

A greenhouse gas emissions assessment and target scenario for the Exmoor National Park

A report by Small World Consulting Ltd

January 2023

Contents

Executive summary	5
Background	5
This report	5
Limitations and uncertainties	8
Results	8
Key highlights	9
Targets scenario	10
1. Introduction	14
2. Policy drivers	15
2.1. Climate change policy	15
2.2. Health impacts of air pollution	16
2.3. Climate-driven impacts in the UK	17
2.4. Real-world action and behaviour change	17
2.5. Policy implications for local planning authorities	18
3. Exmoor: demographic profile and key statistics	20
3.1. People and key characteristics	20
3.2. Geography and landscape	21
3.3. Consumption and spending characteristics	23
4. GHG reporting conventions and methods	25
5. Exmoor: Consumption-based GHG emissions	29
5.1. Results overview	29
5.2. Residents' and visitors' GHG footprint components	32
5.2.1. Food	32
5.2.2. Homes and accommodation away from home	34
5.2.3. Travel	34
5.2.4. Everything else	36
5.2.5. Comparison of residents' GHG emissions with UK national average by category	38
5.3. Industry assessment	38
5.3.1. Scope of industry assessment	39
5.3.2. Industry sector analysis	39
5.3.1. Energy-only industry analysis	44
5.3.2. Large emitters analysis	44
5.3.3. Comparison of annual industry footprint with UK averages	45
5.4. Analysis of emissions from through-traffic and major roads	46

5.5.	Land use emissions	47
5.6.	Factors for consideration in land use target-setting	49
5.6.1.	Trees, woodlands and forestry	49
5.6.2.	Local authority opportunities	50
5.6.3.	Peatlands and wetlands	51
5.6.4.	Blue carbon sequestration	52
5.6.5.	Agricultural landscape and food production	53
5.6.6.	UK Timber production context	54
6.	A vision for a low-carbon National Park: GHG targets.....	56
7.	Conclusions and recommendations.....	65
8.	Acronyms	68
9.	Glossary.....	69
10.	Appendices.....	77
10.1.	Appendix: National Park key statistics.....	77
10.2.	Appendix: Summary datasets used for carbon footprint and confidence levels	78
10.3.	Appendix: Carbon footprint definitions and data sources	79
10.4.	Appendix: Residents GHG emissions	80
10.5.	Appendix: Visitors GHG emissions	81
10.6.	Appendix. Industry footprint estimates.....	82
10.6.1.	Appendix: SIC Codes (2007) summary and IDBR description	82
10.6.2.	Appendix: IDBR industry footprint.....	83
10.6.3.	Appendix: IDBR vs. GVA industry footprint estimates.....	84
10.6.4.	Appendix: Pollution inventory for large emitters	85
10.7.	Appendix: Emissions from major roads	86
10.8.	Appendix: Methodology	87
10.8.1.	Appendix: History of model development.....	87
10.8.2.	Appendix: Model development for the National Park and AONB family	87
10.8.3.	Appendix: Outline of emissions estimation methodology	88
10.8.4.	Appendix: Assumptions for visitors' surveys	89
10.8.5.	Appendix: Target-setting rationale	91
10.8.6.	Appendix: Assumptions for land use sector	94
10.8.7.	Appendix: Land class categories for reporting nationally.....	96
10.8.8.	Appendix: Changes in methodology for quantifying peatland GHG emissions.....	97
10.8.9.	Appendix: Target-setting methodology for land use change	100

Document control

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Proofreading: Jennifer Lyon, Lioness Translation

Results quality checked by: Mike Berners-Lee

Title: A greenhouse gas emissions assessment and target scenarios for the Exmoor National Park

Report Version: 6

Status: Approved by Clare Reid, Head of Strategy and Performance, Exmoor National Park Authority

Dated: 30th January 2023

Approved by: Approved by Mike Berners-Lee

Expected Changes: Client comments incorporated

Document Details

Reference: Exmoor NP GHG Assessment Report v6 FINAL 230130

Template: National Park Carbon Baseline Report Template Version 17.doc

No of pages: 107

Acknowledgements

With thanks to the Exmoor National Park Authority project team for their input and support.

Executive summary

Background

As the world wakes up to the climate and wider environmental emergency, rapid reduction of greenhouse gas emissions and sustainable land management are becoming increasingly central to the local, national and international policy agendas.

Together, the UK's 15 National Parks (NPs) and 46 Areas of Outstanding National Beauty (AONBs) are home to over 1.5 million residents, attract approximately 250 million visitors per year, and account for around 18% of the UK's land area. If these protected landscapes can become exemplars of low-carbon transition and environment-conscious land management, their national and international profiles could give them a level of influence that far outweighs the scale of their own emissions. The exciting and creative challenge for each protected landscape is to find a way to cut emissions in line with current science, and be leaders in land stewardship and planning while simultaneously creating better places for people to live, work and visit.

This report

This report, for the Exmoor National Park, is one of a series of methodologically compatible reports produced for each UK National Park and Welsh AONB, with the Cotswolds AONB and Cannock Chase AONB also joining. They are designed to provide a robust and consistent evidence basis for climate action, matched to the unique characteristics and circumstances of each protected landscape, as we enter an era in which climate mitigation and sustainable land management become ever more central to all our lives, our work and to all policy decisions.

This report contains a consumption-based assessment of the greenhouse gas emissions attributable to residents and visitors, including travel to and from the landscape (Figure 1), and a set of Paris-aligned target recommendations for transitioning to a low-carbon economy.

Consumption-based emissions reporting differs from more traditional production-based reporting, such as that used by the UK in setting its 2050 net zero target. A production-based assessment would cover all the emissions that are directly produced within the boundary of the landscape whether by people or businesses or from land, plus those arising from production of the electricity used within the landscape. However, the consumption-based approach adopted here covers, in addition, all indirect emissions that are embodied in the goods and services consumed by residents and visitors within the landscape. In doing so, it better reflects the full climate impact of people's lifestyles, and brings into focus for policymakers important areas of climate impact that a production-based assessment overlooks. The most important of these are the impact of food, of other purchased items (such as cars, clothes, IT equipment, household goods and furnishings), and of residents' and visitors' travel to and from the landscape, outside its boundaries.

Accounting for emissions from land use and management is also crucial for National Parks and AONBs. These landscapes are mostly rural, with comparatively small populations and large parts of land under various forms of agricultural management, including wildflower meadows, heathlands and peatlands, in addition to non-agricultural habitats such as woodlands. Land-based emissions

originate predominantly from ruminants (methane), synthetic fertiliser use (nitrous oxide), and degrading peatlands (mostly CO₂). These emissions are, to a degree, compensated by carbon sequestration in the habitats such as existing woodlands, meadows, hedgerows, heathlands and healthy peatlands, while agricultural soils could also sequester carbon under certain types of management. Reducing land-based emissions and scaling up land-based carbon sequestration efforts is going to be crucial for addressing the joint climate and ecological emergencies, while ensuring sustainable food production and contributing to a greater self-sufficiency of the UK in terms of food.

One feature of consumption-based reporting is that it does not include emissions from industry (except where an industry's goods and services are consumed by residents and visitors). Therefore, for perspective, this report also includes a simple estimate of emissions related to industries within the National Park or AONB, including their supply chains. It is important to note that there is some inevitable overlap between industry-related emissions and residents' and visitors' emissions, for example when people buy from local businesses within the area. Likewise, there is an overlap between emissions from agriculture as an industry sector and land-based emission within each landscape. Figure 1 illustrates the relationship between the main components of our central assessment and the industry emissions.

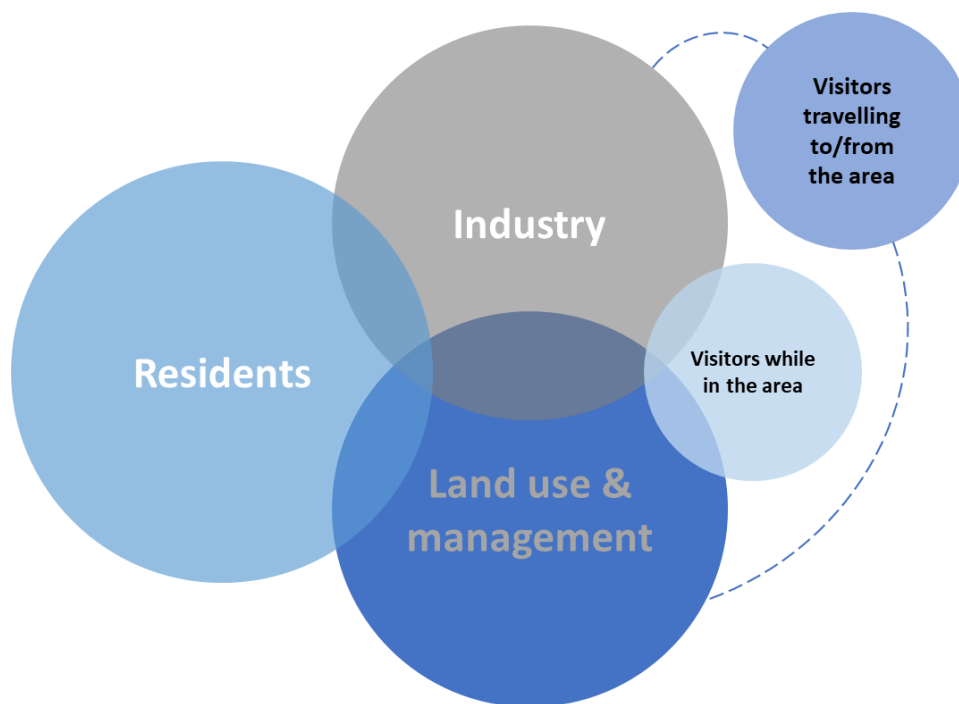


Figure 1: Boundaries of the greenhouse gas footprint assessment

This report also includes a scenario for Paris-aligned greenhouse gas emission targets across six key areas. These areas were selected for the original Lake District National Park assessment, and have been chosen in order to find a “best fit” between competing desires: to cover everything of significance within the influence of local policymakers, to keep the boundary simple to describe, to avoid double-counting, and to make use of any data readily available for tracking progress. As a result, the scope for the target areas is slightly different from that of the overall emissions assessment. The six target areas are:

- Energy-only emissions by residents, visitors and industry (see below)
- Food and drink consumed by residents and visitors
- Other goods purchased by residents and visitors (see below)
- Visitor travel to and from the National Park or AONB
- Land use non-CO₂ component (including emissions from livestock and fertilisers)
- Land use CO₂ component (including both emissions and sequestration)

They include the following components of the broader set of GHG emissions assessed in the report:

Priority area	Emissions components	Decarbonisation roadmaps
Energy-only emissions by residents, visitors and industry	<ul style="list-style-type: none"> • Emissions from electricity, gas and other fuels consumed by residential and commercial properties within the landscape • Emissions from residents' road travel both within and outside of the landscape • Emissions from industry's road travel both within and outside of the landscape • Emissions from visitors' travel using all modes of transport within the landscape only 	UK's Sixth Carbon Budget; Tyndall Centre Energy-Only Carbon Budget for UK's Local Authorities
Food and drink consumed by residents and visitors	<ul style="list-style-type: none"> • Full embedded emissions in food and drink consumed by residents • Full embedded emissions in food and drink consumed by visitors while travelling in the landscape 	UK's National Food Strategy; UK's Sixth Carbon Budget
Other goods purchased by residents and visitors	<ul style="list-style-type: none"> • Embedded footprint of all goods other than food consumed by residents, including cars • Embedded footprint of all goods other than food consumed by visitors while travelling in the landscape, including cars 	UK's Sixth Carbon Budget
Visitor travel to and from the National Park or AONB	<ul style="list-style-type: none"> • Footprint associated with fuel and electricity used by visitors while travelling to and from the landscape on land (no flights) • Embedded footprint of cars due to visitors travelling to and from the landscape 	UK's Sixth Carbon Budget
Land use non-CO ₂ component within the landscape	<ul style="list-style-type: none"> • Methane and N₂O emissions from livestock • N₂O emissions from fertilisers 	UK's Sixth Carbon Budget; UK's National Food Strategy

Priority area	Emissions components	Decarbonisation roadmaps
	<ul style="list-style-type: none"> Methane and N₂O emissions from degrading peat soils 	
Land use CO ₂ component within the landscape	<ul style="list-style-type: none"> Carbon sequestration in woodlands, hedgerows and other vegetation Carbon sequestration in soils CO₂ emissions from degrading mineral agricultural soils CO₂ emissions from degrading peat soils 	UK's Sixth Carbon Budget

Limitations and uncertainties

Due to the complexity of supply chains and the limitations of available data, consumption-based emissions estimates always contain a considerable degree of uncertainty. However, given current constraints on data availability, these estimates are sufficiently robust to provide an evidence basis for carbon management and target-setting. The estimate of industry-related emissions is particularly crude, being based on comparatively simple revenue data and generic UK-wide emission factors.

Results

Table 1 summarises the key consumption-based and landscape-based GHG footprint estimates for the Exmoor National Park in line with the assessment boundary in Figure 1. A subset of these estimates is subsequently broken down into the six broad categories introduced above to define the GHG emissions baseline and set the targets (Section 6).

Table 1. Exmoor National Park: Estimated GHG emissions in the base year (2019); see Figure 2 – Figure 5

Exmoor National Park	
Annual consumption-based emissions from residents	149,381 tCO₂e (42.8 kgCO ₂ e per resident per day; 15.6 tCO ₂ e per resident per year; the UK average is 12.4 tCO ₂ e per person per year)
Annual emissions from visitors while in the National Park	42,416 tCO₂e (18.3 kgCO ₂ e per visitor per day)
Annual emissions from visitors travelling to/from the National Park	82,630 tCO₂e (56.5 kgCO ₂ e per visit)
Annual industry emissions, including supply chains	66,056 tCO₂e
Annual emissions from through road traffic not related to the National Park	10,729 tCO₂e
Annual CO ₂ emissions from land (including carbon sequestration)	7,871 tCO₂e
Annual non-CO ₂ emissions from land (including ruminants and fertiliser)	119,889 tCO₂e

Key highlights

For its area, the Exmoor National Park has a comparatively low residential population and a smaller number of visitors compared to other National Parks. The estimated total footprints of residents and of all visitors are nearly equal.

The estimated per capita household consumption of the Exmoor National Park's residents is 16.6% above the UK average (excluding public services), which is one of the highest among all National Parks and AONBs on the current programme. Demographic data points to a disproportionately retired population, with health expenditure being particularly high.

In a given year, the per capita footprint of the residents of the Exmoor National Park is estimated to be around 26% higher than the UK average. This figure is higher than the underpinning per capita residents' consumption relative to the UK average (16.6%) because several fossil fuel-based sources of greenhouse gas emissions are particularly high. Residents' emissions from flying are estimated to be over two times higher than for an average UK resident, and driving emissions and other transport emissions (excluding driving) are around 36% and 43% above the UK average, respectively. Household electricity emissions are around 9% higher than for an average UK resident. Household fuel emissions (excluding vehicle fuel) are around 16% higher than for the average UK resident, although this estimate has high uncertainty since a relatively high proportion of properties are off the gas grid in the National Park, and because there is insufficient data for residual fuel use (oil, coal, biomass). It must be noted that our estimates for emissions from household fuel and electricity use do not include renewable energy solutions such as solar panels and heat pumps, nor do they factor in the uptake of electric vehicles. As of 2019, the share of these technologies across households was comparatively low and no suitable data with sufficient geographical detail was available.

Exmoor's share of visitors staying overnight (around 21% of all visitors) and their average duration of stay (just under 4 days) are in the middle of the range among all National Parks and AONBs on the programme. The visitors' footprint while in the National Park is dominated by food (48%), followed by driving (14%) and accommodation (12%).

Estimated average mileage travelled on land to get to Exmoor is around 140 miles, further than the average across all National Parks and AONBs on the programme. The visitors' travel is dominated by cars, while a moderate number of visitors come from overseas (flights and ferries). As a result, the visitors' footprint while travelling to and from the National Park is dominated by driving (62%), followed by flying (18%). Overall, the visitors' footprint while travelling to and from the National Park is over two times higher than the emissions attributed to their activities while in the National Park.

The industry footprint in the Exmoor National Park is dominated by agriculture, forestry and fishing (63%), followed by accommodation and food services (8%) and production (all types of manufacturing as well as mineral extraction and energy generation; 7%).

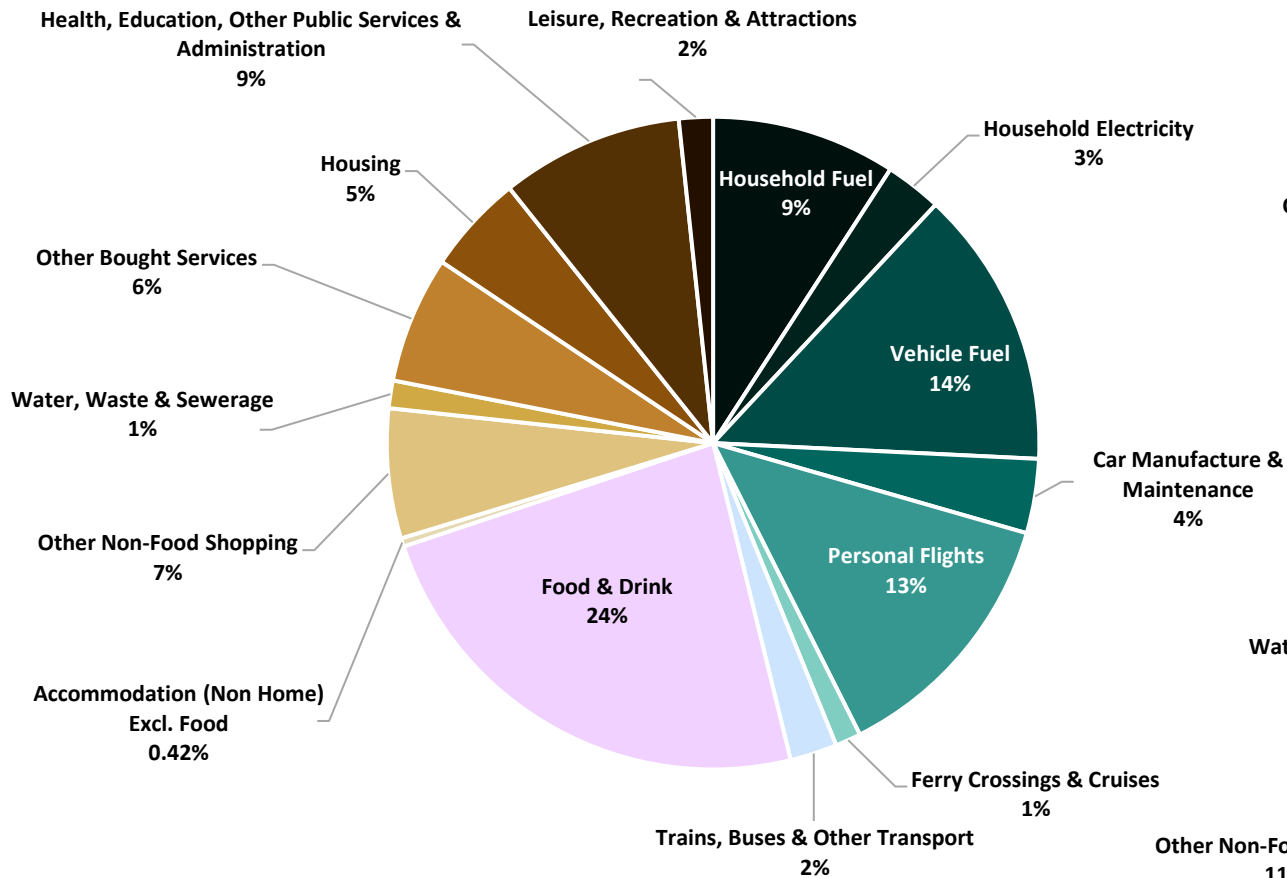
Exmoor is estimated to have a considerable traffic footprint from the major roads (A399, A39, A396 and B3224), which at 21.6 ktCO₂e per year amounts to around 14.5% when compared to the total

consumption-based footprint of the residents (149.6 ktCO₂e per year). Through-traffic is estimated to account for just under 50% of the emissions from the major roads.

Targets scenario

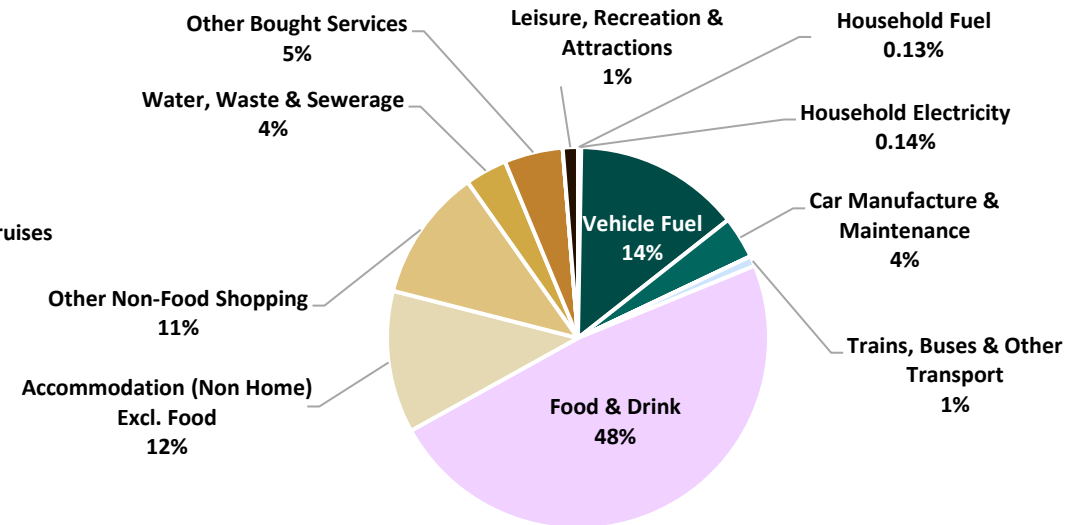
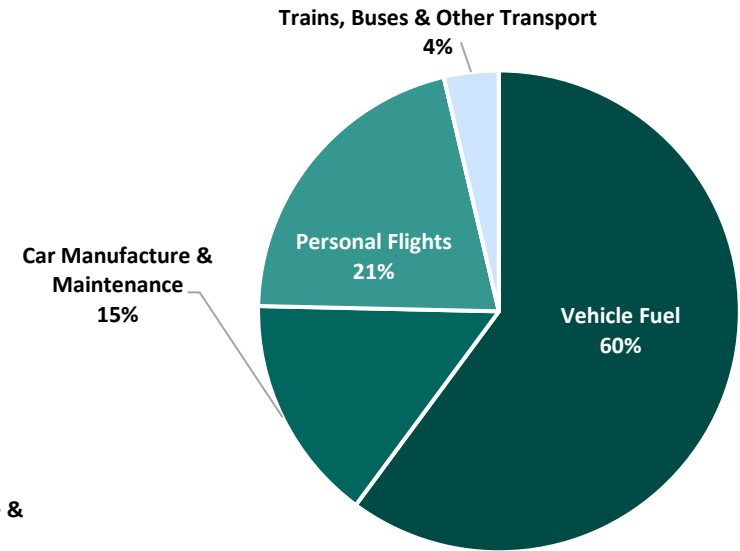
A minimum target trajectory aligned with the Paris Agreement pledge to keep global temperature rise within 1.5°C relative to pre-industrial conditions has been constructed for each of the six elements of the targeted footprint categories, as illustrated in Figure 6. When combined, they result in a net zero date of 2035 for the Exmoor National Park, which uses 2019 (rather than 2022) as the baseline year. We note that the net zero date reflects the unique characteristics of the landscape, including the land use types and their respective areas, the number of residents and visitors and their consumption patterns, and the level and type of industrial activity. It also assumes the recommended decarbonisation and carbon sequestration efforts, including land use change, ratchet up to the required levels immediately in the base year of the assessment. In reality, the high levels of ambition for different sectors explored in this report are likely going to take several years to achieve, given that post-COVID emissions have largely rebounded as of 2022, and that decarbonisation trends to date have been relatively small in magnitude compared to what we know is required for keeping global warming below the safer 1.5°C limit from the Paris Agreement. These factors are expected to push the projected net zero year back until the early 2040s (Section 6). The net zero date should therefore not be taken in isolation as a level of ambition.

Residents: 149,381 tCO₂e



Visitors travel to & from the National Park: 82,630 tCO₂e

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Visitors while in the National Park: 42,416 tCO₂e

Figure 2: (left) Residents' GHG emissions in Exmoor National Park by percentage

Figure 3: (top right) Visitors' GHG emissions on the way to & from Exmoor National Park by percentage

Figure 4: (bottom right) Visitors' GHG emissions while in Exmoor National Park

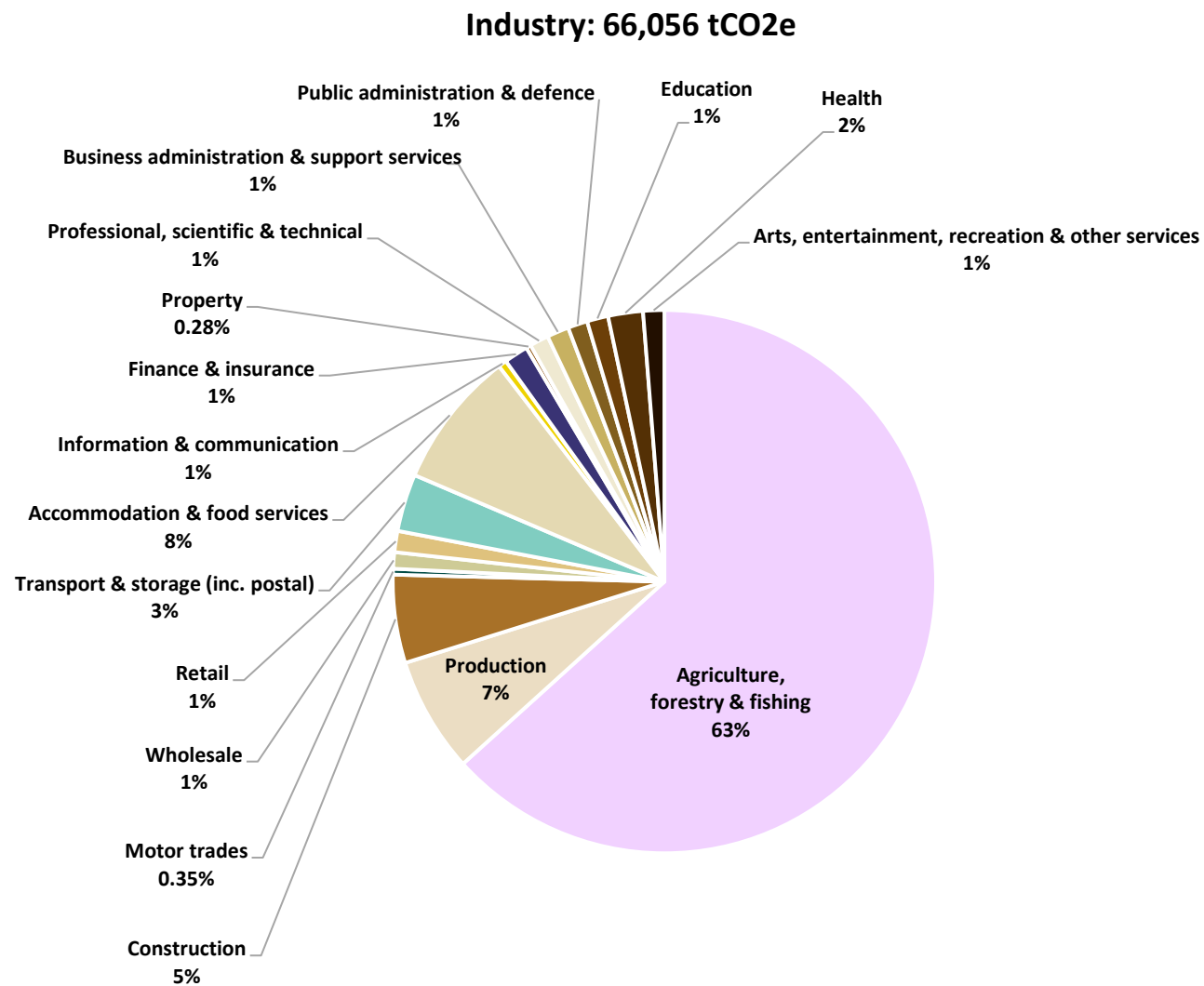


Figure 5. An estimate of emissions from industries within Exmoor National Park and their supply chains (scopes 1, 2 and upstream scope 3)

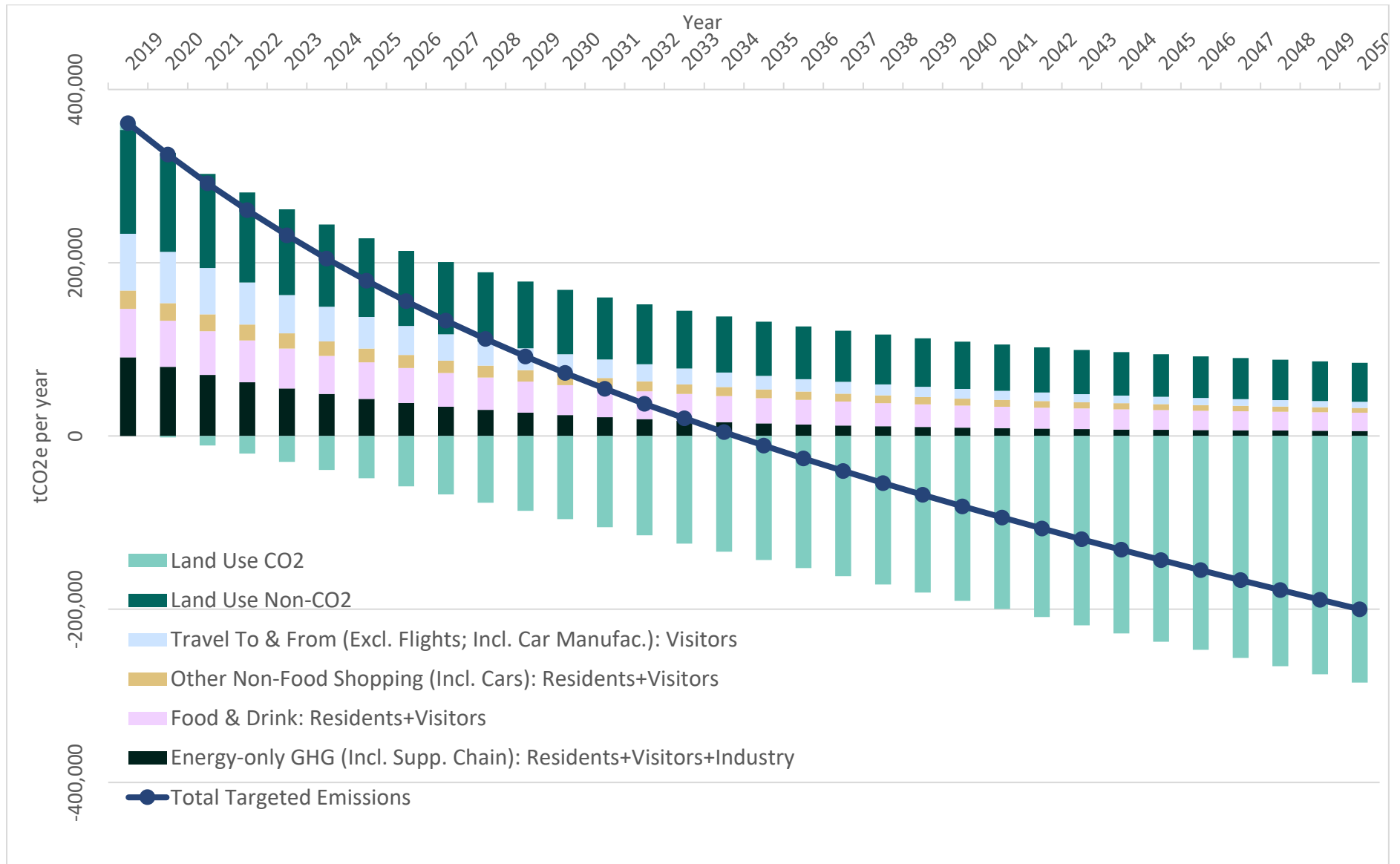


Figure 6: Recommended consumption-based target pathways for Exmoor National Park across the six shortlisted categories of emissions between 2019 and 2050. The total emissions reach net zero in 2035, using 2019 as the baseline year and neglecting the lags in ratcheting up the efforts to the required levels, including between 2019 and 2022

1. Introduction

As the world wakes up to the climate and wider environmental emergency, rapid reduction of greenhouse gas (GHG) emissions and sustainable land management are becoming increasingly central to the local, national and international policy agendas. In 2019, the UK strengthened its production-based targets, setting itself a legally binding target of net zero by 2050. This prompted the family of UK National Park Authorities and several Areas of Outstanding Natural Beauty (AONBs) to seek assessment of their greenhouse gas emissions collectively. The ambition of these protected landscapes was to go beyond the UK Government's production-based targets and identify the full consumption-based scale of the greenhouse gas emissions attributable to residents and visitors, including travel to and from the landscape.

This report, for the Exmoor National Park, is one of a series of methodologically compatible reports produced for each UK National Park, each Welsh AONB, as well as the Cotswolds and Cannock Chase AONBs in England. The baseline year for the assessment is 2019, the most recent pre-COVID year. The report also includes recommendations for Paris-aligned targets on GHG emissions reduction across six key areas, as well as for carbon sequestration through land-based climate mitigation measures. Together with the estimated 2019 GHG baseline, achieving these targets would mean the Exmoor reaching consumption-based net zero emissions by 2031, subject to the targets being fulfilled and to the considerable uncertainties remaining in the data.

Together, the UK's 15 National Parks and 46 AONBs are home to over 1.5 million residents, attract approximately 250 million visitors per year, account for around 18% of the UK's land area, and contain significant amounts of peat. If they can become exemplars of low-carbon transition and environment-conscious land management, their national and international profiles could give them a level of influence that far outweighs the scale of their own emissions. The exciting and creative challenge for each protected landscape is to find a way to cut emissions in line with current science, and be leaders in land stewardship while simultaneously creating better places for people to live, work and visit.

Almost every action connected with people living, working and spending time in the National Parks and AONBs gives rise to greenhouse gas emissions. Understandably, most of these emissions are not directly within the management responsibilities of the National Park Authorities or Local Authorities for the AONBs. However, through their partnership work, National Park Authorities and Local Authorities are often able to engage with a wide range of stakeholders, and, in addition to their statutory powers, they could use this influence to play a leading role in communicating the extent of greenhouse gas emissions and advocating for far-reaching measures to reduce them. While the need to transition from fossil fuels to renewable energy is the single greatest challenge in responding to the climate emergency, for the protected landscapes in particular, land management is also a critical element of dealing with both the climate and biodiversity crises.

The unique characteristics of each protected landscape give rise to different priorities and opportunities for cutting greenhouse gas emissions and for sustainable land management. For example, the ratio of visitors to residents varies greatly. Some National Parks and AONBs have large industrial or military sites within their boundaries. To varying degrees, each landscape is traversed by major roads that carry considerable volumes of traffic (not necessarily stopping in the area). All these factors affect the economic makeup of each landscape's geography, and have strong

implications for the associated GHG footprint and decarbonisation efforts. In terms of land management challenges and opportunities, the protected landscape vary greatly in their levels of peatland and woodland coverage, in their amount and types of agricultural land, and in the population densities of residents and visitors.

The main body of this report is designed for a broad audience, including some who may be less familiar with carbon analysis, but who have an active interest in the findings. This includes National Park and AONB board members, local businesses, partner organisations, and members of the general public who wish to participate in the transition to a low-carbon and sustainable economy. A technical appendix has been produced for those wishing to consult more methodological detail.

2. Policy drivers

2.1. Climate change policy

While the world has had to focus on dealing with the global pandemic since January 2020, climate change has nevertheless remained high on the international agenda. This section summarises key drivers for change which the National Park may wish to respond to in delivering its statutory duties.

Climate change driven by anthropogenic GHG emissions, plus the wider ecological crisis, are some of the biggest challenges facing humanity today, and a joined-up response to tackling them is likely to improve both situations. A 2018 report by the Intergovernmental Panel on Climate Change (IPCC) outlined the need to reduce global greenhouse gas emissions by 45% (from 2010 levels) by 2030, and achieve net zero emissions by 2050¹. It states that these reductions are necessary in order to limit the increase in global mean temperature to 1.5°C relative to pre-industrial levels. This is the more ambitious target of the Paris Agreement by the parties to the UN Framework Convention on Climate Change (UNFCCC); it is also understood to be a “safer” warming limit both for societies and ecosystems globally. In 2019, the UK Government agreed to a legally binding target of net zero greenhouse gas emissions by 2050.

Subsequently, the IPCC published its Sixth Assessment Report (AR6) in stages, with the final volume released in March 2022. Compiled by the world’s leading scientists, this report provides a comprehensive update on the latest scientific learnings about climate change, and is intended to serve as a resource for global climate negotiations, national policies and business planning.

The first part of the AR6, entitled “Climate Change 2021: The Physical Science Basis”, was released ahead of the 26th UNFCCC Conference of the Parties (COP26) hosted in Glasgow in November 2021². Notably, it affirms that the increase of carbon dioxide, methane, and nitrous oxide in the Earth’s atmosphere through the industrial era, i.e. since the late 19th century, is the result of human activities. What is clear in the report is that our chance of limiting the increase in global mean temperature to 1.5°C above pre-industrial levels now appears small. Keeping warming below the “safer” 1.5°C limit will likely require the most ambitious actions – i.e. those at the top end of known technical feasibility – to reduce emissions and also upscale efforts on carbon sequestration.

¹ IPCC (2018) Special Report: “Global Warming of 1.5°C Summary for Policymakers.” <https://www.ipcc.ch/sr15/chapter/spm/>.

² IPCC (2021) Climate Change 2021: The Physical Science Basis <https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/>.

The Department of Business, Energy and Industrial Strategy (BEIS) is the lead for reporting on GHG emissions in line with the UNFCCC requirements in the UK, including Scotland and Wales. An independent body, the UK Climate Change Committee, advises the whole of the UK, including devolved administrations, on emissions targets and progress. The Sixth Carbon Budget (2020) recommends that the UK set a budget to require a 78% reduction in UK greenhouse gas emissions by 2035 relative to 1990, which is a 63% reduction from 2019 levels³. Further detail relating to this is provided in Section 2.4 of this report, outlining associated real-world change towards decarbonisation.

Ahead of COP26, in October 2021, the UK Government published its Net Zero Strategy: Build Back Greener⁴. This outlines the Government's strategy to reduce emissions across the economy, including power, fuel supply and hydrogen, industry, heat and buildings, transport, waste, and greenhouse gas removals. It also considers supporting the wider transition across the economy.

COP26 concluded with the agreement of the Glasgow Climate Pact, with 153 countries putting forward new 2030 emissions targets ("Nationally Determined Contributions", NDCs)⁵. The NDCs pledged at COP26 are estimated to represent a trajectory towards a temperature *rise* of 2.4°C (relative to pre-industrial levels) by the end of the century, whereas the existing Net Zero pledges, if fully implemented, would limit global warming to 1.8°C.⁶

Prior to COP26 closing on the 13th of November, the UK's Environment Act 2021 received Royal Assent, becoming law on the 9th of November 2021 as an Act of Parliament. The broad aims of the UK Environment Act are to improve air and water quality, protect wildlife, increase recycling and reduce plastic waste. The Act also provides the means to set targets for particulate matter (affecting the quality of ambient air) and species abundance. More importantly, it sets environmental principles which the National Park Authorities or Local Authorities for AONBs will need to be familiar with as they fulfil their statutory planning authority obligations, namely:

- The principle that environmental protection should be integrated into policymaking,
- The principle of preventative action to avert environmental damage,
- The precautionary principle, insofar as it relates to the environment,
- The principle that environmental damage should, as a priority, be rectified at source,
- The "polluter pays" principle.

2.2. Health impacts of air pollution

In addition to the impact of climate change on the environment, greenhouse gas emissions also have an impact on human health and well-being. It is estimated that between 28,000 and 36,000 UK deaths each year are attributable to air pollution. Poor air quality can have a disproportionate impact on the health and well-being of children, older people and other vulnerable individuals. The

³ Climate Change Committee (2020): "The Sixth Carbon Budget: The UK's Path to Net Zero," p. 13,

<https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf>.

⁴ HM Government (2021), "Net Zero Strategy: Build Back Greener" <https://www.gov.uk/government/publications/net-zero-strategy>.

⁵ COP26, "The Glasgow Climate Pact," p. 8 <https://ukcop26.org/wp-content/uploads/2021/11/COP26-Presidency-Outcomes-The-Climate-Pact.pdf>.

⁶ <https://climateactiontracker.org/global/temperatures/>.

NHS has identified that more than 2,000 GP practices and 200 hospitals are in localities affected by toxic air. In the UK, 5.4 million people are currently receiving treatment for asthma: 1.1 million children (1 in 11) and 4.3 million adults (1 in 12). Every day, three families are devastated by the death of a loved one due to an asthma attack, and tragically, two thirds of these deaths are preventable (Asthma UK, 2020).

2.3. Climate-driven impacts in the UK

The impact of climate change on our natural world is evidenced by higher temperatures, changing rainfall patterns, changes in ecosystems, sea level rise, increasing frequency and intensity of storm surges, retreating glaciers, and melting sea ice and ice sheets. In the UK we are seeing significant changes in the winter and summer rainfall patterns. The UK Met Office's latest report states that "Winters in the UK, for the most recent decade (2009-2018), have been on average 5% wetter than 1981-2010 and 12% wetter than 1961-1990", and that "Summers in the UK have also been wetter, by 11% and 13% respectively"⁷. Total rainfall from extremely wet days increased by around 17% in the decade 2008-2017 for the UK as a whole. However, the changes are most marked for Scotland, and not significant for most of southern and eastern England. In addition to increasing precipitation volumes, climate change has already made it 12-25% more likely that the UK will again experience a summer as hot as 2018, which is projected to become 50% more likely with future warming.

In terms of human responses to flooding, a recent report by Natural England also suggests that environmental inequality is greater within deprived communities, which experience the largest negative climate impacts, e.g. flood risk, air pollution, poor-quality river water and waste hazards. Research has shown that there are significant mental health impacts associated with flooding, including a 20.1% chance of probable depression within 12 months, 28.3% probable anxiety and 32.6% probable PTSD for those individuals who directly experience being flooded (based on the cost per household over a 2-year period, ranging from £3,144 to £6,980 dependent on flood depth)⁸.

In addition, climate-driven changes in rainfall patterns and temperatures create significant adaptation challenges for species that depend on their local environmental conditions and habitats, posing an even greater risk to future biodiversity and food security.

2.4. Real-world action and behaviour change

The Sixth Carbon budget, together with sector reports, has responded to these policy drivers with high-level proposals that necessitate real-world planning, action and behaviour change across the UK. Key highlights from the report are listed below:

- By the early 2030s, all new cars and vans, and all domestic and non-domestic replacement boilers are low-carbon – largely electric.
- By 2040 all new trucks are low-carbon.
- UK industry shifts to using renewable electricity or hydrogen instead of fossil fuels.
- UK industry captures its remaining carbon emissions and stores them safely (and permanently).

⁷ Met Office (2015), "UK Climate Projections: Headline Findings", July 2021, version 3 p. 6-7

https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18_headline_findings_v3.pdf

⁸ Priest, S., Viavattene, C., and Cotton, J. (2019) Environment Agency presentation: "New economic costs for the mental health impacts of flooding."

- By 2035 the UK's electricity production is zero carbon.
- Low-carbon hydrogen is scaled up as a fuel for shipping, transport and industry, and for some buildings it replaces natural gas for heating (demand for natural gas is set to double/treble by 2050).
- UK wastes fewer resources and reduces its reliance on high-carbon goods.
- UK has a national programme to improve insulation of existing buildings⁹.
- Fewer miles travelled by car and air.
- Diets change, reducing consumption of high-carbon meat and dairy products¹⁰ by 20% by 2030.
- Agriculture and the use of farmland are transformed, while maintaining the same levels of food per head produced today.
- By 2035, 460,000 hectares of new mixed woodland are planted to remove CO₂ from the atmosphere and deliver wider environmental benefits.
- By 2035, 260,000 hectares of current farmland are dedicated to producing energy crops.
- Woodland coverage of the UK's land surface rises from 13% today to 15% by 2035 and 18% by 2050.
- Peatlands are widely restored and managed sustainably.

Detailed guidance is contained within eleven sector reports, namely: 1) Aviation, 2) Buildings, 3) Fluorinated gases (F-gases), 4) Electricity generation, 5) Fuel supply, 6) Greenhouse gas removals *i.e. a) Bioenergy with carbon capture and storage (BECCS), b) Direct Air Capture with Carbon Storage (DACCS) and c) Wood in Construction*; 7) Manufacturing and construction, 8) Shipping, 9) Surface transport, 10) Waste and finally 11) Agriculture, Forestry and Other Land Use (AFOLU). In relation to agriculture and land, the report specifically comments that recommendations for policy “must be implemented in a way that is fair to farmers,” and that “policy design must account for the challenges of the changing climate and reflect wider environmental priorities, including for biodiversity, to harness potential synergies and avoid unnecessary trade-offs. Policies are also needed to cut food waste and encourage a reduction in consumption of meat and dairy”¹¹.

The key challenge for Local Authorities and National Park Authorities will be translating the targets and initiatives to their geographical areas.

2.5. Policy implications for local planning authorities

Planning is one of the tools the Authority can use to address GHG emissions, specifically through decarbonising the built sector. Ideally, policies within the Local Development Plan will influence the construction sector to consider the embodied GHG emissions in the materials used, achieve dramatic improvements in energy efficiency, and install low/zero-carbon energy technologies in new-builds. Planning policies can also encourage the uptake of low/zero-carbon transport in new developments. Although new-builds emit relatively small quantities of GHGs compared to existing buildings, GHG savings achieved in new-build stock will minimise the need for expensive future

⁹ Building regulations for new homes have been strengthened to require high energy performance and electric vehicle charging points.

¹⁰ In the context of food, the term “high-carbon” means that GHG emissions from producing a unit of calories and nutrition ready for human consumption are high compared to other food types. For further details, see Poore & Nemecek (2018), “Reducing food's environmental impacts through producers and consumers,” *Science*, 360(6392), 987-992.

¹¹ Climate Change Committee (2020), “The Sixth Carbon Budget: The UK's Path to Net Zero,” p. 30.

retrofitting. They will also demonstrate the potential of – and stimulate the market for – building techniques and products that are more sustainable.

Planning can also provide information on which types of renewable energy technology will be appropriate and where to site them within the National Park, facilitating a transition by communities and businesses to non-fossil sources of power and heat. Along Exmoor’s coastline, the Bristol Channel has the second-largest tidal range in the world, and consequently there is considerable interest in renewable energy opportunities^{12, 28}. Exmoor’s topography, combined with high rainfall, provides opportunities for hydropower¹³. Exmoor National Park’s Climate Emergency Action Plan reports that renewable energy generation is already under way on the land owned by the National Park Authority, and this Authority is considering options to increase the output¹⁴. Renewable energy installations at Exmoor National Park Authority’s premises include one wind turbine at the Pinkery Outdoor Education Centre, solar panels, heat pumps and biomass boilers (using local wood fuel)¹⁴. The potential of these technologies is outlined in the Renewable Energy Resource Assessment for Exmoor National Park, along with hydropower, systems to produce energy from waste (e.g. municipal and agricultural), tidal stream and wave energy¹⁵. Existing planning policies permit small-scale renewable energy technologies including wind and solar¹⁶.

The National Park Authority, in partnership with the Exmoor Trust, has supported community renewable energy installations using grants awarded through the Carbon Neutral Exmoor project¹⁷. Additionally, the privately-owned hydroelectric scheme at West Lyn Gorge at Lynmouth, which generates 1.5 million kWh of energy for the grid annually, received financial support from the Exmoor National Park Sustainable Development Fund (provided by DEFRA)¹⁸. Developments within the protected landscape remain subject to careful consideration, and consultation with statutory agencies and the public, to ensure that the special qualities of the National Park are not adversely affected. Exmoor’s Local Plan states that proposals for “major and nationally significant” electricity transmission infrastructure, including from large-scale offshore renewable energy schemes, will be considered in accordance with the relevant policy (Major Development)¹⁹. Hence, the National Park Authority’s stance and planning considerations could be instrumental in championing small-scale renewable energy for England’s future clean energy supply.

¹² “Exmoor National Park Partnership Plan 2018-2023,” https://www.exmoor-nationalpark.gov.uk/_data/assets/pdf_file/0016/251161/Partnership-Plan-2018-2023-single-pages.pdf.

¹³ [Exmoor - Hydropower \(exmoor-nationalpark.gov.uk\)](https://www.exmoor-nationalpark.gov.uk/).

¹⁴ Exmoor National Park Authority, “Climate Emergency Action Plan,” August 2021, https://www.exmoor-nationalpark.gov.uk/_data/assets/pdf_file/0015/400902/Climate-Action-Plan-spreads.pdf.

¹⁵ “Renewable Energy Resource Assessment for Exmoor National Park, 2008,” https://www.exmoor-nationalpark.gov.uk/_data/assets/pdf_file/0034/289384/Renewable-Energy-Assessment-for-Exmoor_2008.pdf.

¹⁶ Exmoor National Park Local Plan, “5-Year Review, Environment Topic Paper,” May 2022, [Exmoor-Local-Plan-5-Year-Review-Environment-Topic-Paper-May-2022.pdf \(exmoor-nationalpark.gov.uk\)](https://www.exmoor-nationalpark.gov.uk/_data/assets/pdf_file/0024/271347/Glen-Lyn-Gorge-fact-sheet.pdf).

¹⁷ [Exmoor - Grants available for community renewable energy projects \(exmoor-nationalpark.gov.uk\)](https://www.exmoor-nationalpark.gov.uk/).

¹⁸ “Glen Lyn Gorge,” https://www.exmoor-nationalpark.gov.uk/_data/assets/pdf_file/0024/271347/Glen-Lyn-Gorge-fact-sheet.pdf.

¹⁹ “Exmoor National Park Local Plan: 2011-2031,” https://www.exmoor-nationalpark.gov.uk/_data/assets/pdf_file/0030/257763/Local-Plan-2011-2031-for-web.pdf.

3. Exmoor: demographic profile and key statistics

In section 3.1 – 3.2 we consider the key characteristics of people and landscape which may call for further reflection later in this GHG emissions assessment, in terms of the likely impact on land management and behaviour arising from the changes needed to create a more sustainable long-term future for both people and nature. These insights may benefit the delivery of projects by the programme partners.

3.1. People and key characteristics

Exmoor has the third-smallest residential population of all UK National Parks, after Northumberland and the Broads: 10,284 people²⁰. For the purposes of this carbon footprint assessment, population estimates from mid-2019 were used, and we included all postcodes where at least 30% of properties fall within the National Park boundary, which gives a total of 9,581 residents. This postcode inclusion approach defines the region for which we report the key results relating to the carbon baseline and net zero.

There are no major settlements within Exmoor National Park, only small towns, villages and hamlets. The largest settlements by population are Lynton and Lynmouth on the north coast, Porlock eastwards along the coast, Dulverton to the south, and Dunster to the north-east. Settlements on the National Park boundary, such as Combe Martin to the west, and Minehead and Carhampton to the north-east, have higher populations but are located mostly outside the National Park boundary²¹. The rural, dispersed nature of the resident population is characteristic of Exmoor, which influences activities and services such as transport; some key services are provided at nearby urban centres such as Ilfracombe, Tiverton, Taunton and Minehead²².

When considering partnership-working on decarbonisation agendas, there are four local authorities represented within the National Park: Somerset West and Taunton Council, North Devon District Council, Somerset County Council and Devon County Council. In 2023, Somerset West and Taunton Council and Somerset County Council will be replaced by a single Somerset unitary authority.

Exmoor's Local Plan indicates that the resident population declined between 2001 and 2011. The age profile (2011 census) shows that a high proportion of the resident population (around 40%) were aged 60 years and over, with the median age (53) being notably higher than the national average (39)²². The latest data (2021 census) indicates that a high proportion of the populations of two areas – North Devon, and Somerset West and Taunton – are over 50 years old (nearly 50% in each area)²³. The ageing population may impact on future health and social care planning by the relevant local authority and NHS partners.

Economic activity data (2011 census) shows that the percentage of self-employed people resident in the National Park (26%) is considerably higher than the England average (9.8%), reflecting an economy dominated by small-scale businesses. According to recent research by Rural Enterprise

²⁰ [National Park population estimates \(Experimental Statistics\) - Office for National Statistics \(ons.gov.uk\)](https://ons.gov.uk).

²¹ [Exmoor – Exmoor Facts and Figures \(exmoor-nationalpark.gov.uk\)](https://exmoor-nationalpark.gov.uk).

²² "Exmoor National Park Local Plan: 2011-2031," https://www.exmoor-nationalpark.gov.uk/data/assets/pdf_file/0030/257763/Local-Plan-2011-2031-for-web.pdf.

²³ [Population and household estimates, England and Wales: Census 2021 - Office for National Statistics \(ons.gov.uk\)](https://ons.gov.uk).

Exmoor, farming accounts for 14% of all businesses in the National Park by count, for 9% of the total employment, and for 10% of the estimated economic gross value added (GVA)²⁴. Engaging small and medium enterprises in carbon literacy will therefore be essential in any future decarbonisation strategy for Exmoor. Of the working-age people within the National Park, two-thirds are economically active, while two-thirds of economically inactive people are retired, indicating low levels of unemployment. Tourism and land-based activities are the main drivers of the National Park's economy, and the accommodation and food sector, together with tourism and agriculture, make up more than 40% of employment for Exmoor National Park's residents²².

The English Indices of Deprivation (2019) reveal pockets of higher deprivation within Exmoor²⁵. However, when averaged across the National Park, estimated household consumption is 16.6% above the UK average (excluding public services), which is one of the highest among all National Parks and AONBs in the programme.

It is important to understand and reflect upon the diverse demographic profile of the National Park when considering potential opportunities to change behaviour in spending habits. Further detail pertaining to the key consumption and industry characteristics in Exmoor National Park can be found in Appendix 10.1.

3.2. Geography and landscape

Exmoor is one of the UK's smallest National Parks by area, at only 693 km² (69,300 ha)²⁶. Within its relatively small area are diverse landscapes, including open heather and grass moorland, rounded hills, wooded valleys, coastline and high sea cliffs. The area comprises a mosaic of habitats supporting various rare species of plants and animals²⁶.

Over 13% of the National Park is wooded, with diverse habitats including species-rich ancient woodlands, unique coastal woodlands and conifer plantations, all offering important biodiversity and economic value²⁸. Exmoor's rivers and streams, flowing from the moorlands to the sea, are key landscape features and supply half a million people with drinking water. Clatworthy (outside of the National Park) and Wimbleball reservoirs (administered by South West Water and Wessex Water²⁹) also contribute significantly to the drinking water supply. Most rivers are privately owned and managed. Several catchment projects within the National Park are delivering upland restoration and riparian management, to improve water storage and quality²⁸. Exmoor's coastline along the Bristol Channel is designated as Heritage Coast, extending 59 km from Minehead in the east to Combe Martin in the west. The coastline encompasses the highest sea cliffs (up to 244 m²⁷) and the longest stretch of coastal woodland in England and Wales, as well as one of the few coastal heath sites in the country. Saltmarsh is becoming established in Porlock Bay, one of several coastal habitats in Exmoor National Park that support diverse wildlife, including important seabird colonies. There are also geomorphological features such as wave-cut platforms, rocky bays and beaches, together with a rich cultural heritage²⁸. The landscapes of Exmoor National Park are connected via an extensive

²⁴ <https://www.exmoor-nationalpark.gov.uk/living-and-working/business-and-economy/rural-enterprise-exmoor-research>

²⁵ "English Indices of Deprivation," <https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019>.

²⁶ "Exmoor National Park Partnership Plan, 2018-2023," https://www.exmoor-nationalpark.gov.uk/data/assets/pdf_file/0016/251161/Partnership-Plan-2018-2023-single-pages.pdf.

²⁷ [Exmoor - Exmoor's Coast \(exmoor-nationalpark.gov.uk\)](https://www.exmoor-nationalpark.gov.uk).

network of rights of way, comprising almost 1,000 km of pathways, 376 km of permitted paths (and a section of the South West Coast Path), and more than 17,500 ha of Access Land²⁸.

Each protected landscape has special qualities with particular management requirements. The National Park supports rare lichen communities, stable numbers of red deer, important populations of rare heath and high brown fritillary butterflies, almost all the breeding bat species found in the UK, healthy populations of fish (including brown trout and the internationally vulnerable Atlantic salmon), as well as riverflies and otters. However, the open moorlands are suffering from major loss and fragmentation of heather, while numbers of moorland birds such as curlew and merlin are declining. Some losses to the landscape are historic, such as a 29% reduction in moorland since the 1940s, and the loss of hedgerows and 80% of orchards over the last century. A decline in dormouse numbers, and the threat of invasive plant species, are further concerns²⁸.

Exmoor's 29 Priority Habitats include its heathland, grassland, arable and horticultural, woodland, boundary, wetland, freshwater, inland rock, coastal, and marine ecosystems. Many of these habitats are protected under national and international designations. Exmoor Heaths and Quantock Oakwoods Special Areas of Conservation (SACs) cover around 12,600 ha and protect the dispersal areas of two species: otter and Barbastelle bat. More than 19,300 ha (about 28%) of the National Park is designated as Sites of Special Scientific Interest (SSSIs), including three National Nature Reserves (NNRs). Over a third of Exmoor's woodlands are protected as ancient semi-natural woodland (ASNW; 2,004 ha) and plantations on ancient woodland sites (PAWS; 1,346 ha), and 1,668 ha of ancient woodland is designated as a SAC. The non-statutory sites include over 500 Local Wildlife Sites and several Regionally Important Geological Sites (RIGS). The Priority Species list identifies 198 nationally and internationally important species on Exmoor, and so the National Park Authority works with various partners to enhance the numerous ecological networks and protect Exmoor's special qualities²⁹.

Hill farming employs around 1200 people, and much of the National Park is under some kind of Environmental Stewardship scheme (58% as of 2021). Distinct to the farmed landscape are local breeds of cattle (Red Devon cattle), sheep (Devon Closewool and Exmoor Horn) and Exmoor ponies²⁸. Most of the National Park land is classified as Grade 4 and 5 (poorly productive), particularly the central and western regions. There is some Grade 3 land towards the eastern National Park boundary, particularly the north-east, and several small patches in the north-west of the National Park. A few very small patches of Grade 1 and 2 land (most productive) lie in the north-east region (largely within Porlock Vale). Areas of timber forestry land can also be found towards the eastern boundary of Exmoor National Park³⁰. Recently, the character of the farmland has been evolving somewhat, with farms either expanding, being replaced with smallholdings, or shifting to equestrian use²⁸.

The cultural landscape encompasses ancient burial mounds and farmsteads, and historic estates, with non-designated sites left vulnerable to deterioration³¹. In terms of the built environment,

²⁸ Exmoor National Park State of the Park Report: Summary 2017; https://www.exmoor-nationalpark.gov.uk/_data/assets/pdf_file/0026/243629/State-of-the-Park-summary-2017.pdf.

²⁹ Exmoor National Park Local Plan: 2011-2031, https://www.exmoor-nationalpark.gov.uk/_data/assets/pdf_file/0030/257763/Local-Plan-2011-2031-for-web.pdf.

³⁰ [Magic Map Application \(defra.gov.uk\)](https://www.magicmap.gov.uk/)

³¹ Exmoor National Park State of the Park Report: Summary, January 2017, [Reflections on the past 15 years \(exmoor-nationalpark.gov.uk\)](https://www.exmoor-nationalpark.gov.uk/_data/assets/pdf_file/0030/257763/Reflections-on-the-past-15-years-exmoor-nationalpark.gov.uk).

Exmoor has low levels of light pollution, and its Dark Sky Reserve status is a visitor attraction. The latest “State of the Park” report acknowledges the impact of substantial numbers of recent developments including agricultural buildings, wind turbines and telecommunications infrastructure. The National Park Authority is working to maintain the special qualities of the Park while supporting rural livelihoods²⁸.

3.3. Consumption and spending characteristics

When it comes to the National Park or AONB’s residents, learning shared from a Catapult Energy Systems (2021) report suggests that people in vulnerable circumstances are at increased risk of experiencing barriers to adopting the behavioural changes identified as being key to achieving net zero GHG emissions³². The categories of vulnerability included: rural, low income, privately renting, residents with disabilities, pensionable age residents, the digitally excluded and those disproportionately affected by COVID-19.

A number of results, particularly around spending habits, may be influenced by levels of affluence and lack of means within the National Park or AONB. We therefore include a brief commentary on indices of deprivation as an indicator of economic wealth within the National Park or AONB, as this provides context for the spend-based consumption analysis and results, which may be influenced by such factors.

According to the Office for National Statistics (ONS) Household Expenditure Survey for different demographic groups, the average affluence of residents in all the National Parks and AONBs who joined this programme is higher than the UK average, even though these landscapes tend to have pockets of deprivation. On average, the Exmoor National Park’s residents spend around 16.6% more than other UK residents, excluding public services, which is higher than the average spend of all National Parks (Table 2). The spending patterns of Exmoor are similar to the average of all National Parks, with significantly higher levels of spend on healthcare (48.6%) and transport (43.1%), and lower spend on education (-48.3%) compared to the UK average. The notable differences in consumption patterns between Exmoor and other National Parks are higher spend on transport, and alcoholic drinks, tobacco and narcotics, and a lower spend on education. Similar to the other National Parks, the consumption data supports the demographic profile of an ageing population, with fewer children and working age adults and more people of retirement age compared to the UK average.

A detailed summary of the key statistics and spending habits for Exmoor residents is provided in Appendix 10.1.

Table 2: Relative difference in consumer spending per capita (excluding public services) between Exmoor National Park and the UK average, and the relative difference between all 15 UK National Parks averaged and the UK average.

Consumer Expenditure Category	Exmoor National Park vs. UK average Consumer Spending (excl. Public Services)	All National Parks vs. UK average
Food & non-alcoholic drinks	12.7%	10.2%

³² Catapult Energy Systems (June 2021). “Net Zero Societal Change Analysis: Summary report,” p. 11.

Alcoholic drinks, tobacco & narcotics	24.5%	14.6%
Clothing & footwear	10.6%	9.2%
Housing, fuel & power	-5.0%	-8.3%
Household goods & services	14.9%	16.7%
Health	48.6%	41.9%
Transport	43.1%	29.8%
Communication	5.5%	4.7%
Recreation & culture	25.2%	22.1%
Education	-48.3%	-39.8%
Restaurants & hotels	2.3%	3.1%
Miscellaneous goods & services	7.9%	7.8%
Other expenditure items	27.3%	23.1%
Total	16.6%	12.9%

4. GHG reporting conventions and methods

The following part of this report provides an estimate of greenhouse gas (GHG) emissions resulting from consumption by residents and visitors, including travel to and from the National Park or AONB, along with a section introducing the methodology. By taking a consumption-based approach, we include embodied, indirect emissions in everything that residents and visitors buy and do while in the area. The assessment covers all greenhouse gases in the “basket of six”, and the term “carbon footprint” is used as shorthand to mean the GHG emissions released both directly and indirectly within supply chains of goods and services.

More specifically, the following are within the scope of the assessment:

- all residents’ personal travel and visitor travel to, from and around the area;
- fuel and electricity consumed in homes and places to stay;
- emissions from food and drink and other purchases;
- emissions resulting from the use of services, including public services; and
- the supply chains of all the above (e.g. fuel supply chains and embodied emissions).

The baseline year for the assessment is 2019, the most recent pre-COVID year.

Accounting for emissions from land use and management is also crucial for National Parks and AONBs. These landscapes are mostly rural, with comparatively small population and large parts of land under various forms of agricultural management, in addition to non-agricultural habitats such as woodlands, wildflower meadows, heathlands and peatlands. Land-based emissions originate predominantly from ruminants (methane), synthetic fertiliser use (nitrous oxide), and degrading peatlands (mostly CO₂). These emissions are, to a degree, compensated by carbon sequestration in existing woodlands, meadows, hedgerows, and healthy peatlands, while agricultural soils could also sequester carbon under certain types of management.

As a separate and overlapping analysis, we also include a simple assessment of emissions from industry within each protected landscape and associated supply chains (Scopes 1, 2 and upstream Scope 3). We provide this to give some sense of the relative scale of industry emissions compared to those linked to visitors and residents. However, important caveats apply to this assessment. Firstly, it is not possible to eliminate the double-counting of emissions, occurring when industries within the area sell to each other or to residents and visitors. Secondly, this crude estimate for industry has been made by applying generic, UK-wide emissions factors for each industry sector to local revenue data from businesses registered in the area. This may in some cases misrepresent actual industry-related activities within the landscape boundary.

Figure 7 illustrates the relationship between the main components of our central assessment and the industry emissions.

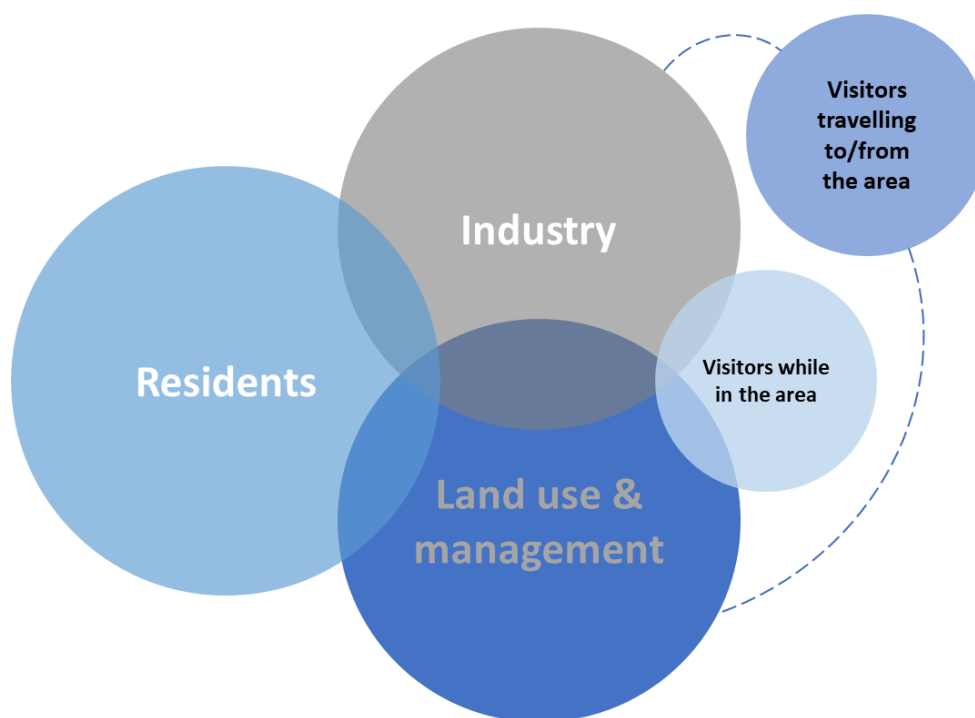


Figure 7: Boundaries of carbon footprint assessment (repeat of Figure 1)

This report also includes a recommendation for Paris-aligned greenhouse gas targets across six key areas. These six areas have been selected in order to find a best-fit between the competing desires to cover everything of significance within the influence of policymakers, to keep the boundary simple to describe, to avoid double-counting, and to make use of any data readily available for tracking progress. As a result, the scope for the target areas is slightly different from that of the overall emissions assessment. The six target areas are:

- Energy-only emissions (incl. supply chains) by residents, visitors and industry
- Food and drink consumed by residents and visitors
- Other goods purchased by residents and visitors
- Visitor travel to and from the National Park or AONB
- Land use non-CO₂ component (including emissions from livestock and fertilisers)
- Land use CO₂ component (including both emissions and sequestration)

The Greenhouse Gas Protocol considers six greenhouse gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulphur Hexafluoride (SF₄). It also categorises company emissions into three scopes: Scope 1 for direct emissions from company facilities and vehicles; Scope 2 for indirect emissions from electricity and steam consumed in company activity but generated elsewhere; and Scope 3 for indirect emissions in the value chain³³. Scope 3 can be split into two parts: upstream and downstream. Our assessment of Industry

³³ Greenhouse Gas Protocol, "Technical Guidance for Calculating Scope 3 Emissions: Supplement to the Corporate Value Chain (Scope 3) Accounting and Reporting Standard," https://ghgprotocol.org/sites/default/files/standards/Scope3_Calculation_Guidance_0.pdf.

emissions includes scope 1, 2 and upstream scope 3 (Figure 8). This can be thought of as the full “carbon footprint” of industry up to the point of sale. Similarly, when residents and visitors buy goods and services, we include the embodied emissions of these purchases.

In the report, we measure greenhouse gas emissions in tonnes of carbon dioxide equivalent (tCO₂e)³⁴. We have used 100-year global warming potential (GWP) conversion factors for all non-CO₂ gases, in line with established greenhouse gas accounting conventions. In other words, we consider the contribution that each gas makes over a one-hundred-year period. However, it should be remembered that if we are interested in climate impacts over a shorter timescale, the relative importance of some gases increases. In particular, the relative contribution of methane is roughly doubled if we are interested in climate impacts over a period of fifty years, or roughly three times as important as represented in this report if we are looking at climate impacts by 2050.

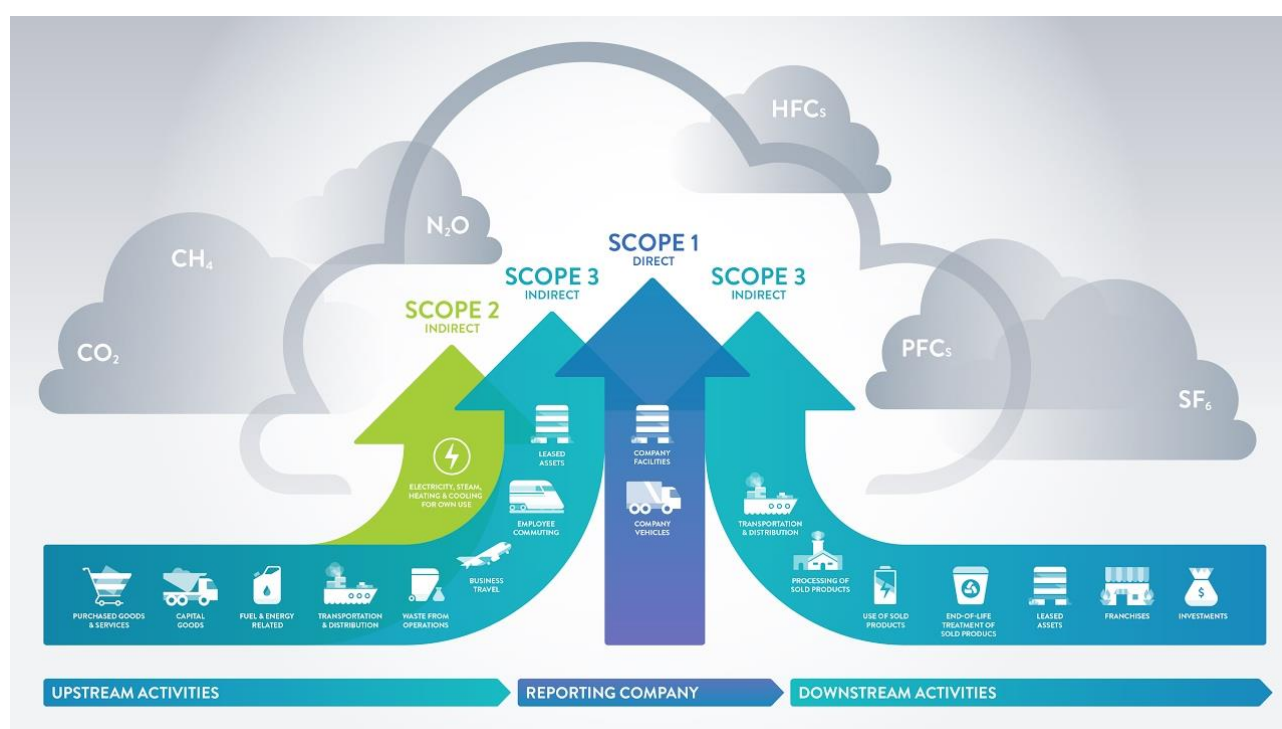


Figure 8: Types of greenhouse gas emissions used for carbon accounting. Source: Greenhouse Gas Protocol.

A National Park’s or AONB’s greenhouse gas emissions could be reported in three ways:

Consumption-based emissions: We assess the greenhouse gas “footprint” of residents, visitors and industry, including the supply chains of everything that residents and visitors buy and do while in the National Park. Consumption-based reporting attributes the emissions from product and service supply chains to the National Park, **regardless of where emissions are physically released during production**. Consumption-based reporting is important for looking at the climate change impacts that people and businesses have through their entire lifestyles and operations, including the food they eat and the products and services they buy. For example, taking a consumption-based approach, the impact of driving includes not just the exhaust pipe emissions, but also emissions

³⁴ DEFRA (2014) Guidance: “Calculate the carbon dioxide equivalent of an F gas”; see <https://www.gov.uk/guidance/calculate-the-carbon-dioxide-equivalent-quantity-of-an-f-gas>, accessed 07.12.2021.

resulting from the manufacture and maintenance of cars, and emissions resulting from the extraction and refining of fuels and their transport to the pump. For businesses, it includes the full impact of business practices, including procurement supply chains. The footprint of the National Park's industry is reported separately, as there is some unavoidable double-counting with the footprint of residents and visitors, where people in the National Park buy from local companies.

Production-based emissions: These are the net emissions that are physically released in the National Park, most notably by burning coal, oil and gas; those arising from the production of electricity used in the National Park (wherever that power is generated), and direct emissions associated with land use within the National Park or AONB (parts of agriculture, peatland degradation, etc.). This is the UK Government's standard emissions-reporting approach and only CO₂ emissions are reported by the Department for Business, Energy & Industrial Strategy (BEIS) at the local level. However, it also excludes emissions arising from production – outside the landscape – of goods and services that are used in the area by residents, visitors and industry. The approach also includes through-traffic emissions from vehicles that are passing through the National Park or AONB without stopping. We use the term “net emissions” because we subtract any negative emissions (i.e. removal of CO₂ from the air) that may result from Land Use, Land Use Change and Forestry (LULUCF).

Extraction-based emissions: These are the emissions produced by burning any fossil fuels that are extracted from the ground in the National Park, wherever they are burned. This type of emissions reporting is important for understanding the climate change implications of decisions relating to any fossil fuel extraction in the National Park.

As mentioned earlier, in this assessment we focus on a consumption-based approach and report the Scope 1, 2 and 3 GHG footprints of residents and visitors, including visitor travel to the area. Since we are including upstream scope 3 emissions, our parallel rough assessment of industry emissions can also be regarded as taking a consumption-based approach. The datasets used are outlined in Appendices 10.2 and 10.3.

5. Exmoor: Consumption-based GHG emissions

5.1. Results overview

Here, we outline our analysis of the Exmoor residents and visitors' GHG emissions for 2019 (Figure 9). Residents' emissions were estimated at 149,381 tCO₂e (Figure 10) and visitors' emissions – from time spent in the area and during travel to and from – were estimated at 125,046 tCO₂e (Figure 11 and Figure 12). The resident population stands at 9,581 people, compared to over 1.5 million visitors per year (both single-day and overnight). A full breakdown of these figures is provided in Appendix 10.4. The data shows that the typical footprint of the Exmoor resident is 26.2% higher than that of the average UK resident. The final annual consumption per year of all the Exmoor residents (including public services) is estimated to be around 0.33 billion pounds, which is based on the postcode-level population and demographic profile data combined with UK-wide household expenditure survey and estimates for the share of public services in the final consumption (Appendix 10.8.3).

To indicate the scale of annual GHG emissions from the Exmoor residents and visitors, you would need to plant around 740 Premier League football pitches with broadleaf trees, and let them grow for over 100 years, to mitigate the combined GHG emissions of the regions' residents and visitors for the single year of 2019. This shows the need to prioritise GHG emissions *reductions* to limit global warming, rather than just mitigating emissions through carbon removal. Emissions reductions, including decarbonisation of industry and personal consumer spending, will be challenging in our modern world, but represents the more practical option.

For simplicity in facilitating personal behaviour change, the typical UK resident's average carbon footprint can be split into four key categories: food, home and accommodation, travel, and everything else³⁵. We shall use these four key categories to comment on the results, and to suggest where the local councils and partners could target initiatives aimed at behaviour change.

³⁵ Berners-Lee, M. (2021), "How Bad Are Bananas? The Carbon Footprint of Everything", p. 149.

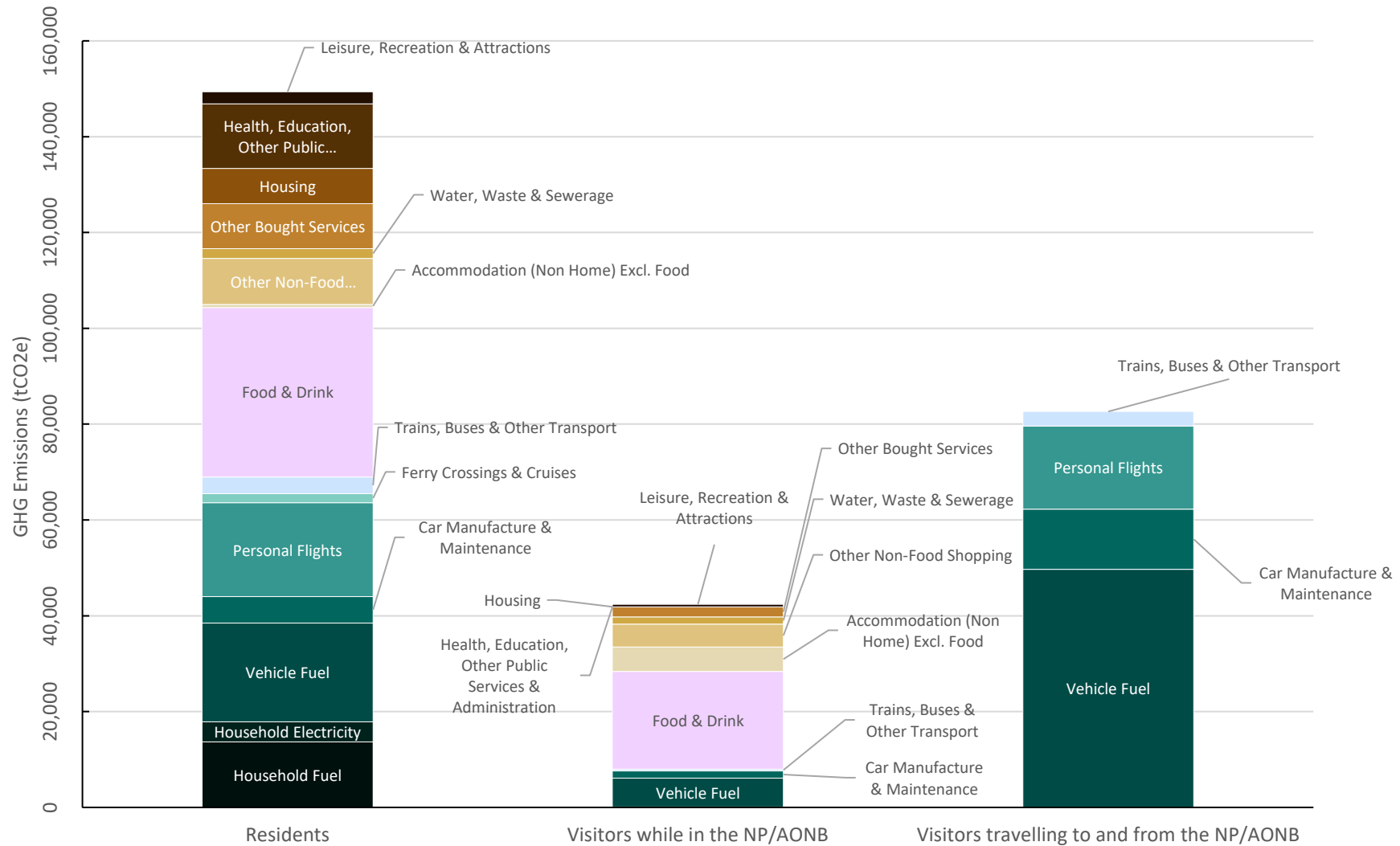


Figure 9: A consumption-based assessment of emissions relating to residents, visitors, and visitor travel to and from Exmoor National Park.

Residents: 149,381 tCO₂e

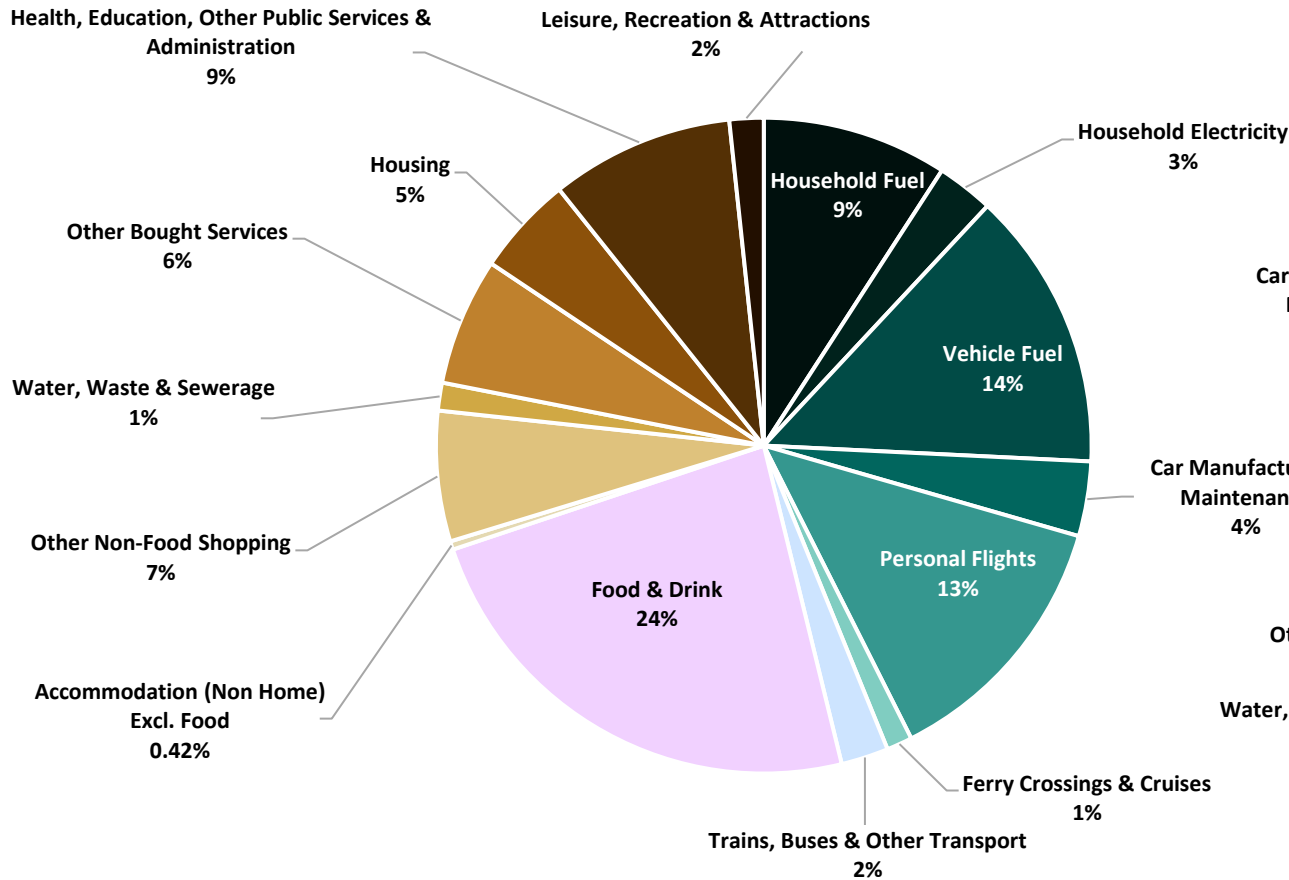


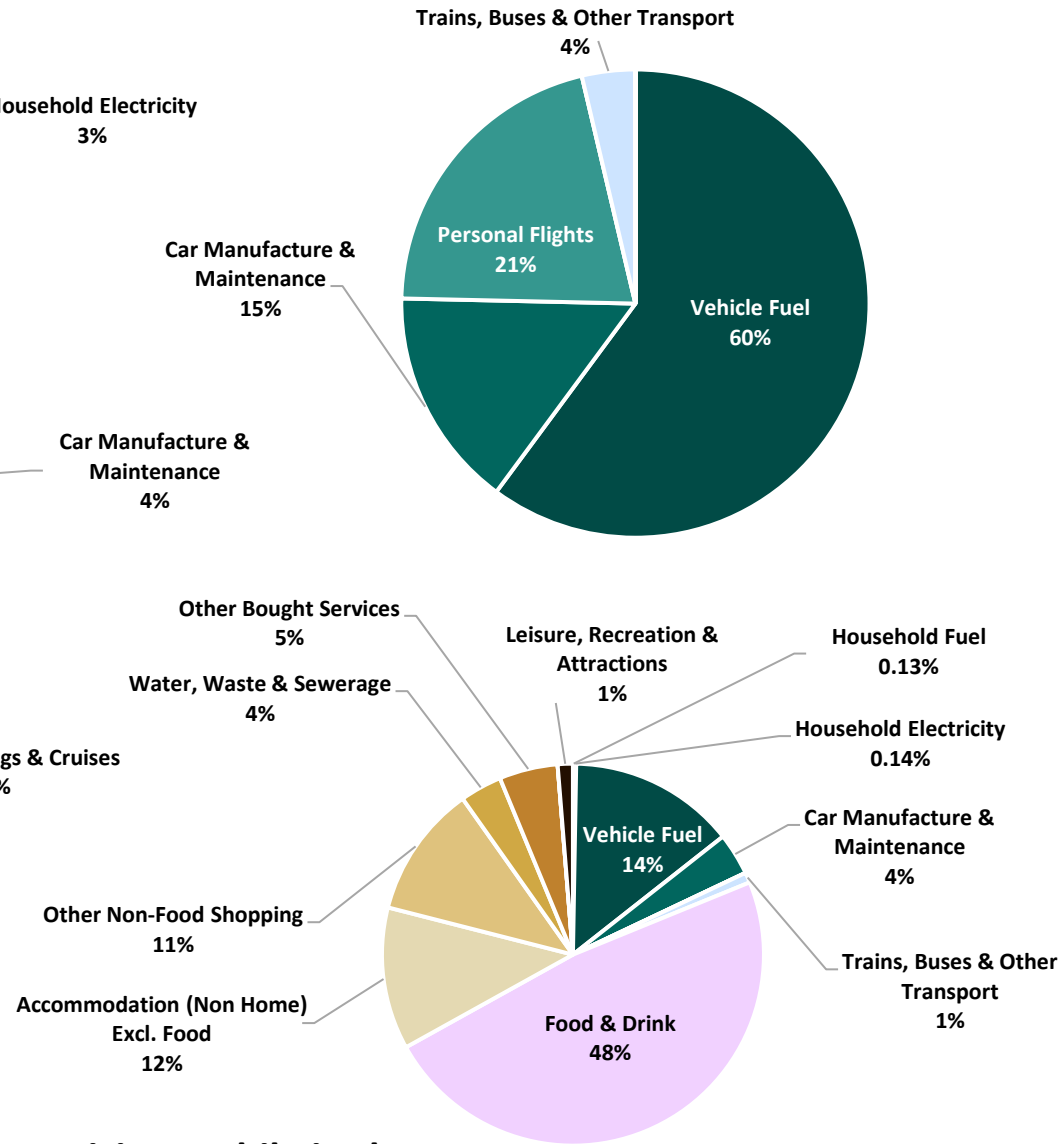
Figure 10: (left) Residents' GHG emissions in Exmoor National Park, by percentage (repeat of Figure 2).

Figure 11: (top right) Visitors' GHG emissions on the way to and from Exmoor National Park, by percentage (repeat of Figure 3).

Figure 12: (bottom right) Visitors' GHG emissions while in the Exmoor National Park, by percentage (repeat of Figure 4).

Visitors travel to & from the area: 82,630 tCO₂e

SMALL
WORLD
CONSULTING



Visitors while in the area: 42,416 tCO₂e

5.2. Residents' and visitors' GHG footprint components

Exmoor residents' GHG emissions totalled 149,381 tCO₂e in 2019, with the highest emissions arising from Food and Drink (24%), Vehicle Fuel (14%) and Personal Flights (13%).

GHG emissions produced by visitors to the Exmoor totalled 125,046 tCO₂e in 2019, comprised of 82,630 tCO₂e from travelling to and from the National Park, and 42,416 tCO₂e produced while in the Park. The chart presenting visitor travel to and from the National Park indicates that GHG emissions are dominated by Vehicle Fuel (60%) and Personal Flights (21%), with only 4% arising from public transport (excluding flights). Of the footprint of visitors while in the National Park, 48% is linked with Food & Drink, while Vehicle Fuel accounts for 14%.

5.2.1. Food

When considering behaviour change around food at its simplest level, we look at the sustainable choices available to us when we buy food and drink from shops, and when we “eat out”, which follow recommendations from UK's Sixth Carbon Budget³⁶ and the National Food Strategy³⁷. The estimated carbon footprint from food and drink consumed while in the Exmoor is considerable: for residents it is 35,387 tCO₂e (24% of the residents' total), and for visitors 20,409 tCO₂e (48% of the visitors' total while in the National Park); see Appendices 10.4 and 10.5.

“Buy local, eat local” has become a common aspiration among the more environmentally aware, along with eating seasonal fruit and vegetables, and varying traditional eating patterns to include more plant-based protein and meal choices (a “flexitarian” diet). It is also possible to use carbon intensity as the basis for choosing which meat to consume, with beef having the highest intensity, followed by lamb, pork and chicken. As well as alleviating the burden on the environment, these kinds of dietary choices can also help individuals live healthier lifestyles. This is because red meat (beef, lamb, pork) as a source of protein and fat is typically a moderate-to-high calorie density food, and therefore needs to be consumed in moderation for a balanced healthy diet. Lean protein sources like turkey and chicken, on the other hand, have a low calorie density. The number of calories people consume as they eat and drink has a direct impact on weight, with obesity being a key risk factor for long term conditions in later life; see section 5.2.4.

Eliminating food waste can reduce an individual's food footprint by a further 12%, as well as saving them money. Forgoing fruit and veg grown in hot-houses or air-freighted to the UK in favour of local, seasonal varieties could deliver a 5% reduction in the total food footprint³⁸. Ship-transported and frozen produce are also good low-carbon alternatives, as the emissions per item are far lower than for air-freighted goods³⁹.

Farming and land management communities are being asked to produce food, address environmental issues such as nature recovery and climate change, while also providing enhanced access opportunities. Collaboration is needed to develop a balanced approach to the delivery of public goods and food production so that it is not “either/or”, but rather that all the desired

³⁶ The Sixth Carbon Budget, “Agriculture and land use, land use change and forestry” section.

³⁷ “National Food Strategy Independent Review, The Plan”; <https://www.nationalfoodstrategy.org>.

³⁸ Hoolohan, C. Berners-Lee, M., McKinstry-West, J. and Hewitt, C.N. (2013), “Mitigating the greenhouse gas emissions embodied in food through realistic consumer choices.” *Energy Policy* Vol. 63, p. 1065.

³⁹ Berners-Lee, M. (2010), “How Bad Are Bananas? The Carbon Footprint of Everything,” p. 26-29.

objectives are being achieved simultaneously and enhance one another. The socio-economic context is complex as support systems are changing to reflect the delivery of these public goods, while the farming sector is also facing an ageing workforce and workers opting to leave the industry. Many farmers, particularly those rearing livestock in upland areas, are highly dependent on the government's agricultural funding schemes, which are set to change in the aftermath of the UK's departure from the European Union⁴⁰.

Based on the latest science, the "National Food Strategy for England, Independent Review of England's food chain from field to fork" outlines a number of recommendations for government, with a formal response to be released in a white paper expected imminently⁴¹. The recommendations are targeted on achieving shifts in the national diet by 2032 (compared to 2019) to meet commitments aimed at improving health, climate and nature, including: a 30% reduction in meat consumption; a 30% increase in the consumption of fruit and vegetables; a 50% increase in fibre intake; a 25% decrease in consumption of foods high in fat, sugar and/or salt⁴².

The Sixth Carbon budget (2021) supplementary "Agriculture and land use" report references "modelling by Oxford University of Public Health's Eatwell Guide, the Government's official guide to achieving a healthy and balanced diet", which provides some even more challenging proposals. It suggests "an average reduction in the consumption of meat by around 89% for beef, 66% for pork and 63% for lamb, and a 20% reduction in dairy products"⁴³.

The health improvements that accompany a more sustainable diet are highly relevant when considering the public health agenda and the public purse. Diet-related health issues are long-term conditions that place a considerable load on the NHS. Being overweight is associated with many of the most common long-term health risks, i.e. coronary heart disease, hypertension (high blood pressure), liver disease, osteoarthritis, stroke, type 2 diabetes and cancer. According to data from the Department of Health: "people with long-term conditions account for about 50% of all GP appointments, 64% of all outpatient appointments and over 70% of all inpatient bed days"⁴⁴, and treatment and care for people with long-term conditions is estimated to absorb around £7 in every £10 of total health and social care expenditure (Department of Health, 2012).

These discussions present significant challenges for the agriculture industry, regarding how to transition given the implications for livestock and food production in the UK. The National Farmers' Union (NFU) is aware of these and has set the goal of reaching net zero greenhouse gas (GHG) emissions across the whole of agriculture in England and Wales by 2040⁴⁵. Achieving this would require considerable reductions of emissions from livestock, and reduced use of synthetic fertilisers, while actively pursuing efforts to sequester carbon by creating woodland, restoring peatland within agricultural land, and implementing regenerative farming practices⁴⁶. Although home-grown meat often has a lower environmental footprint than some of the imported meat, particularly the one coming from recently deforested areas, its climate and ecological footprints still tend to be

⁴⁰ <https://heartofswlep.co.uk/wp-content/uploads/2022/05/GSW-agricultural-transition-report.pdf>

⁴¹ "National Food Strategy Independent Review, The Plan," Chapter 16: The Recommendations; <https://www.nationalfoodstrategy.org>

⁴² "National Food Strategy Independent Review, The Plan," p. 147; <https://www.nationalfoodstrategy.org>

⁴³ The Sixth Carbon Budget, "Agriculture and land use, land use change and forestry" section, p. 21.

⁴⁴ Department of Health (2012) Policy Paper. "Long-term conditions compendium of Information: 3rd edition."

⁴⁵ National Farmers Union (2021), "Achieving Net Zero, Farming's 2040 goal."

⁴⁶ The Sixth Carbon Budget, "Agriculture and land use, land use change and forestry" section.

considerably higher than of comparable plant-based alternatives⁴⁷, which needs to be reflected in the future sustainable farming and food strategies for the UK.

5.2.2. Homes and accommodation away from home

The “Home and accommodation” category accounts for 25,795 tCO₂e (17%) of the footprint of Exmoor National Park residents, and 5,223 tCO₂e of the visitors’ footprint (12% of their footprint while in the National Park). We considered the following components: household fuel (13,665 tCO₂e; 9% of residents’ total footprint), housing (7,315 tCO₂e; 5%), household electricity (4,194 tCO₂e; 3%), and accommodation away from home (621 tCO₂e; 0.4%); see Appendix 10.4 for further details. The single biggest intervention the public can readily make is changing their energy supplier (switching to one that is divesting from fossil fuels) and actively sourcing a supply derived from genuinely renewable energy, e.g. solar, wind, tidal and/or hydro-electric power. The public generally lack knowledge about where their household energy comes from, with many consumers not being able to distinguish between:

- a) “green tariffs” backed only by cheap Renewable Energy Guarantees Origin (REGO), which have little impact on encouraging further expansion of renewable electricity generation, and
- b) suppliers that are more genuinely investing in renewable electricity, and offering tariffs wholly backed by Power Purchase Agreements (PPAs).

Further improvements can be made by reducing energy use within homes. Options vary from lowering the thermostat temperature, to improving home insulation, to replacing oil or gas boilers with alternatives such as an electric heat pump. Moving off-gas-grid properties from oil heating to a heat pump has the potential to reduce emissions significantly, while offering householders a more convenient system. Increased electricity demand in rural areas can be met by local renewable energy production and/or improved grid connections, which are particularly relevant if the locals will be using electric heat pumps and electric vehicles. We recognise that affordability is always a factor, and depends on individuals’ financial means; however, a variety of home energy efficiency measures can be installed at different levels of cost, often met in part by access to Government grants or other funding.

The historic nature of many of the National Park’s building stock alongside the statutory requirement to protect the aesthetic quality of the area presents additional challenges to the successful decarbonisation of this sector. Affordable practical solutions will have to be found and incentivised to ensure emissions from historic buildings are reduced sufficiently, for example by introducing secondary glazing.

5.2.3. Travel

Travel is responsible for the biggest share of the total footprint of Exmoor National Park visitors (90,498 tCO₂e, 72%), including the entire footprint of travelling to and from the National Park and 19% of the visitors’ emissions while in the National Park. The majority of this travel footprint comes from fuel burned in private vehicles, (55,670 tCO₂e; 45% of visitors’ total), personal flights (17,324 tCO₂e; 14%), vehicle manufacture and maintenance (11%), as well as comparatively small amount from the use of trains, buses and other transport (11%).

⁴⁷ Poore & Nemecek (2018), “Reducing food’s environmental impacts through producers and consumers,” *Science*, 360(6392), 987-992.

Travel accounts for 34% of the residents' GHG footprint. In considering residents' travel we looked at personal flights (19,596 tCO₂e; 13% of residents' footprint), vehicle fuel (20,639 tCO₂e; 14%), vehicle manufacture and maintenance (5,501 tCO₂e; 4%), trains, buses and other transport (3,493 tCO₂e; 2%) and ferry crossings and cruises (1,891 tCO₂e; 1%). See Appendix 10.4 for further details.

Car travel is the single largest contributor to the overall footprint of the Exmoor National Park (35% of the combined footprint of the residents and visitors).

All National Park users – whether visitors travelling to and from, or residents travelling locally – could benefit from work undertaken with local authorities to provide additional public transport services and promote their use. This could explore mechanisms to help fast-track electrification of public-use vehicles such as buses, taxis and hire vehicles, and to influence Government to support the transition from diesel-powered to electric trains.

In terms of vehicle fuel use, variations in residents' annual mileage, and in vehicle size (both residents and visitors) make a big difference to carbon footprints. If someone drives 10,000 miles in a year, the associated emissions are around 4.5 tCO₂e if their vehicle is a small petrol run-around, 5.6 tCO₂e for a medium family-size car and 8.3 tCO₂e for a large car. It is also worth noting that while car travel can have a high footprint if the driver travels alone, it becomes a far lower-carbon option per person when a car is full, e.g. transporting a family of 4 or 5.

The vehicle type also affects the GHG impact. A trip from Manchester to London in an average petrol car would produce 0.11 tCO₂e of emissions, including the embodied emissions of the vehicle and its fuel. For the same journey an ordinary hybrid vehicle produces 0.08 tCO₂e, and for a plug-in electric hybrid car the figure is 0.07 tCO₂e. The average diesel car's greenhouse gas emissions are slightly lower than for petrol, at 0.10 tCO₂e, but bear in mind that while diesel vehicles produce less CO₂e per mile and deliver better fuel economy than petrol vehicles, they may perform less well in terms of soot and nitrogen oxide production. Exhaust fumes are a key contributor to air pollution, so the cleanest choice is an electric car, which would also produce the lowest emissions: 0.04 tCO₂e⁴⁸. We note that the latter estimate accounts for the current average carbon intensity of the UK electricity grid and the embedded carbon footprint of manufacturing the battery (largest embedded footprint of manufacturing electric vehicles), both of which are expected to come down as electricity generation and other related industries decarbonise.

In the UK in 2019, 10% of all new cars and vans purchased were electric⁴⁹. The Committee on Climate Change (CCC) has recommended that 60% of all new cars and vans sold should be electric by 2030, and the Government recently announced a ban on selling new petrol, diesel or hybrid cars in the UK from 2030⁵⁰. As the Exmoor National Park has a more affluent demographic profile on average, the typically cost-prohibitive entry into owning an electric car is more likely to be within reach for some

⁴⁸ Like all other road vehicles, electric cars emit particulates from tyres and brakes. Compared to tailpipe exhaust, emissions from electric vehicles mostly impact air quality rather than the climate. Since electric cars tend to be heavier on average than conventional cars, due to the battery, their emissions from tyres are marginally higher. Conversely, thanks to regenerative braking into the battery, electric cars' emissions associated with braking are lower than for conventional cars.

⁴⁹ <https://www.ft.com/content/d57efdf6-ffad-11e9-be59-e49b2a136b8d>.

⁵⁰ <https://www.bbc.co.uk/news/science-environment-5136612354981425>.

residents in the area. Aside from switching to an electric car, there are other choices that everyone can make to reduce vehicle emissions:

- The average person walks 210 miles per year⁵¹. Walking an additional 2.5 miles per week for local journeys, e.g. visits to local shops or the school run, could save 70 kgCO₂e in a year and bring co-benefits for health.
- Emissions would be reduced if more people travelled more often by bicycle, perhaps on an electric bike which uses just 5% of the energy per mile of an electric car.
- Driving outside the rush hour avoids prolonged time at low vehicle speeds: an average car crawling five miles each way emits 22 kgCO₂e a day, which over a year would equal 4.8 tCO₂e.
- When replacing an ageing medium family-size car, downsizing to a small petrol car would save 1.1 tCO₂e a year.
- When replacing an ageing large car, downsizing to a medium family-size petrol car would save 2.7 tCO₂e a year.
- If affordable, replacing a medium-sized petrol car with an electric car would save 2.2 tCO₂e a year. If you replaced a large car with a medium electric car the savings would be 5.5 tCO₂e a year.

Increasing the availability of electric car charging points could encourage both the residents and the visitors to travel by electric vehicle.

The other main contributor to the travel footprint is flying. One approach that could have the single biggest impact in reducing this travel footprint could be to step up messaging that encourages the public to fly less, and suggest in particular that they reduce “casual flying” for short-haul trips where other means of transport are feasible, e.g. travel by train, bus and/or boat.

5.2.4. Everything else

The remainder of the residents’ footprint consisted of: public services including health and education (13,508 tCO₂e; 9% of residents’ footprint), other bought services (9,403 tCO₂e; 6%), other non-food shopping (9,606 tCO₂e; 6%), leisure, recreation and attractions (2,515 tCO₂e; 2%), and waste, water and sewerage (2,048 tCO₂e; 1%). The remainder of the visitors’ emissions arose from: water, waste and sewerage (1,508 tCO₂e; 4% of footprint while in the National Park), other non-food shopping (4,761 tCO₂e; 11%), other bought services (2,104 tCO₂e; 5%), and leisure, recreation and attractions (544 tCO₂e; 1%).

The biggest single factor in the “everything else” category is health and education. As discussed in Section 5.2.1, there can be a causal relationship between food, obesity and long-term health conditions. The public health “prevention” (of illness) agenda is therefore also important in helping National Parks and Local Authorities to decarbonise, as well as benefiting health and well-being.

We suggest that the role played by the National Parks in enabling the public to access green/blue space – known to support mental and physical well-being – should not be underestimated. Recent research by White *et al.* (2019) identified that the amount of recreational time individuals need to spend in natural environments in order to gain self-reported health and well-being benefits is at

⁵¹ Department of Transport (2019), “National Travel Survey (England): 2018”.

least 120 minutes per week⁵². White *et al.* (2010) also suggest that green space combined with aquatic blue space (water) offers enhanced perceived benefits, which can be incorporated into landscape design and opportunities for improving public accessibility⁵³.

*Summary of key findings of exposure to green space to gain health and well-being benefits
(White et al. 2010 and 2019)*



Threshold \geq 120 mins of green space exposure per week = health and well-being benefits.

Results suggest it does not matter how the “threshold” is achieved per week.

E.g.
4 x 30 mins = 120 mins
6 x 20 mins = 120 mins



Psycho-physiological benefits gained from sitting passively in natural settings.



Scenes with water are associated with greater positive affect and higher perceived restorativeness than those without water.

The next biggest factors to consider in the “Everything else” category are other bought services and other non-food shopping. Simply put, the choices we make around which goods and services we purchase count towards our carbon footprint, due to the amount of fossil fuels used in production, or the air/road miles associated with those products and services. Making different choices when procuring goods and services can make a notable difference in reducing the resulting carbon costs.

Encouraging a circular economy within the National Park and its neighbouring Local Authorities may help reduce the emissions associated with goods and services. A circular economy is a model of production and consumption that involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible, rather than throwing them away and buying new.

In terms of waste, water, and sewerage, the National Park Authority is well-placed to support partners in strategic planning to deliver multi-environmental benefits, especially given the new Environment Act (2021) and the role the National Park Authority plays in processing and scrutinising planning applications. It is important to consider opportunities for:

- Mitigating the impact of air pollution
- Supporting healthy river basin catchments
- Supporting and restoring nature
- Protecting endangered species and fragile habitats
- Highlighting and improving the relationship between people and the landscape

Another issue to bear in mind: interventions to “slow the flow” in flood risk areas. When choices are made around nature-based solutions in upstream areas, or civil engineering solutions downstream which are likely to use cement in their construction, we suggest that both cost and carbon benefits are considered when undertaking option appraisals.

⁵² White *et al.* (2019) “Spending at least 120 minutes a week in nature is associated with good health and well-being.” *Scientific Reports*. 9:7730 <https://doi.org/10.1038/s41598-019-44097-3>.

⁵³ White, M.P., Smith, A., Humphries, K., Pahl, S., Snelling, D. and Depledge, M. (2010), “Blue space: the importance of water for preference, affect and restorativeness ratings of natural and built scenes.” *Journal of Environmental Psychology* 30, 482-493.

5.2.5. Comparison of residents' GHG emissions with UK national average by category

Figure 13 compares the average per capita footprint of the Exmoor National Park residents with the UK national average.

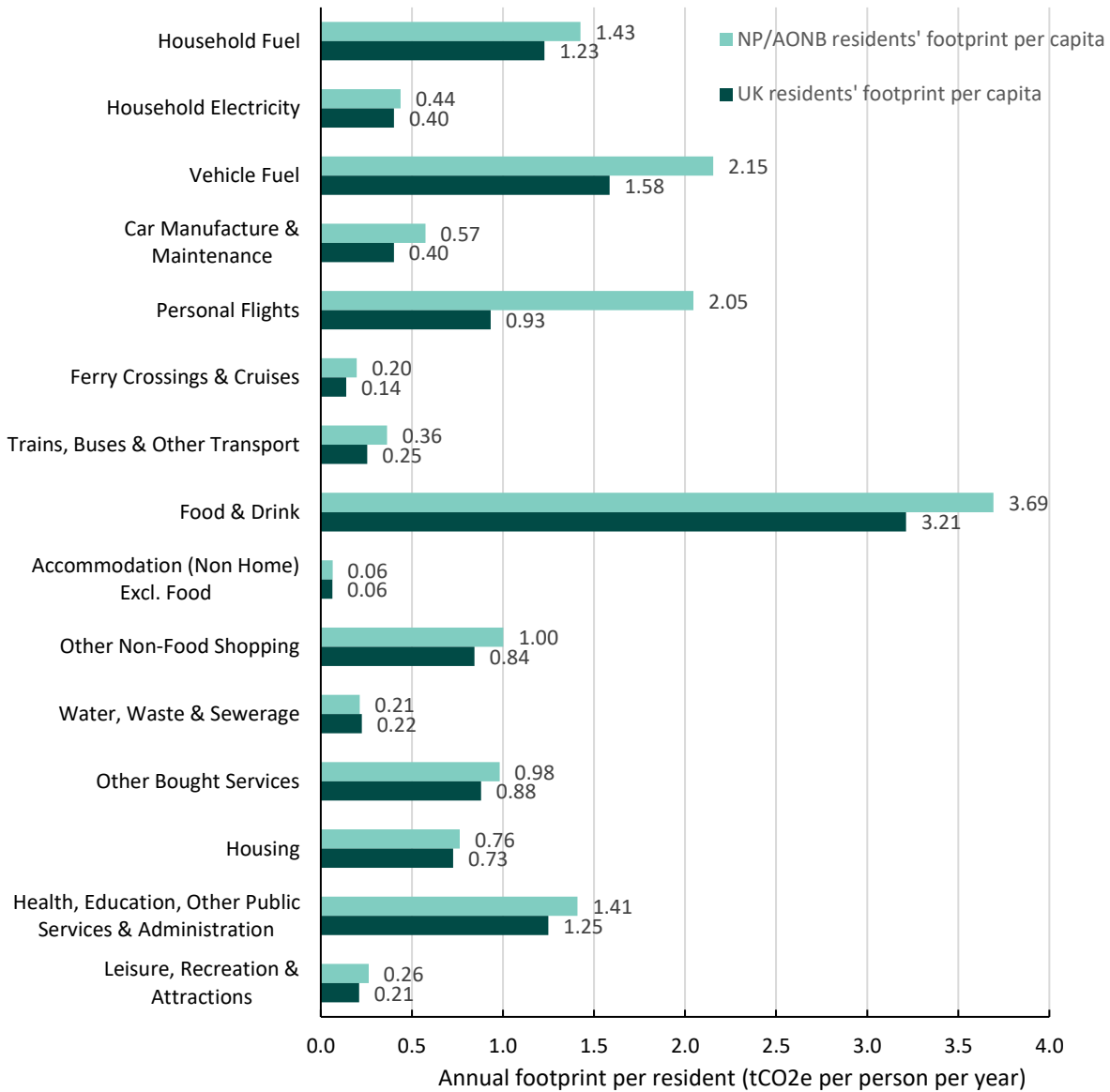


Figure 13: Residents' GHG footprints compared between the Exmoor National Park average and the UK national average, by category

5.3. Industry assessment

This section presents the GHG emissions from industry but first outlines the scope of the industry assessment given that two approaches were used, as explained in Section 5.3.1.

5.3.1. Scope of industry assessment

Aside from the footprint of residents and visitors, we also include, for perspective, a rough assessment of the footprint of industries and their supply chains. We use data from the Office for National Statistics' Inter-Departmental Business Register (IDBR) for business turnovers in Census Output Areas (COA). This is used rather than Local Authority Gross Value Added (GVA) data since it is more geographically specific (see Appendices 10.6.1 to 10.6.4). Please note that the reported turnover data does not necessarily reflect on the actual geographical distribution of locations where business revenue is being generated.

Because of confidentiality constraints regarding the ONS IDBR data, we also had to include all COA geographies overlapping with the landscape's boundary, leading to marginal overestimates of the total turnover and the resulting industry footprint within the landscape. The industry footprint assessment is comparatively crude since COA-level business turnover data has only fifteen broad sectors, and the footprint calculation is based on the associated industry-specific carbon intensity averages for the UK. The use of UK-average carbon intensities could have a particular effect on the footprints for agriculture and forestry, because these sectors are known to have unique features across most National Parks and AONBs.

Please also note that this assessment overlaps with our more detailed analysis of resident and visitor emissions, since it is not feasible to eliminate double-counting arising from sales by local businesses to residents and visitors.

5.3.2. Industry sector analysis

The ONS UK Standard Industrial Classification (SIC) Hierarchy is used in formulating data analysis by the UK government to assess economic activity⁵⁴. For transparency we include the IDBR broad industry group structure and see how this compares with the SIC (2007); see Appendix 10.6.1. When interpreting the results, please note that the IDBR production category includes mining, quarrying and utilities (Division 05/09, 35/39); added together with manufacturing (Division 10/33). Similarly, the SIC (2007) code "arts, entertainment and recreation" is aggregated to include: "Other service activities; activities of households as employers; undifferentiated goods-and-services-producing activities for own use; and activities of extraterritorial organisations and bodies", Division 90/99 respectively.

Please note also that the IDBR national dataset suppresses data under seven categories, so an incomplete picture may apply to:

- 023: Gathering of wild-growing non-wood products.
- 071: Mining of iron ores.
- 072: Mining of non-ferrous metal ores.
- 531: Postal activities under universal service obligation
- 642: Activities of holding companies
- 653: Pension funding
- 843: Compulsory social security activities

We now consider the results for industry-related GHG emissions which total 66,056 tCO₂e.

⁵⁴ https://onsdigital.github.io/dp-classification-tools/standard-industrial-classification/ONS_SIC_hierarchy_view.html.

Figure 14 highlights Agriculture, Forestry & Fishing as the largest source of GHG emissions (41,810 tCO₂e; 63%); followed by Accommodation & Food Services (5,391 tCO₂e; 8%) and Production (4,537 tCO₂e; 7%), see Appendix 10.6.2. Industry-related flights account for 6,604 tCO₂e of the total footprint but are not separately categorised. Each of the main contributing categories are discussed in turn below.

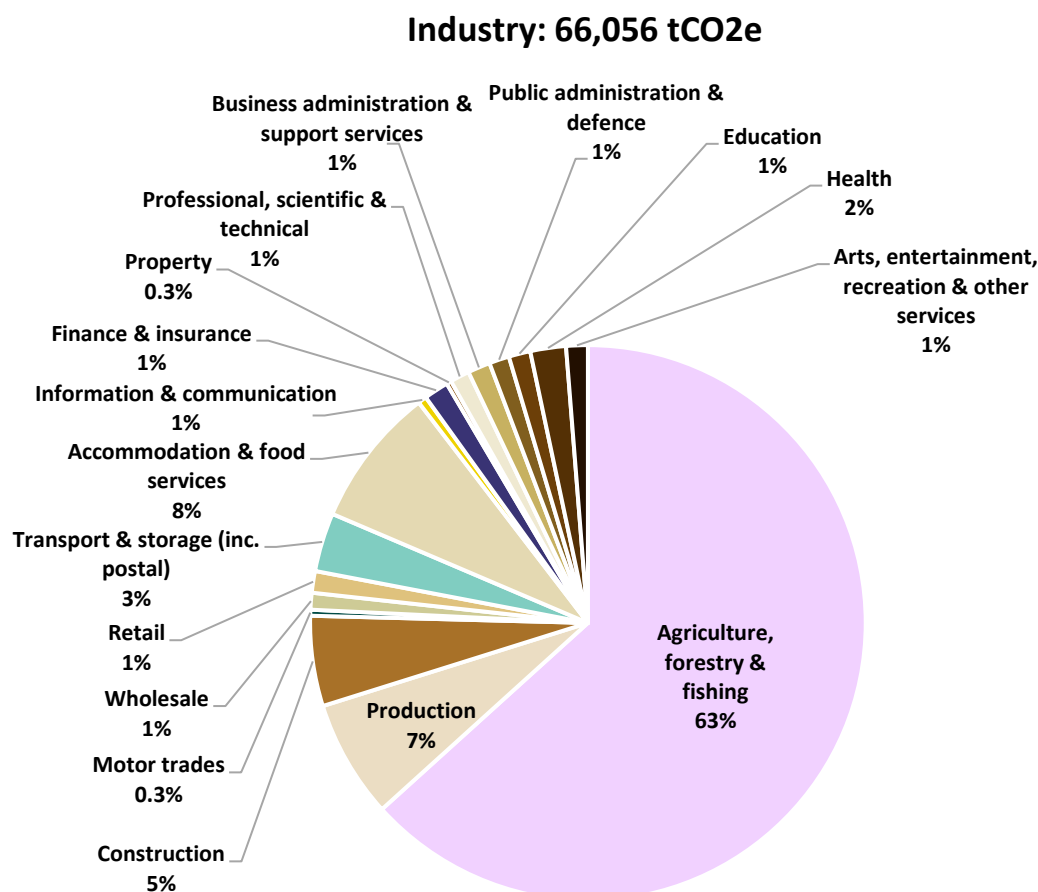


Figure 14: The Exmoor National Park consumption-based GHG emissions for Industry by percentage (repeat of Figure 5)

Agriculture, forestry and fishing

The top industry for GHG emissions is agriculture, forestry and fishing (41,810 tCO₂e; 63%). The issues pertaining to this industry are discussed in detail under 3.2 (Agricultural landscape), 5.2.1 (Food) and 5.2.4 (Everything else). Extensive grassland farming is the dominant agricultural system on Exmoor, primarily sheep and cattle, including traditional local breeds⁵⁵. Farming is more intensive in the area of Porlock Vale to the East⁵⁵, where the soils are the most productive within the National Park. With a substantial proportion of the land subject to grazing, rearing of livestock is likely to be the biggest contributor to GHG emissions in this sector.

⁵⁵ Exmoor National Park Partnership Plan 2018-2023, https://www.exmoor-nationalpark.gov.uk/data/assets/pdf_file/0016/251161/Partnership-Plan-2018-2023-single-pages.pdf.

The Sixth Carbon Budget (2020) “Agriculture and land use, land use change and forestry” report suggests multiple opportunities for reducing emissions, as follows.

The initial focus relates to low-carbon farming practices, including livestock measures such as selective breeding, increased milking frequency (less applicable for the Exmoor since there are only few dairy farms in the area), changes to livestock diet to decrease enteric methane emissions, and improved livestock health. The second focus is on soil improvement, achieved through the use of legumes, cover crops and grass leys. The third focus is on waste and manure, including the use of anaerobic digestion and covering slurry tanks.

The Sixth Carbon Budget also discusses reducing the numbers of cattle, sheep, pigs and poultry reared, through technological and dietary changes, leading to smaller overall areas of grassland and cropland, as well as shifting to new hydrogen technology. JCB, for example, have developed a prototype hydrogen tractor, so there may be benefits in the LEP collaborating with manufacturers who can facilitate, and even accelerate, such a transition. Moving some production across the UK to greenhouses and vertical urban farms, collectively referred to as indoor horticulture, is also likely going to be required to make the UK self-sufficient in terms of food while enabling large-scale nature recovery programmes⁵⁶. Such technologies have been piloted successfully by other countries including the Netherlands, which has become the second-largest food exporter globally despite its comparatively small land area.

We need a systemic change to happen in the ways we use land and in the broader food system in the UK. Current systems are not sustainable from the climate, biodiversity and food security points of view⁵⁷. Changes to a more plant-based diet will go hand in hand with the recommended scaling-up of indoor horticulture. In terms of innovations, options such as lab-grown meat and insects as new sources of protein should also be on the table. Livestock still has a part to play in nature recovery, for example through silvopastoral agroforestry systems that enhance biodiversity and tend have lower production volumes and environmental impacts than conventional systems. Another crucial point is to reduce high-carbon imports of both animal and plant-based products to ensure they do not simply replace home-grown produce. Ultimately, reducing consumer demand for foods with high climate and broader environmental impacts, regardless of whether they are imported or home-grown, is going to be key to achieving a more sustainable food system in the UK.

Other opportunities relate to improving productivity and efficiency, with a headroom to increase average crop yields from around 8 t/ha at present to around 11 t/ha. It must be noted, though, that climate change is likely to pose additional risks to yields, and this is discussed in the report. It suggests land management measures such as increasing soil quality, smaller tillage, nutrition and pesticide management, and opportunity mapping. Innovations in breeding are also discussed along with increasing stocking density. Another key suggestion is to adopt paddock grazing, which improves the quality of grass, enhances sequestration of carbon in the soil, and is estimated to increase grass utilisation rates (the amount of grass that is eaten) from 50% to 80%.

⁵⁶ Importantly, scaling up indoor horticulture in one part of the country is going to help alleviate parts of the existing demand for land to be farmed elsewhere, freeing up crucial space for nature recovery projects.

⁵⁷ “National Food Strategy Independent Review, The Plan,” p. 147; <https://www.nationalfoodstrategy.org>

Another clear and significant intervention that would reduce requirements from agriculture, alongside improved productivity and dietary changes, would be measures to reduce food waste, amid data showing that 3.6-13.6 million tonnes of UK food is wasted per year.

In addition to agriculture, forestry is a prominent industry and distinct feature of Exmoor's upland landscape. The Exmoor Forest Plan area is made up of several Forestry Commission plantations within the north-eastern region of the National Park, totalling 1,328 ha⁵⁸. There is also a considerable area of privately owned woodlands, which are often under a more active management compared to the Forestry Commission woodlands. Exmoor's forestry plantations are among the highest yielding and extensive in South-West England. Production of softwood, for various uses including wood fuel and manufacturing, is expected to remain an important part of the local economy within the National Park⁵⁹.

Exmoor's coast historically supported a fishing industry, but fish weirs have long since fallen out of use⁶⁰. Fishing within the National Park predominantly relates to some private businesses⁶¹ and recreation⁶².

Accommodation and food services

The second-largest industry for GHG emissions in the Exmoor is accommodation and food services (5,391 tCO₂e; 8%), and so there is a considerable opportunity for this sector to reduce its carbon footprint. The accommodation sector accounts for around 9 million tCO₂e every year in the UK as a whole (over 1% of the UK's total annual emissions). Around 30% of this footprint is assigned to gas and electricity, 26% to food and drink, 6% to air travel and a further 6% to vehicle fuel⁶³.

Therefore, the biggest impact for accommodation and food services in Exmoor National Park would be for businesses to reduce their energy footprint, and thus GHG emissions. As outlined in section 5.2.2 (Homes and accommodation away from home), switching to a renewable energy supplier and/or installing renewable electricity sources, such as solar and wind, on-site would be the most impactful action in this area. Reducing gas and oil consumption by improving heating and insulation in buildings and by installing a renewable heat source such as heat pumps would also significantly cut emissions in this area. Improved insulation plays a significant factor in reducing energy usage.

The second-largest impact would be for this sector to offer more sustainable food choices to consumers, as discussed in section 5.2.1 (Food). Some suggestions for achieving this include offering more plant-based options, using local and seasonal produce, reducing the content of meat and dairy (especially for beef and lamb), and reducing air-freighted or hot-housed foods in favour of shipped or frozen produce. Limiting food waste would also significantly reduce this sector's carbon footprint. Over 9.5 million tonnes of food are wasted in the UK each year, accounting for around 36 million

⁵⁸ Exmoor Forest Plan 2021-2031: West England Forest District, Forestry England, [Exmoor Forest Plan 0.pdf \(forestryengland.uk\)](#).

⁵⁹ Exmoor National Park Local Plan: 2011-2031, https://www.exmoor-nationalpark.gov.uk/_data/assets/pdf_file/0030/257763/Local-Plan-2011-2031-for-web.pdf.

⁶⁰ <https://www.exmoorher.co.uk/theme/TEM5>.

⁶¹ <http://www.exmoorfisheries.co.uk/>.

⁶² <https://www.exmoor-nationalpark.gov.uk/enjoying/fishing>.

⁶³ Berners-Lee, M. (2020), "How Bad Are Bananas? The Carbon Footprint of Everything," p.109-111.

tonnes CO₂e⁶⁴. To reduce food waste, accommodation and food services can make sure they do not offer excessive portions and use kitchen leftovers for future meals.

Finally, reducing emissions arising from travel, as outlined in section 5.2.3 (Travel), by reducing flight emissions and using public transport options where possible, while simultaneously facilitating electrification of transport, would be the third most impactful action for this sector to reduce its emissions.

Production

Production (referring to manufacturing industries as well as electricity generation and quarrying) plays an important role in the National Park (4,537 tCO₂e; 7% of the estimated total industry footprint in the region). It must be noted that there are inevitable overlaps between the National Park and the nearby regions when it comes to industry data since it is being sourced from the coarse COA geographies instead of the postcodes. While these overlaps cannot be eliminated until a more spatially granular data becomes available, we suggest that manufacturing as a sector should be one of the top industries to decarbonise in the wider area. This is where Local Enterprise Partnerships may wish to focus efforts by encouraging companies to undertake assessment of their Scope 1, 2 and 3 GHG emissions and to develop credible roadmaps to reduce them.

Construction

We estimate that construction is the fourth-largest GHG-emitting industry in Exmoor National Park and the adjacent region (5% of the total industry footprint). However, this is an area where emissions may increase in the coming years with an expansion of the infrastructure to deliver renewable energy and construction of more affordable housing in the National Park while retrofitting existing buildings. Exmoor has 740 listed buildings and 200 Scheduled Monuments⁶⁵, which require sensitive maintenance and renovation. The latest Partnership Plan mentions the challenge of meeting affordable housing needs for local communities⁶⁵. This could increase construction in the Park over the coming years and so the most sustainable building practices may wish to be considered to minimise emissions related to this sector.

The Sixth Carbon budget (2020) “Manufacturing and construction sector” report showed that GHG emissions from this sector contributed 12% of the total production-based UK GHG emissions in 2019. Opportunities for interventions to reduce construction-related emissions include:

- Resource efficiency: reducing the flow of materials through the economy, and using products more efficiently (and for longer), can reduce manufacturing emissions as part of a shift towards a more circular economy.
- Material substitution: manufacturing emissions can be reduced by switching from high-embodied-carbon materials to low-embodied-carbon materials, including home-grown timber. Measures include using wood in construction and using alternatives to clinker (e.g. fly ash) in cement.
- Energy efficiency: using energy more efficiently reduces operating costs while cutting emissions. The energy efficiency measures that we include are “low-regret” actions that

⁶⁴ WRAP 2018, “Food surplus and waste in the UK – key facts.”

⁶⁵ Exmoor National Park Partnership Plan 2018-2023, https://www.exmoor-nationalpark.gov.uk/_data/assets/pdf_file/0016/251161/Partnership-Plan-2018-2023-single-pages.pdf.

often reduce fuel costs significantly. Measures include process and equipment upgrades, installing/improving heat recovery systems, and clustering/networking with other sites and businesses to efficiently utilise waste heat and other by-products.

- Fuel switching in manufacturing: hydrogen, electricity and bioenergy can all be used to meet demands for heat, motion and electricity, thus removing the need for fossil fuels and reducing GHG emissions.
- Carbon Capture and Storage (CCS): CCS can be used to capture CO₂ produced by larger industrial point-sources and transport it to a CO₂ storage site, thereby reducing emissions to the atmosphere⁶⁶.

IDBR and GVA-based emissions comparison

We undertook a comparison between the IDBR data for the COA geographies overlapping with the National Park boundary and the GVA data projected from the neighbouring unitary local authorities (LAs) to the National Park, as we know that economic reporting often uses GVA as the primary measure upon which many Local Enterprise Partnerships base their workforce planning; see Appendix 10.6.1. When the GVA dataset projected on the National Park from the unitary authorities is compared to the IDBR data, this indicates a potential under-reporting of GVA-based emissions from agriculture, forestry and fishing, and considerable over-reporting for other sectors (Figure 15). The National Park may wish to discuss this with Local Enterprise Partnerships in the area.

5.3.1. Energy-only industry analysis

This analysis is a subset of the industry carbon footprint estimate. Energy makes up 69% of emissions from industry (45,643 tCO₂e). Table 3 shows the breakdown of industry emissions from electricity and fuels in Exmoor National Park.

Table 3: Energy-only industry (subset of industry) – Exmoor National Park

Industry Electricity	16,245 tCO ₂ e
Industry Fuels Excl. Road	24,478 tCO ₂ e
Industry Road Fuels	4,921 tCO ₂ e
Total	45,643 tCO₂e

5.3.2. Large emitters analysis

As a further component of the industry GHG footprint analysis, the BEIS Pollution Inventory (2018) enables us to identify specific large emitters within each UK National Park (see Appendix 10.6.4). Please note that the BEIS Pollution Inventory reports carbon dioxide emissions only and is limited to Scope 1 (direct emissions from fuels consumed on-site). The estimated total volume of carbon dioxide relating to large emitters in Exmoor is zero tCO₂. If at a future date large emitters emerge within the Park it may be possible to engage with them either directly or through the relevant Local Authorities. The aspiration is to promote carbon assessment of Scope 1, 2, and 3 GHG emissions, and carbon reduction planning with a view to net zero⁶⁷.

We also identify where IDBR data has been suppressed the ONS's own software, which means a null value is returned for confidentiality reasons. Where this poses an issue for the reliability and validity

⁶⁶ The Sixth Carbon Budget (2020), "Manufacturing and construction" section, p. 6-11.

⁶⁷ UK local authority and regional carbon dioxide emissions national statistics: 2005-2018.

of the results, these issues are discussed, and the missing data is approximated using LSOA-based and UK-based business turnover datasets (also made available to us by the ONS). In the case of the Exmoor National Park, 13% of the estimated business turnover has been suppressed in the COA-based dataset.

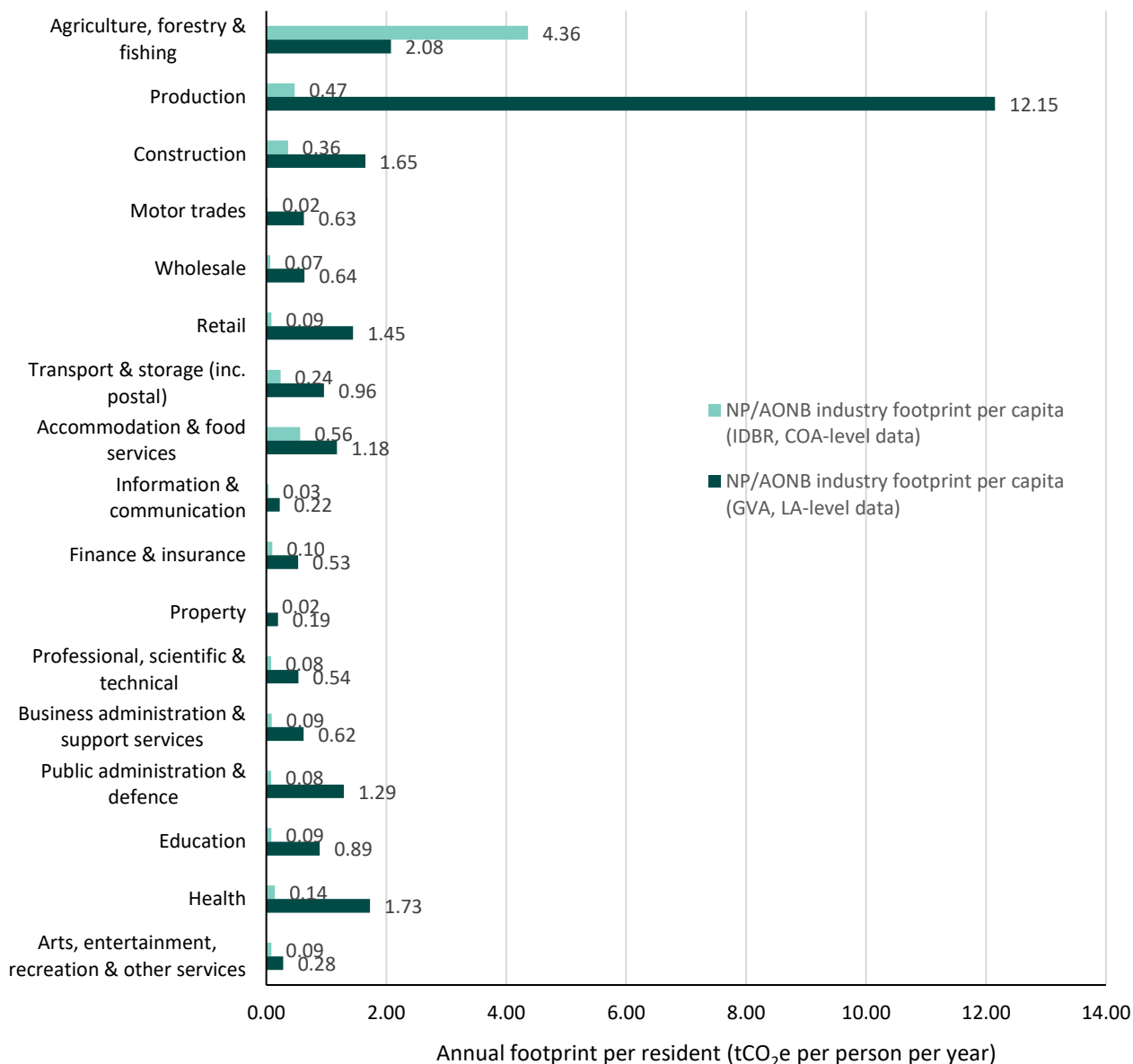


Figure 15: The Exmoor National Park industry footprint estimates: IDBR vs. GVA, by sector

5.3.3. Comparison of annual industry footprint with UK averages

It may be helpful for the National Park to compare itself with the UK national average for each industry category. This helps to identify patterns and pinpoint where it would be beneficial to focus partnership-working with Local Authorities. The results (Figure 16) show higher-than-national averages for: Agriculture; Forestry & Fishing and Accommodation & Food Services.

As background to influencing change, the UK Government enacted legislation on the 1st of October 2013 making it mandatory for the UK's largest quoted companies to report their GHG emissions

(Statutory Instrument (SI) 2013/1970:5). In 2018, this SI 2013 was amended to include “emissions, energy consumption and energy efficiency action by quoted companies” (SI 2018/1155, Part 6) to reflect the true impact of their operations⁶⁸. This was extended to all large companies, including the public sector. Due to this legislation, one should expect all large organisations to be in the process of assessing their full GHG emissions and preparing carbon reduction plans aimed at reaching net zero. However, large businesses fall under the new statutory reporting requirements and are new to carbon accounting may find the process challenging, so joined-up approaches may be helpful, particularly in the public sector.

Some organisations are attempting to encourage a sector-wide approach, e.g. the National Farmers Union and water utility companies. It is recognised that there is much goodwill in industry, with many leaders and individuals in organisations concerned about the climate emergency and striving to make their business more sustainable. However, we also recognise that capacity and capability often pose challenges to medium and small enterprises that have more limited resources.

5.4. Analysis of emissions from through-traffic and major roads

The analysis of the impact of through-traffic has been included at the request of several National Park Authorities and Local Authorities for AONBs (see Appendix 10.7). Through-traffic refers to vehicles passing through the National Park or AONB without visiting, regardless of their origin and destination. Its footprint is estimated by comparing total traffic point counts with pump-level fuel sales within each National Park or AONB, along with assumptions about commuting in out of the area. The estimate represents the emissions from through-traffic that occur within the geographical boundary of the National Park or AONB, unlike the total driving footprints of the residents and visitors that mostly occur outside of the boundary. The purpose of reporting the through-traffic emissions is to show how much of the geographical footprint due to road traffic within the National Park or AONB boundary is not related to living in or visiting the area, which could be used to support new road electrification infrastructure as well as public transport.

For the Exmoor National Park, estimated total through-traffic emissions from cars, buses, motorbikes, vans and lorries are **10,729 tCO₂e**. This data is **not included** in the residents’, visitors’ or industry footprints.

We also report emissions from smaller and larger subsets of selected A-roads, which carry elements of through-traffic as well as traffic from residents, visitors and industry. The selected roads assessed for Exmoor National Park are the A399, A39, A396 and B3224 (Appendix 10.7). The estimated footprint of these roads within the Exmoor National Park geographical boundary is 21,628 tCO₂e per year across all vehicle types. This amounts to around 15% compared to the total footprint of the residents.

⁶⁸ “The Companies Act 2006 (Strategic Report and Directors’ Report) Regulations 2013 (SI 2013/1970) (Strategic Report Regulations 2013),” enacted from 1st October 2013 to the present.

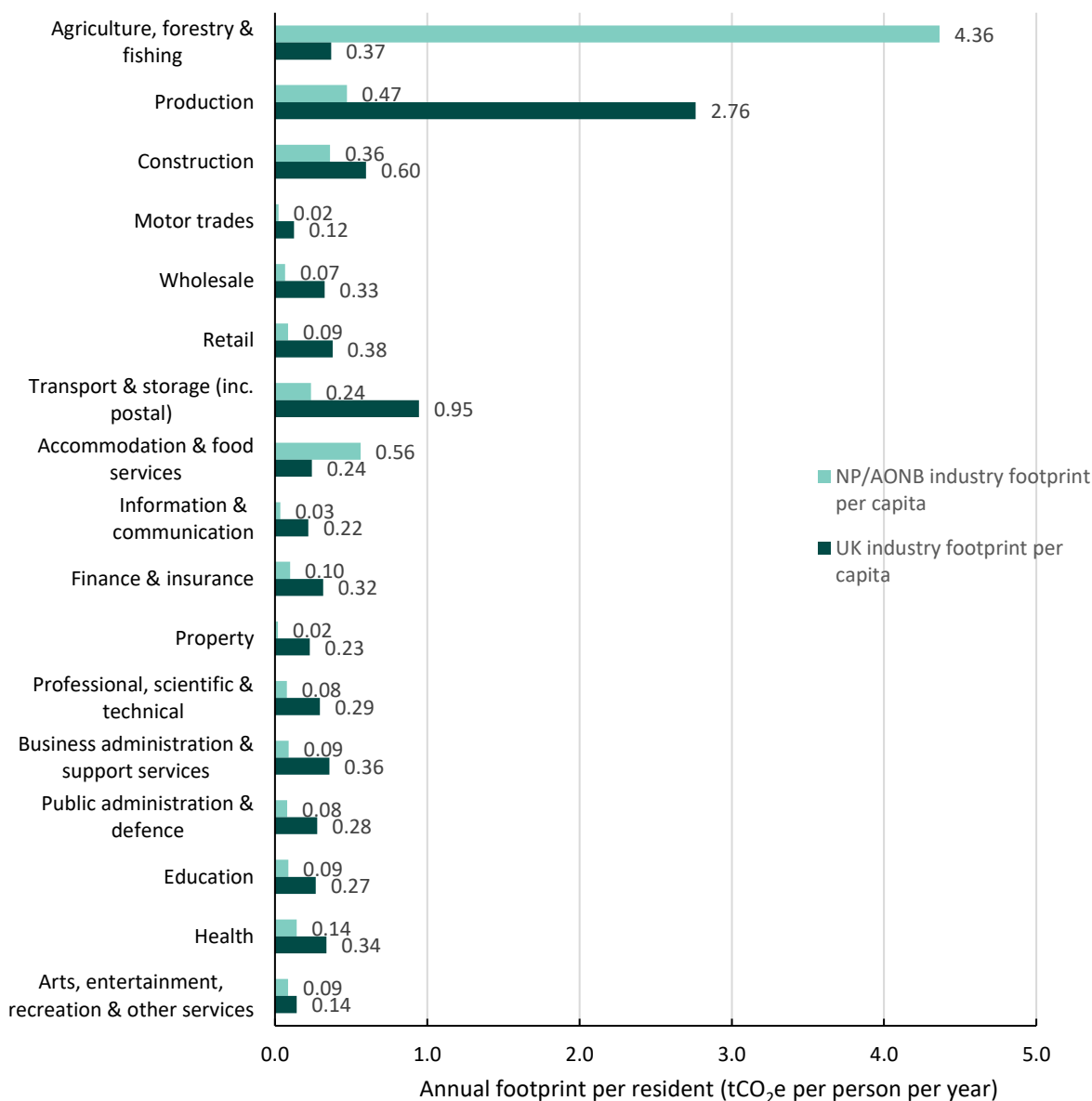


Figure 16: The Exmoor National Park industry GHG emissions compared with UK national average, by sector

5.5. Land use emissions

The land use sector differs from other sectors in the Greenhouse Gas Inventory in that it contains both sources and sinks of greenhouse gases. The sources, or emissions to the atmosphere, are given as positive values; the sinks, or removals from the atmosphere, are given as negative values, see Table 4. Our definition of the land use sector includes emissions from livestock (mostly methane), synthetic fertiliser use (mostly N₂O), degrading mineral and organic soils (peat) (mostly CO₂), and lost biomass (CO₂), as well as carbon sequestration in soils and biomass through woodland creation, peatland restoration and regenerative agriculture practices. The net land use GHG flux is therefore split into CO₂ and non-CO₂ components. Our land use sector overlaps with the “land use, land use change and forestry” (LULUCF) sector for national GHG reporting in line with the IPCC guidelines. However, LULUCF excludes emissions from livestock and fertiliser use, which are reported

separately as part of the “agriculture” sector; the latter is different from our IDBR “agriculture, forestry and fishing” industry sector.

Land use GHG emissions data for all National Parks is prepared by the Department for Business, Energy and Industrial Strategy (BEIS) through three subcontractors – Ricardo Energy & Environment, Centre for Ecology and Hydrology, and Forest Research – in accordance with the requirements to report UK Greenhouse Gas Emissions for the United Nations Framework Convention on Climate Change (UNFCCC). There is a risk that future improvements to the methodology for reporting land use GHG emissions might shift the sector from a net sink to a net source of emissions, as indicated within the Sixth Carbon Budget (2020).

For the Exmoor National Park, we employed an average between the BEIS land use emissions estimates and our own estimates derived from the habitat and peat data summary provided by the National Park Authority (Appendix 0), in conjunction with the new habitat and peat emission factors from the BEIS inventory (Appendix 10.8.8) and the relevant 2021 Natural England report⁶⁹. The main reason behind this approach is to capture emissions from degrading peatland more fully, particularly from the agriculturally managed peat which is very common in the National Park. The associated estimates for the current CO₂ and non-CO₂ emissions from peatland in the Exmoor National Park are provided in Appendix 10.8.8.

Table 4: Land use GHG emissions – The Exmoor National Park. The estimates represent an average of the BEIS figures and own results derived from the habitat and peat data for the National Park

Land use CO ₂	7,871	tCO₂e per year
Land use non-CO ₂	119,889	tCO₂e per year
Total: Land use	127,760	tCO₂e per year

Although the latest (BEIS) land use emissions estimates (2019) are more accurate than in previous years, they remain subject to considerable uncertainty. This is due to an evolving methodology and a process to refine the measurement of emission factors for UK peatlands, attempting to take into account transitions from heavily modified peatlands (forested land, cropland, grassland, peat extraction, eroding bog) and semi-natural peatlands (heather-dominated and grass-dominated bogs). Peatlands in their semi-natural state may be near-natural, modified, or rewetted. The estimates for CO₂ emissions in the form of dissolved organic carbon (DOC) use Tier 1 emission factors, and therefore are the least robust of all (IPCC 2014). Tier 2 emission factors for the UK-relevant peat condition categories were subsequently developed by Evans *et al.* (2017), providing estimates for “particulate organic carbon” (POC) emissions, as well as direct CO₂ emissions. The Tier 2 estimations add more granularity and are country-specific, being tested for robustness using at least four different study locations considered reliable enough to replace Tier 1 values. The CARBINE Tier 3 carbon accounting model developed by Forest Research was employed to derive the emission factor for forested peatland between 1990 and 2019, and was tested using field data⁷⁰. For the full set of assumptions made in order to estimate peatland emissions in the National Parks using the latest (2019) land use emissions data released by BEIS, please see Table 12 in Appendix 10.8.8 (Table A.3.4.28 in the BEIS methodology annex).

⁶⁹ <http://publications.naturalengland.org.uk/publication/5419124441481216>.

⁷⁰ Ricardo Energy & Environment, UK NIR 2020 (Issue 1): “UK GHG Inventory 1990-2019,” Annex p. 854.

In relation to the “family” of National Parks and AONBs, it is worth noting four key reports which outline implementation of land use policy, namely:

- The 25-Year Environment Plan⁷¹
- Climate Change Committee (2020) – Land Use: Policies for a Net Zero UK
- Climate Change Committee (2020) – The Sixth Carbon Budget: Agriculture and land use, land use change and forestry
- England Peatland Action Plan (2021).

Given that only 13% of England’s peatlands are estimated to be in a near-natural state at present, the Peatland Action Plan explicitly states that: “We will support National Parks and Areas of Outstanding Natural Beauty teams to deliver significant amounts of peatland restoration over the next 10 years⁷².” The next section reflects upon this guidance in terms of target-setting.

5.6. Factors for consideration in land use target-setting

To increase reliability of the land use data, the National Park Authority has undertaken its own GIS assessment of its key habitat types by area, as described in Appendix 10.8.9, which provides baseline area data for the target-setting discussed in Section 6. The GIS estimates are derived from best available evidence, including state of the art remote sensing data and local knowledge regarding habitat condition.

Reflecting upon the Sixth Carbon Budget (2021) we identify hectares-per-year targets for creating native broadleaf/mixed woodland, planting new productive coniferous woodland, restoring peatland, adopting agroforestry practices and increasing the extent of hedgerows (both of which improve grassland and cropland), adding legume species to improved grassland, and adopting winter cover cropping for cropland.

Please note that the land use GHG estimates for National Parks are published by BEIS, and given the existing levels of uncertainty they are expected to change in the future. Any changes introduced to the figures may impact on the proposed glide paths to net zero for all the UK National Parks and AONBs to varying degrees. It is expected that the BEIS land use data will be refined in subsequent years, and retrospectively applied to the entire published time series. Baseline year data will therefore be impacted in future years. Sections 5.6.1 to 5.6.5 discuss the importance of woodland, peatlands, and agricultural landscapes when developing subsequent strategies to implement LULUCF targets that support climate adaptation and mitigation.

5.6.1. Trees, woodlands and forestry

A notional target of 130 ha of new woodland per year proposed in Section 6 is based on apportioning UK-wide woodland targets from The Sixth Carbon Budget to the specifics of the habitat and peat areas in a given designated landscape. We focus on total canopy cover, which implies that new woodland could be created as a mosaic habitat across much of the landscape, rather than a single connected woodland area.

⁷¹ HM Government (2018), “A Green Future: Our 25-Year Plan to Improve the Environment.”

⁷² UK Government (2021), “England Peat Action Plan”, p. 12.

Our approach for apportioning the woodland target, which has been applied to all National Parks and AONBs participating in this programme, safeguards existing woodland (leaving aside the issue of replacing conifers with native broadleaf/mixed species), peatland and protected habitats such as lowland heathland, while also reflecting on the agricultural make-up of the area. However, it is recognised that this the apportioned target does not replace discussions by the relevant National Park Authorities, their members, partners and stakeholders in developing real-world operational strategies for land use change implementation, particularly in relation to developing a Tree, Forestry and Woodland Strategy.

There are multiple issues for stakeholders to consider including the complexities associated with the “right tree, right place” principle. Key to changing hearts and minds about the area of tree coverage is the public perception of natural beauty within protected landscapes and how much change is acceptable within historic landscapes. For instance, woodland design may benefit from emulating “natural” patterns and forms rather than linear boundaries, unless there is a historic precedent⁷³. There are also practical considerations in the choice of tree species to foster long-term resilience to the anticipated average temperature increases, increased average rainfall, more frequent flood events, and more severe drought periods driven by climate change. The Met Office has recorded a 1.1°C increase in average monthly maximum temperatures over the last 60 years or so, for the weather station in Liscombe⁷⁴. Natural England published another helpful report, worthy of review, examining the relative sensitivity of habitats to climate change⁷⁵.

Any new woodland planning requires multi-benefit opportunity mapping to identify the optimum strategic placement and economic considerations for farmers and landowners (e.g. “a wood that pays is a wood that stays”). Another key factor to consider is the UK’s demand for productive woodland to supply the construction and biomass industries, as well as sustainable woodland management. An example case study of where a local partnership has followed this approach to produce a woodland strategy is the Forest of Bowland Area of Outstanding Natural Beauty (2021) “Trees, Woodland and Forestry Strategy”.

5.6.2. Local authority opportunities

There are other opportunities to establish trees, some of them particularly town-friendly; for example, working with local authority partners to plant micro-forests, shrubs and hedgerows in urban settings such as parks and schools, and on public highways, e.g. roundabouts. These natural barriers can also offer some protection against air pollution if the correct species are chosen. Public highways can provide excellent spaces for pollinator patches, and the costs paid by local authorities to maintain these stretches can be reduced by changing grass-cutting regimes, as discussed, for example, in the Lancaster City Council (2021) Grassland Management Strategy⁷⁶ (see Box 1) and in the National Pollinator Action Plan (2021-2024)⁷⁷.

⁷³Forestry Commission (2017), “The UK Forestry Standard: The government’s approach to sustainable forestry.”

⁷⁴ <https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcj6tuher>.

⁷⁵ Climate Change Adaptation Manual, “Evidence to support nature conservation in a changing climate.”

⁷⁶ Lancaster City Council (2021), “Grassland Management Strategy”;

<https://www.lancaster.gov.uk/news/2021/feb/implementation-of-new-grassland-management-strategy>.

⁷⁷

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1077200/Pollinator_Action_Plan_2021_to_2024.pdf

Box 1: Sharing the learning example case study: Lancaster City Council Pollinator Patches

“Since the 1930s, England has lost 97% of its grasslands, with more than 500 species having disappeared, and more could yet follow, including hedgehogs and house sparrows. Lancaster City Council has developed several different cutting palettes specific to different grassed areas across the district, based on advice from experts in the field including Natural England, Butterfly Conservation, Lune Valley Pollinators, landscape architects and ecologists. The nine cutting palettes are public open space, managed long meadow, desirelines, meadow edges, verges, amenity prestige, informal sports, and two types of wildflower meadows (introductory mix and perennial mix).”

Source: Extracts from LCC (2021) Grassland Management Strategy

5.6.3. Peatlands and wetlands

Peatlands are globally important in tackling climate change; they cover only 3% of the global land surface, yet hold nearly 30% of the world’s soil carbon⁷⁸. In the UK, peat soils account for nearly 33% of land cover⁷⁹. According to the UK Peatland Strategy (2018) peatlands form the UK’s largest expanse of semi-natural habitat occupying 10% of the UK’s land area and are extremely important habitats. They are our largest terrestrial carbon store, a haven for rare wildlife, and natural providers of water regulation, with 13% of the world’s blanket bog formed in the UK.

Both the UK Peatland Strategy (2018-2040) and the Sixth Carbon Budget (2020) recommend that Peatlands are widely restored to their natural state and managed sustainably. It is estimated that eighty percent of peatlands in the UK have been modified as a result of past and present management⁸⁰.

There are three broad types of peatland in the UK:

- Blanket bog (globally rare and typically found in uplands)
- Raised bog (mainly found in lowlands)
- Fens (fed by both surface and groundwater)

Peatland areas in the Exmoor National Park largely consist of the former blanket bog communities - heather grassland, improved grassland and acid grassland; however, there are also substantial areas of peat within the heather, bog, broadleaved woodland and coniferous woodland habitats.

Peat restoration involves raising the water table nearer to the surface and re-establishing peat-forming fen or bog vegetation. Peatlands damaged by drainage and other human activities can rapidly lose their stored carbon, predominantly in the form of carbon dioxide (CO₂) release to the atmosphere. It’s worth stating that peatlands are complex; they both emit and capture CO₂, and the

⁷⁸ IUCN National Committee United Kingdom (2021) “About Peatlands”; <https://www.iucn-uk-peatlandprogramme.org/about-peatlands>.

⁷⁹ IUCN National Committee United Kingdom (2018) “UK Peatland Strategy 2018-2040”, p. 25.

⁸⁰ IUCN National Committee United Kingdom Peatland Programme (2021) “Peatland Damage”; <https://www.iucn-uk-peatlandprogramme.org/about-peatlands/peatland-damage>.

balance between these processes depends on the peatland's condition. Peatlands may also be either sources or sinks of methane, and sources of nitrous oxide. However, the evidence suggests that, overall, peatland restoration delivers greenhouse gas benefits by protecting stored carbon and drastically reducing the amount of carbon dioxide emitted, even after factoring in the initial increase in methane emissions following re-wetting⁸¹.

We estimate that peat soils account for up to 47% of Exmoor National Park's land area. Restoring peatland is therefore of large significance for the National Park, although it is not clear how much of the former blanket bog area can be restored as functioning peat bog. The Exmoor Mires Partnership has been investigating and restoring peatlands in the uplands of Exmoor for the past 20 years⁸², including assessments of the peatland condition, the habitat types and the associated areas featuring peat soils, which has allowed the Partnership to identify priorities for peatland restoration in the National Park.

5.6.4. Blue carbon sequestration

Marine and coastal carbon sequestration, or "blue carbon", techniques are increasingly recognised as important solutions to climate change. However, the carbon sequestration processes in these habitats are relatively understudied compared to terrestrial habitats such as woodlands and peatlands, and their carbon storage potential is less well understood as a result⁸³. The practicalities of creating and maintaining these sequestering marine habitats are, in general, also less industry-ready compared to terrestrial climate solutions⁸⁴. As such, they have not been included in the projections for future carbon sequestration provided in this report. With sufficient data in the future, blue carbon sequestration may allow the Exmoor National Park to accelerate its carbon sequestration efforts and help reach an earlier Net Zero date.

A 2021 Natural England report found that most UK studies analysing blue carbon habitats only cover small geographic areas, for example the south coast of England or west coast of Scotland⁸⁵. For some habitats, like seagrasses, carbon sequestration estimates largely come from European and global studies which have vastly different climate conditions and abundance compared to the UK. Because of this lack of the local UK evidence, the available estimates of carbon storage rates for various distinct blue carbon habitats may not accurately represent different areas of the UK. However, restored saltmarshes in Eastern England are estimated to have initial sequestration rates of 3.9 tCO₂e/ha/year (declining to 2.4 tCO₂e/ha/year after 20 years), while kelp forests in Scotland are estimated to sequester 1.47 tCO₂e/ha/year. Studies of seagrasses in temperate waters are estimated to sequester between 0.42 to 1.36 tCO₂e/ha/year⁸⁶. It may therefore be a worthwhile endeavour for the Exmoor National Park to create or restore blue carbon habitats along its coastline.

⁸¹ "Carbon storage and sequestration by habitat: a review of the evidence (second edition)." Natural England Research Report NERR094.

⁸² <https://www.exmoor-nationalpark.gov.uk/Whats-Special/moorland/exmoor-mires-project>

⁸³ <https://www.frontiersin.org/articles/10.3389/fmars.2022.851448/full>.

⁸⁴ <https://www.frontiersin.org/articles/10.3389/fclim.2020.575716/full>.

⁸⁵ Natural England (2021). "Carbon storage and sequestration by habitat: a review of the evidence (second edition; October 2021), Chapter 6 – Marine and coastal habitats", p. 149-171.

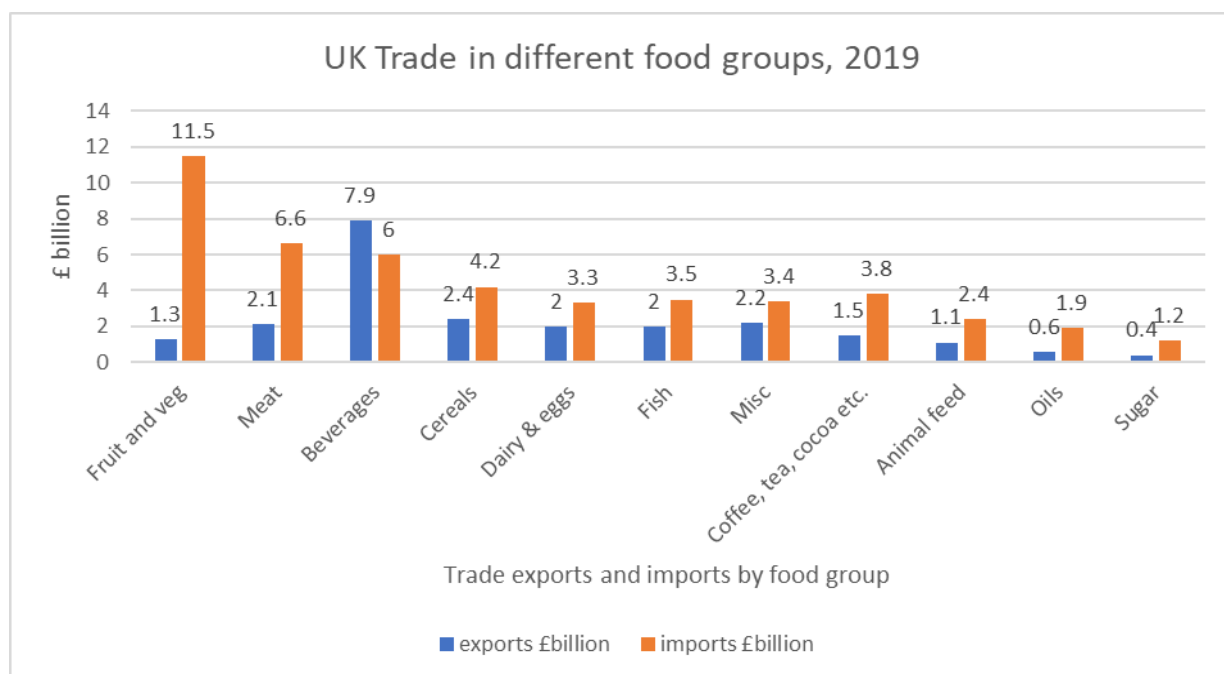
⁸⁶ PostNote Blue Carbon (September 2021).

Another important avenue for coastal carbon sequestration in the Exmoor National Park is a relatively new saltmarsh establishing in the Porlock Bay, which has been identified as an important habitat in terms of carbon sequestration and storage^{87,88}.

5.6.5. Agricultural landscape and food production

In considering land use and land use change potential, it is also important to understand the nature of the land in the protected landscape and how it contributes to UK food security. The UK is a net importer of food (Figure 17). Only 55% of food consumed in the UK (by economic value) is of UK origin, with 26% imported from Europe⁸⁹.

The Agricultural Land Classification System (England and Wales) identifies six grades of land. Grades 1, 2 and subgrade 3a are considered the “best and most versatile” land category in the current planning system⁹⁰. This land is deemed to be the most flexible and productive, and the best to deliver future crops for food and non-food uses (such as biomass, fibres and pharmaceuticals). Subgrade 3b is deemed only moderate-quality agricultural land, with substantial limitations that affect the choice of crop, level of yield, and/or timing and type of cultivation/harvesting. Grades 4 and 5 both designate poor-quality agricultural lands. Along with level 3b they offer, in general terms, the greatest opportunities for land use change, even though agricultural land of poorer quality can still be important for landscape, wildlife or the historic environment. A land use change could be marginal or could raise possibilities for larger projects such as woodland creation, peatland restoration and grassland improvement. However, we suggest reviewing all opportunity mapping in the context of regional food production and security, given that the UK is a net importer of food; see Figure 17.



⁸⁷ <https://www.exmoor-nationalpark.gov.uk/learning/coastal-management-in-porlock-bay>.

⁸⁸ <https://www.exmoor-nationalpark.gov.uk/Whats-Special/porlock-marsh-vision>

⁸⁹ GOV. UK (2021) “National statistics: Food Statistics in your pocket: Global and UK supply”;

<https://www.gov.uk/government/statistics/food-statistics-pocketbook/food-statistics-in-your-pocket-global-and-uk-supply>.

⁹⁰ There are relatively few areas of agricultural land which fall within these grades in the Exmoor National Park, and they are found predominantly within Porlock Vale.

Figure 17: UK trade in different food groups, 2019

5.6.6. UK Timber production context

The UK is heavily reliant on imported timber; timber products worth £7.5 billion entered the UK in 2020, compared to exports of £1.5 billion. The UK mostly uses timber in sawmills, for making wood-based panels, and increasingly for wood fuels (although this remains a small proportion of the total). In 2020 the UK softwood industry harvested around 10 million green tonnes, and the hardwood industry 0.8 million green tonnes⁹¹. This only satisfies around a fifth of current UK demand; the rest is met by imports from Sweden, Norway, the USA and other countries. This makes the UK the world’s second-largest importer of wood, which poses a risk to the security of supply for construction and manufacturing⁹². The House of Commons’ Environmental Audit Committee has launched an inquiry into the links between the sustainability of the UK’s timber industry, imports of key commodities, and global deforestation⁹³. UK’s National Parks and other designated landscapes have an important role to play in providing sustainable supply of timber for domestic consumption.

Figure 18 illustrates timber imports and total consumption in the UK, as reported by Forest Research.

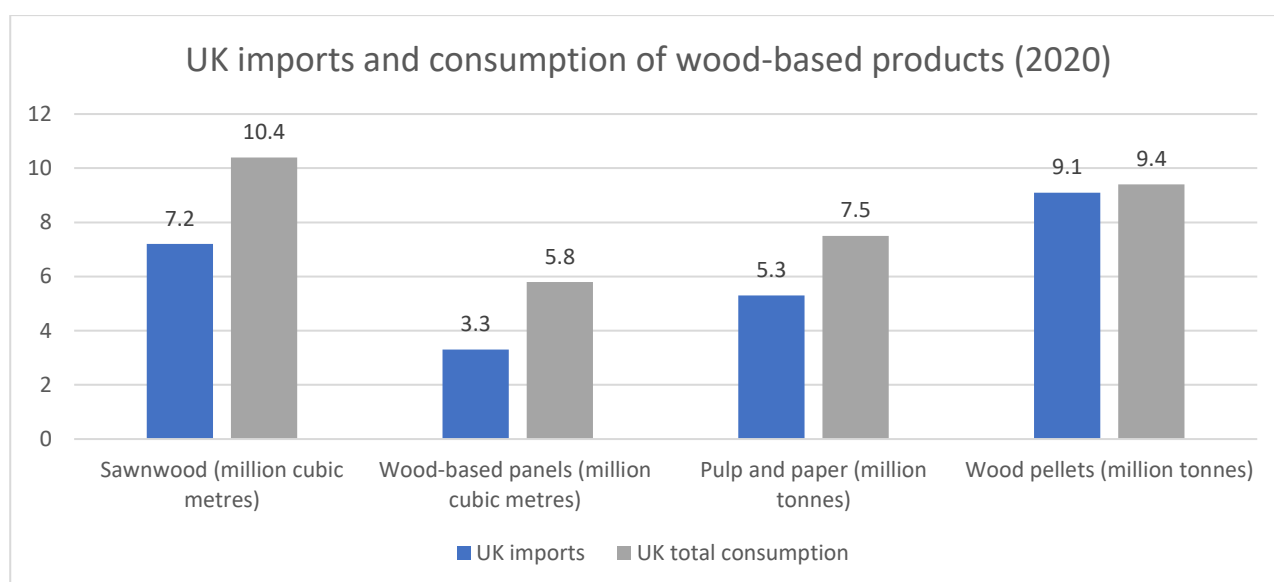


Figure 18. Source: Forest Research (2021) “UK Wood Production and Trade: provisional figures, 2020 release”

Demand for wood from UK forests continues at unprecedented levels, but the market remains constrained by a lack of supply. There is rising demand for wood, but limited availability due to long rotation periods, diversification into tangible assets, and increasing recognition of the environmental benefits of woodlands. There may also be new opportunities for monetisation, such as woodland carbon code credits. Capital values are therefore rising, although there is concern within the industry as to whether this trend is sustainable. The value of growth for the UK forestry market in 2018 showed a 19% drop in supply; however, the overall market value went up by nearly

⁹¹ Forest Research (2021) “UK Wood Production and Trade: 2020 Provisional Figures.”

⁹² Tilhill (2022) “Confederation of Forest Industries Warns More Tree Planting is Urgently Needed to Avoid UK Facing Crisis in Wood Supply”, <https://www.tilhill.com/resource-hub/our-news/confederation-of-forest-industries-warns-more-tree-planting-is-urgently-needed-to-avoid-uk-facing-crisis-in-wood-supply/>.

⁹³ <https://committees.parliament.uk/call-for-evidence/2713/>

6%, meaning a 30% increase in the average value per gross hectare, although this value varies according to region. In contrast, Savills (2019) states that in the north of Scotland prices are relatively low and static, indicative of “the geography and productive capacity of the woodland resource, with large areas of low-quality softwood, remote from timber markets and often challenging to harvest”⁹⁴. In terms of the timber marketplace, the best softwood parcels traded at higher prices of £79 per cubic metre in 2021 (Softwood Sawlog) compared to small roundwood sales of almost £38 per cubic metre⁹⁵. This is in contrast to carbon credits (for carbon sequestration) sold on the UK open market at £10-25 per tCO₂e⁹⁶ (Forest Research states 1.25 to 1.43 cubic metres per tonne for harvested roundwood). It is possible to sell woodland carbon units to help finance and incentivise a planting project, in addition to the England Woodland Creation Offer scheme⁹⁷, and depending on which of the management options one enters into, there is the potential to sell timber, too.

⁹⁴ Savills (2019) “The Forestry Market: UK Rural – March 2019,” p.3.

⁹⁵ Forest Research (2021) Timber Price Indices <https://www.forestresearch.gov.uk/tools-and-resources/statistics/statistics-by-topic/timber-statistics/timber-price-indices/>.

⁹⁶ Strutt & Parker (2021) Rural Hub: “5 ways to generate income from carbon farming.”

⁹⁷ <https://www.gov.uk/guidance/england-woodland-creation-offer>

6. A vision for a low-carbon National Park: GHG targets

This section outlines the aspiration for the Exmoor National Park in setting a challenging pathway to reach a consumption-based Net Zero by 2035 and subsequently to become a carbon sink as one of the “lungs” of the Southwest region contributing to the UK’s Net Zero target. The 2035 net zero date reflects on the unique characteristics of the landscape and should not be taken in isolation as a level of ambition. It uses 2019 (rather than 2022) as the base year and assumes that the recommended decarbonisation and carbon sequestration efforts, including land use change, ratchet up to the required levels immediately in the base year of the assessment. In reality, the high levels of ambition for different sectors explored in this report are likely going to take several years to achieve even as of 2022, which could push the projected net zero year back until the early 2040s.

To deal with certain targets such as energy, we have taken a pro-rata approach for all National Parks based on a percentage of GHG emissions. However, the land use sector requires a bespoke approach of setting UK targets in proportion to known key habitats within the Exmoor National Park boundary, and uses area assumptions.

Six categories of emissions were selected for the original Lake District National Park assessment and have been chosen in order to find a best fit between the competing desires to:

1. Cover everything of significance within the influence of policymakers (both through direct management responsibilities and through broader partnerships);
2. Keep the target simple enough to describe;
3. Avoid double-counting;
4. Make use of any readily available data for tracking progress.

As a result, the scope for the target categories is slightly different from that of the overall emissions assessment in Section 5 and contains elements of both the consumption-based and production-based footprint estimates (Section 4). The six target categories are summarised below, with further supporting data in Appendix 10.8.5.

Understandably, most of these emissions are not directly within the management responsibilities of the National Park Authorities or Local Authorities for the AONB. However, through their partnership work, local authorities are often able to engage with a wide range of stakeholders, and, in addition to their statutory powers, local authorities could use this influence to play a leading role in communicating the extent of greenhouse gas emissions and advocating for far-reaching measures to reduce them.

- **Target Category 1: Energy-only greenhouse gas emissions.** This includes emissions relating to energy use within the National Park by residents, visitors and industry. It includes emissions from roads, except those from (estimated) through-traffic that does not stop in the National Park. This target has been chosen because relatively high-quality data is regularly published by BEIS, and because it covers a significant proportion of the total emissions. Furthermore, its selection allows us to draw on a robust tool developed by the Tyndall Centre for Climate Change to help local authorities establish Paris-aligned trajectories for energy-only emissions reduction in local areas.

- **Target Category 2: Food and drink consumed by residents and visitors.** This includes food and drink at the point of purchase in shops as well as from hospitality businesses. A food and drink target is important because when measured on a consumption basis, this category represents roughly a quarter of UK residents' emissions.
- **Target Category 3: Other goods purchased by residents and visitors while in the area.** This includes all purchases of tangible non-food and drink items such as clothing, electronic equipment, furniture, soft furnishings and cars. This target is important because it brings two particular elements into the landscape's carbon management agenda: sustainable consumption of non-edible products, and circular economy principles into the National Park's carbon management agenda.
- **Target Category 4: Visitor travel to and from the area.** We include here only travel within the UK, not visitor travel to the UK. International travel is omitted purely due to the practical difficulty of tracking change (as described in Appendix 10.8); visitor aviation emissions are still an important consideration for policymakers.
- **Target Category 5: Land use non-CO₂ component.** This includes all net non-CO₂ emissions from land within the National Park or AONB, and most notably includes enteric emissions from ruminants, and emissions from manure and fertilizer use. A comparatively small contribution to the non-CO₂ land use emissions comes from a range of ecosystems, in both near-natural and modified states, for example from peatlands releasing methane.
- **Target Category 6: Land use CO₂ component.** This most notably includes emissions from degrading peat and carbon sequestration by woodland, farm trees, hedges and soils (including healthy peat) in the National Park or AONB. It is the only emissions category that stands to become negative, relative to present-day values, through land use and management targets. This involves reducing peatland emissions through restoration projects, and also sequestering carbon by creating new woodlands, switching to agroforestry systems, extending hedgerows and adopting better practices for managing agricultural soils. Therefore, the CO₂ land use component could well enable "net zero" and "net negative" emissions in any of the National Parks.

Across these six categories, the 2019 carbon baseline for the Exmoor National Park (with elements of production-based territorial emissions; Section 4) is estimated at 361,063 tCO₂e per year (Figure 19).

Following the principles outlined above, some components of the wider carbon footprint of the Exmoor National Park presented in the previous sections have been excluded from the 2019 carbon baseline and the associated emissions reduction targets. These excluded components are:

- Residents' travel by air, ferries, trains, buses and other transport (excl. cars). Local public transport will be counted through the energy GHG emissions linked to local industry (Target Category 1 above), and resident's travel outside of National Park is beyond the scope of influence by local authorities
- Residents' holiday accommodation outside the National Park
- Residents' housing (construction and maintenance). Local construction companies' energy use will be counted through the energy GHG emissions linked to local industry (Target Category 1 above)

- Residents’ health, education and other public services. Local providers’ energy use will be counted through the energy GHG emissions linked to local industry (Target Category 1 above)
- Residents’ and visitors’ other bought services (e.g. financial, telecoms, travel agents, hairdressers). Local providers’ energy use will be counted through the energy GHG emissions linked to local industry (Target Category 1 above)
- Residents’ and visitors’ art, sport and other leisure activities. Local providers’ energy use will be counted through the energy GHG emissions linked to local industry (Target Category 1 above)
- Residents’ and visitors’ water, waste and sewerage. Local providers’ energy use will be counted through the energy GHG emissions linked to local industry (Target Category 1 above)
- Industries’ supply chains (both within and outside the National Park)

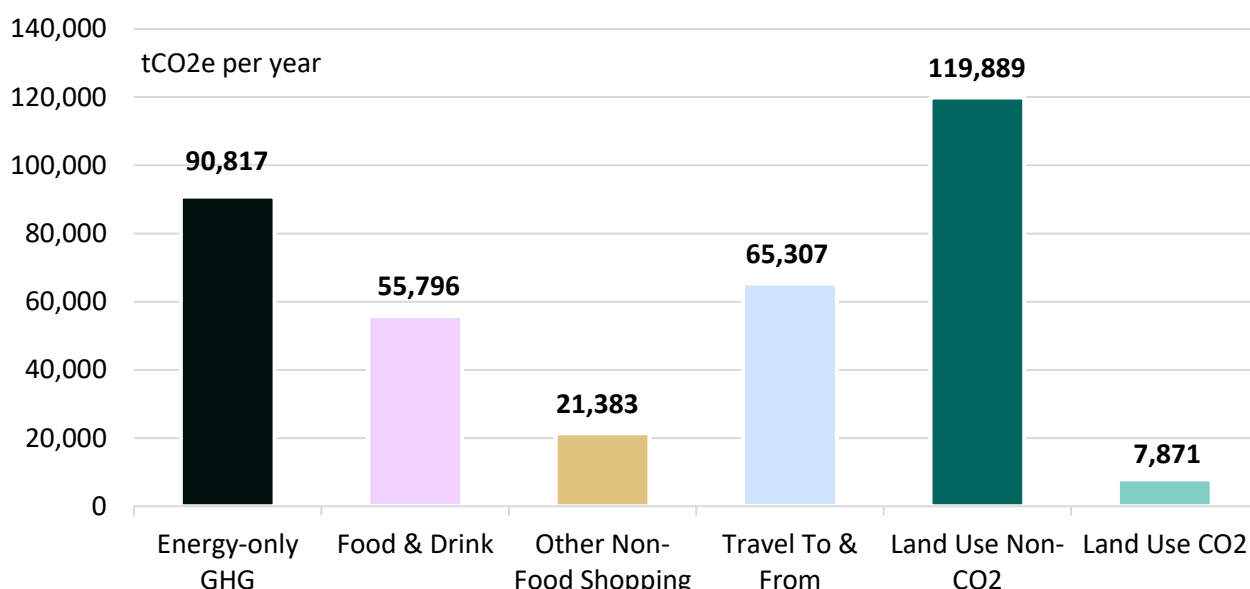


Figure 19. GHG emissions baseline for the Exmoor National Park represented using six broad categories of emissions introduced in the text

Our expectation is that these footprint components will be tackled, where appropriate, by the other local authorities, the UK Government, international climate agreements, and the local, national and international industries responsible for the respective types of emissions.

Our recommended target trajectories are summarised in Table 5, and represent the minimum that can be considered to be Paris-aligned. For some of the target areas where primary data is lacking, an element of expert judgement has been applied to determine what is required. The targets have been set to fit with the best available science and the latest policy recommendation. Some or all will require appropriate support from government in order to be feasible, and part of the role of each National Park Authority may be to push for the necessary support.

Table 5. Decarbonisation targets for the selected components of carbon footprint. For further details, see Appendix 10.8.7

Category	New Model for All National Parks and AONBs (2021) – used in this report	Achievable ceiling
1. Energy only GHG emissions (incl. supply chains) by residents, visitors and industry	12.8 % (specific to Exmoor National Park) reduction per year	5% of present-day emissions
2. Food consumed by residents and visitors	5% reduction per year	30% of present-day emissions
3. Other goods purchased by residents and visitors	5% reduction per year	10% of present-day emissions
4. Visitor travel to and from the National Park or AONB	10% reduction per year	7.5% of present-day emissions
5 & 6. Land use (non-CO₂ and CO₂)	We have split land use emissions and targets into non-CO ₂ and CO ₂ components. See Appendix 0 for further details	30% of present-day emissions for the non-CO ₂ component only; Achievable ceiling is not applicable for the CO ₂ component in the current assessment

The six elements outlined above can be combined into an overall decarbonisation pathway, which in the case of Exmoor National Park results in a net zero date of 2035. Note that targets 1 to 4 should be adjusted in proportion to any significant changes in resident and visitor numbers in the National Park.

Each trajectory, apart from that for the land use CO₂ component, has been based on exponential decay (emissions decreasing by the same proportion each year) towards residual unavoidable emissions in the long run. The proposed reductions are broadly aligned with the Paris Agreement and with the UK's 2050 net zero policy.

The land use CO₂ component has been assumed to change linearly with time, which is characteristic of gradual uptake of a number of measures to manage land sustainably, increase its carbon uptake (and/or reduce CO₂ emissions through restoring peatland), and enhance biodiversity. The rate of change has been drawn from the Sixth Carbon Budget and apportioned to Exmoor National Park according to its land characteristics (see Appendix Section 0).

When the Sixth Carbon Budget's apportionment methodology is applied to the Exmoor National Park, it produces the annual target for land use change summarised in Table 6, plus the associated annual increases in carbon sequestration flux. When measured in hectares per year converted, restored peatland target comes on top at 771 ha/yr., followed by legumes (improved grassland) at 555 ha/yr. and new native broadleaf/mixed woodland at 104 ha/yr. When converted to changes in carbon sequestration fluxes, peatland restoration (-5532 tCO₂e per year added each year) provides nearly 3 times more sequestration compared to the second-largest contribution from new native broadleaf/mixed woodland, and nearly 5 times more sequestration compared to the third-largest contribution from legumes (improved grassland) (Table 6). This clearly illustrates the priorities for land use measures in order to achieve Net Zero.

We emphasise that priority must be given to managing agricultural land sustainably, both to enhance soil carbon sequestration, and to achieve co-benefits such as biodiversity gains and flood

risk mitigation⁹⁸. However, global evidence shows that soil carbon sequestration is a slow process, and requires the necessary management practices to be maintained indefinitely. Also, despite one’s best efforts, carbon sequestration in soils tends to reach saturation over time (years/decades), and it is vulnerable to climate change as predicted increases in flood events are likely to increase soil erosion⁹⁹. Typical sequestration values associated with regenerative agricultural practices (such as agroforestry, hedging, and growing legume-rich grasses and cover crops) are estimated to be between 1 and 3 tCO₂e per year per hectare in the first couple of decades. This is only a small fraction (a fifth to a tenth) of the carbon sequestration benefits typically achieved by creating new woodland on similar timescales, which – due to its natural simplicity and its age-old familiarity – is always going to be the main source of carbon sequestration, and delivers wider co-benefits such as biodiversity gains. Healthy soils alone cannot reverse the negative effects associated with centuries-long conversion of natural landscapes to pasture and cropland, nor can they offset the broad-ranging emissions associated with our economic activities. It is therefore imperative that regenerative agricultural practices aimed at enhancing soil carbon stocks go hand in hand with ambitious woodland creation (and where applicable, peatland restoration) programmes.

Table 6: Exmoor National Park: Apportioned Sixth Carbon Budget targets for land use change and the associated additions to annual carbon sequestration fluxes (see Appendix 10.8.9 for further details). These targets need to be maintained until 2050 under the proposed pathway

Proposed Land Use Targets	Value	Units
New Native Broadleaf / Mixed Woodland	104.0	ha per year
New Productive Coniferous Woodland	26.0	
Restored Peatland	770.7	
Agroforestry (improved grassland & cropland)	76.3	
New Hedgerows (improved grassland & cropland)	4.4	
Legumes (improved grassland)	554.8	
Cover Cropping (cropland)	38.4	
Associated Carbon Sequestration	Value	Units
New Native Broadleaf / Mixed Woodland	-1,919	tCO ₂ e per year capacity added each year
New Productive Coniferous Woodland	-575	
Restored Peatland	-5,532	
Agroforestry (improved grassland & cropland)	-179	
New Hedgerows (improved grassland & cropland)	-46.4	
Legumes (improved grassland)	-1,139	
Cover Cropping (cropland)	-45.0	

Based on the target-setting assumptions outlined in Table 6 and in Appendix 10.8.5, the Exmoor National Park will achieve a total cumulative reduction in the net annual GHG emissions of 561,131 tCO₂e per year between the base year (2019) and 2050. The net estimate includes both reductions in emissions and carbon sequestration, depending on the contributing footprint category.

⁹⁸ Bossio, D. A., *et al.* (2020). “The role of soil carbon in natural climate solutions.” *Nature Sustainability*, 3(5), 391-398.

⁹⁹ Frank, D., *et al.* (2015). “Effects of climate extremes on the terrestrial carbon cycle: concepts, processes and potential future impacts.” *Global Change Biology*, 21(8), 2861-2880.

Percentage breakdown of the projected total cumulative reduction in the net annual GHG emissions by individual footprint categories and land-based measures is provided in Figure 20.

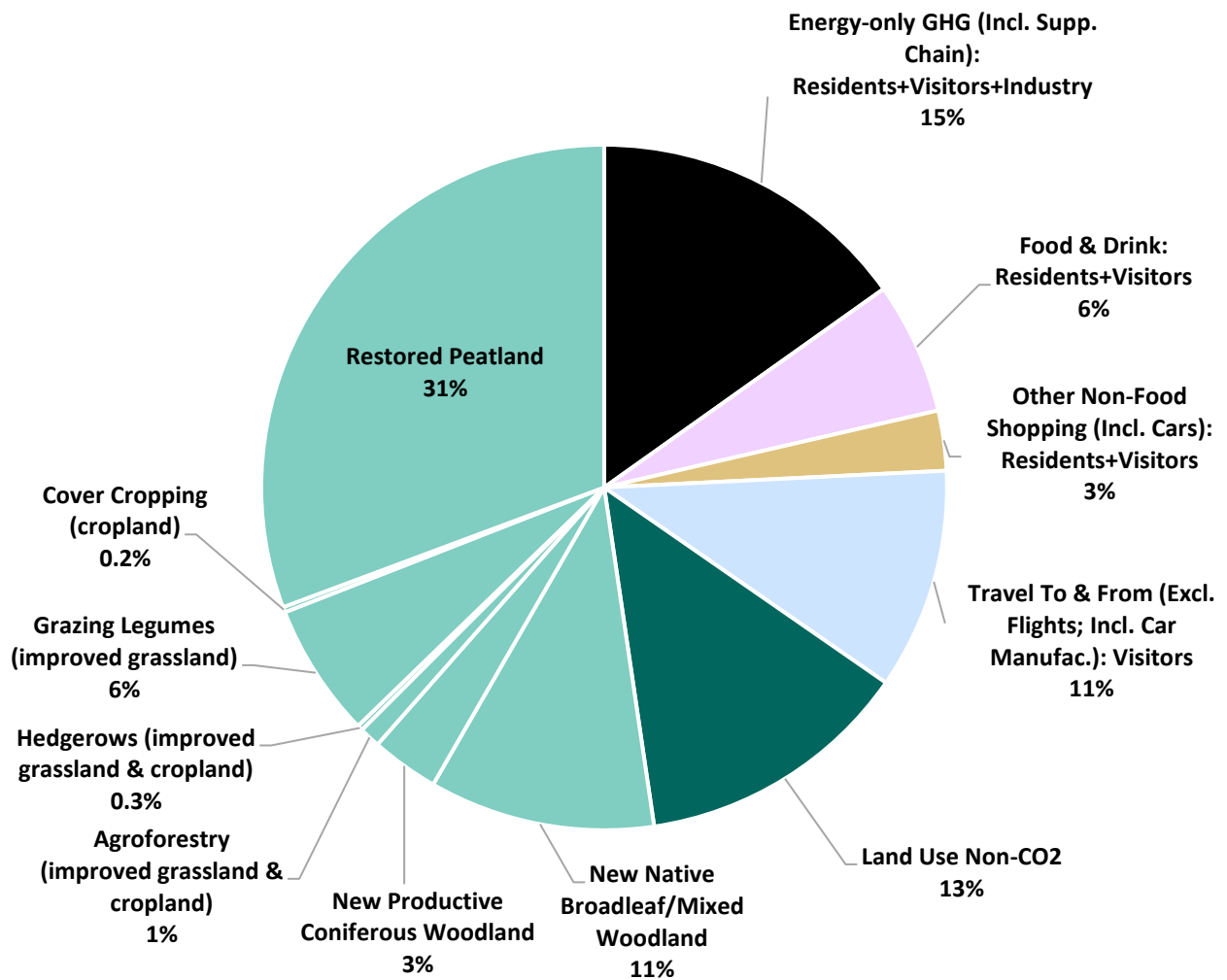


Figure 20. Percentage breakdown of the projected cumulative reduction in net annual GHG emissions for Exmoor National Park between the base year (2019) and 2050 according to the individual emitting categories and carbon sequestration measures considered in this assessment

The assumptions above imply that the Exmoor National Park would achieve Net Zero emissions in 2035 and will act as a net carbon sink in subsequent years (Figure 21). We note that the net zero date reflects the unique characteristics of the area, including the quantity and type of land, the number of residents and visitors and their consumption patterns, and the level and type of industrial activity (see earlier in this section for the target figures). It also assumes the recommended decarbonisation and carbon sequestration efforts, including land use change, ratchet up to the required levels immediately in the base year of the assessment. In reality, the high levels of ambition for different sectors explored in this report are likely going take several years to achieve, given that post-COVID emissions have largely rebounded, and that decarbonisation trends to date have been relatively small in magnitude compared to what we know is required for keeping global warming below the safer 1.5°C limit from the Paris Agreement. These factors are expected to push the

projected net zero year back by several years. The stated net zero date on its own should therefore not be taken as the main level of ambition to decarbonise for a given landscape.

We also note that the 2035 net zero projection is based on the assumption that the areas identified as peatland, which include “peaty soils” from the Natural England peat data, can be restored to functioning bog. This is highly uncertain and further research is needed to test it in the whole range of peaty soil scenarios, especially where the peat is in non-moorland areas. In the current assumption, peatland restoration is projected to contribute nearly a third (31%, Figure 20) of the recommended total cumulative reduction in the net GHG emissions for the Exmoor National Park between 2019 and 2050. This figure may have to be revised as further evidence regarding restoration of peaty soils emerges.

To explore the likely effect of the lags in ratcheting up emission reduction and carbon sequestration efforts to the recommended levels, we constructed an alternative pathway shown in Figure 22. This pathway starts with the same baseline emissions in 2022 rather than 2019, which is justified by the fact that emissions are understood to have largely rebounded to the 2019 levels following the COVID pandemic. The pathway also assumes that all the efforts take 5 years to ratchet up from the current incremental reductions in the net GHG emissions to the considerably more ambitious reductions, which are described in this report as being necessary to keep the 1.5°C target from the Paris Agreement on track. The delays imply that the Exmoor National Park is only going to reach net zero emissions in the early 2040s, therefore delaying the default 2035 net zero target by several years.

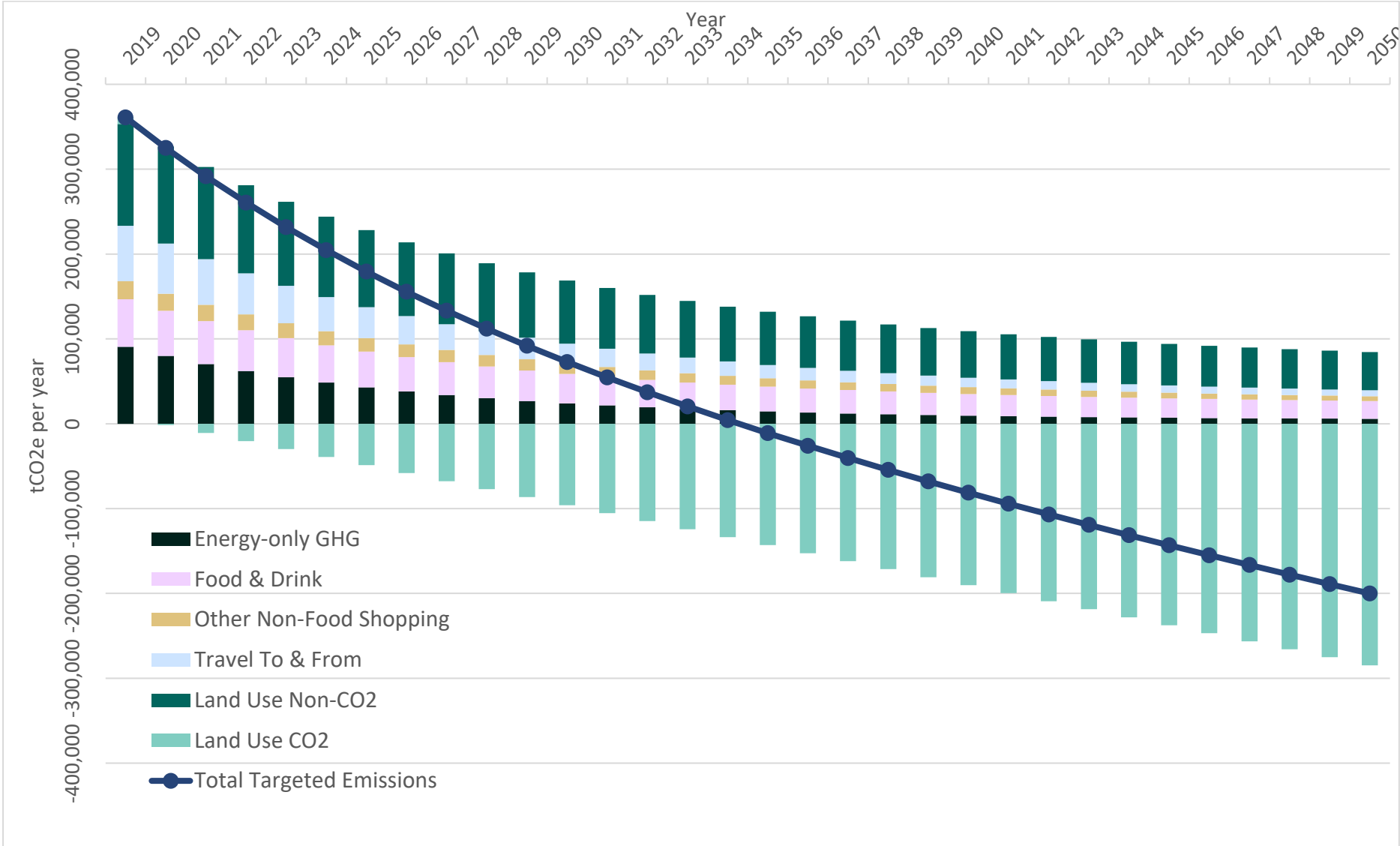


Figure 21. Recommended pathways for the Exmoor National Park across the six shortlisted categories of emissions between 2019 and 2050, reaching Net Zero in 2035 (repeat of Figure 6)

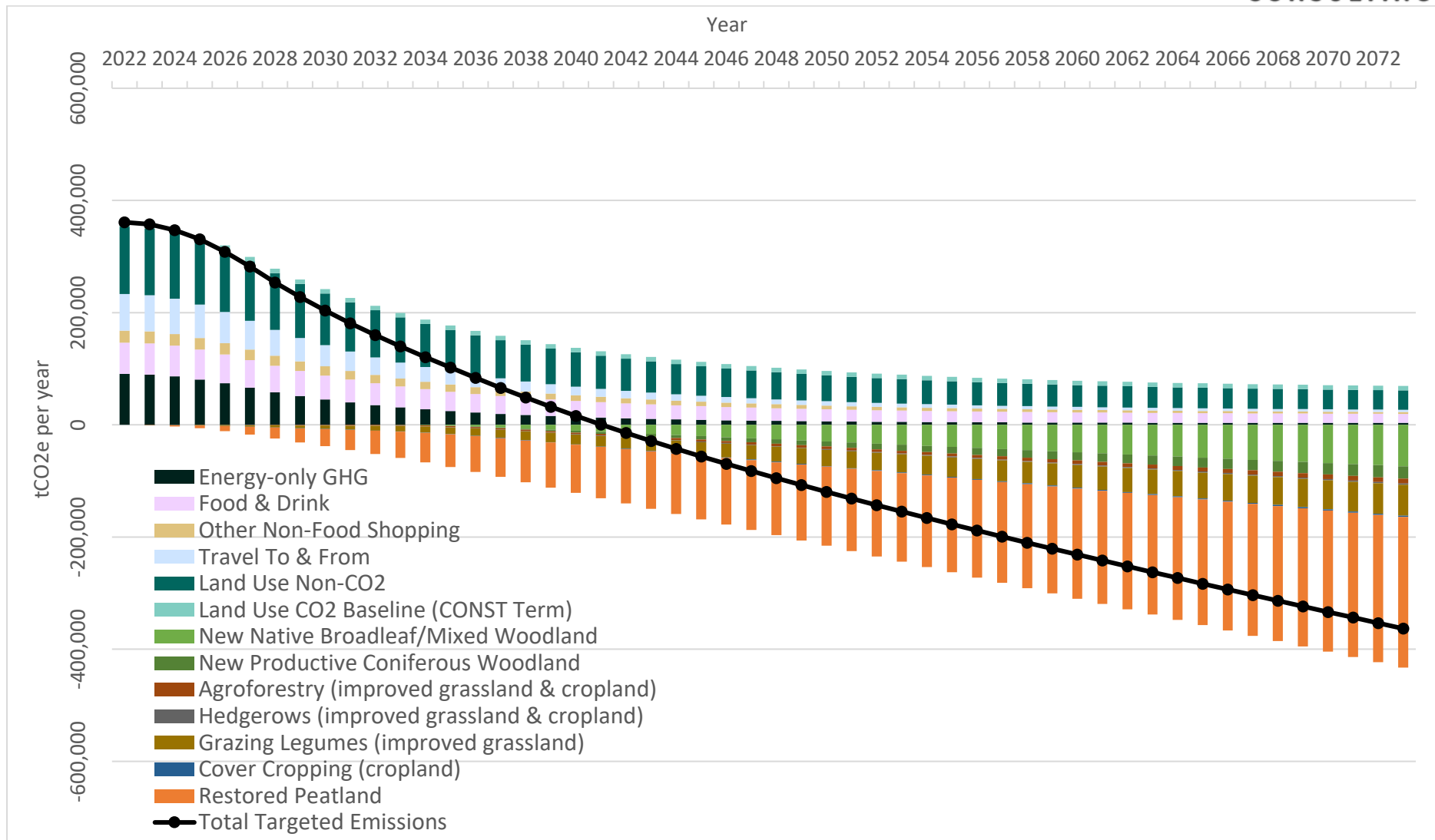


Figure 22. Exmoor National Park: Alternative pathway to Net Zero using 2022 as the base year (based on the 2019 data) and assuming 5-year lags in ratcheting up the efforts to the recommended levels

7. Conclusions and recommendations

The emissions assessment in this report is designed to bring every relevant area of carbon management into perspective for policymakers. A transition to a low-carbon future for Exmoor National Park entails strong action in many areas: construction, home energy, food production and diets, travel and transport, business energy use, the nature of tourism and the visitor experience, the circularisation of the material economy (including repair, maintenance, renting and reselling of consumer goods), and significant changes in land management.

The challenge is to find a coherent way of bringing these policy areas together, one that adds up to more than the sum of its parts and delivers an enhanced experience of living, working and spending time in the National Park.

The National Park Authorities' planning powers are a tool that can provide substantial leverage in:

- Preparing the construction sector for zero-carbon building (embodied GHG emissions),
- Ensuring that new buildings are energy-efficient and supplied with low/zero-carbon energy (operational energy / GHG emissions),
- Encouraging low/zero-carbon transport in new developments (cycling, electric vehicles, etc.),
- Implementing Ecosystems Services-oriented policies and Biodiversity Net Gain initiatives in new-builds,
- Encouraging refurbishment of existing buildings to ensure they are energy-efficient and supplied with low/zero-carbon energy.

If all the targets proposed in this report were met, Exmoor National Park would achieve net zero GHG emissions in 2035, using 2019 as the base year (not 2022). It would subsequently reach negative emissions of approximately -200,068 tCO₂e per year by 2050, with annual carbon sequestration in the Park scaling up to around -284,646 tCO₂e per year, and residual emissions dropping roughly to 84,578 tCO₂e across the shortlisted policy priority areas (23% of the present-day carbon footprint baseline).

Although designed to be the minimum Paris-aligned targets, the trajectories for each of the six components of the target are steep and challenging. This reflects the severity of the climate emergency in which the world now finds itself. The Exmoor National Park net zero date of 2035 should not be interpreted to mean that the target recommendation is stronger than the UK's 2050 net zero target, but rather as a reflection of the Park's proportionately greater capacity for carbon sequestration compared to the UK as a whole. In other words, the Exmoor National Park could act as one of the 'lungs' for the South West in the 2040s, making a vital and proportionate contribution to achieving nation-wide climate and broader environmental goals.

In meeting the targets, some help from outside the National Park can be expected, thanks to anticipated changes in the UK and global economy. For example, the electricity grid is endeavouring to decarbonise, and the use of electric vehicles will be more widespread, meaning less fossil fuel powering all forms of road transport. On top of this, the public may become increasingly carbon-conscious and choose more sustainable options, for example insulating their homes, installing

renewable heating systems and solar panels, and opting for less carbon-intensive diets. Last but not least, businesses would also want to play an active role in the transition to low carbon by cutting their direct emissions, while simultaneously opting for suppliers that provide products and services with lower embedded carbon, thus accelerating the transition across the whole value chain.

A very considerable degree of help can be expected to come from government policies, and where this is not sufficient, part of the role of the Exmoor National Park Authority and its partners will be to push for the support it needs in order to deliver the recommended targets. This will require an active engagement with all stakeholders, drawing on both existing and future relationships and partnership programmes with local organisations, with constituent Local Authority Districts and Counties, with the UK Government, and with the general public. It is through collaborative creative thinking, followed by sustained joined efforts by all stakeholders, that the exciting and realistic vision outlined in this report of how a low-carbon future may work for everyone in Exmoor National Park will become a reality.

Land management is central to all National Parks and deserves a separate discussion. The wide-ranging land use measures proposed for Exmoor National Park, dominated by restored peatland and new native broadleaf/mixed woodland, must be ambitious enough and sustained for long enough, for the sequestration flux to scale up sufficiently year on year, in line with the suggested land use CO₂ pathway. Establishing irreversible carbon sinks (with biodiversity co-benefits), however, is conditional on having suitable incentives being made available for land managers to implement land use changes such as woodland creation, peatland restoration and regenerative farming, in line with current recommendations by the UK Government.¹⁰⁰

Furthermore, public perceptions of how a protected natural landscape should look may also need to evolve, in order for people to continue visiting the National Park and finding it beautiful after changes in land use. Most UK National Parks and AONBs have considerable areas of low agricultural grade grassland and moorland, which create the landscapes familiar to many in the UK and abroad and can be of high value in terms of their historical landscape features, wildlife and access. However, centuries and millennia ago the majority of the UK was covered in woodland, compared to just 12% today, and relatively large swathes of land may need to be returned to this forested state in the coming years and decades, in line with climate goals. Visitors and residents' perception of natural beauty in these protected landscapes may therefore need to shift towards greater appreciation of more widespread woodland coverage, alongside restored peatland areas, applying the "right tree, right place" principle.

To assist with the transition towards the required land use and management options, there are a range of new funding opportunities which may be available to landowners, tenant farmers or public sector partners, depending on each set of grant conditions. These options are listed below.

Environmental Land Management Schemes (ELMS)

Three new schemes were piloted during 2021, and launched in 2022, to reward environmental land management: the Sustainable Farming Incentive, Local Nature Recovery (which will now be called

¹⁰⁰ UK 6th Carbon Budget; Agriculture, Forestry and Other Land Use section

Countryside Stewardship), and Landscape Recovery¹⁰¹. Through these schemes, according to current public communications, farmers and other land managers may enter into agreements to be paid for delivering the following: clean and plentiful water, clean air, thriving plants and wildlife, protection from environmental hazards, mitigation of and adaptation to climate change, beauty, heritage, and engagement with environmental law.

*Woodland grants and incentives*¹⁰²

- Forestry Commission Local Authority Treescapes Fund
- Forestry Commission Urban Tree Challenge Fund
- Woodland Creation Planning Grant
- HS2 Woodland Fund (land must be within a 25-mile zone of phase one of the HS2 route from London to the West Midlands)
- England Woodland Creation Offer (new grant scheme for farmers and landowners to encourage investment in woodland creation)
- Woodland Carbon Code or Scottish Forestry Grant Scheme
- Woodland Carbon Guarantee
- Countryside Stewardship grants
- Woodland Creation and Maintenance part of Countryside Stewardship
- Woodland Tree Health part of Countryside Stewardship
- Woodland Improvement (WD2 and capital items) part of Countryside Stewardship

Peatland restoration

- Peatland Code
- Nature for Climate Peatland Grant Scheme

As a response to the climate and ecological emergency, we hope that the National Park Authority members and partners welcome this greenhouse gas emissions assessment, its findings and recommendations to help the partnership support decarbonisation and plan actions for change.

¹⁰¹ <https://www.gov.uk/government/publications/environmental-land-management-schemes-overview/environmental-land-management-scheme-overview>.

¹⁰² <https://www.gov.uk/government/publications/woodland-grants-and-incentives-overview-table/woodland-grants-and-incentives-overview-table>.

8. Acronyms

AFOLU	Agriculture, Forestry, and Other Land Use
BEIS	UK Government Department for Business, Energy and Industrial Strategy
CH ₄	Methane
CO ₂	Carbon Dioxide
COA	Census Output Areas
DACCS	Direct Air Capture with Carbon Storage
DEFRA	Department for Environment, Food and Rural Affairs
DOC	Dissolved organic carbon
EV	Electric vehicle
GIS	Geographic Information System
GDPR	General Data Protection Regulations
GWP	Global warming potential
GVA	Gross Value Added
Ha	Hectares
HFCs	Hydrofluorocarbons
IDBR	Office for National Statistics' Inter-Departmental Business Register
LEP	Local Enterprise Partnership
LULUCF	Land Use, Land Use Change and Forestry
NAEI	National Atmospheric Emissions Inventory
NFU	National Farmers' Union
N ₂ O	Nitrous Oxide
ONS IDBR	Office of National Statistics' Inter-Departmental Business Register
PFCs	Perfluorocarbons
POC	Particulate organic carbon
SPD	Sustainable Construction Supplementary Planning Document
SF ₄	Sulphur Hexafluoride

9. Glossary

Adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate change and its effects (IPCC AR5 Glossary Annex 11)

Air pollution: Degradation of air quality with negative effects on human health or the natural or built environment due to the introduction, by natural processes or human activity, into the atmosphere of substances (gases, aerosols) which have a direct (primary pollutants) or indirect (secondary pollutants) harmful effect (IPCC, 2018: Annex 1: Glossary [Matthews, J.B.R. (ed)]).

Anaerobic digestion: Anaerobic digestion (AD) is a natural process in which plant and animal materials are converted into useful products by micro-organisms in the absence of air. The process releases biogas (mainly a mixture of around 60% methane and 40% carbon dioxide), which can be used directly to provide heat, power or transport fuel. Biogas can also be purified by removal of the carbon dioxide to produce biomethane, which can be fed directly into the public natural gas grid in the same way as natural gas or used as a vehicle fuel. The types of materials suitable for AD include food waste, slurry and manure, crops and crop residues (DEFRA, GOV.UK, published 9th December 2021).

Anthropogenic emissions: Emissions of greenhouse gases, greenhouse gas precursors and aerosols caused by human activities. These activities include the burning of fossil fuels, deforestation, land use changes, livestock production, fertilization, waste management, and industrial processes (IPCC AR5 Glossary Annex 11).

Anxiety: A feeling of stress, panic or fear that can affect your everyday life physically and psychologically (NHS, 2021).

Asthma: A common lung condition that causes occasional breathing difficulties. It affects people of all ages and often starts in childhood, although it can also develop for the first time in adults. There's currently no cure, but there are simple treatments that can help keep the symptoms under control (NHS, 2021).

BEIS pollution inventory: The UK Government (department for Business, Energy and Industrial Strategy (BEIS)) produces an annual greenhouse gas inventory for local authorities and large industrial sites that act as point-sources of emissions, which forms a consistent time series of UK greenhouse gas emissions from 1990 onwards (www.gov.uk, 2021).

Biodiversity: Biological diversity means the variability among living organisms from all sources, including *inter alia*: terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (UN, 1992).

Biodiversity net gain: Biodiversity net gain (BNG) is an approach to development, and/or land management, that aims to leave the natural environment in a measurably better state than it was beforehand (Local Government Association, 2022).

Carbon capture and storage: The process of capturing and storing carbon dioxide (CO₂) before it is released into the atmosphere (Grantham Research Institute on Climate Change and the Environment, 2018).

Carbon intensity: The amount of emissions of carbon dioxide (CO₂) released per unit of another variable such as gross domestic product (GDP), output energy use or transport (IPCC, 2018: Annex 1: Glossary [Matthews, J.B.R. (ed)]).

Carbon flux: A carbon flux is the amount of carbon exchanged between Earth's carbon pools, i.e. the oceans, atmosphere, land and living things, during a specified time period (e.g. a day or a year).

CARBINE model: A modelling tool used to estimate the carbon stocks of stands and forests (in living and dead biomass and soil), and any associated harvested wood products. It is also used to estimate the greenhouse gas emissions avoided through the use of wood products that displace fossil fuels and fossil-fuel intensive materials (Forest Research, 2021).

Catapult (energy systems): Energy Systems Catapult was set up to accelerate the transformation of the UK's energy system and ensure that UK businesses and consumers capture the opportunities of clean growth. The Catapult is an independent, not-for-profit centre of excellence that bridges the gap between industry, government, academia and research. The Catapult takes a whole-systems view of the energy sector, helping it identify and address innovation priorities and market barriers in order to decarbonise the energy system at the lowest cost (Catapult Energy Systems, 2021).

Consumption-based footprint assessment: This means assessing the greenhouse gas "footprint" of residents, visitors and industry in a given landscape, including the entire lifestyles of residents, visitors' travel to and from the area, and supply chains of industry. Put differently, consumption-based footprint assessment includes everything that residents and visitors buy and do while in the landscape, as well as their travel to and from the area. Consumption-based reporting attributes the emissions from product and service supply chains to the landscape, regardless of where emissions are physically released during production (Small World Consulting, 2022).

Coronary heart disease (CHD): A major cause of death in the UK and worldwide. CHD is sometimes called ischaemic heart disease or coronary artery disease, and describes what happens when blood supply to the heart is blocked or interrupted by a build-up of fatty substances in the coronary arteries.

Census output areas (COAs): The 2001 Census Output Areas are designed specifically for statistical purposes. They are based on data from the 2001 Census and were built from postcode units. Output Areas are used not only for Census output but also as the basis of Super Output Areas, which have been introduced as stable and consistently sized areas for Neighbourhood Statistics. (ONS, 2022).

Climate action: Actions taken to pursue the goal of positive change for the climate.

Cumbria's Zero Carbon Programme: The Zero Carbon Cumbria Partnership is working towards the shared aim of making Cumbria the first carbon-neutral county in the UK, by 2037. It is funded by a

£2.5 million grant from the National Lottery Climate Action Fund (Cumbria Action for Sustainability, 2022).

Decarbonisation: The process by which countries or other entities aim to achieve a low-carbon economy, or by which individuals aim to reduce their consumption of carbon (IPCC AR5 Glossary Annex 11).

Direct emissions: Scope 1 (direct emissions from owned or controlled sources) includes company facilities and vehicles (Greenhouse Gas Protocol (2013), Technical Guidance for Calculating Scope 3 Emissions, Version 1.0).

Ecosystem services: Ecological processes or functions that have monetary or non-monetary value to individuals or wider society. These are frequently classified as (1) supporting services such as biological productivity or *biodiversity* maintenance, (2) provisioning services such as food or fibre, (3) regulating services such as climate regulation or *carbon sequestration*, and (4) cultural services such as tourism or spiritual and aesthetic appreciation (IPCC, 2018: Annex 1: Glossary [Matthews, J.B.R. (ed)]).

Electric vehicle: A car, a van, a bus or a lorry that uses electric motor and battery storage as sole means of propulsion and energy. Electric vehicles do not generate direct emissions apart from those associated with tyres and brake pads.

Electric heat pump: An air-, ground-, or water-source heat pump is an electric heating system that absorbs internal heat energy from the air, earth or water outside, to provide domestic space heating and hot water. To transfer the heat energy from the colder outdoors to the warmer indoors, a heat pump uses a relatively small amount of electricity (around 30% of the total heat transferred). The heat pump works in reverse of an air conditioning system and is sometimes combined with the latter.

Embodied emissions: This term (also referred to as “embedded carbon”) describes the set of greenhouse gas emissions attributed to the whole production process of a product, up to the point of usage.

Environmental land management: An approach providing the means to store carbon, reduce the risks from a changing climate such as more frequent and severe flooding or crop failures, and restore wildlife and habitats, while maintaining a thriving agricultural and forestry sector, growing high-quality food and timber, and supporting human health and well-being.

Extraction-based emissions: These are the emissions produced by burning any fossil fuels that are extracted from the ground within a given landscape, wherever they are burned. This type of emissions reporting is important for understanding the climate change implications of decisions relating to any fossil fuel extraction in the landscape (Small World Consulting, 2021).

Flexitarian diet: A flexitarian or semi-vegetarian diet (SVD) is one that is primarily vegetarian with the occasional inclusion of meat or fish (Derbyshire E.J., “Flexitarian Diets and Health: A Review of the Evidence-Based Literature.” *Front Nutr.* 2017; 3:55. Published 6th Jan, 2017. Doi:10.3389/fnut.2016.00055)

Fossil fuels: A fossil fuel is a hydrocarbon-containing material formed underground over tens of millions of years from the remains of dead plants and animals that humans extract and burn to release energy for use. The main fossil fuels are coal, petroleum and natural gas, which humans extract through mining and drilling.

Greenhouse gas (GHG): Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself, and clouds. This property causes the greenhouse effect. Water vapour (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄), and ozone (O₃) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO₂, N₂O, and CH₄, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride (SF₆), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs) (IPCC AR5 Glossary Annex 11).

Greenhouse gas protocol: The GHG Protocol establishes comprehensive global standardised frameworks to measure and manage greenhouse gas (GHG) emissions from private and public sector operations, value chains and mitigation actions. The standards are designed to provide a framework for businesses, governments, and other entities to measure and report their greenhouse gas emissions in ways that support their missions and goals (ghgprotocol.org, 2022).

GHG reporting: The quality of greenhouse gas (GHG) inventories relies on the integrity of the methodologies used, the completeness of reporting, and the procedures for compilation of data. To this end, the Conference of the Parties (COP) has developed standardised requirements for reporting national inventories. The UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention (Annex I Parties) require each Annex I Party, by 15th April each year, to provide its annual GHG inventory covering emissions and removals of direct GHGs (carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF₆) and nitrogen trifluoride (NF₃)) from five sectors (energy; industrial processes and product use; agriculture; land use, land-use change and forestry (LULUCF); and waste), and for all years from the base year (or period) to two years before the inventory is due (United Nations Framework Convention on Climate Change, 2022).

Hybrid car: A car that combines a conventional combustion engine with an electric motor and battery storage.

Hypertension: High blood pressure.

Indirect emissions: Indirect emissions may be classified as Scope 2 and 3 emissions. Scope 2 are indirect emissions from the generation of purchased electricity, steam, heating and cooling consumed by the reporting company. Scope 3 includes all other indirect emissions that occur in a company's value chain. The 15 categories in scope 3 are intended to provide companies with a systematic framework to measure, manage and reduce emissions across a corporate value chain. The categories are designed to be mutually exclusive, to avoid a company double-counting

emissions among categories (Greenhouse Gas Protocol (2013), Technical Guidance for Calculating Scope 3 Emissions, Version 1.0 p.6).

Land cover map: The UK Centre for Ecology and Hydrology (UKCEH) uses satellite imagery and machine learning algorithms to classify land cover according to one of 21 distinct habitats. The first national Land Cover Map of Great Britain was produced in 1990. Since 2016, Land Cover Maps and land cover change data have been produced on yearly basis. The UKCEH land cover (habitat) classes are based on the UK Biodiversity Action Plan (BAP) Broad Habitats (Jackson, 2000). They describe the physical material occupying the surface of the United Kingdom, providing an uninterrupted national dataset of land cover classes from grassland, woodland and fresh water to urban and suburban built-up areas (CEH, 2022).

Natural capital: That part of nature which directly or indirectly provides value to people, including ecosystems, species, freshwater, soils, minerals, the air and oceans, as well as natural processes and functions (Natural Capital Committee, 2019).

Net Zero: Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic greenhouse gas removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential and others, as well as the chosen time horizon). See also “Net zero CO₂ emissions”, “Negative emissions” and “Net negative emissions” (IPCC, 2018: Annex 1: Glossary [Matthews, J.B.R. (ed)]).

Osteoarthritis: A condition that causes joints to become painful and stiff, and may impact movement. Almost any joint can be affected by osteoarthritis, but the condition most often causes problems in the knees, hips and small joints of the hands (NHS, 2021).

Point sources: Point source pollution comes mostly from spills, leaks and discharges at a single point or over a small area. It’s often easy to identify because it results from mainly isolated events or activities with a clear link to a polluter (Environment Agency, 2022).

Partnership management plan: Every National Park and AONB has a Partnership Management Plan, which is among its most important documents. This Plan sets out how a range of organisations will work together to achieve shared objectives for the future management of the National Park or AONB. Each Management Plan will look 5-10 years ahead (National Parks England, 2022; <https://landscapesforlife.org.uk>).

Pollinator patches: A pollinator patch is a bed of annual flowers which may be native, non-native or a mixture of both. To be a successful pollinator patch, the ground needs to be meticulously prepared, which involves digging the site over and removing all existing vegetation, especially grasses, docks and nettles. Seed is sown in the spring (Lune Valley Beekeepers, 2022).

Production-based emissions: These are the net emissions that are physically released in a given landscape (most notably by burning coal, oil and gas), those arising from the production of electricity used in the area (wherever that power is generated), and direct emissions associated with land use

within the landscape (parts of agriculture excluding fuel use and supply chains, peatland degradation, etc.) (Small World Consulting, 2022).

Paris Agreement: The Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in December 2015 in Paris, France, at the 21st session of the Conference of the Parties (COP) to the UNFCCC. The agreement, adopted by 196 Parties to the UNFCCC, entered into force on 4th November 2016, and as of May 2018 had 195 Signatories and was ratified by 177 Parties. One of the goals of the Paris Agreement is “Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels”, recognising that this would significantly reduce the risks and impacts of climate change. The temperature targets require reducing net anthropogenic greenhouse gas emissions through a range of measures collectively referred to as climate mitigation. Additionally, the Agreement aims to strengthen the ability of countries to deal with the impacts of climate change through climate adaptation measures. The Paris Agreement became fully effective in 2020. See also United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and Nationally Determined Contributions (NDCs). (IPCC, 2018: Annex 1: Glossary [Matthews, J.B.R. (ed)]).

Paris-aligned greenhouse gas targets: Greenhouse gas emission reduction targets (and/or carbon sequestration targets) that are aligned with the Paris Agreement targets on warming.

Post-traumatic stress disorder (PTSD): Post-traumatic stress disorder (PTSD) is an anxiety disorder caused by very stressful, frightening or distressing events. People experiencing PTSD often relive the traumatic event through nightmares and flashbacks, and may experience feelings of isolation, irritability and guilt. Problems sleeping, insomnia, and concentration difficulties are often associated with PTSD. These symptoms are often severe and persistent enough to have a significant impact on the person's day-to-day life (NHS, 2022).

Precautionary principle: As referred to within the Environment Bill 2021, the precautionary principle states that where there are threats of serious or irreversible environmental damage, a lack of scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation (GOV.UK, 2021). This appears to have been adopted from the United Nations General Assembly (1992) definition.

Public health prevention: This is split into three categories:

Primary prevention: Taking action to reduce the incidence of disease and health problems within the population, either through universal measures that reduce lifestyle risks and their causes or by targeting high-risk groups.

Secondary prevention: Systematically detecting the early stages of disease and intervening before full symptoms develop – for example, prescribing statins to reduce cholesterol, and taking measures to reduce high blood pressure.

Tertiary prevention: Softening the impact of an ongoing illness or injury that has lasting effects. This is done by helping people manage long-term, often complex health problems and injuries (e.g.

chronic diseases, permanent impairments) in order to improve as much as possible their ability to function, their quality of life and their life expectancy (Local Government Association, 2022).

Quoted (listed) company: Under the Companies Act 2006, a “quoted company” means a company whose equity share capital:

- (a) has been included in the official list in accordance with the provisions of Part 6 of the Financial Services and Markets Act 2000 (c. 8), or
- (b) is officially listed in a European Economic Area (EEA) State, or
- (c) is admitted to dealing on either the New York Stock Exchange or the exchange known as Nasdaq.

In paragraph (a) “the official list” has the meaning given by section 103(1) of the Financial Services and Markets Act 2000 (Legislation.gov.uk, 2006).

Railway electrification: The process of transition from diesel-powered locomotives (trains) to electric railways using either electric locomotives (hauling passengers or freight in separate cars), electric multiple units (passenger cars with their own motors) or both. Electricity is typically generated in large and relatively efficient generating stations, transmitted to the railway network, and distributed to the trains via overhead power lines.

Resilience: The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation. This definition builds on the definition used by the Arctic Council (2013) (IPCC, 2018: Annex 1: Glossary [Matthews, J.B.R. (ed)]).

Revenue: In accounting, revenue is the total amount of income generated by the sale of goods and services related to the primary operations of the business. Commercial revenue may also be referred to as sales or as turnover.

Rewilding (landscape recovery): There are varying definitions for rewilding, from popularised terms to more science-based definitions. In the public perception the practice of “rewilding” has emerged as a method for returning native flora and fauna to landscapes humans have altered. However, due to differing definitions and interpretations, the practice of rewilding has been both promoted and criticised in recent years. Benefits of rewilding include flexibility to react to environmental change and the promotion of opportunities for society to reconnect with nature. Criticisms include the lack of a clear conceptualization of rewilding, insufficient knowledge about possible outcomes, and the perception that rewilding excludes people and agriculture from landscapes. This particularly relates to the re-introduction of natural predators such as wolves and lynx where there may be human-wildlife conflicts, specifically where communities’ livelihoods and food production are impacted.

(Summarised from Alice Di Sacco, Kate A. Hardwick, *et al.* “Ten golden rules for reforestation to optimize carbon sequestration, biodiversity recovery and livelihood benefits,” *Global Change Biology*, 27, 7, (1328-1348), (2021). <https://doi.org/10.1111/gcb.15498>)

Riparian woodland: Woodlands on the banks of natural bodies of water, such as lakes and rivers.

SIC codes (industry sectors): Information about activities of businesses and industry in the UK – including data on the production and trade of goods and services, sales by retailers, characteristics of businesses, the construction and manufacturing sectors, and international trade – is collected by the Office of National Statistics. “Standard industrial classification of economic activities” (SIC) codes are used to classify and report industrial activity in specific sectors (ONS, 2022).

Supply chain: The suppliers used by a company or organisation to produce and distribute products, goods and services.

Sustainable land management: A knowledge-based procedure that helps integrate land, water, biodiversity, and environmental management (including input and output externalities) to meet rising demands for food and fibre while sustaining ecosystem services and livelihoods. Sustainable land management is necessary in order to satisfy the requirements of a growing population while avoiding irreversible damage to ecosystems that support our livelihoods. Improper land management can lead to land degradation and a significant reduction in the productive and service functions (biodiversity niches, hydrology, carbon sequestration) of watersheds and landscapes (The World Bank).

Slurry: Manure is organic matter that is used as organic fertilizer in agriculture. Most animal manure consists of faeces. Common forms of animal manure include farmyard manure or farm slurry (liquid manure).

Statutory instrument: Statutory instruments are the most common form of secondary (or delegated) legislation in the UK. The power to make a statutory instrument is set out in an Act of Parliament and nearly always conferred on a Minister of the Crown. The Minister is then able to make law on the matters identified in the Act, using the parliamentary procedure set out in the Act. Statutory instruments may follow affirmative or negative procedure, or have no procedure at all; the decision on which to use is fixed by the Act (UK Parliament, 2022).

Toxic air: This refers to pollutants in the air at high enough concentrations to cause or contribute to an increase in mortality or an increase in serious illness, or pose a present or potential future hazard to human health.

Turnover: A synonym to business revenue.

Zero-carbon energy supply: Zero carbon means that no carbon emissions are being produced from a product or service (for example, a wind farm generating electricity, or a battery deploying electricity) (National Grid, 2022).

10. Appendices

10.1. Appendix: National Park key statistics

Output Variable	Value	Unit	Source
Land Area	69,400	ha	Official Figures / CEH LCM
Resident Population	9,581	persons	ONS Mid-2019 LSOA Population; ONSPD 2019; BEIS 2019 Postcode Electricity Meters; Custom Postcodes
Resident Population Density	0.14	persons per ha	Based on the Above
Annual Final Consumption (Households + Public Services)	34,253	£ per person per year	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes
Annual Household Fuel per Resident	6,555	kWh per person per year	BEIS 2019 Postcode Gas; BEIS 2018 Residual Fuels; ONSPD 2019; Custom Postcodes
Annual Household Electricity per Resident	1,292	kWh per person per year	BEIS 2019 Postcode Electricity; ONSPD 2019; Custom Postcodes
Annual Vehicle Fuel per Resident	4,479	kWh per person per year	BEIS 2018 Road Fuels; ONSPD 2019; Custom Postcodes
Annual Personal Flights per Resident, Economy Class	1.24	fraction	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes; SWC Population Estimate
Annual Personal Flights per Resident, Business Class	0.009	fraction	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes; SWC Population Estimate
Average Resident One-Way Mileage per Flight, Economy Class	2,346	miles	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes
Average Resident One-Way Mileage per Flight, Business Class	3,974	miles	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes
Annual Business Turnover, COA-based	268,786,000	£ per year	IDBR 2019; ONSPD 2019; Custom Postcodes
Percentage of Suppressed Turnover Output, COA-based	12.92%	percentage	IDBR 2019; ONSPD 2019; Custom Postcodes

Output Variable	Value	Unit	Source
Average Visitors Per Day	6,350	persons	STEAM 2019
Visitor Population Density	0.09	persons per ha	Based on the Above
Annual Visitors Spend	83,086,809	£ per year	STEAM 2019
Annual Visitors All Types	1,461,808	persons per year	STEAM 2019
Percentage of Visitors Staying Overnight	21.2%	percentage	STEAM 2019
Average Duration of Stay for Overnight Visitors	3.8	days	STEAM 2019
Average Visitor Party Size	3.0	persons	Visitor Survey
Average Visitor One-Way Road/Train/Boat Mileage Travelled	143	miles	Visitor Survey
Estimated Fraction of Trips by Car	80.4%	percentage	Visitor Survey
Estimated Fraction of Trips Involving Flights	6.9%	percentage	Visitor Survey
Average Visitor One-Way Mileage per Flight, Economy Class	2,548	miles	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes
Average Visitor One-Way Mileage per Flight, Business Class	0	miles	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes

10.2. Appendix: Summary datasets used for carbon footprint and confidence levels

Summary of Datasets		Level of granularity of data											Confidence Levels: High/Medium/Low	
Dataset	Data Year	Industry sector base	Fuel type base	Land Use base	Demographic base	Geographical pinpoints	Postcodes	COA	LSOA	MSOA	LA (Local Authority District)	NP / AONB	Original Dataset	Implement. in SWC Tool
SWC EEIO Emissions Factors for Industries	2019												High	Medium
SWC-BEIS Emissions Factors for Fuels	2019												High	High
ONS Postcode Directory	2019												High	High
Custom Postcode Boundary	2019 or later												High	High
BEIS Domestic Electricity	2019												High	High
BEIS Domestic Gas	2019												High	High
ONS Population Demographics (2011 Census)	2011												High	High
ONS Population Numbers (mid-year)	2019												High	High
BEIS Non-Domestic Electricity	2019												High	Medium
BEIS Non-Domestic Gas	2019												High	Medium
BEIS Residual Fuels	2018												Medium	Medium
BEIS Road Fuels	2018												Medium	Medium
Custom DfT Traffic Points	2019												Medium	High
ONS Gross Value Added (GVA)	2019												Medium	Low
IDBR Data for Business Turnover	2019												High	Medium
NAEI Data for Large Emitters	2018												High	High
BEIS CO2 Emissions	2018												High	Medium
BEIS Non-CO2 Emissions	2018												High	Medium
BEIS-DEFRA Land Use GHG Emissions for NPs (CO2 & Non-CO2)	2019 & 2017												Medium	High
ONS Atmospheric Emissions Inventory	2019												High	High
STEAM Tourism Dataset	2019												Medium	Medium
Civil Aviation Authority	2019												Medium	Medium
Custom Visitor Surveys (where available)	2019 or earlier												Medium	Medium
ONS Household Expenditure A52 (by demographics)	2018												Low	Medium
Custom Habitat and Peatland Maps	2019 or earlier												High TBC	Medium
6 th Carbon Budget, Tyndall Carbon Budget Tool, National Food Strategy, etc	2019-2021												Medium	Medium

10.3. Appendix: Carbon footprint definitions and data sources

Consumption-based Footprint Category	Contributing Factors	Source
Household Fuel	Gas and other fuels consumed in homes	BEIS 2019 Postcode Gas; BEIS 2018 Residual Fuels; ONSPD 2019; Custom Postcodes; SWC 2019 Emission Factors. In addition for Visitors: STEAM 2019
Household Electricity	Electricity consumed in homes	BEIS 2019 Postcode Electricity; ONSPD 2019; Custom Postcodes; SWC 2019 Emission Factors. In addition for Visitors: STEAM 2019
Vehicle Fuel	Petrol and diesel use by private cars, taxis, motorhomes/campervans and motorbikes	BEIS 2018 Road Fuels; ONSPD 2019; Custom Postcodes; SWC 2019 Emission Factors;. In addition for Visitors: Visitors Survey, STEAM 2019
Car Manufacture & Maintenance	Footprint associated with making & maintaining private vehicles	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes; SWC 2019 EEIO* UK Consumption; SWC 2019 EEIO Emissions Factors
Personal Flights	Flights for purposes other than business	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes. In addition for Visitors: Visitors Survey, STEAM 2019
Ferry Crossings & Cruises	Residents: ferries, boats and cruises; Visitors (where applicable): boats (in NP) and ferries (to & from NP)	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes; SWC 2019 EEIO UK Consumption; SWC 2019 EEIO Emissions Factors. In addition for Visitors: Visitors Survey, STEAM 2019; Custom Datasets (where applicable)
Trains, Buses & Other Transport	Trains (excl. freight), buses, coaches, etc.	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes; SWC 2019 EEIO UK Consumption; SWC 2019 EEIO Emissions Factors. In addition for Visitors: Visitors Survey, STEAM 2019
Food & Drink	Entire food & drink consumption, including from shops, restaurants, take-aways, pubs, hotels and B&Bs	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes; SWC 2019 EEIO UK Consumption; SWC 2019 EEIO Emissions Factors. In addition for Visitors: STEAM 2019
Accommodation (Non Home) Excl. Food	Includes accommodation energy use and supply chains (excl. food) Residents: holiday accommodation; Visitors: accomod. while in NP	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes; SWC 2019 EEIO UK Consumption; SWC 2019 EEIO Emissions Factors. In addition for Visitors: STEAM 2019
Other Non-Food Shopping	All other shopping	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes; SWC 2019 EEIO UK Consumption; SWC 2019 EEIO Emissions Factors. In addition for Visitors: STEAM 2019
Water, Waste & Sewerage	Water, waste and sewerage	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes; SWC 2019 EEIO UK Consumption; SWC 2019 EEIO Emissions Factors. In addition for Visitors: STEAM 2019
Other Bought Services	Includes financial services, telecoms, letting agents (for residents only), travel agents, etc.	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes; SWC 2019 EEIO UK Consumption; SWC 2019 EEIO Emissions Factors. In addition for Visitors: STEAM 2019
Housing	Everything connected with building, buying and maintaining private properties (for residents only)	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes; SWC 2019 EEIO UK Consumption; SWC 2019 EEIO Emissions Factors. In addition for Visitors: STEAM 2019
Health, Education, Other Public Services & Administration	Includes hospitals, schools, police, firefighting, bin collection, etc.	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes; SWC 2019 EEIO UK Consumption; SWC 2019 EEIO Emissions Factors. In addition for Visitors: STEAM 2019
Leisure, Recreation & Attractions	Arts & entertainment, sports facilities, libraries, museums, etc.	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes; SWC 2019 EEIO UK Consumption; SWC 2019 EEIO Emissions Factors. In addition for Visitors: STEAM 2019

10.4. Appendix: Residents GHG emissions

Residents GHG emissions: Exmoor National Park

Consumer Expenditure Categories Summary	ALL Scopes	Units
Household Fuel	13,665	tCO2e per year
Household Electricity	4,194	tCO2e per year
Vehicle Fuel	20,639	tCO2e per year
Car Manufacture & Maintenance	5,501	tCO2e per year
Personal Flights	19,596	tCO2e per year
Ferry Crossings & Cruises	1,891	tCO2e per year
Trains, Buses & Other Transport	3,493	tCO2e per year
Food & Drink	35,387	tCO2e per year
Accommodation (Non Home) Excl. Food	621	tCO2e per year
Other Non-Food Shopping	9,606	tCO2e per year
Water, Waste & Sewerage	2,048	tCO2e per year
Other Bought Services	9,403	tCO2e per year
Housing	7,315	tCO2e per year
Health, Education, Other Public Services & Administration	13,508	tCO2e per year
Leisure, Recreation & Attractions	2,515	tCO2e per year
Total	149,381	tCO2e per year

NOTE: The total could be marginally different to the sum of individual components due to rounding

10.5. Appendix: Visitors GHG emissions

**Visitors GHG
emissions:
Exmoor
National Park**

Consumer Expenditure Categories Summary	In NP	To & From NP	Units
Household Fuel	56	0	tCO2e per year
Household Electricity	60	0	tCO2e per year
Vehicle Fuel	5,986	49,684	tCO2e per year
Car Manufacture & Maintenance	1,515	12,579	tCO2e per year
Personal Flights	0	17,324	tCO2e per year
Ferry Crossings & Cruises	0	0	tCO2e per year
Trains, Buses & Other Transport	367	3,043	tCO2e per year
Food & Drink	20,409	0	tCO2e per year
Accommodation (Non Home) Excl. Food	5,107	0	tCO2e per year
Other Non-Food Shopping	4,761	0	tCO2e per year
Water, Waste & Sewerage	1,508	0	tCO2e per year
Other Bought Services	2,104	0	tCO2e per year
Housing	0	0	tCO2e per year
Health, Education, Other Public Services & Administration	0	0	tCO2e per year
Leisure, Recreation & Attractions	544	0	tCO2e per year
Total	42,416	82,630	tCO2e per year

NOTE: The total could be marginally different to the sum of individual components due to rounding

10.6. Appendix. Industry footprint estimates

10.6.1. Appendix: SIC Codes (2007) summary and IDBR description

SIC (2007)	The SIC hierarchy High-Level Summary	IDBR																																																															
Section A	Agriculture, Forestry and fishing	<p>This dataset uses the 2007 revision to the Standard Industrial Classification (UK SIC 2007) in place of the 2003 revision Standard Industrial Classification (UK SIC 2003). The UK SIC 2007 is a major revision of UK SIC 2003 with changes at all levels of the SIC. Further details on Standard Industrial Classification can be found on the ONS website:</p> <p>http://www.ons.gov.uk/ons/guide-method/classifications/current-standard-classifications/index.html</p> <p>The broad industry group structure has been defined under UK SIC 2007 and is listed below:</p> <table border="1"> <thead> <tr> <th>Description</th> <th>UK SIC 2007 Section</th> <th>Division</th> </tr> </thead> <tbody> <tr> <td>Agriculture, forestry & fishing</td> <td>A</td> <td>01/03</td> </tr> <tr> <td>Production</td> <td>B, C, D and E</td> <td>05/39</td> </tr> <tr> <td>Mining, quarrying & utilities</td> <td>B, D and E</td> <td>05/09, 35/39</td> </tr> <tr> <td>Manufacturing</td> <td>C</td> <td>10/33</td> </tr> <tr> <td>Construction</td> <td>F</td> <td>41/43</td> </tr> <tr> <td>Wholesale and retail; repair of motor vehicles</td> <td>G</td> <td>45/47</td> </tr> <tr> <td>Motor trades</td> <td>G</td> <td>45</td> </tr> <tr> <td>Wholesale</td> <td>G</td> <td>46</td> </tr> <tr> <td>Retail</td> <td>G</td> <td>47</td> </tr> <tr> <td>Transport & storage (inc postal)</td> <td>H</td> <td>49/53</td> </tr> <tr> <td>Accommodation & food services</td> <td>I</td> <td>55/56</td> </tr> <tr> <td>Information & communication</td> <td>J</td> <td>58/63</td> </tr> <tr> <td>Finance & insurance</td> <td>K</td> <td>64/66</td> </tr> <tr> <td>Property</td> <td>L</td> <td>68</td> </tr> <tr> <td>Professional, scientific & technical</td> <td>M</td> <td>69/75</td> </tr> <tr> <td>Business administration and support services</td> <td>N</td> <td>77/82</td> </tr> <tr> <td>Public administration & defence</td> <td>O</td> <td>84</td> </tr> <tr> <td>Education</td> <td>P</td> <td>85</td> </tr> <tr> <td>Health</td> <td>Q</td> <td>86/88</td> </tr> <tr> <td>Arts, entertainment, recreation and other services</td> <td>R, S, T and U</td> <td>90/99</td> </tr> </tbody> </table> <p>Source: IDBR Meta Data</p>	Description	UK SIC 2007 Section	Division	Agriculture, forestry & fishing	A	01/03	Production	B, C, D and E	05/39	Mining, quarrying & utilities	B, D and E	05/09, 35/39	Manufacturing	C	10/33	Construction	F	41/43	Wholesale and retail; repair of motor vehicles	G	45/47	Motor trades	G	45	Wholesale	G	46	Retail	G	47	Transport & storage (inc postal)	H	49/53	Accommodation & food services	I	55/56	Information & communication	J	58/63	Finance & insurance	K	64/66	Property	L	68	Professional, scientific & technical	M	69/75	Business administration and support services	N	77/82	Public administration & defence	O	84	Education	P	85	Health	Q	86/88	Arts, entertainment, recreation and other services	R, S, T and U	90/99
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Section T	Activities of households as employers; undifferentiated goods-and services-producing activities for own use																																																																
Section U	Activities of extraterritorial organisations and bodies																																																																

Source: SIC (2007) https://onsdigital.github.io/dp-classification-tools/standard-industrial-classification/ONS_SIC_hierarchy_view.html



Industry GHG emissions (IDBR-based): Exmoor National Park

Industry Categories Summary (IDBR sectors)	ALL Scopes	Units
Agriculture, forestry & fishing	41,810	tCO2e per year
Production	4,537	tCO2e per year
Construction	3,468	tCO2e per year
Motor trades	230	tCO2e per year
Wholesale	645	tCO2e per year
Retail	832	tCO2e per year
Transport & storage (inc. postal)	2,260	tCO2e per year
Accommodation & food services	5,391	tCO2e per year
Information & communication	332	tCO2e per year
Finance & insurance	946	tCO2e per year
Property	187	tCO2e per year
Professional, scientific & technical	746	tCO2e per year
Business administration & support services	864	tCO2e per year
Public administration & defence	773	tCO2e per year
Education	833	tCO2e per year
Health	1,370	tCO2e per year
Arts, entertainment, recreation & other services	831	tCO2e per year
Total	66,056	tCO2e per year
ENERGY-ONLY INDUSTRY (subset of INDUSTRY) -- Exmoor National Park		
Industry Road Fuels	16,245	tCO2e per year
Industry Fuels Excl. Road	24,478	tCO2e per year
Industry Electricity	4,921	tCO2e per year
Total	45,643	tCO2e per year
LARGE EMITTERS (Scope 1) * -- Exmoor National Park		
Large Emitters	-	tCO2e per year
INDUSTRY-RELATED FLIGHTS (subset of INDUSTRY) ** -- Exmoor National Park		
Industry-related flights	6,604	tCO2e per year
Land Use -- Exmoor National Park		
Land Use CO₂	7,871	tCO2e per year
Land Use Non-CO₂	119,889	tCO2e per year

NOTE: The total could be marginally different to the sum of individual components due to rounding

10.6.3. Appendix: IDBR vs. GVA industry footprint estimates



**IDBR vs. GVA Industry
Footprint Estimates:
Exmoor National Park**

Industry Categories Summary (IDBR sectors)	NP/AONB industry footprint per capita (IDBR, COA-level data)	NP/AONB industry footprint per capita (GVA, LA-level data)	Units
Agriculture, forestry & fishing	4.36	2.08	tCO ₂ e/person/year
Production	0.47	12.15	tCO ₂ e/person/year
Construction	0.36	1.65	tCO ₂ e/person/year
Motor trades	0.02	0.63	tCO ₂ e/person/year
Wholesale	0.07	0.64	tCO ₂ e/person/year
Retail	0.09	1.45	tCO ₂ e/person/year
Transport & storage (inc. postal)	0.24	0.96	tCO ₂ e/person/year
Accommodation & food services	0.56	1.18	tCO ₂ e/person/year
Information & communication	0.03	0.22	tCO ₂ e/person/year
Finance & insurance	0.10	0.53	tCO ₂ e/person/year
Property	0.02	0.19	tCO ₂ e/person/year
Professional, scientific & technical	0.08	0.54	tCO ₂ e/person/year
Business administration & support services	0.09	0.62	tCO ₂ e/person/year
Public administration & defence	0.08	1.29	tCO ₂ e/person/year
Education	0.09	0.89	tCO ₂ e/person/year
Health	0.14	1.73	tCO ₂ e/person/year
Arts, entertainment, recreation & other services	0.09	0.28	tCO ₂ e/person/year
Total	6.89	27.03	tCO₂e/person/year

NOTE: The total could be marginally different to the sum of individual components due to rounding

10.6.4. Appendix: Pollution inventory for large emitters

Pollution Inventory: Large Emitters (2018 data) Within Adopted Postcode Boundaries for National Parks (2018 data)					
National Park	LAD14NM	Operator	Site	Postcode	CO₂ emissions (kt)
The Broads	Broadland	British Sugar Plc	Cantley	NR133ST	120.672408
Peak District National Park	Derbyshire Dales	HJ Enthoven & Sons Ltd	Darley Dale	DE42LP	25.8
Peak District National Park	Derbyshire Dales	Tarmac Ltd	Ballidon Quarry	DE61QX	0.002702
Peak District National Park	High Peak	Hope Construction Materials Ltd	Hope Works	S336RP	1048.8045
South Downs National Park	Horsham	Viridor Waste Management Ltd	Horton Landfill	BN59XH	16.9
South Downs National Park	Lewes	Veolia ES South Downs Ltd	Newhaven EfW Plant	BN90HE	201.611
North York Moors National Park	Redcar and Cleveland	Cleveland Potash Ltd	Saltburn-By-The-Sea	TS134UZ	13.73193
New Forest National Park	Wiltshire	Renewable Power Systems Ltd	Poundbottom Landfill Site	SP52PU	3.82

10.7. Appendix: Emissions from major roads



**Emissions from major roads:
Exmoor National Park**

SELECTED A-ROADS – SMALLER SUBSET * – Exmoor National Park		
Road Names, Smaller Subset	A399 A39	
Cars, Buses & Motorbikes	10,023	tCO ₂ e per year
Vans & Lorries	3,322	tCO ₂ e per year
Total	13,344	tCO₂e per year
SELECTED A-ROADS – LARGER SUBSET * – Exmoor National Park		
Road Names, Larger Subset	Smaller Set + B3224 A396	
Cars, Buses & Motorbikes	15,819	tCO ₂ e per year
Vans & Lorries	5,809	tCO ₂ e per year
Total	21,628	tCO₂e per year
THROUGH-TRAFFIC ** – Exmoor National Park		
Cars, Buses & Motorbikes	6,164	tCO ₂ e per year
Vans & Lorries	4,565	tCO ₂ e per year
Total	10,729	tCO₂e per year

NOTE: The total could be marginally different to the sum of individual components due to rounding

10.8. Appendix: Methodology

10.8.1. Appendix: History of model development

In 2010, Small World Consulting (SWC) carried out a first consumption-based greenhouse gas assessment for the Lake District National Park (LDNP). This project adopted a consumption-based assessment approach alongside more traditional production-based metrics.

This opened up policy areas such as food, shopping, business supply chains, and travel by both residents and visitors to and from the Park. The study led to a carbon budget being set each year, with a target to reduce annual emissions by 1% per year compared to business as usual (therefore 6% by 2016). Each year actions taken to cut emissions were collated from members of the Park's strategic partnership, and assessed in terms of their contribution to the target. Overall, after seven years, these emission reduction actions are thought to have accumulated to around 3% reduction in annual emissions, compared to business as usual.

Seven years after the baseline study for the LDNP, a lot had changed, including: reporting methods, underlying model data, the numbers and behaviours of residents and visitors, and the climate change agenda. SWC therefore refreshed the LDNP carbon assessment in 2017 and again in 2020, extending the latter to the whole of Cumbria. Through this work, a Zero Carbon Cumbria Partnership was formed in 2021, financed by a successful bid for National Lottery funding. Subsequently, SWC was commissioned in 2021 to undertake a similar consumption-based carbon footprint assessment for all the UK National Parks, plus several AONBs.

10.8.2. Appendix: Model development for the National Park and AONB family

Our development of a carbon footprint model for the National Parks and AONBs has been and remains an iterative process, with insights obtained from each tranche to date (namely 1, 2, 3 and 4) serving to improve various parts of the model.

Tranche 5 (April-July 2022) is considered the point by which all major updates of the model were completed. Subsequent updates, which will be applied to all National Parks and AONBs on the current programme, are possible but less likely at this stage.

The datasets and methodologies used in the May 2022 version of the footprint model are considerably more complex than in the LDNP and Cumbria assessments, but the model is robust and could easily be updated when new post-COVID data becomes available.

The main methodological challenge arises from the need to map data between various geographies: postcode, COA, LSOA, MSOA, LA, and National Park boundaries. This has been dealt with by constructing appropriate masks with mapping weights, as well as performing custom GIS analysis.

Another key addition is that of the traffic points data, which can be used to assess through-traffic in each National Park or AONB and estimate footprints linked to the motorways, the main A-roads and the largest B-roads within its boundaries.

Another noticeable change in methodology concerns industry footprint estimates. An initial analysis was conducted using GVA datasets from Local Authorities; however, when this was applied across the National Parks and AONBs, it became apparent that a better geographical representation of industry sectors within each landscape was required.

As a result, additional licences were purchased for ONS IDBR datasets, for COA-level industry turnover, in order to estimate the relevant footprint. By necessity, the turnover estimates include all COA geographies overlapping with the National Park or AONB boundary, leading to marginal overestimates. The COAs within and on the boundary that are known to contain large point-source emitters were excluded from the turnover figures.

The emissions estimates for the agriculture and forestry sector, derived using IDBR data, reflect local enterprise turnovers; however, they rely on the UK-average carbon intensities of these sectors, which may not reflect the unique farming and forestry characteristics within each landscape.

Another key footprint category updated recently is land use emissions based on the latest version of the Department of Business, Energy and Industrial Strategy (BEIS) land use CO₂ data, for 2019. The 2019 BEIS land use CO₂ dataset includes, for the first time, emissions from different types of peatland and varying levels of peat degradation. We also employ peat emission factors from this dataset, alongside afforestation and peatland restoration targets from the Sixth Carbon Budget, as part of our net zero pathway recommendations for each National Park and AONB.

A summary of the datasets used in the carbon footprint model is provided in Appendix 10.2.

10.8.3. [Appendix: Outline of emissions estimation methodology](#)

This section provides a brief outline. A more detailed methodology document will be produced separately by the end of 2022.

- Household energy-related emissions were derived from consumption data available at postcode and local authority levels. The energy-related emissions factors used included supply chain components.
- Local authority level fuel use data was employed as the starting point for estimating residents' road fuel emissions. Road traffic counts data was used to estimate emissions from through-traffic and emissions from selected major roads. The emissions factors used for all transport take account of direct vehicle emissions, energy supply chain emissions and the emissions embodied in the production and maintenance of vehicles and transport infrastructure.
- Emissions from UK residents, other than those relating to household energy and vehicle use, were derived using a well-established environmentally extended input output model (EEIO) developed by Small World Consulting. Residents' emissions per capita were adjusted from the UK averages provided by the EEIO model, using demographic data for the National Park or AONB at the postcode level, together with survey data on national household expenditure.
- For visitors, the same EEIO model was used to estimate emissions from consumption other than road fuel. We used data from multiple visitor surveys and tourism modelling to derive

estimates of visitor numbers and visitor spending, which we combined with emission factors from the EEIO model.

- Emissions relating to land-based visitor travel to and from the National Park and within the National Park were derived using visitor surveys, and comparisons with resident road travel emissions.
- Emissions related to through-traffic, which by definition occur within the boundary of the National Park or AONB, are estimated by comparing total traffic point counts with pump-level fuel sales within the National Park or AONB, along with assumptions about commuting in out of the area.
- Civil Aviation Authority survey data was used to estimate the emissions associated with flights taken by residents and visitors. The emission factors used take account of flight distances and flight class, and include a markup factor for high-altitude climate effects.
- A very rough estimate of industry emissions (including their supply chains), which overlaps with resident and visitor emissions, was included for added perspective. The estimate was derived from Inter-Departmental Business Registry (IDBR) turnover data for businesses registered in an area that was mapped as closely as possible to the National Park, combined with industry-specific emission factors that were drawn from the EEIO model. Separately, energy-related emissions from industry were calculated from consumption data and energy-related emission factors that included supply chain components.
- We adopted land use emissions estimates published by BEIS for all National Parks (both for the CO₂ and non-CO₂ components). For AONBs, the CO₂ component of land-based emissions and carbon sequestration was estimated separately using bespoke land use datasets provided by the AONBs following a common methodology developed as part of this programme, together with the BEIS and Natural England habitat-specific emission factors. The non-CO₂ component of land-based emissions for AONBs (including emissions from livestock and fertiliser use) was approximated using footprint estimates for the industry sector “agriculture, forestry and fishing” derived from the IDBR data.

The data sources used are listed in Appendix 10.2.

10.8.4. Appendix: Assumptions for visitors’ surveys

Visitor party size

Where visitor party size is not stated in the visitor’s survey report, we can either infer it from an average of nearby protected landscapes (e.g. Snowdonia for Anglesey), or use historical data from earlier reports (if presented) to work out an average. It is useful to apply both methods to triangulate results before deciding which one to use. For this report, a party size of 3.0 was estimated by making an inference from two sources: visitor’s survey data for the New Forest National Park, giving average party size of 3.0, and data for the Exmoor National Park on the percentage of different party types, from which an estimated group size of 2.9 was made, corroborating the New Forest data.

Modes of transport

Some data on the modes of transport used while travelling to and from the National Park was provided in the visitors’ survey. However, the modes of transport were only broken down into “private transport”, “shared transport” and “walk/cycle”. The breakdown of private cars, hire cars, campervans, motorbikes for private transport, and buses, coaches and trains for shared transport, was taken from the Cairngorms National Park, which has some of the most comprehensive visitor survey data across all the landscapes on the current programme.

There was no data on the models of transport within the Park, so these were assumed to be the same as on the way to and from the National Park.

Inferring flights share using Cairngorms data

No data on flights was provided in the visitor survey, and the approximations for the hired cars and private bus tours, which are often used as a proxy for inferring the percentage of overseas visitors who took a flight on the way to the UK, is less than the stated fraction of Non-European overseas visitors. As a result, the flight share was assumed to be a sum of the stated Non-European overseas visitors’ percentage (4%), and 60% of the stated share of European visitors (0.6*5%, based on the Cairngorms National Park estimates), giving a total of 6.5%.

Using Snowdonia and Cairngorms data to infer distances travelled by road from mainland Europe

The only data provided for Exmoor was the overall percentage of overseas visitors. The breakdown of European and Non-European visitors was taken from Snowdonia National Park (the closest National Park with the relevant bespoke data). The data on the breakdown of countries within the European visitor category was also taken from Snowdonia National Park. This data served to calculate a weighted average distance for road travel from different European countries, assuming 40% of all European visitors travelled to the UK by land (in line with the Cairngorms data).

Using Exmoor visitor surveys to estimate average distances by road for UK visitors

Postcode-level places of origin within the UK were provided in the four most recent Exmoor visitors surveys, totalling nearly 1,500 records. With the support from the National Park’s GIS team, this data was used to identify representative cities of origin for each region within the UK, and road distances between these cities and the Valley of Rocks in Exmoor were calculated using Google Maps (Table 7).

Table 7. Representative places of origin and travel distances (on land and via ferry) to the Valley of Rocks

Level 1 Breakdown	Percentage of All Trips	Level 2 Breakdown	Percentage of Level 1	Representative Level 2 City	Distance to the top destination (miles)
England	49%	South West	10%	Exeter	54.7
South West			10%	Plymouth	106

			27%	Barnstaple	20.8	
			27%	Taunton	44.1	
			27%	Bristol	107	
England	-	38%	West Midlands	18%	Bromsgrove	172
Other			East Midlands	13%	Nottingham	239
			East Anglia	15%	Chelmsford	271
			North	15%	Manchester	268
			South East	38%	Surbiton	199
Wales	3%	Wales	100%	Cardiff	138	
Scotland	0.5%	Scotland	100%	Glasgow	471	
USA	1.9%	Fly to the UK	100%	London	224	
Australia	1.9%	Fly to the UK	100%	London	224	
France	1.7%	Fly to the UK	60%	Bristol	81.4	
		Travel by road to the UK	40%	Paris	491	
Germany	1.7%	Fly to the UK	60%	Bristol	81.4	
		Travel by road to the UK	40%	Duesseldorf	580	
Ireland	1.7%	Fly to the UK	60%	Bristol	81.4	
		Travel by road to the UK	40%	Dublin	430	

10.8.5. Appendix: Target-setting rationale

Each component of the overall emissions reduction target has been judged to be the minimum required in order to align with the IPCC's recommendations for limiting global temperature change to 1.5°C compared to pre-industrial conditions. The components' feasibility may depend on appropriate government and private sector support, for which the Park should advocate as part of its climate response. The steepness of the proposed emissions reduction trajectories reflects decades of global inaction, and illustrates the scale and urgency of the challenge we now face.

For energy-related emissions we drew on modelling by the Tyndall Centre for Energy and Climate Change Research for setting local authority targets. For food-related emissions we examined recommendations from the National Food Strategy and other sources. For goods other than food, the target reflects the relative difficulty of reducing emissions from global supply chains, compared to UK energy-related emissions. For visitor travel the target reflects both possible changes in future travel habits and the likely decarbonisation of land transport. The land use targets reflect the feasibility assessment in line with the Sixth Carbon Budget's 2050 net zero pathway for the UK.

Table 8 outlines the methodology used in this report (New Model for All National Parks 2022) and how it compares with an earlier iteration (Cumbria 2020). Methodological differences arose from new learning and knowledge transfer incorporated in the planning assumptions for National Park target-setting. In setting targets, we have made a pragmatic assumption that we may reach

percentage ceilings in the emissions reductions that can be achieved for some sectors, as it may not be entirely possible to achieve real zero emissions in these sectors given that there will always be residual emissions.

Table 8: High-level comparison between the target setting methodologies used in the 2020 Cumbria assessment and in the new assessment for the National Parks and AONBS

Category	Previous model for Cumbria (2020)	New model for all National Parks (2022) – used in this report	Achievable ceiling
Energy-only emissions by residents, visitors and industry	13% per year reduction in energy-related CO ₂ (as prescribed by the Tyndall Carbon Budget Tool ¹⁰³). Includes Scope 1 and 2 carbon dioxide emissions only (excl. motorways).	12.8% per year reduction in energy-related CO ₂ (specific to the Exmoor National Park) as prescribed by the Tyndall Carbon Budget Tool, and extended to other GHGs. Includes Scope 1, 2 and 3 GHG energy emissions expressed at tCO ₂ e for residents, visitors and industry.	5% of present-day emissions. This is our expert judgement for embedded emissions across various forms of renewable energy, for example assuming little or no CCS.
Food consumed by residents and visitors	5% reduction per year	5% reduction per year. This assumes 3% of emissions reduction per year from dietary changes (National Food Strategy: 30% in 10 years), 1% per year from waste reduction and 1% per year from other changes incl. technology.	30% of present-day emissions. This is based on the Sixth Carbon Budget (AFOLU section), which states that UK agriculture emissions are set to halve from 54 MtCO ₂ e today to 27 MtCO ₂ e in 2050 under the Net Zero pathway. Some further savings may come from widespread adoption of vertical farming, which is why we opted for the more ambitious 30% ceiling.
Other goods purchased by residents and visitors	5% reduction per year	5% reduction per year, including purchases of cars. This assumes that sectors such as cement and steel, which feed into complex supply chains (incl. making cars), will take time to decarbonise globally and won't reach zero emissions in large exporters like China by 2050.	10% of present-day emissions. This is our expert judgement for residual emissions from sectors such as cement and steel that will take time to decarbonise globally and won't reach zero emissions in large exporters like China by 2050.
Visitor travel to and from the	Visitor travel to and from Exmoor (excluding international travel)	10% reduction per year. Excludes flights but includes car manufacturing. This assumes a 4% per year increase in duration of stay (roughly doubling after	7.5% of present-day emissions. This is our expert judgement for embedded emissions across various forms of renewable energy,

¹⁰³ A budget tool to calculate energy -only CO₂ for local authorities, based on IPCC recommendations for “well below 2 degrees and in pursuit of 1.5 degrees,” developed by the Tyndall Centre and available at <https://carbonbudget.manchester.ac.uk/reports/>.

National Park		20 years), a 4% per year reduction in the footprint of transport (roughly halving emissions from cars in 20 years, leaving predominantly the embedded car manufacturing footprint), and a 2% per year shift in the mode of transport from cars	and from sectors (via supply chains) such as cement and steel that will take time to decarbonise globally (affecting car manufacturing, buildings, etc.).
Land Use	Expert judgement based on discussions with the stakeholders involved.	We have split land use into Land Use Non-CO ₂ and Land Use CO ₂ . See Table 9 for further details.	30% of present-day emissions for Land Use Non-CO ₂ only, which follows the arguments for the Food & Drink category. Land Use CO ₂ : achievable ceiling is not applicable in this assessment due to 2050 being a comparatively short horizon in terms of land-based carbon sequestration measures.

A detailed breakdown of how the land use targets are derived, and the relevant planning assumptions, can be found in 0. Table 9 below provides a brief overview.

Table 9. Land Use target assumptions for National Parks.

Land Use Non-CO₂	<p>The Non-CO₂ component includes methane and N₂O emissions from livestock and fertilizer use within the National Park, which must be reduced in line with broader targets for the Food & Drink category. We therefore assume a 5% per year reduction for this component.</p> <p>Inevitably, there will be a small amount of double-counting, linked to residents and visitors consuming locally produced food in the area.</p>
Land Use CO₂	<p>The CO₂ component includes emissions from degraded peatland and other types of soil, as well as carbon sequestration through woodland creation, peatland restoration and regenerative agricultural practices. This component changes linearly with time as the land use change measures are extended to bigger land areas, and becomes negative when the carbon sink quantities exceed carbon emissions from land.</p> <p>The assumed year-on-year changes to land use are based on apportionment of the Sixth Carbon Budget targets according to present-day land use in each National Park; see Table 15. The resulting rates of land conversion (e.g. afforestation or peatland restoration) and/or application of new management practices (e.g. cover cropping or grazing legumes) are then combined with the per-hectare carbon sequestration fluxes associated with these land use changes (established from field studies and desk-based research). In Exmoor National Park, the proposed land use measures are estimated to add -9,436 tCO₂e/year to the total carbon sequestration flux in the</p>

	landscape each year (i.e. an extra 9,436 tCO ₂ e removed per year in each of the subsequent years).
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10.8.6. Appendix: Assumptions for land use sector

The Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (IPCC 2006, IPCC 2014) describes a uniform structure for reporting emissions and removals of greenhouse gases. The Department for Business, Energy and Industrial Strategy (BEIS) contracts a company, Ricardo Energy & Environment, to compile an annual Inventory of UK Greenhouse Gas Emissions for the United Nations Framework Convention on Climate Change (UNFCCC). Ricardo subcontracts two further entities – the UK Centre for Ecology and Hydrology, and Forest Research – to prepare the data relating to Land Use, Land-Use Change and Forestry (LULUCF) in the UK.

The LULUCF sector differs from other sectors in the Greenhouse Gas Inventory in that it contains both sources and sinks of greenhouse gases¹⁰⁴. The sources, or emissions to the atmosphere, are given as positive values; the sinks, or removals from the atmosphere, are given as negative values.

To provide context, an analysis was undertaken to understand and extract the key facts, logic and rationale applied to changes in either reporting or target-setting, as outlined in the Sixth Carbon Budget report on agriculture, forestry and other land use (AFOLU); see Table 10 and Table 11. The report states that emissions from the AFOLU sector “have declined by 16% since 1990. This is mainly due to successive reform of the Common Agricultural Policy (CAP) in the 1990s and early 2000s, which reduced livestock numbers, coupled with changes in farming practices due to EU environmental legislation to address non-GHG pollutants (e.g., Nitrates Directives). There has been little change in emissions since 2008”.

Table 10: UK baseline for Agriculture emissions (2018), by GHG. Global warming potential for methane and nitrous oxide: IPCC AR5

	Percentage of UK emissions	Quantity of CO ₂ equiv.t
Summary for Agriculture	10%	54.6 MtCO₂e
<i>Breakdown</i>		<i>SWC planning assumptions</i>
Methane (CH ₄) from livestock	63%	34.4 MtCO ₂ e
Nitrous oxide (N ₂ O) mostly from soil	26%	14.2 MtCO ₂ e
Carbon dioxide (CO ₂) from fossil fuel use	11%	6.0 MtCO ₂
Total	100%	54.6 MtCO₂e
Data Source: The Sixth Carbon Budget: Agriculture and land use, land use change and forestry, p.6		

¹⁰⁴ DEFRA (2021), “UK Local and Regional Carbon Dioxide Emissions Estimates for 2005-2019,” Technical Report p.62.

Table 11: UK baseline for Agriculture emissions (2018), by source. Global warming potential for methane and nitrous oxide: IPCC AR5

	Percentage of UK emissions	Quantity of CO ₂ equiv.t
Agriculture Breakdown		<i>SWC planning assumptions</i>
Methane from livestock (Enteric fermentation digestion process of ruminant livestock)	53%	28.9 MtCO ₂ e
Agricultural soils	21%	11.5 MtCO ₂ e
Waste and manure management	16%	8.7 MtCO ₂ e
Stationary machinery	8%	4.4 MtCO ₂ e
Other	2%	1.1 MtCO ₂ e
Total	100%	54.6 MtCO₂e
Data Source: The Sixth Carbon Budget Agriculture and land use, land use change and forestry p.6 Figure M.7.1		

10.8.7. Appendix: Land class categories for reporting nationally

For reporting purposes all land in the country must be identified as having remained in one of six classes since a previous survey, or as having changed to a different (identified) class in that period¹⁰⁵. The six land classes are:

Land use category	Sub-category
4A: Forest Land	<ul style="list-style-type: none"> • Forest land remaining forest land • Biomass burning • Land converted to forest land • Drainage of organic soils • Direct N₂O emissions from N mineralisation/mobilisation
4B: Cropland	<ul style="list-style-type: none"> • Biomass burning • Cropland remaining cropland • Land converted to cropland • Direct N₂O emissions from N mineralisation/mobilisation
4C: Grassland	<ul style="list-style-type: none"> • Biomass burning • Grassland remaining grassland • Land converted to grassland • Drainage of organic soils • Direct N₂O emissions from N mineralisation/mobilisation
4D: Wetlands	<ul style="list-style-type: none"> • Wetlands remaining • Drainage of organic soils • Land converted to wetland
4E: Settlements	<ul style="list-style-type: none"> • Settlements remaining settlements • Biomass burning • Land converted to settlements • Drainage of organic soils • Direct N₂O emissions from N mineralisation/mobilisation
4F: Other land	<ul style="list-style-type: none"> • Harvest wood • Indirect N₂O emissions

There is a seventh category (4G) for the pool of harvested wood products.

¹⁰⁵ BEIS, CEH, Forest Research (2020): "National Atmospheric Emissions Inventory: Projections of Emissions and Removals from LULUCF Sector to 2050," p. 3.

10.8.8. Appendix: Changes in methodology for quantifying peatland GHG emissions

In 2017 the Centre for Ecology and Hydrology proposed changes to the methodology for reporting emissions from peatlands¹⁰⁶. Emissions from the drainage and rewetting of peatlands were included for the first time in the 1990-2019 LULUCF inventory (Brown *et al.* 2021). These emissions are reported under all LULUCF land use categories and are **not** specifically identified separately. In summary, the following principles are applied:

- Emissions from drained and rewetted organic soils are allocated to UK local authorities using peat condition mapping outputs from Evans *et al.* (2017).
- The majority of the peatland area, reported in the Grassland category, includes semi-natural bog categories, extensive and intensive grassland, and rewetted bog or fen from semi-natural bog and intensive and extensive grassland.
- Emissions from active extraction of peat (on site, and off-site for horticultural peat), as well as from organic soils affected by historical peat extraction, are reported under Wetlands.
- Naturally occurring GHG emissions and/or removals from pristine areas of bog and fen, rewetted bog or fen, and from peat extraction, are now included in LULUCF reporting under Wetlands.
- Emissions of CO₂ from drained organic soils in Forest, Cropland and Settlement areas are reported in those respective categories.
- The “Other land” category predominantly comprises bare rock and scree, with no emissions or removals reported.

These recommendations were further refined for the current UK GHG Inventory 1990-2019¹⁰⁷.

Although the latest (BEIS) LULUCF estimations (2019) are more accurate than previous years, they remain subject to considerable uncertainty. This is due to an evolving methodology and a process to refine the measurement of emission factors for UK peatlands, attempting to take into account transitions from heavily modified peatlands (forested land, cropland, grassland, peat extraction, eroding bog) and semi-natural peatlands (heather-dominated and grass-dominated bogs). Peatlands in their semi-natural state may be near-natural, modified, or rewetted (Table 12). The estimates for CO₂ emissions in the form of dissolved organic carbon (DOC) use Tier 1 emission factors, and therefore are the least robust of all (IPCC 2014). Tier 2 emission factors for the UK-relevant peat condition categories were subsequently developed by Evans *et al.* (2017), providing estimates for “particulate organic carbon” (POC) emissions, as well as direct CO₂ emissions. The Tier 2 estimations add more granularity and are country-specific, being tested for robustness using at least four different study locations considered reliable enough to replace Tier 1 values. The CARBINE Tier 3 carbon accounting model developed by Forest Research was employed to derive the emission factor for forested peatland between 1990 and 2019, and was tested using field data.

¹⁰⁶ Centre for Ecology and Hydrology (2017) “Implementation of an Emissions Inventory for UK Peatlands: A report to the Department for Business, Energy, and Industrial Strategy,” Issue Number 1.

¹⁰⁷ Ricardo Energy & Environment UK NIR 2020 (Issue 1), “UK GHG Inventory 1990-2019,” Annex p. 854.

Table 12. Extract from Ricardo Energy & Environment UK NIR 2020 (Issue 1) UK GHG Inventory 1990-2019 Annex p. 858

Table A 3.4.28 Emission factors for peat condition types updated from Evans et al (2017). All fluxes are shown in tCO₂e ha⁻¹ yr⁻¹. Note that a positive EF indicates net GHG emission, and a negative EF indicates net GHG removal.

Peat Condition	Drainage status	Direct CO ₂	CO ₂ from DOC	CO ₂ from POC	Direct CH ₄	CH ₄ from Ditches	Direct N ₂ O	Total
Forest	Drained	2.52 to -1.79 ^c	1.14 ^a	0.3 ^b	0.06 ^a	0.14 ^a	1.31 ^a	5.46 to 1.15
Cropland	Drained	28.60 ^b	1.14 ^a	0.3 ^b	0.02 ^b	1.46 ^a	6.09 ^a	37.61
Eroding Modified Bog (bare peat)	Drained	6.18 ^b	1.14 ^a	5.0 ^b	0.14 ^a	0.68 ^a	0.14 ^a	13.28
	Undrained	6.18 ^b	0.69 ^a	5.0 ^b	0.15 ^a	0 ^a	0.14 ^a	12.17
Modified Bog (semi-natural Heather + Grass dominated)	Drained	0.13 ^b	1.14 ^a	0.3 ^b	1.26 ^b	0.66 ^a	0.06 ^b	3.54
	Undrained	0.13 ^b	0.69 ^a	0.1 ^b	1.33 ^b	0 ^a	0.06 ^b	2.31
Extensive Grassland (combined bog/fen)	Drained	6.96 ^b	1.14 ^a	0.3 ^b	1.96 ^b	0.66 ^a	2.01 ^a	13.03
Intensive Grassland	Drained	21.31 ^b	1.14 ^a	0.3 ^b	0.68 ^b	1.46 ^a	2.67 ^b	27.54
Rewetted Bog	Rewetted	-0.69 ^b	0.88 ^a	0.1 ^b	3.59 ^b	0.0 ^a	0.04 ^b	3.91
Rewetted Fen	Rewetted	4.27 ^b	0.88 ^a	0.1 ^b	2.81 ^b	0.0 ^a	0 ^a	8.05
Rewetted Modified (Semi-natural) Bog	Rewetted	-3.54 ^b	0.69 ^a	0 ^b	2.83 ^b	0 ^a	0 ^a	-0.02
Near Natural Bog	Undrained	-3.54 ^b	0.69 ^a	0 ^b	2.83 ^b	0 ^a	0 ^a	-0.02
Near Natural Fen	Undrained	-5.41 ^b	0.69 ^a	0 ^b	3.79 ^b	0 ^a	0 ^a	-0.93
Extracted Domestic	Drained	10.27 ^a	1.14 ^a	1.01 ^b	0.14 ^a	0.68 ^a	0.14 ^a	13.37
Extracted Industrial	Drained	6.18 ^b	1.14 ^a	5.0 ^b	0.14 ^a	0.68 ^a	0.14 ^a	13.28
Settlement	Drained	0.07 ^b	0.57 ^a	0.15 ^b	0.63 ^b	0.16 ^a	0.03 ^b	1.61

^a Tier 1 default EF (IPCC 2014)

^b Tier 2 EF (updated literature analysis in 2019 incorporating data from Evans et al. 2017)

^c Tier 3 Forest Research CARBINE model implied EF for 1990 to 2019. The decreasing trend is due to an increase in age of forests on organic soils due to decreasing afforestation on organic soils.

Applying these emissions factors to the estimated habitat and peat areas in the Exmoor National Park (Appendix 0) allowed us to derive our own results for the current CO₂ and non-CO₂ emissions from degrading and near-natural peat in the Park (Table 13). These results were used alongside the BEIS estimates to put forward an average estimate for the current land-based emissions in the National Park (Section 5.5).

Table 13. Estimated present-day emissions from peatland in the Exmoor National Park derived from the based on the 2019 CEH Land Cover Map, the Living England habitat map, and the Natural England peatland map, supplemented by in-house habitat and peat data, as well as local knowledge on the peat condition from the Exmoor Mires Partnership (Appendix 0), in conjunction with the BEIS / Natural England emission factors for UK peatland (Table 12)

Peatland Type	Baseline CO ₂ flux, peatland, tCO ₂ e/yr	Baseline non-CO ₂ flux, peatland, tCO ₂ e/yr
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Eroding modified bog (bare peat), drained	0	0
Eroding modified bog (bare peat), undrained	0	0
Modified bog (heather/grass dominated), drained	27,913	35,203
Modified bog (heather/grass dominated), undrained	3,341	5,048
Cropland on peat soil, drained	1,644	414
Intensive grassland on peat soil, drained	81,488	17,229
Extensive grassland (on bog/fen), drained	30,088	16,584
Forest on peat soil, drained	6,287	5,259
Total modified / degrading peat	150,761	79,737
Near-natural bog	-1,037	1,030
Nar-naturel fen	-586	471
Total near-natural peat	-1,623	1,500

10.8.9. Appendix: Target-setting methodology for land use change

The land use change and management targets in each National Park or AONB, which include woodland creation, peatland restoration and several regenerative agriculture measures, are derived by apportioning land-based carbon sequestration measures from the UK's Sixth Carbon Budget (2020)¹⁰⁸ according to present-day land use distribution in each National Park or AONB.

In the case of woodland creation, a more ambitious target has been introduced for each protected landscape through a high-level opportunity mapping (Table 14) and conversations with the National Park and AONB teams on the ground, with a preference (in most cases) for native broadleaf or mixed species in order to achieve broader environmental benefits across protected landscapes, such as those in National Parks and AONBs.

Our land use change and management options focus on either creating, enhancing or restoring (as applicable) four common land use types (habitats) on mineral soils, and eight types of degrading peatland habitats:

- Broadleaf woodland on mineral soil
- Coniferous woodland on mineral soil
- Improved grassland on mineral soil
- Cropland on mineral soil
- Eroding modified bog (bare peat), drained
- Eroding modified bog (bare peat), undrained
- Modified bog (heather/grass-dominated), drained
- Modified bog (heather/grass-dominated), undrained
- Cropland on peat soil, drained
- Intensive grassland on peat soil, drained
- Extensive grassland (on bog/fen), drained
- Forest on peat soil, drained.

The degraded peatland classification follows the methodology adopted by BEIS for annual LULUCF GHG inventories¹⁰⁹, which is based on the assessment by Evans *et al.* (2017)¹¹⁰.

For Exmoor National Park, the current land use distribution is illustrated in Table 14. It is based on the 2019 CEH Land Cover Map, the Living England habitat map, and the Natural England peatland map, supplemented by in-house habitat and peat data, as well as local knowledge on the peat condition from the Exmoor Mires Partnership. The UK-wide areas of the selected land use (habitat) types and the corresponding percentages accounted for by the National Park are shown for context in Table 15.

At roughly 69,400 ha, the Exmoor National Park accounts for around 0.3% of the UK's total land area, while the National Park's current share of tree cover on mineral soils is 43% lower than the UK

¹⁰⁸ UK's Sixth Carbon Budget: "Agriculture and land use, land use change and forestry" (AFOLU) report. Climate Change Committee, 2020.

¹⁰⁹ Ricardo Energy & Environment, UK NIR 2020 (Issue 1) "UK GHG Inventory 1990-2019," Annex p. 854 .

¹¹⁰ Centre for Ecology and Hydrology (2017) "Implementation of an Emissions Inventory for UK Peatlands: A report to the Department for Business, Energy, and Industrial Strategy," Issue 1.

average (and is similar to the UK average if the nearly 3,500 ha of woodland on peat soils in the National Park are factored in). There may be an opportunity to expand the existing woodland area. We propose to prioritise new native broadleaf trees, recognising that a native permanent woodland also has multiple co-benefits in addition to carbon sequestration, while reserving a fraction of the new woodland target for productive coniferous forestry to contribute to the UK becoming more self-sufficient in timber.

The estimated occurrence of peatland in Exmoor National Park is nearly 4 times higher than the UK average per unit area. Restoring peatland can therefore make a considerable contribution to reducing land-based emissions in the National Park, therefore it needs to be a priority. This provides both challenges and opportunities to manage large parts of the land more sustainably and reduce carbon emissions associated with degrading peat.

The Exmoor National Park improved grassland and cropland areas are estimated to be 60% higher and nearly 10 times lower than the respective UK averages. There is potential to apply restorative agricultural practices as part of proposed UK-wide measures to manage land more sustainably, which are outlined in the Sixth Carbon Budget. Some of the least productive and lowest grade farmland, including rough grazing, may need to be taken off agricultural production to enable new woodland plantations and peatland restoration.

Table 14. Exmoor National Park: Key land use types by area (present-day), including underlying peat areas and the estimated percentage of peat in a healthy condition (by area). The right-most column illustrates the empirically assigned relative likelihoods of the habitats (excluding peat soil areas within) to be considered for woodland creation projects. These relative likelihoods define the high-level opportunity mapping procedure; see the section below for further details

Land Cover (Habitat) Type	Habitat Area (ha)	Peat Area (ha)	Estimated % of Peat Area in Healthy Condition	Proposed % of Area (Excl Peat) to Consider for New Woodland
Broadleaved woodland	5,913.0	1,994.9	0%	0%
Coniferous woodland	2,811.4	1,488.1	0%	0%
Arable and horticulture	2,010.7	54.7	0%	25%
Improved grassland	35,435.4	7,163.8	0%	25%
Neutral grassland	0.0	0.0	NA	50%
Calcareous grassland	0.0	0.0	NA	0%
Acid grassland	5,827.7	5,827.7	0%	75%
Fen, marsh, swamp	0.0	0.0	NA	0%
Heather	3,696.1	3,696.1	0%	50%
Heather grassland	8,917.9	8,917.9	0%	75%
Bog	3,333.0	3,333.0	11%	0%
Saltmarsh	124.2	124.2	100%	0%
Urban	29.3	0.0	NA	0%
Suburban	847.2	0.0	NA	25%
Total	68,945.9	32,600.3	NA	NA

Table 15. Exmoor National Park: Estimated areas of the main land cover types on mineral soils as well as areas of degraded peatland (all types) compared with the relevant UK totals

Land Cover Type	Current UK Area (ha)	Current NP Area (ha)	NP Area as % of UK Area
Broadleaf Woodland (mineral soils only)	1,582,700	3,918	0.248%
Coniferous Woodland (mineral soils only)	1,647,300	1,323	0.080%
Improved Grassland (mineral soils only)	6,161,798	28,272	0.459%
Cropland (mineral soils only)	5,788,356	1,956	0.034%
Degraded peatland (all types)	2,182,455	32,112	1.471%
Total Woodland Area (Broadleaf + Coniferous)	3,230,000	5,241	0.163%
Total Agricultural Area (Improv. Grassland + Cropland)	11,950,154	30,228	0.253%
Total Area of Selected Land Cover Types (above)	17,362,609	67,581	0.390%
Total Area (incl. urban, rough grassland, water, rock, etc)	24,249,500	69,400	0.286%

We consider the following seven options for land use change and management that will enable carbon sequestration (or emissions reduction in the case of degraded peatland) and create wider environmental benefits (biodiversity gains, flood mitigation, air quality improvements, gains in recreational value, etc.), in alignment with the Sixth Carbon Budget:

- New native broadleaf/mixed woodland
- New productive coniferous woodland
- Peatland restoration (across all degraded types)
- Agroforestry (for improved grassland and cropland)
- Hedgerows (for improved grassland and cropland)
- Introducing legume grass species (for improved grassland)
- Introducing cover crops (for cropland)

Each of these measures is described in the subsections below.

Woodland creation

Our chosen UK-wide woodland creation target from the Sixth Carbon Budget is 50,000 ha per yr, representing medium to high levels of ambition as part of the proposed Net Zero scenario for 2050.

As a starting point, we apportion UK-wide woodland creation target based on the current woodland coverage in each National Park and AONB as a percentage of the UK coverage (see Table 15 above), which simply mirrors the approach for apportioning other land use and management options considered here (e.g. peatland restoration and a better agricultural management). However, the fact that creating new woodland requires a fundamental change to land use rather than management changes on existing land, the woodland target has to be set differently, by considering

total areas of suitable habitats within each landscape. We refer to this assessment as a high-level woodland opportunity mapping, which is a first step in setting a practical woodland target, to be followed by a field-level multi-benefit opportunity mapping.

As a default rule, we safeguard habitats such as existing woodland, calcareous grassland, lowland heathland, fen and bog from the opportunity mapping for new woodland (represented by 0% likelihoods of new woodland projects as per the settings in Table 14). On the other hand, habitats such as neutral grassland, acid grassland and upland heathland, part of which are commonly referred to as “moorland”, are prime candidates for woodland opportunity mapping as part of natural regeneration projects, subject to field-level ecological, economic and historic landscape considerations, and excluding peatland areas within these habitats. On the latter point, we note that large areas of the acid grassland and upland heathland habitats contain both deep and shallow peat, typically classified as modified bog dominated by heather/grass, either drained or undrained. We exclude these areas from woodland opportunity mapping, and apply restoration targets to these types of peatland, in addition to degraded areas of peatland classified as blanket bog, peat under agricultural soils or forested peat. For arable land and improved grassland, only a relatively small fraction of the area (25%, see Table 14) is considered for woodland opportunity mapping, for example by creating mosaic habitats with new woodland on field margins freed by reducing livestock numbers and adopting higher-yielding crop varieties.

Our approach for apportioning the UK woodland target to each protected landscape through a high-level opportunity mapping procedure has been applied to all National Parks and AONBs participating in this programme. As a default for this assessment, we assign a custom woodland creation target that exceeds the area-based target described above, which is illustrated for Exmoor National Park in Table 16. For most protected landscapes, the ambition is around two times the minimum target based on suitable areas. This reflects on unique opportunities that Protected Landscapes have in terms of attracting both public and private grants to expand the woodland cover, and the central role they ought to play for meeting ambitious nature recovery goals across the UK. The proposed higher ambition approach is supported by field-level woodland opportunity mapping performed by several landscapes (e.g. Cotswolds¹¹¹, Northumberland¹¹²). Based these principles, the custom woodland target for Exmoor is 130 ha/yr.

Table 16. Three ways of setting new woodland targets in Exmoor National Park.

Woodland target apportioned by woodland land cover area in the National Park or AONB	81	ha/yr
Minimum woodland target apportioned by suitable habitat areas in the National Park or AONB	64	ha/yr
Custom woodland target in the National Park or AONB	130	ha/yr

The combined woodland target is then divided between native broadleaf/mixed woodland and productive coniferous woodland. As a default position, we opted to use a 100%-0% split in favour of native broadleaf/mixed woodland for lowland landscapes and/or those landscapes that advocate for forestry areas to be predominantly outside of their borders, for example in the sphere of influence of the neighbouring Local Authority Districts. For some upland landscapes, 80%-20% or

¹¹¹ <https://www.arcgis.com/apps/dashboards/3652fdb534cf47e58b7262cdb2345366>.

¹¹² <https://envsys-ltd.maps.arcgis.com/apps/MapSeries/index.html?appid=d434eb386d21442694eaa0186a82bb76>.

70%-30% in favour of the native woodland could be considered. A 50%-50% split may be applicable in exceptional circumstances such as strategic importance of forestry in certain protected areas.

In this assessment, we propose to use the 80%-20% woodland cover split in favour of native woodland for Exmoor National Park, to benefit from the broader environmental and social benefits of native woodland, while also reflecting on the importance of productive forestry to the local and UK-wide economies.

Our estimates regarding carbon sequestration in woodland biomass employ yield class (YC) 8 for native broadleaf/mixed woodland and YC 18 for productive conifer trees, as per the Sixth Carbon Budget's recommendations¹¹³. We use 30-year average sequestration fluxes for trees from these yield classes (inferred from the Woodland Carbon Code, WCC), to match the timescales of the Net Zero target of 2050. Different trees planted in the years ahead will be between 0 and 30 years old by 2050, which is why we adopt the 30-year average sequestration flux value in our calculations. Another simplification is that no time lag in carbon sequestration in trees is considered, with the S-shaped curve representing the actual cumulative carbon uptake in trees replaced by a linear function from the moment of planting (i.e. assuming constant annual growth rate for trees in terms of carbon uptake). We also add to the biomass carbon sequestration (inferred from the WCC) representative estimates of soil carbon sequestration for woodland, from a recent literature review by Bossio *et al.* (2020)¹¹⁴.

Peatland restoration

Our adopted UK-wide peatland restoration target follows the recommendation in the Sixth Carbon Budget that 79% of UK's peatland areas will need to be restored by 2050, which would be a big improvement on the current estimate that only 25% of UK's peatlands are in a healthy condition. This results in a combined annual target of just under 52,400 ha/year of peatland to restore across the UK between now and 2050.

The UK-wide peatland restoration target is apportioned to each National Park or AONB according to its total estimated area of peatland. Each National Park's and AONB's target is further broken down into sub-targets for individual peatland areas with distinct types of modification and/or degradation, following the peatland conventions adopted in the BEIS LULUCF GHG inventory (Section 10.8.8). The sub-targets are based on the estimated current surface areas of the relevant types of degraded peatland (Table 14).

Unless bespoke information on peatland degradation levels has been provided by an individual National Park or AONB, we assume that the UK-average estimate of 25% of peatland being in a near-natural or restored condition applies to all peatland areas in each landscape. The remaining peatland areas in each landscape (75%) are assumed to be in various states of degradation. For blanket bog habitats, the most common modification is peat dominated by heather/grass and drained, alongside comparatively small areas of eroding bare peat. For heathland habitats, the peat is commonly dominated by heather/grass and may be either drained or undrained. In some National

¹¹³ UK's Sixth Carbon Budget, AFOLU report, page 27.

¹¹⁴ Bossio, D. A., et al. (2020). "The role of soil carbon in natural climate solutions.." *Nature Sustainability*, 3(5), 391-398.

Parks and AONBs, there are also organic soils under agricultural and forested areas, which have their unique types of peatland degradation and associated carbon fluxes.

As with the peatland classification, our peatland emissions factors follow the BEIS methodology (Section 10.8.8). Restoring a certain amount of peatland means reducing emissions relative to the present-day baseline in line with the adopted peat classifications and emission factors. Because of the considerable uncertainties associated with reversing degradation of peatland so that it becomes a net carbon sink, our analysis focuses on reducing emissions from degraded peat through restoration and excludes subsequent sequestration benefits associated with a healthy restored peatland.

Agroforestry uptake

According to the Sixth Carbon Budget, 10% of UK farmland area may need to be converted to agroforestry systems by 2050 in line with the recommended Net Zero pathway. We apply this target to improved grassland and cropland systems only. Agroforestry is assumed to be current practice on 1% of UK farmland; we do not have definitive figures at this stage. Agroforestry is different from present-day farm woodland, which is estimated to cover 5% of the total farmland area in the UK, in that the trees tend to be planted in alleys crossing the agricultural fields, as opposed to being confined to field margins. This planting system is known to have multiple co-benefits such as higher carbon sequestration in soils and higher agricultural productivity.

Based on the assumptions above, the recommended increase in land managed along agroforestry principles across the UK is just over 30,000 ha/year between now and 2050, which applies to improved grassland and cropland areas. This target is apportioned to each National Park or AONB according to the size of existing areas of improved grassland and cropland within the landscape.

When recommending conversion of land to agroforestry for each National Park or AONB, we take an average of the UK agricultural land area at present and that projected for 2050, in line with the Net Zero pathway from the Sixth Carbon Budget. Under this pathway, the UK's total agricultural land area will be reduced by 3.8 million ha in favour of new woodland, restored peatland and other land uses. The reduction will be compensated by agricultural productivity increases, dietary shifts, and possibly also by moves to alternative production systems such as vertical farming in cities.

Our agroforestry-related carbon sequestration estimates are based on the figures from Bossio *et al.* (2020) for the two most common agroforestry types – alleys and windbreaks – and account for the low tree-planting densities associated with these farming systems. The estimates include both biomass gains and soil carbon sequestration.

Hedgerows expansion

The Sixth Carbon Budget assumes a 40% increase in the area covered by hedgerows across the UK by 2050, amounting to 1,725 ha/year of new hedgerows planted across the UK between now and 2050 (based on estimated present-day coverage). This target is apportioned to each National Park or AONB according to its share of improved grassland and cropland, and is adjusted according to the projected decrease in the total area of the UK's agricultural land by 2050 (the same as for

agroforestry). New hedgerows could be created by dividing larger fields, and on field margins, as part of a transition to smaller-scale and less intensive farming systems.

Our estimates of hedgerow carbon sequestration are based on trees with yield class (YC) 4. As is the case for new woodland creation, we use a 30-year average carbon sequestration flux for trees from this yield class (inferred from the Woodland Carbon Code, WCC) to match the timescales of the Net Zero target of 2050. We do not add soil carbon sequestration to hedgerow carbon flux estimates.

Grazing legumes for improved grassland

According to the Sixth Carbon Budget, 75% of UK grazed grassland area may need to be converted to less intensive systems by 2050, with legume species replacing synthetic fertilisers as natural nitrogen fixers. We apply the grazing legumes target to improved grassland only. Grassland with legume species is assumed to account for 5% of the current improved grassland area; we do not have definitive figures at this stage.

Based on the assumptions above, the recommended increase in land dedicated to UK-wide grazing legumes is just over 120,000 ha/year between now and 2050, which applies to improved grassland areas only. This target is apportioned to each National Park or AONB according to the size of existing areas of improved grassland in the landscape, and is adjusted according to the projected decrease in the total area of UK agricultural land by 2050 (the same as for agroforestry and hedgerows).

The carbon sequestration benefit of introducing grazing legume grassland species follows the figures from Bossio *et al.* (2020).

Cover cropping for cropland

According to the Sixth Carbon Budget, it may be necessary to adopt winter cover cropping on 75% of the UK's cropland area by 2050, with cover crops preventing soil erosion, improving landscapes' flood resilience and enhancing carbon sequestration. Winter cover crops are assumed to account for 5% of the current cropland area; we do not have definitive figures at this stage.

Based on the assumptions above, the recommended increase in land dedicated to cover crops across the UK is just under 114,000 ha/year between now and 2050, which applies to cropland areas only. This target is apportioned to each National Park or AONB according to the size of existing areas of cropland in the landscape, and adjusted in line with the projected decrease in the UK's total agricultural land area by 2050 (the same as for agroforestry, hedgerows and grazing legumes).

The carbon sequestration benefit of introducing cover crops follows the figures from Bossio *et al.* (2020).

Summary: Land use targets and carbon sequestration fluxes for the Exmoor National Park

Table 17 summarises the proposed land use change and management targets for Exmoor National Park, which follow the principles outlined above.

Table 17. Land use targets and the associated additional carbon sequestration fluxes per year (emissions reduction for peat) for Exmoor National Park.

Land Use / Management Category	Land Use Change Target (ha/yr)	Change in Carbon Flux (tCO₂e/yr/yr)
New Native Broadleaf/Mixed Woodland	104	-1,919
New Productive Coniferous Woodland	26	-575
Agroforestry (improved grassland & cropland)	76	-179
Hedgerows (improved grassland & cropland)	4	-46
Grazing Legumes (improved grassland)	555	-1,139
Cover Cropping (cropland)	38	-45
Restored Eroding Modified Bog (bare peat), Drained	0	0
Restored Eroding Modified Bog (bare peat), Undrained	0	0
Restored Modified Bog (heather/grass dominated), Drained	427	-1,515
Restored Modified Bog (heather/grass dominated), Undrained	87	-201
Restored Cropland Peat, Drained	1	-49
Restored Intensive Grassland Peat, Drained	86	-2,369
Restored Extensive Grassland Peat, Drained	86	-1,120
Restored Forested Peat, Drained	84	-277
Total	1,574	-9,436