costs only, for the fuse to TP&N 100amp in the advanced scenario, calculated on the assumption of a 63amp fuse in the baseline. No other electrical upgrades are included within the costs. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.

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Archetype 5 - Industrial			**90 m2**	**Assumed external wall area (m²)**
			8 m2	**Assumed glazing area (m²)**
			54 m2	**Assumed flat roof area (m²)**
			54 m2	**Assumed GIA (m²)**
			581 ft2	**Assumed GIA (ft²)**

Ref.	**Description**	**Unit**	**Cost per '*Unit*' *Baseline* [£ GBP]**	**Cost per '*Unit*' *Advanced* [£ GBP]**	**Comments**
1.	Insulation to external walls	m²	450	510	The baseline scenario has been costed on the basis of a timber frame cavity wall with external facing bricks and insulated plasterboard. The advanced scenario is costed on the basis of cavity walls with single leaf blockwork and single leaf brick work. The advanced scenario has been costed to a design to improve the u-value. Costs include for materials and labour of installing and applying brickwork and insulation. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
2.	Glazing upgrades	m²	850	1,200	Baseline costs include for the installation of double glazing achieving u-value of approximately 1.2. The advanced scenario considers triple glazing installations to achieve an approximate u-value of 0.9. Costs include for materials and labour of installing new windows, based on approximate glazing area. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
3.	Roof insulation	m²	410	440	For both scenarios, a flat roof has been assumed and costs include for the build up of roof structure. Insulation in the advanced scenario is increased to improve u-value's. Costs include for materials and labour of installing the roof. It has been assumed the industrial building is a stand-alone building. This may vary between developments, influencing the costs. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.
4.	PV installations	kW	0	2,300	Baseline scenario assumes no installation of PV panels. For the advanced scenario, the PV capacity has been assumed at 6kW. Output will vary depending on development design and site orientation, which will impact both CAPEX and £/kW. No allowance for the inclusion of battery storage has been made. Costs of main contractor preliminaries and OH&P have been included within supply and installation rates. An allowance has been made for access for the advanced scenario.
5.	Heat generation	kW	220	900	Costs compare installation of gas boiler for the baseline and electric boiler in the advanced scenario. Outputs are assumed at 6kW. Costs noted are inclusive of materials and installation of electric boiler only. Further consideration to the heat emission system would be required and will impact build costs; for example use of radiators compared to underfloor heating system. Costs include for the upgrade costs only, for the fuse to TP&N 100amp in the advanced scenario, calculated on the assumption of a 63amp fuse in the baseline. No other electrical upgrades are included within the costs. Costs are inclusive of main contractor preliminaries at 15% and OH&P at 8%. It has been assumed advanced interventions would be achievable with existing access available on site. No additional allowance for access has been included.

Costs are in GBP
Cost Estimate base date: Q1 2023
The above figure excludes VAT
Inflation has been excluded
The feasibility design detail is equivalent to RIBA Stage 0 Strategic Definition. It is prudent to allow an estimate sensitivity tolerance of +/- 50%.

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A.5 Order of Cost Assumptions and Exclusions

1.0 ASSUMPTIONS AND EXCLUSIONS

1.1 Assumptions

The following assumptions have been allowed for within this cost plan:

1 All relevant systems will be shut-off prior to any work being completed on that system.
2 Protection to works areas, plant and equipment being retained, will be required.
3 There is no requirement for any extraordinary site investigations.
4 The contractor's preliminaries reflect a single phase programme and unrestricted working.
5 The contractor's overheads and profit is based on the likely cost of the main contractor's head office setup, administration proportioned to each contract and reasonable profit. Costs and percentages will vary from development to development.
6 Costs are based on new build developments and assume access and on-going works.
7 A client risk allowance of 5% has been included to allow for design development, unforeseen works during construction, client change during design and construction, and any other client risks, to a reasonable extent.
8 Allowance has been made within estimates for some builder's work in connection with services, such as forming holes, pipe sleeves, fire resistant stopping and making good.
9 The estimates make no provisions for structural alterations to to facilitate the installation of the new heat pumps and / or photovoltaic panels.
10 It should be noted that no commercial information or design details have been provided by the client or construction market for the proposed designs. Therefore, assumptions have been made regarding the design specification and costs in order to determine an order of magnitude for the cost variances.
11 Due to the level of design information available at the time of preparing this report, these costs should be considered with a tolerance of +/- 50%. It has not been possible to account for influencing factors such as programme and therefore market influece, or economies of scale.
12 All costs are in GBP (£).
13 Costs and rates have been obtained from industry price books, previous project information, historic market information and professional experience and judgement.
14 Costs have been calculated on the basis of market conditions returning to pre-pandemic levels and no allowance for additional COVID-19 disruption has been made.
15 The estimates allow for testing and commissioning of mechanical and electrical services, for items such as: testing equipment and consumables, calibration, site installation tests, static and performance testing including records, commissioning including preliminary checks, and the like.
16 An allowance of 10% is included for project/ design team professional fees, for fees associated with the project/design team and other specialist consultants required for the building project (i.e.
17 consultants' fees). No consideration has been given to the client procurement or tendering method at this stage, which could influence these costs.
18 The costs contained within this report should be considered indicative only and be used as a guide for future discussions surrounding the design development of these elements in relation to planning scenarios. These costs should not be used during procurement or tendering activities or to determine project or business commercial targets.
19 Costs have been calculated on a stand-alone basis with assumed dimensions and building methodologies

1.0 ASSUMPTIONS AND EXCLUSIONS

1.2 Exclusions

The following items are excluded from this cost plan:

1 No allowance for tender or construction inflation.
2 Specific risk items that maybe associated with the design changes.
3 No allowance for utility upgrades, except for fuse upgrades associated with the electric boiler installations - assumed baseline electrical, fibre, water, drainage, etc. infrastructure will be of adequate capacity to service the new equipment.
4 Allowances for abnormal site surveys / investigations.
5 Allowance for *Other Development / Project Costs*.
6 Allowances for general or special planning conditions, if required.
7 Any attempt to estimate the client's procurement and tendering methods.
8 No contamination / remediation strategy report is present at the time of producing this order of cost estimate, an allowance has not been included for the removal and disposal of contaminated materials / substances.
9 No allowance has been made for contaminated / hazardous ground
10 Site specific limitations arising from listed building status, or other statutory building requirements.
11 Any archaeological investigations, wildlife mitigation measures and other extraordinary site investigation works, and the like.
12 Does not include for physical restrictions or limitations in accessing site.
13 All works will be undertaken during normal working hours, no allowance has been made for premium time working/ out of hours working.
14 VAT and any other levies have been excluded
15 It is assumed no additional access requirements are needed for the advanced scenarios, with the exception of the PV installations. Costs are exclusive of scaffolding and access requirements
16 No allowance for the inclusion of battery storage for PV interventions has been made

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A.7 List of Abbreviations

Area of Outstanding Natural Beauty (AONB)

Building Research Establishment (BRE)

Business, Energy & Industrial Strategy (BEIS)

Chartered Institution of Building Services Engineers (CIBSE)

CHP (Combined Heat & Power)

Climate Change Committee (CCC)

Department for Energy Security and Net Zero (DESNZ) (formerly BEIS)

Distribution Network Operator (DNO)

Energy Use Intensity (EUI)

Future Energy Scenarios (FES)

Greenhouse gas (GHG)

Gross Internal Area (GIA)

Home Quality Mark (HQM)

Land use, land-use change and forestry (LULUCF)

LETI Total Energy Use Intensity (TEUI)

Local Planning Authority (LPA)

Low Energy Transformation Initiative (LETI)

Lower Super Output Area (LSOA)

Middle layer Super Output Areas (MSOA)

National Energy Efficiency Data-Framework (ND_NEED)

National Planning Policy Framework (NPPF)

Ordnance Survey (OS)

Passive House Planning Package (PHPP)

Photovoltaic Geographical Information System (PV-GIS

primary energy factors (PEF)

Rother District Council (RDC)

Royal Institute of British Architects (RIBA)

Royal Town Planning Institute (RTPI)

Supplementary Planning Document (SPD)

the Government's Standard Assessment Procedure (SAP

The Leading the Way (LTW) Scenario

Town and Country Planning Association (TCPA)

UK Green Buildings Council (UKGBC),

UKPN embedded capacity register (ECR)

Valuation Office Agency (VOA)