A greenhouse gas emissions assessment and target recommendations for the South Downs National Park

A report by Small World Consulting Ltd

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Executive summary

Background

As the world wakes up to the climate and wider environmental emergency, rapid reduction in 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 are home to around half a million residents, attract approximately 100 million visitors per year and account for 10% of the UK's land area. If they can become exemplars of low-carbon transition and environmental land management, their national and international profiles can be expected to give them influence that greatly exceeds the scale of their own emissions. The exciting and creative challenge for each park is to find a way to cut emissions in line with current science and be land stewardship and planning authority leaders, while simultaneously creating better places to live, work and visit.

This report

This report for South Downs National Park is one of a series of methodologically compatible reports carried out for every UK National Park. They are designed to provide a robust and consistent evidence basis for climate action, matched to the unique characteristics and circumstances of each park, as we move into 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 park (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 park whether by people or businesses or from land, and those relating to the production of electricity that is used within the park. However, the consumption-based approach that is adopted here also covers all the indirect emissions that are embodied in the goods and services consumed by residents and visitors within the park. In doing so, it better reflects the full climate impact of people's lifestyles and brings into focus for policy makers important areas of climate impact that are missed by a production-based assessment. The most important of these are the impact of food, of other purchased items (such as cars, clothes, IT equipment, and household goods and furnishings), and of travel outside the park by residents and by visitors on their way to and from.

One feature of consumption-based reporting is that it does not include emissions from industry (except where their goods and services are consumed by residents and visitors). Therefore, for perspective, we also include here a simple estimate of emissions related to industries within the park, including their supply chains. It is important to note that there is some inevitable overlap between this assessment and that of residents and visitors, for example when residents or visitors buy from businesses within the park. Figure 1 illustrates the relationship between the three main components of our central assessment and the industry emissions.

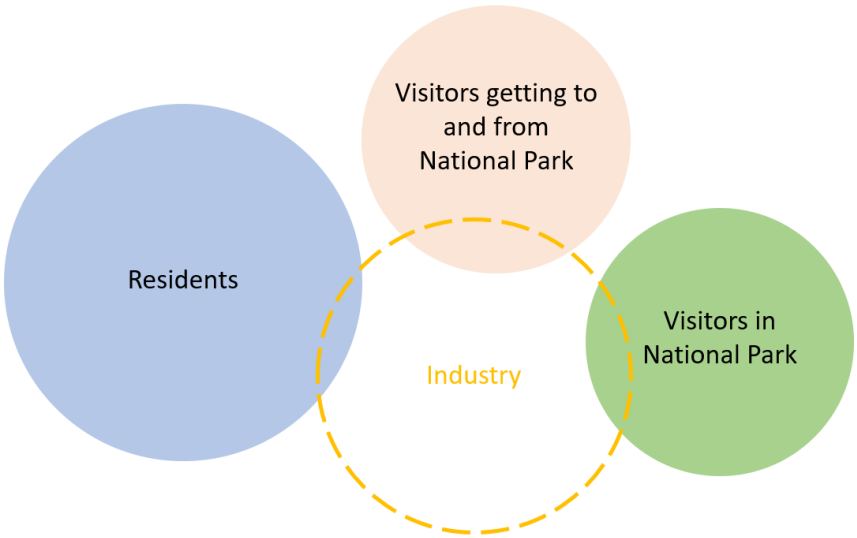


Figure 1: Boundaries of the greenhouse gas footprint assessment

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 policy makers; to keep the boundary simple to describe; to avoid double counting and to make use of any readily available data 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
- Food and drink consumed by residents and visitors
- Other goods purchased by residents and visitors
- Visitor travel to and from the National Park
- LULUCF[1] Non-CO_2 component
- LULUCF CO2 component

Limitations and uncertainties

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

[1] LULUCF stand for Land Use, Land Use Change and Forestry. It is a common way to describe land-based emissions excluding fuel and electricity consumption by agricultural activities.

Results

South Downs **National Park** (See Figure 2 – Figure 5)	
Annual emissions from residents	**2,157,019 tCO_2e** (15.3 tCO_2e per person per year)
Annual emissions from visitors while in the National Park	**388,211 tCO_2e** (19.0 $kgCO_2e$ per visitor-day)
Annual emissions from visitors travelling to/from the National Park	**665,729 tCO2e** (35.1 $kgCO_2e$ per visit)
Annual industry emissions	**1,506,237 tCO_2e**

Key highlights

South Downs is a moderately affluent National Park and has the largest residential population among all the National Parks in the UK. Its average residents' household spending is 11.1% above the UK average, with the consumption results pointing to a mix between working age and retired populations. The total footprint of South Downs residents is 24% higher per capita than the UK average and is around two times higher than that of all visitors.

South Downs residents tend to drive around 26% more and fly almost three times as much as an average UK resident, resulting in proportionately larger carbon footprint contributions from vehicle fuel and flying. South Downs residents also have a higher food & drink footprint than the UK average due to the more affluent demographics. The footprint of visitors while travelling to and from South Downs is nearly double their footprint while in the National Park.

The largest component of the footprint of South Downs visitors while in the National Park is food and drink (46%), followed by driving (38%). In comparison with most National Parks, a smaller proportion of visitors stay overnight. South Downs visitors' footprint while travelling to and from the National Park is dominated by driving (52%), followed by flying (28%).

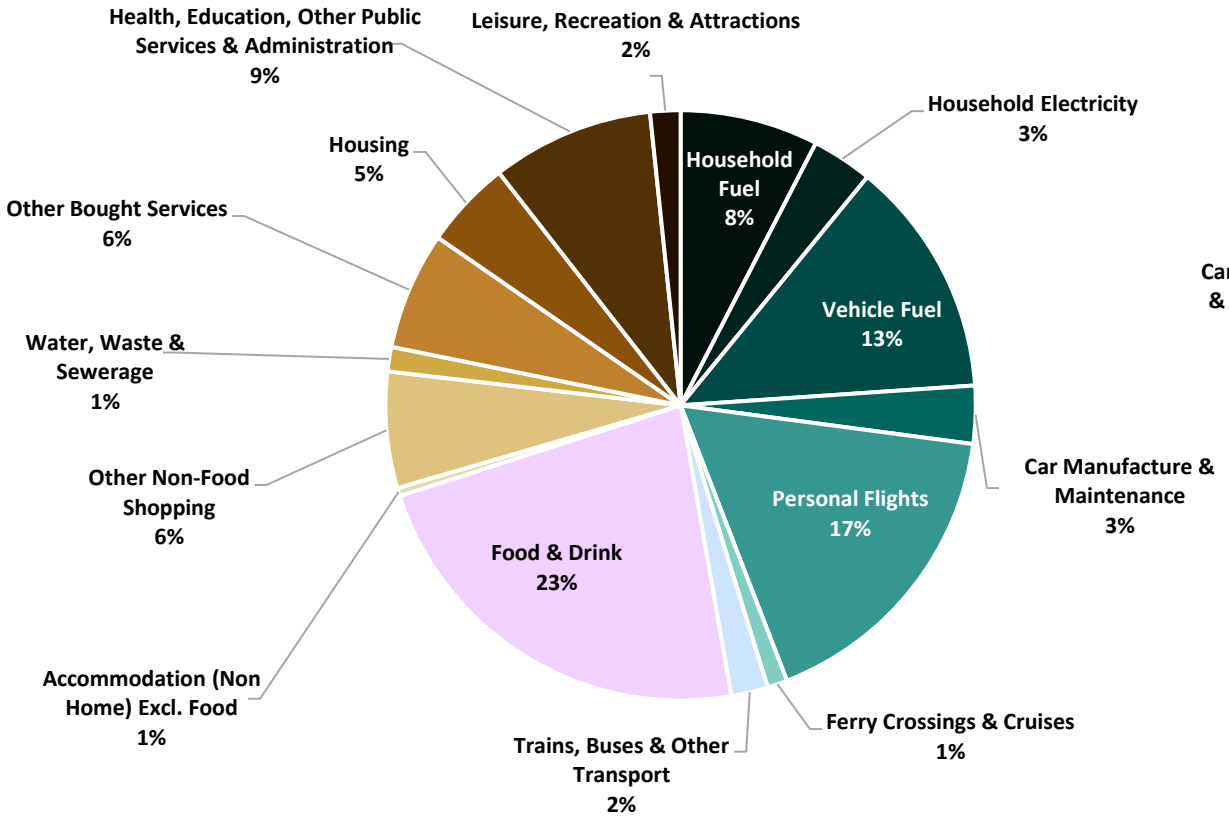
Production businesses (all types of manufacturing) account for 40% of the footprint of industries, with agriculture and fishing accounting for 12% and construction 9%. This is in line with most National Parks, which are largely rural areas. Per-resident footprints of professional services and education are also considerably higher than UK averages.

South Downs is estimated to have considerable transit traffic through the major A roads (passenger and freight), although the associated footprints are a fraction of the National Park totals for residents and industry.

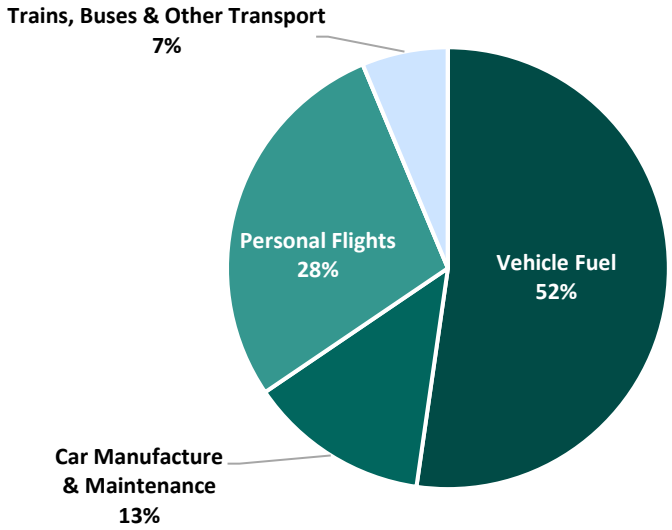
Targets recommendation

A minimum Paris-aligned target trajectory has been constructed for each of the six elements of the targets, as illustrated in Figure 6. When combined, they result in a net zero date of 2041 for the South Downs National Park. Note that the net zero date reflects the unique characteristics of the park, including the quantity and type of land, the number of residents and visitors, and the level and type of industrial activity. (See Section 6 for the target figures). The net zero date on its own should not be taken as a level of ambition since all geographical areas vary in their potential for negative emissions.

Residents: 2,157,019 tCO_2e



Visitors travel to & from the National Park: 665,729 tCO_2e



Visitors while in the National Park: 388,211 tCO_2e

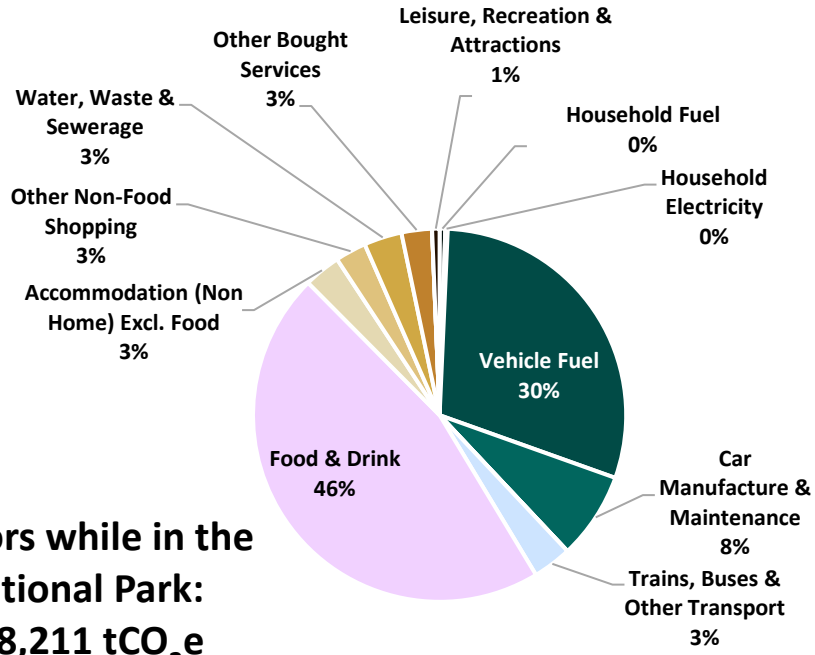


Figure 2: (Left) Residents' GHG emissions in South Downs National Park by percentage

Figure 3: (Top Right) Visitors' GHG emissions on the way to & from South Downs National Park by percentage

Figure 4: (Bottom Right) Visitors' GHG emissions while in South Downs National Park

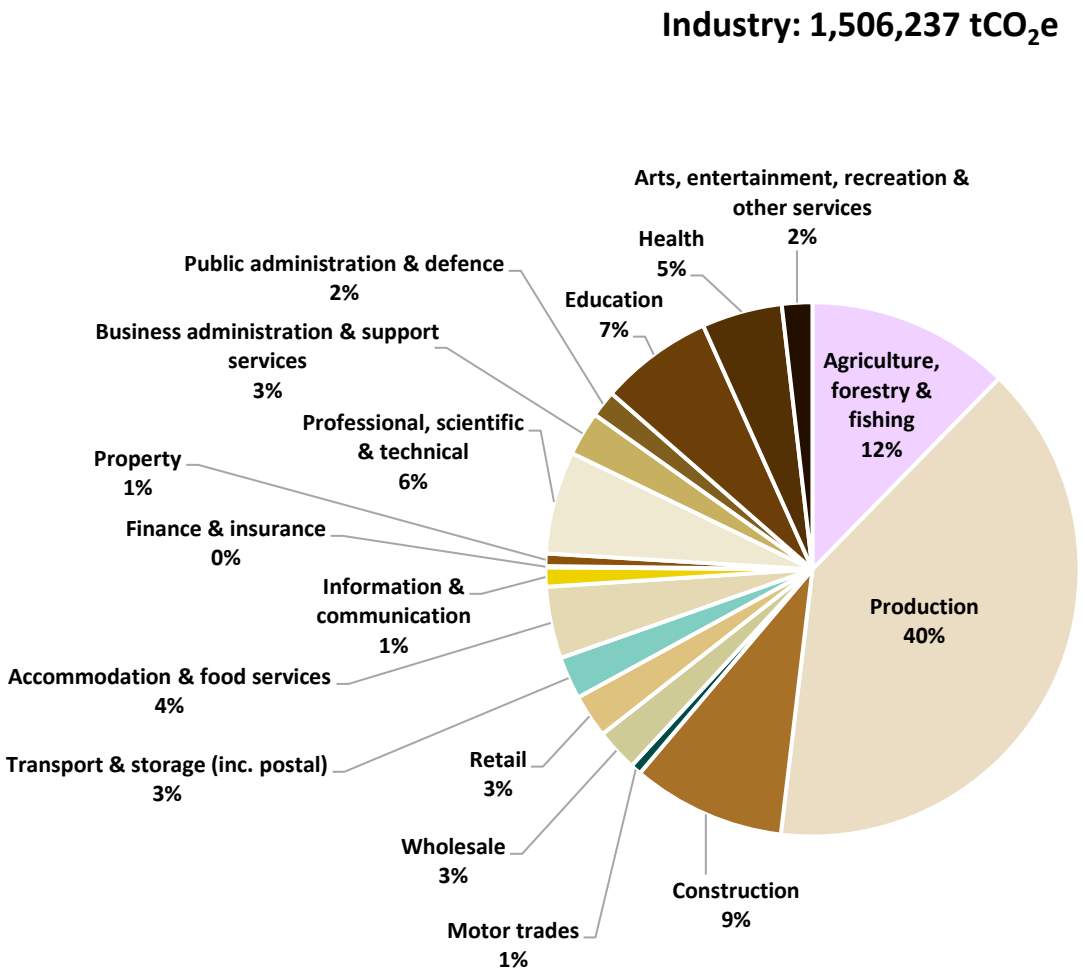


Figure 5: A estimate of emissions from industries within the park and their supply chains (scopes 1, 2 and upstream scope 3)

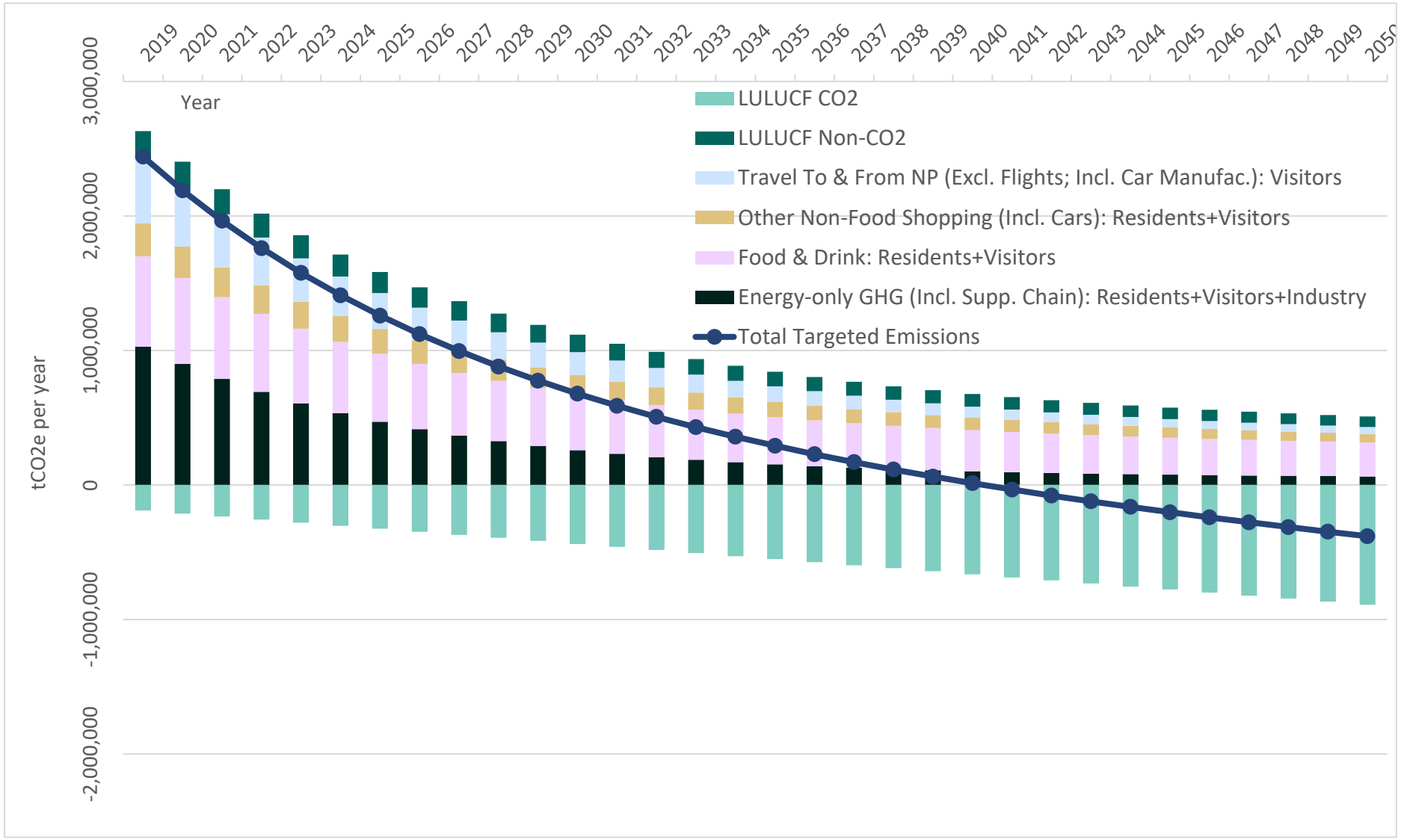


Figure 6: Recommended target pathways resulting in net zero emissions for the South Downs National Park by 2041

1. Introduction

As the world wakes up to the climate and wider environmental emergency, rapid reduction in 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 to a legally binding target of net zero by 2050. This led to the family of participating English, Scottish and Welsh National Parks seeking to assess their greenhouse gas emissions collectively, with Welsh AONBs and the Cotswolds AONB also joining. This report for South Downs National Park is one of a series of methodologically compatible reports carried out for each UK National Park. The baseline year for the assessment is 2019, the most recent pre-COVID year. This report also includes a recommendation for Paris-aligned greenhouse gas targets across six key areas with a net zero date of 2041.

Together, the UK's 15 National Parks are home to around half a million residents, attract approximately 100 million visitors per year and account for 10% of the UK's land area. If they can become exemplars of low-carbon transition and environmental land management, their national and international profiles can be expected to give them influence that greatly exceeds the scale of their own emissions. The exciting and creative challenge for each park is to find a way to cut emissions in line with current science and be land stewardship leaders, while simultaneously creating better places to live, work and visit.

Almost every action connected with living, working and visiting the parks gives rise to emissions which lie within the influence and therefore management responsibilities of the National Park Authorities. While the need to transition from fossil fuels to renewable energy is the single greatest challenge in responding to the climate emergency, for the National Parks in particular, land management is also a critical element of dealing with both the climate and biodiversity crises.

The unique characteristics of each park give rise to different priorities and opportunities for cutting greenhouse gas emissions and for sustainable land management. The ratio of visitors to residents varies greatly. Some National Parks have large industrial or military sites within their boundaries. To varying degrees, each National Park has major roads crossing through with considerable traffic (not stopping in the park). All these factors affect the economic makeup of the parks' areas and have strong implications for the associated GHG footprint and decarbonisation efforts. In terms of land management challenges and opportunities, the parks vary greatly in the quantities of peatland and woodland, in the amount and types of agricultural land, and in the resident and visitor population densities.

The main body of the 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 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 for 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, and the wider ecological crisis are the biggest challenges facing humanity today. A 2018 Intergovernmental Panel on Climate Change (IPCC) report outlined the need to reduce global greenhouse gas emissions by 45% by 2030 from 2010 levels and achieve net zero emissions by 2050[2]. This is in order for the planet to stay within a 1.5°C increase in global temperature 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. The UK Government agreed in 2019 to a legally binding target of net zero emissions by 2050. Subsequently, the IPCC has commenced publishing their Sixth Assessment Report (AR6) in stages between August 2021 – September 2022. Compiled by the world's leading scientists, this report provides a comprehensive update on what the science tells us about climate change and is intended to be used 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 base", was released ahead of the 26th UNFCCC Conference of the Parties (COP26) hosted in Glasgow in November 2021[3]. Notably, it affirms that the increase of carbon dioxide, methane, and nitrous oxide in the atmosphere over the industrial era 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 the warming below the 1.5°C limit will likely require the most ambitious actions both in reducing emissions and scaling-up carbon sequestration efforts that are at the top end of the known technical feasibility.

The Department of Business, Energy and Industry Strategy (BEIS) is the lead for reporting on GHG emissions in line with the UNFCCC requirements in the UK. The Sixth Carbon Budget (2020) recommends that the UK sets a budget to require a reduction in UK greenhouse gas emissions of 78% by 2035 relative to 1990, a 63% reduction from 2019 (CCC,2020:14:15). Further detail relating to this is provided in Section 2.4 outlining associated real-world change towards decarbonisation.

Ahead of COP26, the UK Government published its Net Zero Strategy: Build Back Greener October 2021[4]. 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. The end of COP26 saw the agreement of the Glasgow Climate Pact with 153 countries putting forward new

[2] IPCC (2018) Special Report: Global Warming of 1.5ºC Summary for Policy Makers https://www.ipcc.ch/sr15/chapter/spm/

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

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

2030 emissions targets (NDCs)[5]. The NDCs pledges at COP26 are estimated to lead to a temperature rise of 2.4^{0}C by the end of the century, while the existing Net Zero pledges, if fully implemented, would limit global warming to 1.8^{0}C.[6]

Prior to COP26 closing on the 13th of November, the Environment Act 2021 received Royal Assent, becoming law on the 9th of November 2021 as an Act of Parliament. The broad aims of the Environment Act are to improve air and water quality, protect wildlife, increase recycling and reduce plastic waste. The Act also enables targets for particulate matter (ambient air quality) and species abundance. More importantly, it sets environmental principles which National Park Authorities will need to be cognisant of in discharging their statutory planning authority obligations namely:

- The principle that environmental protection should be integrated into the making of policies,
- the principle of preventative action to avert environmental damage,
- the precautionary principle, so far as relating to the environment,
- the principle that environmental damage should, as a priority, be rectified at source,
- the polluter pays principle.

2.2. Health impacts

In addition to the impact on the environment of climate change, emissions also have an impact on human health and wellbeing. Almost 30% of preventable deaths in England are due to non-communicable diseases specifically attributed to air pollution (NHS Plan, 2019). The NHS has identified that more than 2,000 GP practices and 200 hospitals are in areas 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, the lives of three families are devasted 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 adaptation and mitigation

The impact of climate change on our natural world is evidenced by higher temperatures, changing rainfall, changes in ecosystems, sea level rise and increasing storm surges, and retreating glaciers, sea ice and ice sheets. In the UK we are seeing significant changes in Winter and Summer rainfall patterns. The UK Met Office's latest report indicates 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 overall. However, changes are largest for Scotland and not significant for most of southern and eastern England. Further to causing higher precipitation, "climate change has already increased the chance of seeing a Summer as hot as 2018 to between 12-25%. With future warming, hot Summers by mid-century could become even more common, near to 50%".

In terms of human responses to flooding, a recent report by Natural England also suggests environmental inequality is greater within deprived communities, who experience the greatest

[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/
[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

negative climate impacts e.g. flood risk, air pollution, poor river water quality and waste hazards. Research has shown 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 have direct exposure to being flooded (based on cost per household for a 2-year period ranging from £3,144 - £6,980 dependent on flood depth)[8].

In addition, climate-driven changes in rainfall patterns and temperatures provide significant challenges for species adaptation dependent on local environmental conditions and habitats, posing an even greater future risk to biodiversity.

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 necessitating real world planning, action and behaviour change. Key highlights from the report are listed below:

- By early 2030s all new cars and vans and all home/building boiler replacements are low-carbon – largely electric.
- By 2040 all new trucks are low-carbon.
- Instead of fossil fuels, UK industry shifts to using renewable electricity or hydrogen.
- UK industry captures its remaining carbon emissions and stores them safely.
- By 2035 UK electricity production is zero carbon.
- Low-carbon hydrogen scales-up as a fuel for shipping, transport and industry, and some buildings, as a replacement for natural gas for heating (doubling-trebling demand by 2050).
- UK wastes fewer resources and reduces its reliance on high-carbon goods.
- UK national programme to improve building insulation.
- Fewer car and air miles travelled.
- Diets change, reducing consumption of high-carbon meat and dairy products by 20% by 2030.
- Transformation in agriculture and the use of farmland while maintaining the same levels of food per head produced today.
- By 2035, 460,000 hectares of new mixed woodland are planted to remove CO_2 and deliver wider environmental benefits.
- By 2035, 260,000 hectares of farmland shifts to producing energy crops.
- Woodland rises from 13% of UK land 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 capture and storage (DACCS) and c) Wood in Construction*; 7) Manufacturing and construction, 8) Shipping, 9) Surface transport, 10) Waste and finally 11) Agriculture and land use, land use change and forestry (AFOLU). The report specifically comments in relation to agriculture and land that recommendations for policy "must be implemented in a way that is fair to farmers" and that "Policy design must

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

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"[9].

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

2.5. Policy implications for local planning authorities

South Downs National Park Authority is the Local Planning Authority for the National Park, handling a significant number of planning applications and managing development across the National Park. The size and residential population of the National Park means the South Downs National Park makes far more planning decisions than any other National Park Authority and the number of applications is comparable to that of large cities elsewhere in the country.

Planning is one of the tools the Authority can use to address GHG emissions, specifically through decarbonising the built sector. Policies within the Local Plan and guidance in a Sustainable Construction Supplementary Planning Document (SPD) are pushing the construction sector to consider embodied GHG emissions in materials used, as well dramatically improving energy efficiency and low / zero carbon energy supply for new build. Planning policies also encourage the uptake of low /zero carbon transport in new development. Although the scale of GHG emissions from new build is relatively small compared to those of existing buildings, savings made in new build stock will minimise the need for future expensive retrofitting and demonstrate to and stimulate the market for more sustainable building techniques and products.

Planning can also inform what types of renewable energy technology that will be appropriate and where within the National Park, facilitating communities / businesses switching to non-fossil fuel sources of power and heat. There is also scope for planning to increase urban green space, through new green infrastructure, tree planting and habitat creation. Local Plan policies on Ecosystem Services and Biodiversity Net Gain are delivering biodiversity and climate change adaptation benefits through development. The Local Plan also makes provision for non-motorised transport routes, protecting disused railway lines which offer excellent opportunities for active travel, important both for leisure and commuting within the National Park, and the many day visits from the surrounding urban centres.

3. South Downs National Park: demographic profile and key statistics

3.1. People and key characteristics

The South Downs has by far the largest residential population among all National Parks. The latest partnership management plan suggests a population of 117,000. For the purpose of this carbon footprint assessment, mid-2019 population estimates were used, and we included all postcodes with at least 30% of area within the National Park boundary, which gives around 140,000 residents. A further 2 million people live within 5 km of the National Park in neighbouring towns and cities

[9] Climate Change Committee (2020) The Sixth Carbon Budget The UK's path to Net Zero p.30

including Chichester, Winchester, Worthing, Brighton & Hove, Eastbourne and Alton[10]. This results in a comparatively large urban element in the National Park make-up, as well as a relatively large number of one-day visitors from the nearby urban centres. 43% of residents are believed to commute outside of the park to work[11], and London is only just over an hour away by train.

When considering partnership-working on decarbonisation agendas, there are 15 local authorities represented within the National Park including East Sussex County Council, West Sussex County Council and Hampshire County Council. The SDNP (2018) Economic profile report suggests the population within the park is growing, although at a slower rate than the comparator areas. It is also ageing, with a notable decline in the 25 – 44 age band and an increase in those over 65. The population for the National Park is forecast to increase by nearly 8% or more than 9,000 people by 2033[12]. Therefore, consumption is likely to increase, impacting future GHG emissions.

The SDNP (2018) reports low levels of deprivation and suggests residents' wages are higher than all the comparator areas apart from Enterprise M3. Female full-time wages are 19% lower than those of males, but this is a similar gap to that in most of the comparator areas, apart from Solent Local Enterprise Partnership (LEP). Workplace wages are lower than residents' wages in the National Park, as in the other areas, indicating that those with higher-level skills tend to commute to where there are higher-value jobs. These behaviour patterns are also showing up in our data analysis through fuel usage. The occupational profile suggests the following make-up: Managers/Directors 25.2%, Professionals 14.3%, Associate Professional & Technology 18%, Admin and Secretarial 10.7%, Skilled Trades 11.8%, Caring and Leisure services 14.6% and Elementary 7.7%. These are important factors when considering the opportunities for behaviour change potential in spending habits, as too are the 8,000 businesses registered in the park. Further detail pertaining to the park's key consumption characteristics, including business turnover of over £10 billion, are contained in Appendix 10.1

3.2. Landscape

In terms of its landscape, South Downs National Park is the third-largest in England with an area of 1,627 km^2 (162,700 ha). South Downs is one of England's most valued lowland landscapes, most of which is privately owned farmland with approximately 3,000 people employed within the industry. In terms of habitat characteristics as reflected in the Partnership Management Plan, the National Park consists of over 70% farmland (47% arable land, 20% other farmland and 33% permanent pasture), 23% is woodland cover of which 45% is ancient woodland[13]. Chalk grassland (4%) also feature local heritage landscape figures such as the Long Man of Wilmington[14]. Less than 1% of lowland heath remains, with sites recently restored as part of the Heathland United initiative, which has seen rare sand lizards and natterjack toads returning[15]. These special managed landscapes arose from lowland mixed farming and forestry systems. It is therefore important to reflect on this when considering land use and land use change, given that the wholesale abandonment of farming may be ecologically, as well as culturally and economically undesirable.

[10] South Downs National Park (2020-2025) Partnership Management Plan p.5
[11] South Downs National Park Authority (2018) The Economy of the South Downs National Park p. 3
[12] South Downs National Park Authority (2018) The Economy of the South Downs National Park p. 18, 39, 49, 55, 56
[13] South Downs National Park (2020-2025) Partnership Management Plan p.6
[14] South Downs National Park (2020-2025) Partnership Management Plan p.8
[15] National Trust (2021) Saving our heathlands in the South Downs https://www.nationaltrust.org.uk/black-down/features/saving-our-heathlands-in-the-south-downs

3.3. Consumption and spending characteristics

When it comes to the National Park's residents, learning shared from a Catapult Energy Systems (2021) report suggests people in vulnerable circumstances are at an increased risk of experiencing barriers to adopting the behavioural changes identified as being key to achieving net zero[16]. 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 the level of affluence or otherwise within the National Park. We therefore include a brief commentary on indices of deprivation as an indicator of economic wealth within the National Park, as this provides context to 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, all National Parks are more affluent than the UK average, even though they tend to have pockets of deprivation. On average, South Downs residents spend around 11% more than UK residents (Table 1), excluding public services. This is slightly below the average across all National Parks. The consumption data points to a mix between working age and retired populations, which is different to most other National Parks with predominantly older and, in many cases, more affluent residents. A detailed summary of key statistics and spending habits for South Downs residents is outlined within Appendix 10.1.

Table 1: Relative difference in consumer spending per capita (excluding public services) between South Downs National Park and UK average.

Consumer Expenditure Category	**Difference VS UK**
Food & non-alcoholic drinks	8.1%
Alcoholic drinks, tobacco & narcotics	10.8%
Clothing & footwear	8.3%
Housing, fuel & power	-8.6%
Household goods & services	17.1%
Health	24.0%
Transport	21.0%
Communication	3.5%
Recreation & culture	21.2%
Education	-19.5%
Restaurants & hotels	7.8%
Miscellaneous goods & services	8.7%
Other expenditure items	17.9%
Total	**11.1%**

[16] Catapult Energy Systems (June 2021) Net Zero Societal Change Analysis: Summary report p. 11

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 park, along with a section introducing the process. By taking a consumption-based approach, we include embodied, indirect emissions in everything that residents and visitors buy and do while in the park. The assessment covers all the 'basket of six' greenhouse gases and the term 'carbon footprint' is used as a shorthand to mean the GHG emissions released both directly and indirectly within supply chains of goods and services.

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

- all residents' personal travel and visitor travel to, from and around the park;
- 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.

As a separate and overlapping analysis, we also include a simple assessment of emissions from industry within the park and its 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 from visitors and residents. However, important caveats apply to this assessment. Firstly, it is not possible to eliminate the double counting of emissions when industries within the park 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 park. This may in some cases misrepresent actual industry-related activities within the park boundary.

In Figure 7, the dashed circle represents the overlap of the crude industry estimate with the assessments of emissions from residents, visitors and visitor travel to and from the park.

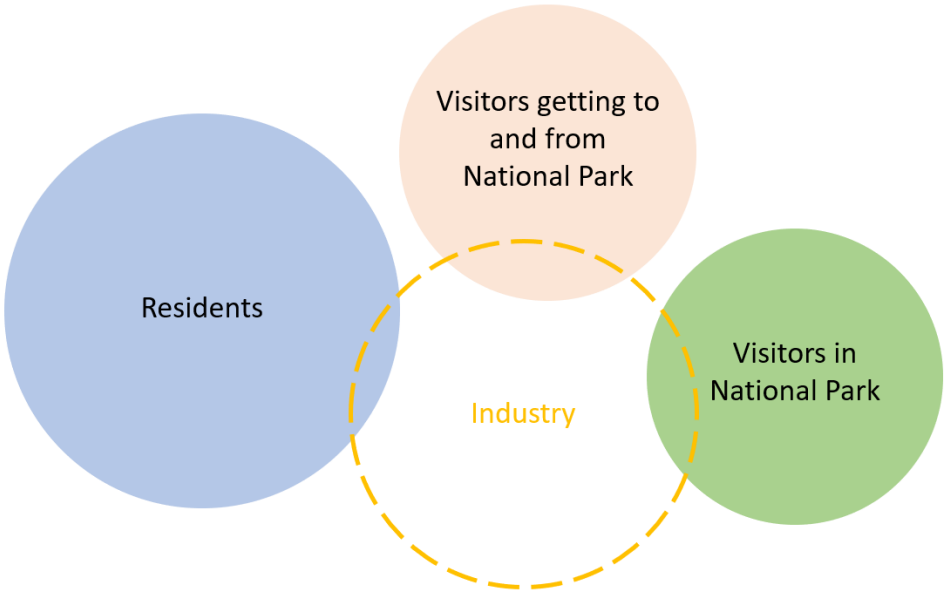


Figure 7: Boundaries of carbon footprint assessment (Repeat of Figure 1)

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 policy makers, to keep the boundary simple to describe, to avoid double counting, and to make use of any readily available data 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
- LULUCF Non-CO_2 component
- LULUCF CO_2 component

The Greenhouse Gas Protocol considers six greenhouse gases namely carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulphur Hexafluoride (SF_4). It also categorises company emissions into three scopes: Scope 1 for direct emissions from company facilities and vehicles; Scope 2 for indirect emissions from consumed electricity and steam generated elsewhere; and Scope 3 for indirect emissions in the value chain [17]. Scope 3 can be split into two parts: upstream and downstream. Our assessment of Industry 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 their embodied emissions.

[17] 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

We measure greenhouse gas emissions in tonnes of carbon dioxide equivalent (tCO_2e) in the report[18]. We have used 100-year global warming potential (GWP) conversion factors for all non-CO_2 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.

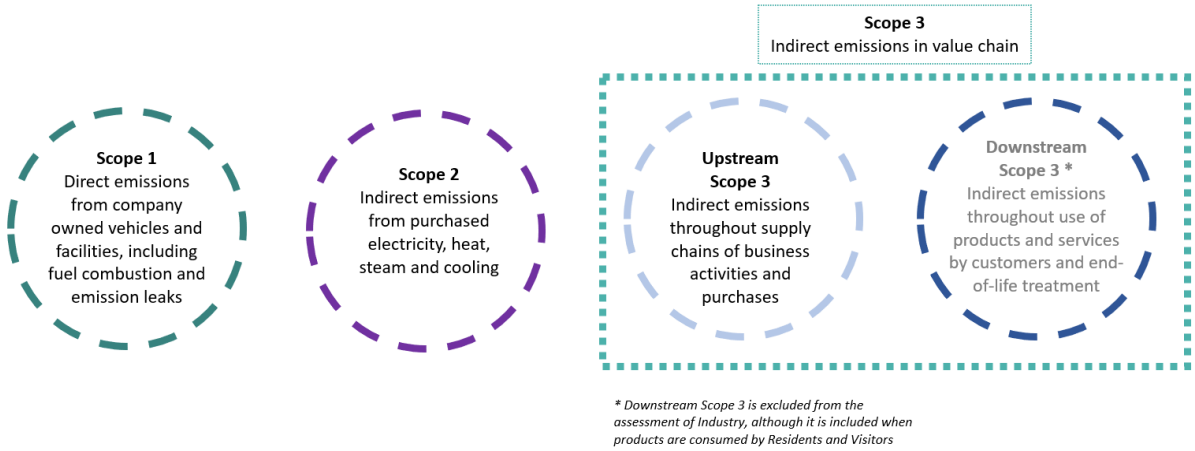


Figure 8: Types of greenhouse gas emissions used for carbon accounting

A National Park'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 resulting from the manufacture and maintenance of cars, and emissions resulting from the extraction, refining and transport of fuels 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 the burning of coal, oil and gas; those arising from the production of electricity used in the National Park (wherever that generation takes place), and direct emissions associated with land use within the Park (parts of agriculture, peatland degradation, etc). This is the

[18] DEFRA (2014) Guidance: Calculate the carbon dioxide equivalent of a F gas https://www.gov.uk/guidance/calculate-the-carbon-dioxide-equivalent-quantity-of-an-f-gas accessed 07.12.2021

UK Government's standard emissions reporting approach and only CO_2 emissions are reported by BEIS at the local level. However, it also excludes emissions arising from the production of goods and services that are used by residents, visitors and industry, if they are produced elsewhere. It also includes motorway emissions from vehicles that are passing through the National Park without stopping. We use the term 'net emissions' because we subtract any negative emissions (taking CO_2 back out of the air) that may result from Land Use, Land Use Change and Forestry (LULUCF).

Extraction-based emissions: These are the emissions that will result from the burning of any fossil fuels that are extracted from the ground in the National Park, wherever this takes place. 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 Scope 1, 2 & 3 GHG footprints of residents and visitors, including visitor travel to the park. By 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 Appendix 10.2 and 10.3.

5. South Downs: Consumption-based GHG emissions

5.1. Results overview

Here, we outline our analysis of the carbon footprint of South Downs residents and visitors' 2019 GHG emissions (Figure 9). Residents' emissions were estimated at 2.16 million tCO_2e (Figure 10) and visitors' emissions, while travelling to and from and while in the park combined, were estimated at 1.05 million tCO_2e (Figure 11 and Figure 12). The resident profile is 140,881 people, compared to over 18 million day-visitors per year. A full breakdown of these figures is provided in Appendix 10.4 and 10.5. This data shows that the South Downs has the largest residential and visitor populations among all National Parks. South Downs residents are also comparatively more affluent, as the demographic profile in Section 3.3 suggests. Annual final consumption per year for residents (including public services) is over 4.5 billion pounds.

To give an indication of the scale of the South Downs National Park's emissions, you would need to plant over 8,600 Premier League football pitches with broadleaf trees, leaving them to grow for over 100 years, to mitigate the resident and visitors combined 2019 GHG emissions . This shows the need to prioritise GHG emissions *reductions* to limit global warming, rather than just mitigating these 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 else [19]. We shall use these four key categories to comment on the results, and to suggest where the National Park may wish to target initiatives focused on behaviour change.

[19] Berners-Lee, M (2021) How Bad Are Banana's: The Carbon Footprint of Everything p.149

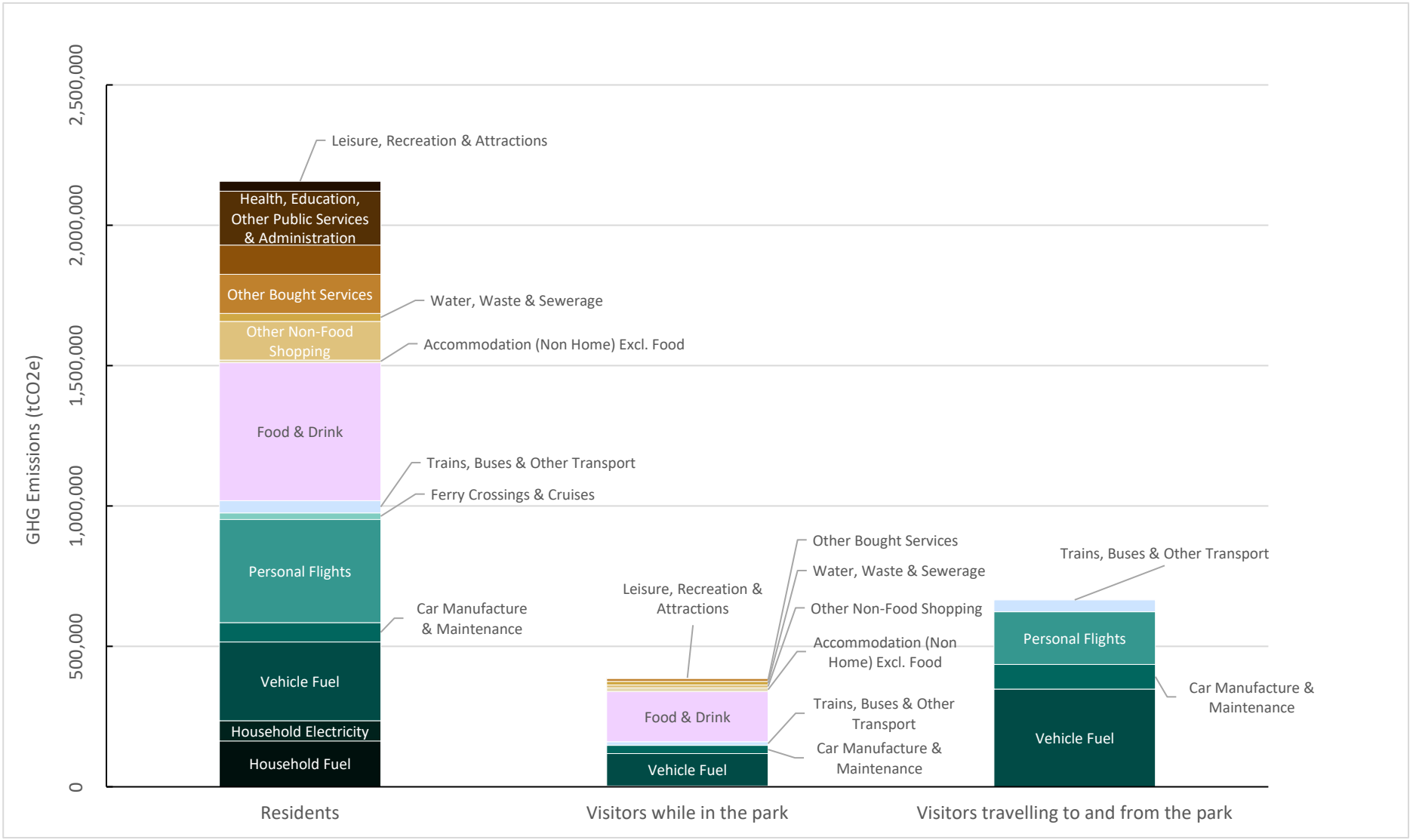
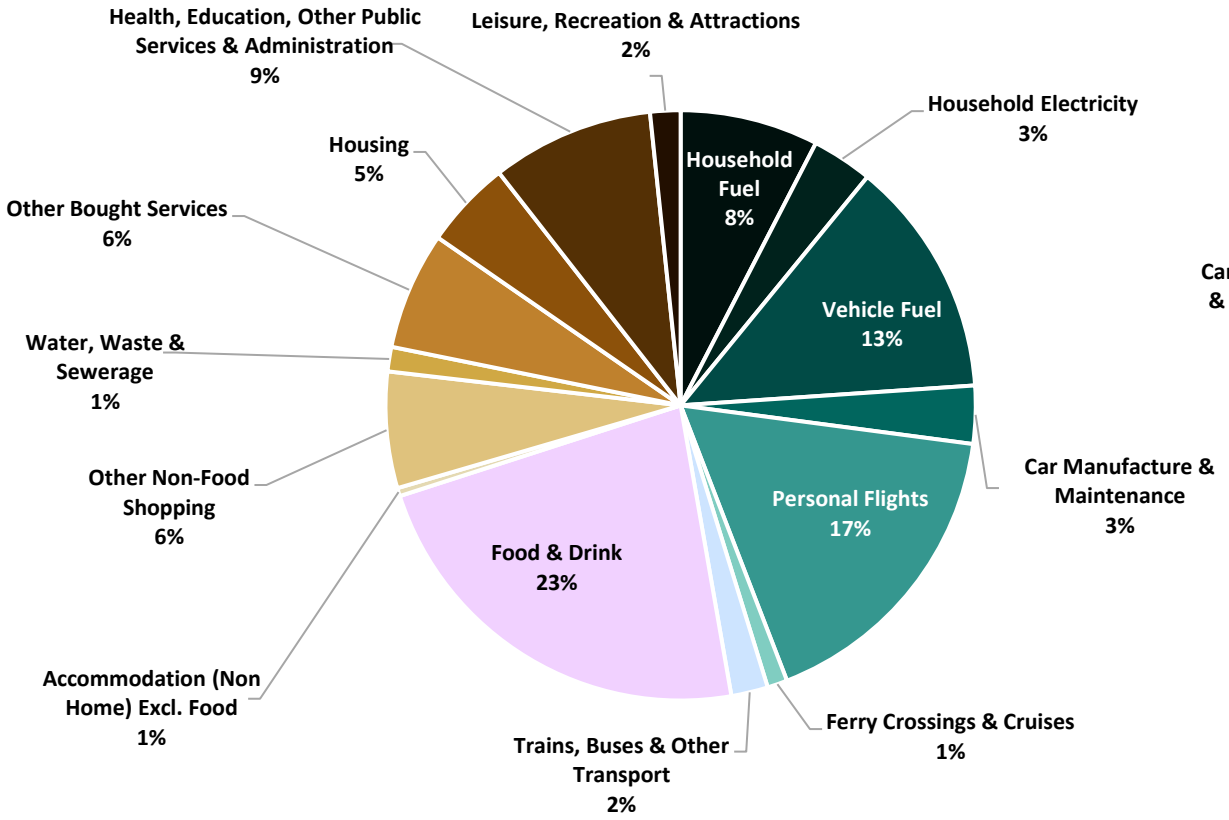
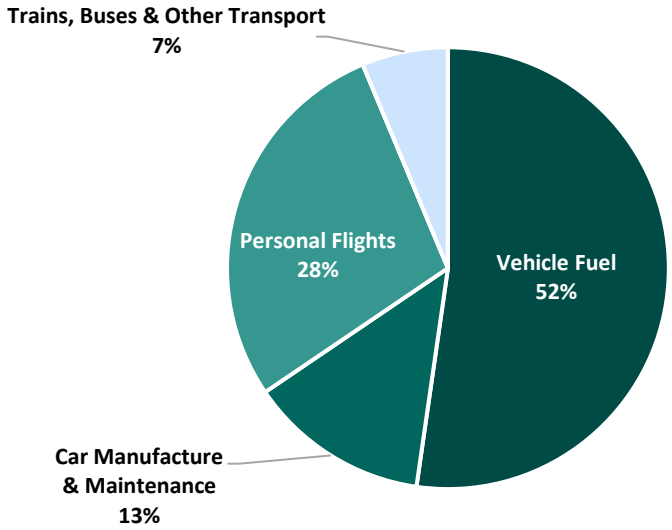


Figure 9: A consumption-based assessment of emissions relating to residents, visitors, and visitor travel to and from the South Downs National Park.

Residents: 2,157,019 tCO_2e



Visitors travel to & from the National Park: 665,729 tCO_2e



Visitors while in the National Park: 388,211 tCO_2e

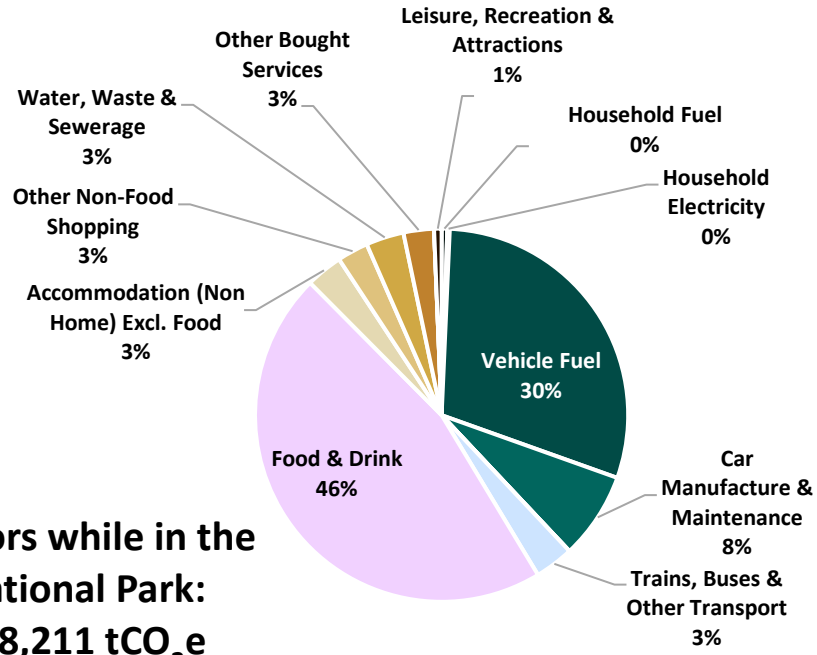


Figure 10: (Left) Residents' GHG emissions in South Downs National Park by percentage

Figure 11: (Top Right) Visitors' GHG emissions on the way to & from South Downs National Park by percentage

Figure 12: (Bottom Right) Visitors' GHG emissions while in South Downs National Park

5.2. Residents' and visitors' GHG footprint components

South Downs residents' emissions totalled 2.16 million tCO_2e in 2019, with the greatest emissions categories being Food & Drink (23%), Personal Flights (17%%) and Vehicle Fuel (13%).

South Downs visitors' emissions totalled 1.05 million tCO_2e in 2019, comprised of 665,729 tCO_2e from travelling to and from the park, and 388,211 tCO_2e while in the park. Visitor travel to and from the National Park indicates GHG emissions are dominated by Vehicle Fuel (52%) and Personal Flights (28%), with only 6% related to the remainder of public transport. Of the footprint of visitors while in the park, Food & Drink consumed represents 46%, while Vehicle Fuel used within the park equates to 30%.

5.2.1. Food

When considering behaviour change around food at its simplest level, we consider the sustainable choices we are able to make when buying 'food and drinks from shops' and 'eating out'. The carbon footprint from food and drink in the South Downs is considerable: residents' food and drink footprint is 491,434 tCO_2e (23% of residents' total), and visitors' is 179,343 tCO_2e (46% of visitors' total); Appendix 10.4 and 10.5. Buy local, eat local has become a common mantra in Cumbria's Zero Carbon Programme, along with eating seasonal fruit and vegetables, and varying traditional eating patterns to include more plant-based meals and protein choices (aka a flexitarian diet). It is also possible to make choices about which meat to consume based on carbon intensity, with beef having the highest intensity, then in descending order: lamb, pork and chicken. Making such dietary choices can also help individuals live a healthier lifestyle.

Eliminating food waste allows individuals' food footprint to reduce a further 12%, alongside saving money. Swapping fruit and veg grown in hot-houses or air-freighted to the UK for local, seasonal varieties could offer a 5% reduction in total food footprint[20]. Shipped or frozen produce is also a good low-carbon alternative versus air freight, as the emissions per item is far reduced[21].

In farming communities particularly, food production and consumption is seemingly one of the hottest topics where positions are likely to be polarised, particularly acknowledging the potential impact on livelihoods and traditional lifestyles. We suggest these complex topics would benefit from a collaborative approach between the agricultural industry and other land managers, and the NHS and public health bodies, to achieve a transition pathway which is acceptable to all and appreciative of the issues pertaining to food production in the UK. Farmers are facing a difficult socio-economic climate in responding to climate change, biodiversity net-gain and food production drivers, while also facing the challenge of an ageing workforce and workers opting to leave the industry.

Based on the science, the National Food Strategy Independent Review of England's food chain from field to fork outlines a number of recommendations for government, with a formal response with a white paper expected imminently. The recommendations target changes to the national diet by 2032 (compared to 2019) to meet health, climate and nature commitments, including a 30% reduction in the consumption of meat; a 30% increase in the consumption of fruit and vegetables; 50% increase in fibre; a 25% decrease in high fat, sugar and salt foods[22] .

[20] 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

[21] Berners-Lee, M. (2010) How Bad Are Bananas -The Carbon Footprint of Everything. p. 26-29

[22] National Food Strategy Independent Review The Plan p.147

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"[23].

The improvements in health that accompany a more sustainable diet are highly relevant when considering the public health agenda and public purse. Dietary-related health issues are long-term conditions that contribute 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. Department of Health data shows: "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"[24], and treatment and care for people with long-term conditions is estimated to take up 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 in 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 2040[25]. Achieving this would require considerable reductions in emissions from livestock and reductions in synthetic fertiliser use while actively pursuing efforts to sequester carbon through creating woodland, restoring peatland within agricultural land, and implementing regenerative farming practices[26].

5.2.2. Homes and accommodation away from home

Homes and accommodation away from home and responsible for 348,997 tCO_2e (16%) of residents' footprint, and 15,105 tCO_2e (4% of footprint while in park) of visitors' footprint. We considered: household fuel 163,507 tCO_2e (16% of residents' total footprint); housing 104,039 tCO_2e (5%); household electricity 71,825 tCO_2e (3%) and accommodation away from home 9,627 tCO_2e (0.4%), see Appendix 10.4. The single biggest intervention the public can readily make is changing energy supplier to those divesting from fossil fuels and actively sourcing their supplies from genuinely renewable energy, e.g. solar, wind, tidal, hydro-electric power. Public knowledge on where household energy comes from is poor, with many consumers not undertaking the due diligence required to distinguish between 'green tariffs' backed only by cheap Renewable Energy Guarantees Origin (REGO), which have little impact on encouraging further renewable electricity expansion, and those that are more genuinely investing in renewable electricity such as tariffs wholly backed by Power Purchase Agreements (PPAs). Further improvements can be made by reducing the energy usage within homes. Options vary from reducing thermostat temperature, to improving home insulation, to replacing oil or gas boilers with electric heat pump alternatives. We recognise affordability is always a factor depending on the public's financial means, but there are varying degrees of measures at different levels of cost and access to Government or other grants.

[23] The Sixth Carbon Budget, Agriculture and land use, land use change and forestry p.21
[24] Department of Health (2012). Report. Long-term conditions compendium of Information: 3rd edition
[25] National Farmers Union (2021) Achieving Net Zero Farming's 2040 goal.
[26] The Sixth Carbon Budget, Agriculture and land use, land use change and forestry section

5.2.3. Travel

Travel is responsible for the majority of South Downs visitors' footprints: 823,553 tCO_2e, making up all of travel to-and-from the park, and 41% of emissions while in the park (78% of total visitor footprint). The majority of this travel footprint is from car fuel, 463,545 tCO_2e (44% of visitors' total); personal flights 187,593 tCO_2e (18%); car manufacture and maintenance (11%) and a small amount from trains, buses and other transport (5%).

For residents, 36% of their footprint is from travel. In considering residents' travel we looked at personal flights 367,469 tCO_2e (17% of residents' footprint); vehicle fuel 280,717 tCO_2e (13%); car manufacture and maintenance 68,411 tCO_2e (3%); trains, buses and other transport 43,440 tCO_2e (2%) and ferry crossings and cruises 23,724 tCO_2e (1%), see Appendix 10.4.

The single biggest impact could be public messaging on reducing flying, particularly in reducing 'casual flying' for short trips where other transport opportunities are feasible by trains, buses and boats. For visitors travelling to the park, and for residents travelling locally, it may be beneficial to work with local authorities on promoting use of public transport, and to explore mechanisms to support fast-tracking of electrification of vehicles such as buses, taxis and hire vehicles and to influence Government to support railway electrification.

In terms of vehicle fuel use, residents' annual mileage and residents' and visitors' size of car make a big difference to their carbon footprint. If you drive 10,000 miles in a small petrol run-around, your emissions total around 4.5 tonnes CO_2e, compared to a medium family size car at 5.6 tonnes CO_2e and a large car at 8.3 tonnes CO_2e. It is also worth noting that while travelling by car can have a high footprint when travelling alone, when a full car is transporting a family of 4 or 5, it becomes a far lower-carbon option per person.

Vehicle type also changes the impact. A trip from Manchester to London for the average petrol car would result in 0.11 tonnes CO_2e, including the embodied emissions of the vehicle and fuel. For the same journey an ordinary hybrid results in 0.08 tonnes CO_2e and a plug-in electric hybrid car is 0.07 tonnes CO_2e. The average diesel car greenhouse gas emissions are slightly lower than petrol at 0.10 tonnes CO_2e, but bear in mind that while they have lower CO_2e per mile and better fuel economy than petrol vehicles, they may be worse for soot and nitrogen oxide. Exhaust fumes are a key contributor to air pollution with the cleaner choice being an electric car, which would also have the lowest emissions produced at 0.04 tonnes CO_2e.

10% of all UK new car and van sales were electric vehicles in 2019[27]. 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 2035[28]. As the National Park has an affluent demographic profile, the typically cost-prohibitive entry into owning an electric car may be more within reach for some residents. Aside from switching to an EV, there are other choices the public can all make to reduce vehicle emissions:

[27] https://www.ft.com/content/d57efdf6-ffad-11e9-be59-e49b2a136b8d
[28] https://www.bbc.co.uk/news/science-environment-51366123

- The average person walks 210 miles per year[29]. Walking 2.5 miles per week more for local journeys, e.g. visits to local shops or school run, could save 1.3 tonnes CO_2e and have health co-benefits.
- Equally, travelling more by bicycle, perhaps on an electric bike which uses just one twentieth of the energy per mile of an electric car.
- Drive outside of rush hour if possible: 22 kgCO_2e emitted from five miles of crawling each way in an average car every working day for a year would equal 4.8 tonnes CO_2e.
- If your current car is old, downsize your medium family size car for a small petrol car and save 1.1 tonnes CO_2e.
- If your current car is old, downsize your large car for a medium family size petrol car and save 2.7 tonnes CO_2e.
- If it's affordable, swap your large car for an electric hybrid car and save 4.49 tonnes CO_2e.

It is not possible to identify from this assessment whether visitors are using their own vehicles or hire cars, but where hire cars are used it may be beneficial for the National Park to work with local providers to fast-track electrification of vehicles. In either case, increasing the availability of electric car charging points could encourage visitors to travel by electric vehicle.

5.2.4. Everything else

For residents, the remainder of the footprint consisted of residents' health, education and other public services 191,734 tCO_2e (9% of residents' footprint); other bought services 138,990 tCO_2e (6%); other non-food shopping 137,340 tCO_2e (6%); leisure, recreation and attraction 35,806 tCO_2e (2%) and waste, water and sewage 28,956 tCO_2e (1%). For visitors, the remainder of emissions come from water, waste and sewerage 12,743 tCO_2e (3% of footprint while in the park); other non-food shopping 10,432 tCO_2e (3%); other bought services 10,260 tCO_2e (3%) and leisure, recreation and attraction 2,503 tCO_2e (1%).

The biggest single factor is health and education. As discussed in Section 5.2.1 food, there can be a causal relationship between food, obesity and long-term conditions. The public health prevention agenda is therefore also important in helping authorities to decarbonise, as well as achieving health and wellbeing benefits.

We suggest the role the National Parks play in enabling the public to access green/blue space known to support mental and physical wellbeing, should not be underestimated. Recent research by White et al. (2019) identified the amount of recreational time individuals need to spend in natural environments to gain self-reported health and wellbeing benefits is equal to or greater than 120 mins per week[30]. White et al. (2010) also suggest green with aquatic blue space (water) offers enhanced perceived benefits, which can be incorporated into landscape design and opportunities for improving public accessibility[31].

[29] Department of Transport (2019) National Travel Survey England 2018

[30] White et. al. (2019) Spending at least 120 minutes a week in nature is associated with good health and wellbeing. Scientific Reports. 9:7730 https://doi.org/10.1038/s41598-019-44097-3

[31] White, M.P., Smith, A., Humphryes, 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.

Summary of key findings of exposure to green space for health and wellbeing benefits (White et al. 2010 and 2019)

Threshold ≥ 120mins green space exposure per week = health and wellbeing benefits.

Results suggest it does not matter how "threshold" achieved per week.

E.g.

4 x 30mins = 120
6 x 20 mins = 120 1 x 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 greatest factors to consider are other bought services and other non-food shopping. Simply put, the choices we make around which goods and services we purchase, based on the amount of fossil fuels used in production, or the air miles or road miles associated with products and services, count towards our carbon footprint. The choices the public and National Park make 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 associated local authorities may help. Circular economy is a model of production and consumption which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible.

In terms of waste, water, and sewage the National Park is well-placed to support partners in strategic planning for multi-environmental benefits, especially given the new Environment Act (2021) and the role the National Park 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
- The relationship between people and the landscape

A further issue to be mindful of relates to interventions to 'slow the flow' in flood risk areas. When choices are made around nature-based solutions in up-stream 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.

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

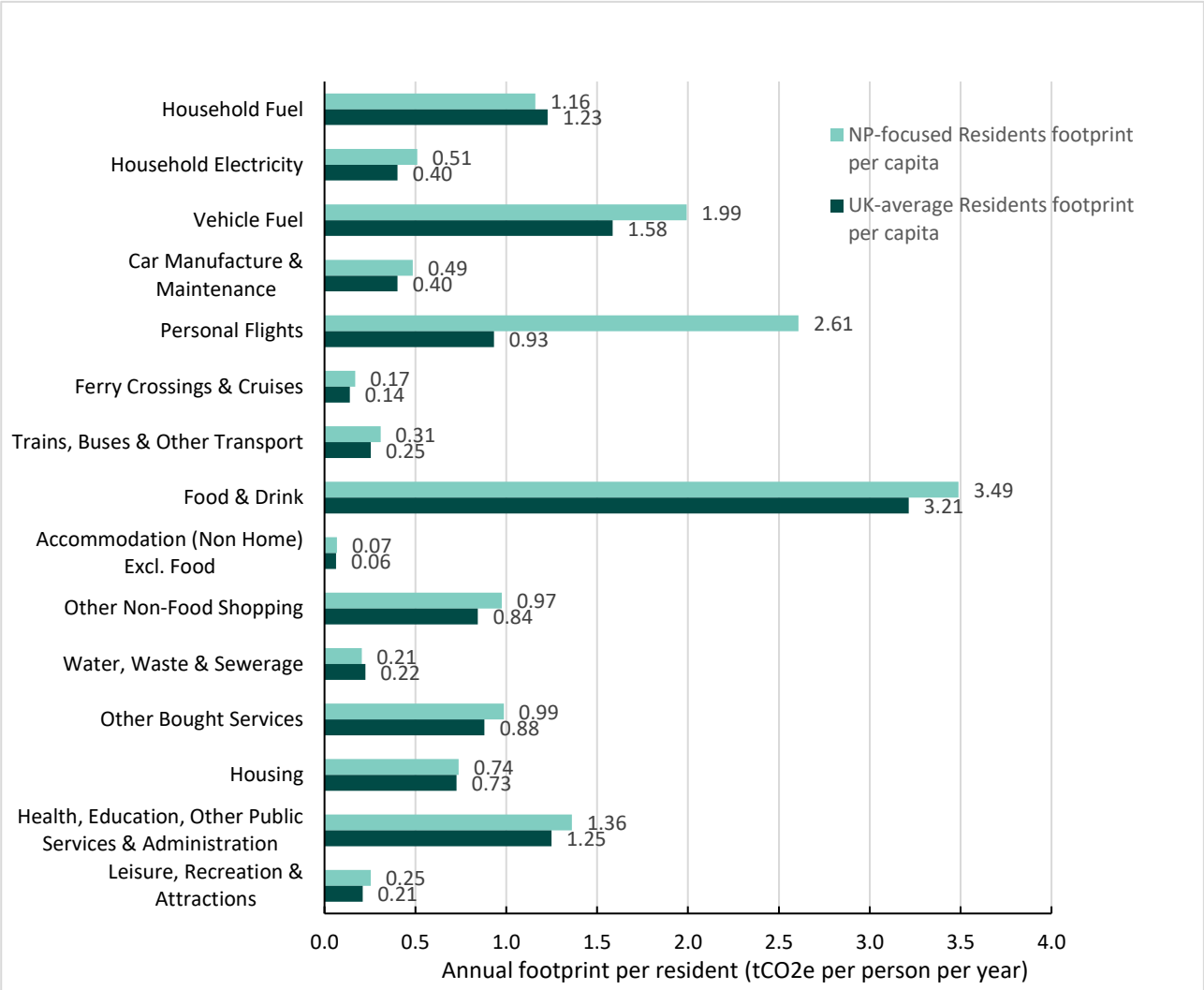


Figure 13: Residents' GHG footprints compared between South Downs National Park average and the UK national average

5.3. Industry assessment

This section presents the GHG emissions from industry but first outlines the scope of the industry assessment given two approaches were used as outlined in 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 the Office for National Statistics Inter-Departmental Business Register (IDBR) data 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 Appendix 10.6.1 to 10.6.3). 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 ONS IDBR data confidentiality constraints, we also had to include all COA geographies overlapping with the National Park boundary, leading to marginal overestimates of the total turnover and the resulting industry footprint within the National Park. 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 agriculture and forestry sector footprints because these sectors are known to have unique features across most National Parks.

Please also note that this assessment overlaps with our more detailed analysis of residents and visitors since it is not feasible to eliminate double-counting when local businesses sell 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 activity[32]. For transparency we include the IDBR broad industry group structure and how this compares with SIC (2007) in Appendix 10.6.1. Please note in interpreting the results 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 1,506,237 tCO_2e. Figure 14 highlights production as the largest source of GHG emissions (596,112 tCO_2e; 40%); followed by agriculture, forestry and fishing (185,515 tCO_2e; 12%) and construction (139,922 tCO_2e; 9%), see Appendix 10.6.2. Industry-related flights account for 127,784 tCO_2e of the total footprint but are not separately categorised. Each of the main contributing categories are discussed in turn below.

[32] https://onsdigital.github.io/dp-classification-tools/standard-industrial-classification/ONS_SIC_hierarchy_view.html

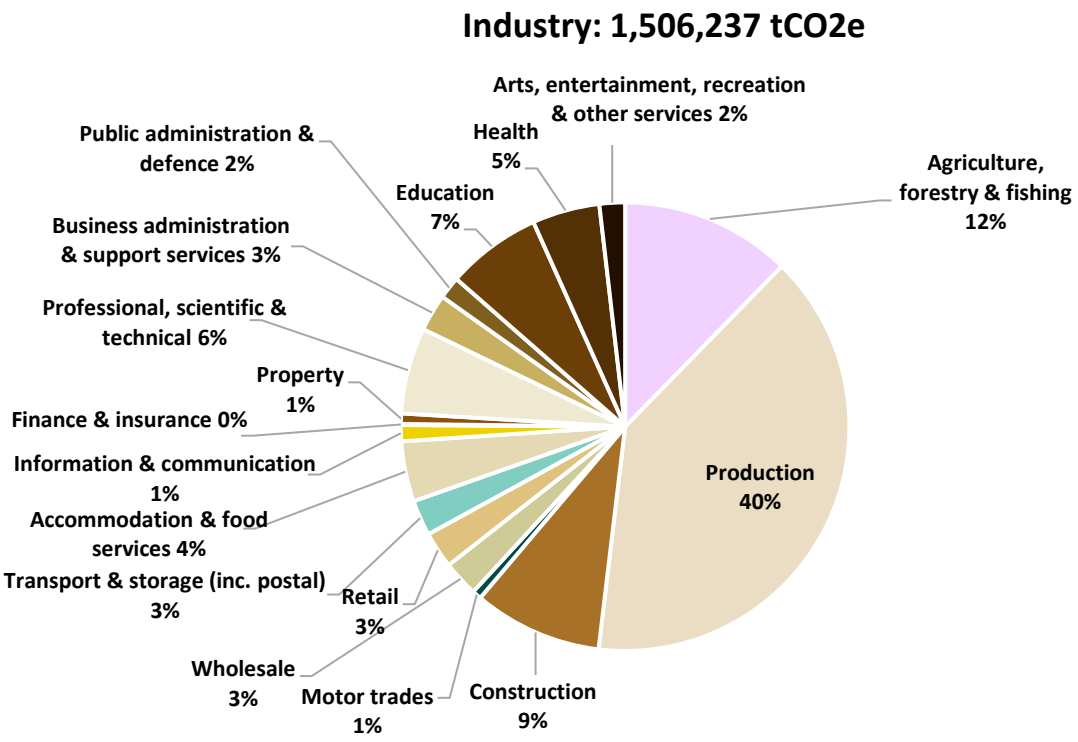


Figure 14: South Downs NP consumption-based GHG emissions for Industry by percentage (Repeat of Figure 3)

Production

Production (referring to manufacturing industries) plays an important role in the National Park. The SDNP (2018) economic profile suggests "manufacturing production makes up 5% of the business base and over 8% when engineering activities are included. Together, manufacturing and engineering account for over 5,000 jobs". However, it is this manufacturing base which is responsible for the greatest volume of emissions. We suggest manufacturing as a sector is the top industry where Local Enterprise Partnerships may wish to focus efforts in encouraging companies to undertake assessment of their Scope 1, 2 and 3 GHG emissions and that priority should be made for carbon reduction planning to decarbonise these industries.

Agriculture

The second top industry for GHG emissions is agriculture, forestry and fishing (185,515 tCO_2e; 12%). The issues pertaining to this industry are discussed in detail under Sections 3.2 (Agricultural landscape), 5.2.1 (Food) and 5.2.4 (Everything else). The Sixth Carbon Budget (2020) Agriculture and land use, land use change and forestry report suggests a number of opportunities for reducing emissions, as follows.

The first pertain to low-carbon farming practices which include livestock measures such as selective breeding, increased milking frequency, changes to livestock diet to decrease methane losses, and improved livestock health. There is also a focus on soil measures through use of legumes, cover crops, and grass leys. The third focus is on waste and manure, including use of anaerobic digestion and covering slurry.

The report discusses reducing numbers of cattle, sheep, pigs and poultry; reducing grassland area and cropland, and shifts to new hydrogen technology. It is known JCB have developed a prototype hydrogen tractor, so there may be benefits in the LEP collaborating with manufacturers who may be able to assist such a transition.

Other opportunities relate to improving productivity and efficiency from 8.2 t/ha to 11 t/ha. In terms of crop yields, the report discusses how climate is likely to increase risks to yields. It suggests management measures such as increasing soil quality, smarter tillage, nutrition and pesticide management, and opportunity mapping. Innovations in breeding are also discussed along with increasing stocking density. Another key suggestion is increasing paddock grazing to 80%, which improves the quality of grass and enhances soil carbon sequestration. The report suggests only 50% of grass produced is actually eaten.

Other options discussed are the use of indoor horticulture and dietary changes to a more plant-based diet. In terms of innovations the report also discusses lab-grown meat and insects as new sources of protein.

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

Construction

We estimate that construction is the third largest GHG-emitting industry in the South Downs. The Sixth Carbon budget (2020) manufacturing and construction sector showed that GHG emissions from manufacturing and construction also contributed 12% of the whole UK total. Opportunities for interventions 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: Material substitution can reduce manufacturing emissions by switching from high-embodied-carbon materials to low-embodied-carbon materials. Measures include using wood in construction and using replacements 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' measures that often save significant fuel costs. 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 heat, motion and electrical demands, thus replacing the use of fossil fuels and reducing GHG emissions.
- Carbon Capture and Storage (CCS): CCS can be used to capture CO_2 produced by larger industrial point-sources, and transport it to a CO_2 storage site, thus reducing emissions to the atmosphere"[33].

[33] The Sixth Carbon Budget (2020) Manufacturing and construction p. 6-11

Please note we also undertook a comparison between IDBR data and GVA data, as we are mindful economic reporting often uses GVA as the primary measure upon which many LEPs base their workforce planning; see Appendix 10.6.13. When the GVA dataset is compared to IDBR, this indicates a potential under-reporting of GVA based emissions from agriculture, production and construction (Figure 15). The National Park may wish to discuss this with local LEPs.

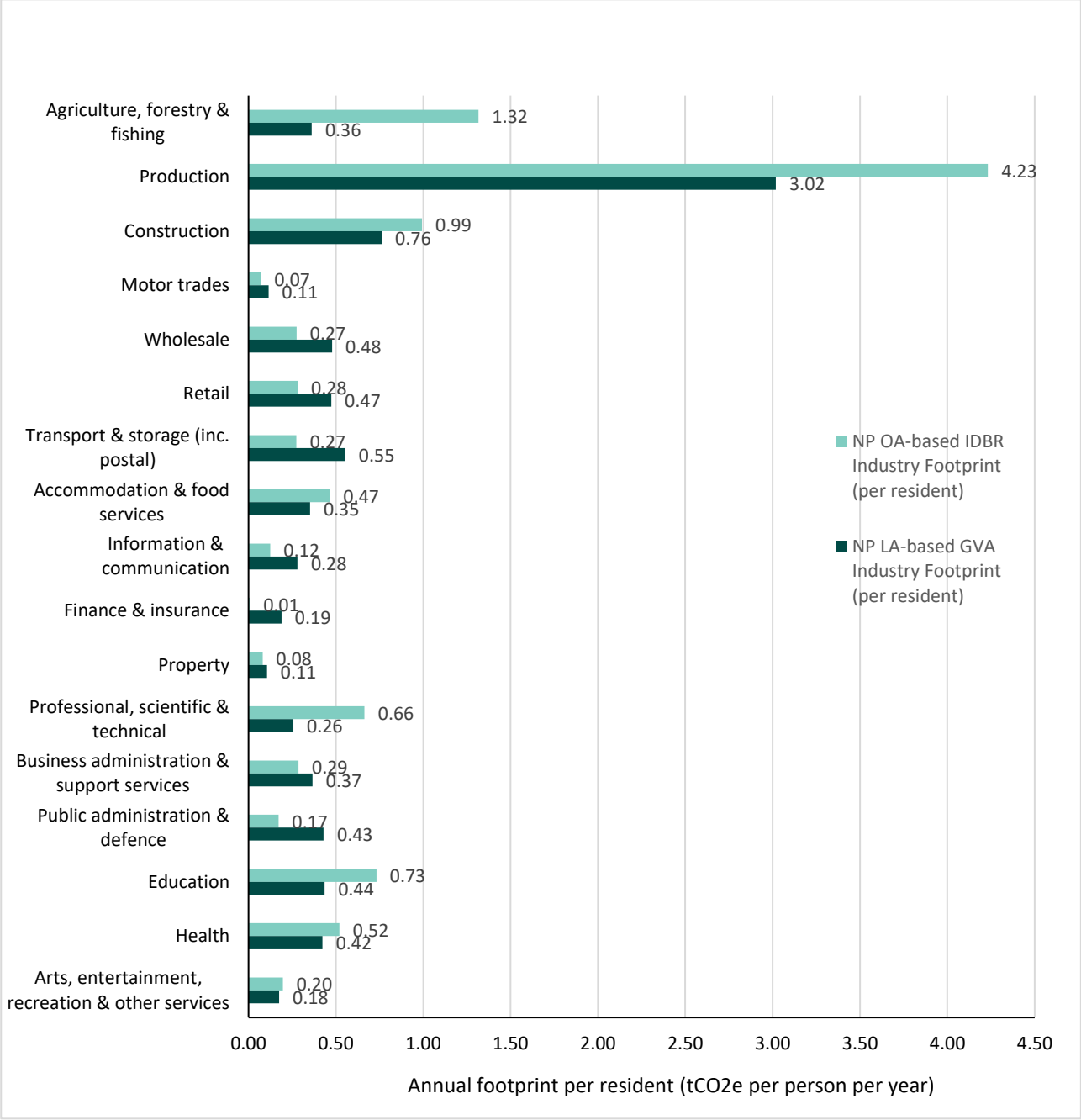


Figure 15: South Downs National Park Industry Footprint Estimates: IDBR vs GVA

5.3.3. Energy-only industry analysis

This analysis is a subset of the industry carbon footprint estimate. Energy makes up 25% of emissions from industry (381,945 tCO_2e). Table 2 shows the breakdown of emissions from electricity and fuels.

Table 2: Energy-only industry (subset of industry) – South Downs National Park

Industry Electricity	35,554 tCO_2e per year
Industry Fuels Excl. Road	141,120 tCO_2e per year
Industry Road Fuels	205,271 CO_2e per year
Total	**381,945 tCO_2e per year**

5.3.4. Large emitters analysis

As a further subset analysis of the industry analysis, the BEIS Pollution Inventory (2018) enables us to identify specific large emitters within each UK National Park (see Appendix 10.6.4). The park may choose to engage with these emitters either directly or through the LEP in promoting carbon assessment of Scope 1, 2, and 3 GHG emissions, and carbon reduction planning for net zero[34]. Please be mindful these are for carbon dioxide emissions only and are limited to Scope 1. These are:

- Viridor Waste Management Ltd (Horton Landfill): 16.9 $ktCO_2$
- Veolia ES South Downs Ltd (Newhaven EfW Plant): 201.611 $ktCO_2$

The total volume of carbon dioxide relating to large emitters is **281,511 tCO_2.**

We also identify where IDBR data has been suppressed the ONS's own software, which means a null value is returned due to reasons of confidentiality. Where this poses an issue for the reliability and validity of the results, these issues are discussed. However, in the case of South Downs National Park, none of the IDBR data was found to be suppressed.

5.3.5. 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 emissions from each industry category. This enables patterns to be identified where it would be beneficial to focus partnership-working with the LEPs. The results (Figure 16) show higher-than-national averages for Agriculture; Forestry & Fishing; Production; Construction; Accommodation & Food Services; Professional; Scientific & Technical; Education and Health.

As background to influencing change, the UK Government enacted legislation on the 1st of October 2013 requiring mandatory reporting of GHG emissions by the UK's largest quoted companies (Statutory Instrument 2013/1970:5). In 2018, Statutory Instrument 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 operations[35]. This was extended to all large companies including the public sector. Due to this legislation, there should be an expectation that all large

[34] UK local authority and regional carbon dioxide emissions national statistics: 2005-2018

[35] The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013 (SI 2013/1970) (Strategic Report Regulations 2013) enacted 1st October 2013 to present.

organisations are in the process of assessing their full GHG emissions and preparing carbon reduction plans for net zero. Large organisations new to carbon accounting with recent legislative changes, may be finding the process challenging. Joined-up approaches may be helpful, particularly in the public sector.

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

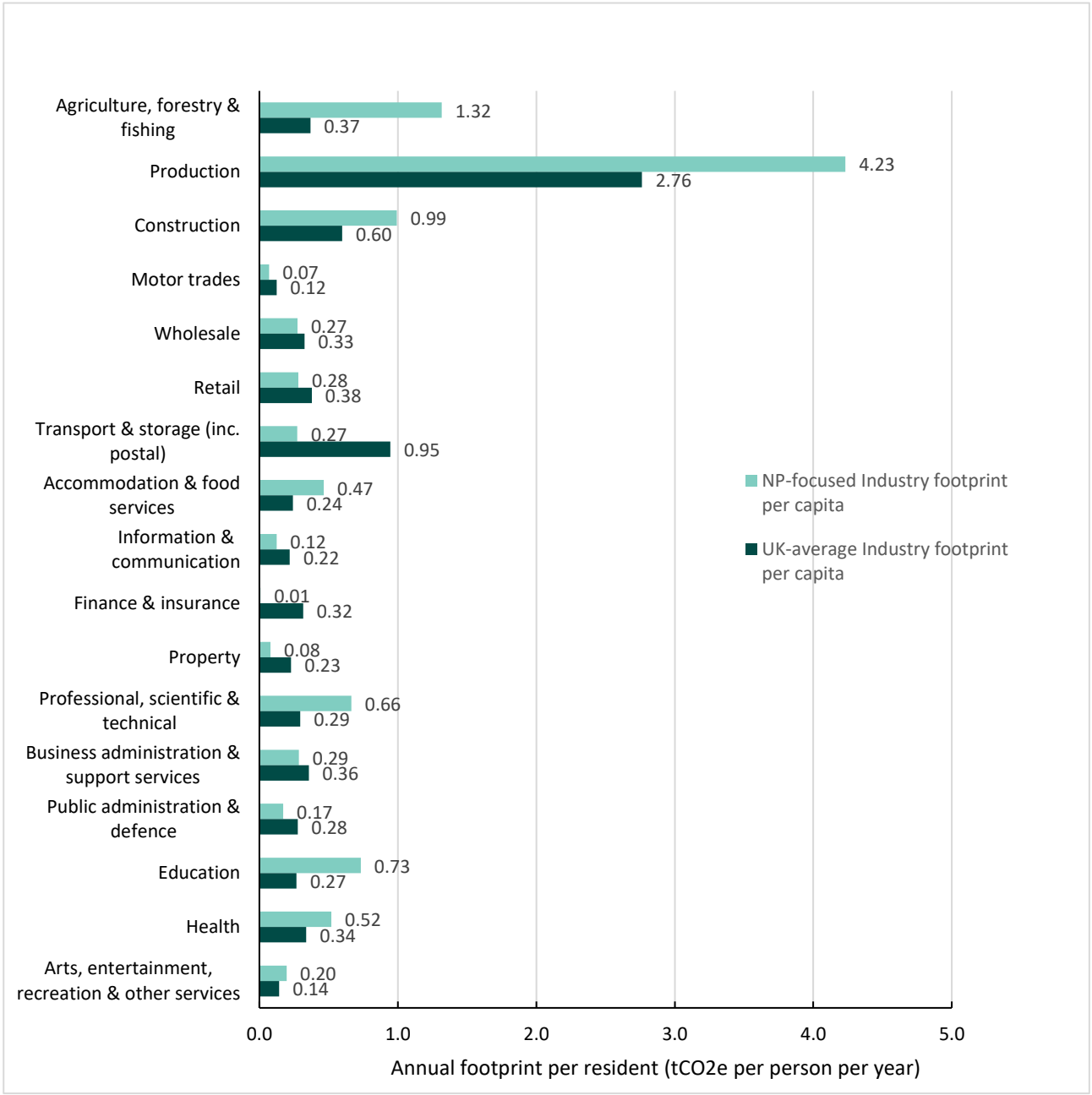


Figure 16: South Downs National Park industry GHG emissions compared with UK national average by sector

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

This analysis of the impact of transit traffic has been included at the request of several National Parks (see Appendix 10.7). Through-traffic refers to vehicles passing through the National Park without visiting. For the South Downs we have included within the analysis: cars, buses, motorbikes, vans and lorries totalling **548,383 tCO_2e.** This data is **not included** in the residents', visitors' or industry footprints. It is estimated by comparing total traffic point counts with pump-level fuel sales within each National Park. The larger and smaller subsets of selected A roads include elements of through traffic as well as traffic from residents, visitors and industry. The selected roads are the M3, A26, A27, A31, A32, A23, A24, A272, A280, A283, A3.

5.5. Land use, land use change and forestry (LULUCF)

The LULUCF 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 3.

Table 3: LULUCF GHG emissions – South Downs National Park

LULUCF CO_2	-189,642 tCO_2e per year
LULUCF Non-CO_2	207,304 tCO_2e per year
Total LULUCF	**17,663 tCO_2e per year**

LULUCF data is prepared by Department for Business, Energy & Industrial Strategy (BEIS) through its subcontractors Ricardo Energy & Environment, Centre for Ecology and Hydrology and Forest Research in accordance with the reporting requirements for the UK Greenhouse Gas Emissions for United Nations Framework Convention on Climate Change (UNFCCC). Future improvements to the reporting methodology for LULUCF GHGs has the potential to move the sector from a net sink to a net source of emissions, as indicated within the Sixth Carbon Budget (2020).

Although more accurate than previous years, there remains considerable uncertainty pertaining to the latest (BEIS) LULUCF estimations (2019). This is due to an evolving methodology and process of refinement for measuring 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 CO_2 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 CO_2 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. Tier 3 Forest Research CARBINE model was employed to derive emission factor for forested peatland between 1990 to 2019, and was

tested using field data[36]. For the full set of assumptions made to estimate peatland emissions in the National Parks in the latest (2019) LULUCF data release by BEIS, please see Table 10 in Appendix 10.8.7 (Table A.3.4.28 in the BEIS methodology annex). As peatlands are not a significant feature of South Downs National Park, given only 12 hectares of lowland fens in a reasonably healthy condition following recent restoration projects, the park will be least-impacted by the changes.

As a family of National Parks and AONBs, it is worth noting four key reports which outline land use policy implementation, namely:

- The 25 Year Environment Plan[37];
- 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 years[38]." The next section reflects upon this guidance in terms of target setting.

5.6. Factors for consideration in LULUCF target setting

To increase reliability of the land use data, the National Park has undertaken its own GIS assessment of its key habitat types by area, as described in Section 3.2, which provides baseline area data for the target setting discussed in Section 6. Reflecting upon the Sixth Carbon Budget (2021) we identify hectare per year targets for creating native broadleaf / mixed woodland, planting new productive coniferous woodland, restoring peatland (excluded for SDNP), adopting agroforestry practices (for improved grassland & cropland), increasing the extent of hedgerows (for improved grassland & cropland), adding legume species to improved grassland, and adopting winter cover cropping for cropland.

Please note that the LULUCF GHG estimates for National Park published by BEIS, given existing levels of uncertainty, may impact on the proposed glide paths to net zero for all the UK National Parks to varying degrees. It is expected that the BEIS LULUCF data will be refined in subsequent years, and retrospectively applied to the entire published timeseries. Baseline year data will therefore be impacted in future years. Sections 5.6.1 -5.6.4 discuss the importance of woodland, peatlands, and agricultural landscapes when developing subsequent strategies for the implementation of LULUCF targets in supporting climate adaptation and mitigation.

5.6.1. Trees, woodlands and forestry

The targets proposed in section six have been developed in discussion with officers of the National Park. It is recognised these do not replace robust discussion by the National Park, it's members, partners and stakeholders in developing real world operational strategies for land use change

[36] Ricardo Energy & Environment UK NIR 2020 (Issue 1) UK GHG Inventory 1990-2019 Annex p. 854
[37] HM Government (2018) A Green Future: Our 25 Year Plan to Improve the Environment
[38] UK Government (2021) England Peat Action Plan p.12

implementation, particularly in relation to developing a Tree, Forestry and Woodland Strategy given a target of 1,000 ha per year is proposed.

It is suggested there are a range of issues for consideration by stakeholders including the complexities associated with the 'right tree, right place' principle. Key to changing hearts and minds about volume 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 regular boundaries unless there is a historic precedent[39]. There are also practical considerations in the choice of tree species for long-term resilience to temperature increases and increased rainfall and flood events driven by climate change.

Any new woodland planning requires multi-benefit opportunity mapping to identify best strategic placement, economic considerations for farmers and landowners e.g. 'A wood that pays is a wood that stays', and the UK nations' need for productive woodland for construction and biomass and sustainable woodland management. An example case study of where partnership have undertaken this thinking to produce a strategy is shared in Box 1:

Box 1: Sharing the learning example case study Forest of Bowland AONB

The Forest of Bowland AONB (2021) recently published their trees, woodland and forestry strategy with partners. Their strategic vision summarised as follows:

- *"Promote continuous cover forestry where appropriate particularly on sites with high landscape value.*
- *Restore replanted woodland on ancient sites to a semi-natural state.*
- *Recognise the value of trees outside woodland. Retain and conserve our 'landmark trees'*
- *Encourage opportunities for new and connecting woodland in cloughs*
- *Encourage planting of field corpses and new farm woodland.*
- *Recognise the benefits of trees next to rivers (riparian woodland) for water quality and to reduce surface water run-off.*
- *Encourage protection and management of farm-scale woodland and hedgerows. Manage existing productive woodlands to UKWAS standard"*

Source: Forest of Bowland Area of Outstanding Natural Beauty (2021) Trees, Woodland and Forestry Strategy (2021) p. 6

5.6.2. Local authority opportunities

Other opportunities exist for tree planting particularly micro forests, shrubs and hedgerows with local authority partners in urban settings, such as parks, schools and on public highways e.g., roundabouts. These can also act as protective factors against air pollution if the correct species are chosen. Public highways are also great for pollinator patches, and maintenance costs to local authorities can be reduced through a change in grass cutting regimes as discussed within Lancaster City Council (2021) Grasslands Management Strategy[40].

[39]Forestry Commission (2017) The UK Forestry Standard The governments approach to sustainable forestry

[40] Lancaster City Council (2021) Grassland Management Strategy see https://www.lancaster.gov.uk/news/2021/feb/implementation-of-new-grassland-management-strategy

Box 2: Sharing the leaning 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 covering only 3% of the global land surface yet holding nearly 30% of the soil carbon[41]. In the UK, peatlands account for nearly 33% of land cover 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. Eighty percent of peatlands in the UK have been modified as a result of past and present management[42]. Only 13% of England's peatlands are in a near natural state[43].

There are three broad peatland types 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)[44]

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 (CO_2). It's worth saying peatlands are complex as they both emit and capture CO_2, and the balance between these processes depends on peatland condition. They may also be 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 accounting for the initial increase in methane emissions following re-wetting[45].

[41] IUCN National Committee United Kingdom (2021) About Peatlands see https://www.iucn-uk-peatlandprogramme.org/about-peatlands

[42] IUCN National Committee United Kingdom Peatland Programme (2021) Peatland Damage https://www.iucn-uk-peatlandprogramme.org/about-peatlands/peatland-damage

[43] UK Government (2021) England Peat Action Plan p.2

[44] South Downs GIS analysis shows nearly 12 ha in the "fens, marsh and swamps" category

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

It is suggested an important action for all National Parks with Peatland habitats is the assessment of the condition, including area, and habitat type to enable priorities for restoration to be identified. It would also be beneficial to assess soil depth, and this could present opportunities to employ citizen science. Hydrology assessments may also be beneficial where appropriate where it is identified water management is needed to encourage higher water levels within the peat soils. Joint working with water utility companies as partners is therefore recommended given their responsibility for ensuring water quality and sustainability as part of the Water Framework Directive Regulations. Water Utility companies are responsible for the delivery of Water Resources West Regional Plan and Water Resources Management Plans.

5.6.4. 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 National Park and the role it plays in UK food security. The UK is a net importer of food (Figure 17). Only 55% of food consumed originates from the UK, with 26% imported from Europe[46].

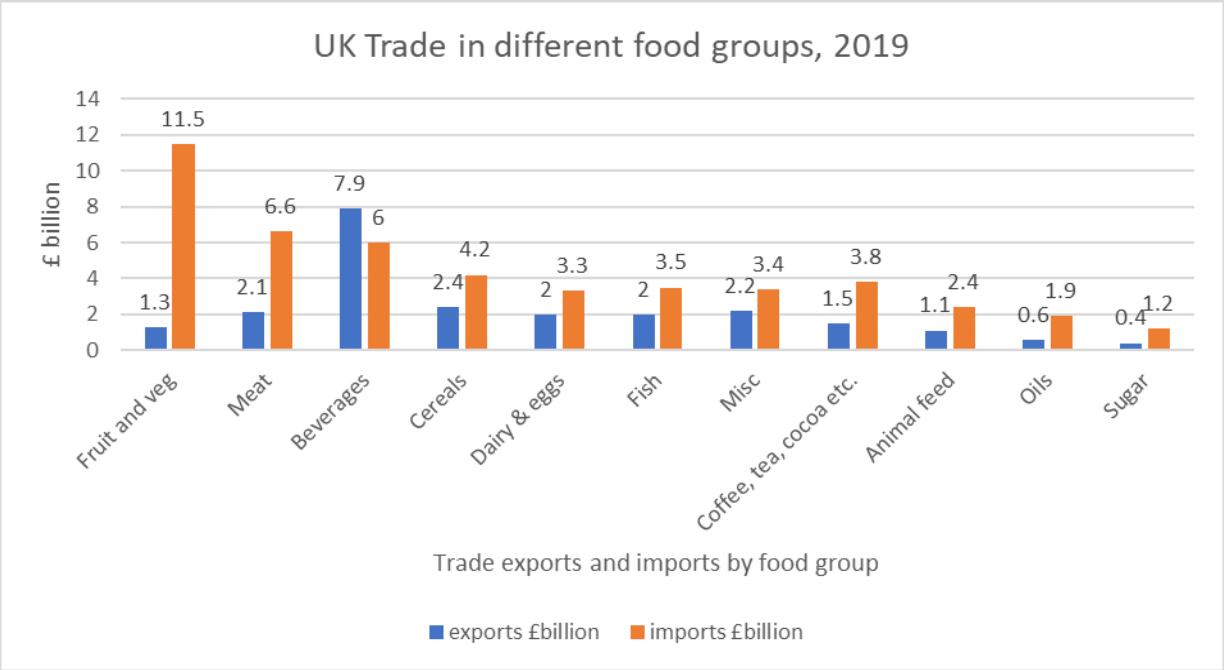


Figure 17: UK trade in different food groups, 2019

The Agricultural Land Classification System (England and Wales) identifies six grades of land. Grades 1, 2 and subgrade 3a are considered within the 'best and most versatile' land category in the current planning system. 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 strong limitations that affect the choice of crop, timing and type of cultivation/harvesting or level of yield. Grades 4 and 5 are both poor-quality agricultural land. Along with level 3b they offer, in general terms, the greatest opportunities

[46] 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

for land use change. Such change could be marginal or could raise possibilities for larger projects such as woodland creation, peatland restoration and grassland improvement projects. However, it is suggested that all opportunity-mapping should be reviewed in the context of regional food production and security, given the UK is a net importer of food; see Figure 5.

The South Downs National Park is an important food producer. A DEFRA (2017) survey of horticulture suggests the following make-up of agricultural holding by type: lowland grazing livestock 36.1%, cereals 23.9%, general cropping 17.2%, mixed 10.6%, horticulture 5.5%, dairy 3.2%, poultry 1.6%, pigs 1.1% and other 0.9%[47]. The landscape predominantly consists of Grade 3 agricultural land, with some Grade 4 land and non-agricultural land (largely forested) and spots of Grade 5 agricultural land[48]. The National Park's internal GIS analysis suggests an average for 2015-2020 of 43,399 hectares of agricultural land. Grasslands are in the order of 65,000 ha.

RPA Crop Map (2019) suggests a wide range of crops are produced including Beet, Clover, Lucerne, Maize, Mixed Crop-Group 1, Perennial Crops and Isolated Trees, Potato, Spring Barley, Spring Field Beans, Spring Linseed, Spring Oats, Spring Oilseed, Spring Peas, Spring Wheat, Winter Barley, Winter Field Beans, Winter Oats, Winter Oilseed, Winter Rye, Winter Triticale and Winter Wheat.

The opportunities presented are therefore different to the majority of the UK's National Parks, where high-grade agricultural land is significantly more limited. The landscape is more likely to present significant opportunities for agroforestry and planting hedgerows on the margins of pasture & cropland, pasture grazing legumes and cropland cover cropping. There may also be further opportunity for planting native broadleaf woodland.

RPA Crop Map (2019) suggests woodland habitats in its broadest sense i.e., trees, scrub, short woody plants and hedgerows occupy 50,500 hectares of the National Park, while Land Cover Map (CEH, 2015) suggests typical broadleaf woodland occupies 30,000 ha, with coniferous woodland exceeding 5,000 ha. These estimates imply that around a quarter of the National Park area is covered in woodland, which grossly exceeds the UK average. The area of woodland in the UK (31 March 2021) is estimated to be 3.23 million hectares. This represents 13% of the total land area in the UK, 10% in England, 15% in Wales, 19% in Scotland[49].

Specifically missing from RPA Crop Map as a category is viticulture, the production of grapevines. A consultancy Vinescapes found only 0.4% of agricultural land was used for viticulture, although it was reported the National Park hosts 51 vineyards and 11 wineries, an industry which could increase with the impact of climate change[50].

A key aim of the Partnership Management Plan is therefore "to build consensus among land managers about how to use agriculture, forestry and rewilding approaches together to rebuild our natural capital alongside, not instead of, producing food"[51] .

[47] The Economy of the South Downs National Park
[48] DEFRA MAGIC (https://magic.defra.gov.uk)
[49] Forest Research (2021) Resources Woodland Statistics https://www.forestresearch.gov.uk/tools-and-resources/statistics/statistics-by-topic/woodland-statistics/
[50] Sky News Climate change could make South Downs ripe for wine-making boom Amar Mehta, News Reporter 21/06/2021
[51] South Downs National Park (2020-2025) Partnership Management Plan p.16

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

This section outlines the aspiration for the South Downs National Park in setting a challenging glide path to Net Zero by 2041 and beyond, to become a carbon sink as one of the 'lungs' of the South of England contributing to the UK's Net Zero target. It also outlines the planning assumptions used. For the treatment of targets such as energy we have taken a pro-rata approach for all National Parks based on a percentage of GHG emissions, however LULUCF requires a bespoke approach of proportioning UK targets to known key habitats within the National Park and uses area assumptions.

These six areas have been selected in order to find a best fit between the competing desires to:

(i) Cover everything of significance within the influence of policy-makers;
(ii) Keep the target simple enough to describe;
(iii) Avoid double-counting;
(iv) 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. The six target categories are summarised below, with further supporting data in Appendix Section 10.8.4.

- **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 the 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 total emissions. Furthermore, its selection allows us to draw upon a robust tool developed by the Tyndall Centre for Climate Change to help local authorities develop Paris-aligned trajectories for energy-only emissions reductions for 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 since, measured on a consumption basis, this represents roughly a quarter of UK residents' emissions.
- **Target Category 3: Other goods purchased by residents and visitors.** This includes all tangible non-food and drink purchases such as clothing, electronic equipment, furniture and soft furnishings, and cars. This target is important since it brings sustainable consumption of non-edible products and circular economy principles into the Park's carbon management agenda.
- **Target Category 4: Visitor travel to and from the National Park.** We include here only travel within the UK and not visitor travel to the UK. The reason for the omission of international travel is the practical difficulty in tracking change (as described in Appendix 10.8), but should not be taken to imply that visitor aviation emissions are not still an important consideration for policy makers.
- **Target Category 5: LULUCF Non-CO_2 component.** This includes all net-emissions from land other than CO_2 and, most notably, includes enteric emissions from ruminants, emissions from manure and emissions as a result of fertilizers. A comparatively small contribution to

LULUCF non-CO_2 emissions comes from a range of ecosystems, both in near-natural and modified states, for example from peatlands.

- **Target Category 6: LULUCF CO_2 component.** This most notably includes emissions from peat and emissions captured by woodland, farm trees, hedges and soils. 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 sequestering carbon by creating new woodlands, switching to agroforestry systems, extending hedgerows and adopting better management practices for agricultural soils. Therefore, the LULUCF CO_2 component is set to enable 'net zero' and 'net negative' emissions in any of the National Parks.

Across these six categories, the 2019 carbon baseline for South Downs National Park is estimated at 2,441,302 tCO_2e per year.

Following the principles outline above, the several components of the wider carbon footprint of South Downs National Park presented in the previous sections have been excluded from the 2019 carbon baseline and the associated emissions reduction targets:

- Residents' travel by air, ferries, trains, buses and other transport (excl. cars). Local public transport will be counted through the energy GHG of local industry (Target Category 1 above), and travel outside of the National Park is beyond the scope of influence by local authorities
- Residents' holiday accommodation
- Residents' housing (building and maintenance)
- Residents' health, education and other public services
- Residents' and visitors' other bought services (e.g. financial, telecoms, travel agents, hairdressers)
- Residents' and visitors' art, sport and other leisure activities
- Residents' and visitors' water, waste and sewerage
- Industries' supply chains (both within and outside the National Park)

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

Our recommended target trajectories are summarised in

Table 4. They are intended to be 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 may be to push for the support that is required.

Table 4. Decarbonisation targets for the selected components of carbon footprint. For further details, see Appendix 10.8.4

Category	New Model for All National Parks (2021) – used in this report	Achievable ceiling
1. Energy only GHG emissions (incl. supply chains) by residents, visitors and industry	**13.4 %** (specific to South Downs 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	**10%** reduction per year	**7.5%** of present-day emissions
5 & 6. LULUCF (Non-CO_2 and CO_2)	We have split land use emissions and targets into LULUCF Non-CO_2 and LULUCF CO_2 components. See Appendix 10.8.8 for further details	**30%** of present-day emissions for LULUCF Non-CO_2 only; Achievable ceiling is not applicable for LULUCF CO_2 in the current assessment

The six elements outlined above can be combined into an overall decarbonisation pathway, which in the case of South Downs National Park results in a net zero date of 2041. 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 LULUCF CO_2 component, has been based on exponential decay (emissions decreasing by the same proportion each year) towards residual unavoidable emissions in the long run. The proposes reductions are broadly aligned with the Paris Agreement and the UK's 2050 net zero policy.

The LULUCF CO_2 component has been assumed to change linearly with time, which is characteristic of a gradual uptake of a number of measures to manage land sustainably, increase its carbon uptake (and/or reduce CO_2 emissions through restoring peatland) and enhance biodiversity. The rate of change has been drawn from the 6th Carbon Budget, apportioned to the South Downs National Park according to its land characteristics (see Appendix Section 10.8.8).

The 6th Carbon Budget apportionment methodology for South Downs results in the annual target for land use change summarised in Table 5, alongside the associated carbon sequestration flux increases each year. When measured in hectares per year converted, Grazing Legume creation target comes on top at 1,159 ha/y., followed by Broadleaf Woodland at 1,000 ha/yr and Cover Cropping at 852 ha/yr. Other measures are comparatively small, and we assume no conifer plantations in South Downs in order to prioritise native broadleaf species, while there is no peatland to restore. When converted to changes in carbon sequestration fluxes, the Broadleaf Woodland creation provides over 7 times higher contribution to the total (-18,456 tCO_2e per year added each

year), compared to the second-largest contribution from Grazing Legumes (Table 5). This clearly illustrates the priorities for land use measures in order to achieve Net Zero.

It is important to note that managing agricultural land sustainably to enhance soil carbon sequestration, as well as to achieve co-benefits such as biodiversity gains and flood risk mitigation, is of high priority[52]. However, global evidence shows that soil carbon sequestration is a slow process requiring the necessary management practices to be maintained indefinitely. Despite one's best efforts, the amount of carbon sequestration in soils also tends to undergo saturation after a period of time (several years/decades), and it is also vulnerable to climate change[53]. Typical sequestration values associated with regenerative agricultural practices such as agroforestry, hedging, legume-rich grasses and cover crops are estimated to be between 1 and 3 tCO_2 per year per ha in the first couple of decades. This is five to ten times less than typical carbon sequestration benefits of creating new woodland on similar timescales, which is always going to be the main source of carbon sequestration and wider co-benefits such as biodiversity gains. Healthy soils alone cannot reverse the negative effects associated with centuries-long conversion of natural landscapes to pastures and cropland, nor can they offset much broader emissions associated with our economic activities. It is therefore imperative that regenerative agricultural practices aimed at enhancing soil carbon stocks should go hand in hand with ambitious woodland creation (and, where applicable, peatland restoration) programmes.

Table 5: South Downs National Park: Apportioned 6th Carbon Budget targets for land use change and the associated additions to annual carbon sequestration fluxes.

Proposed Land Use Targets	**Value**	**Units**
New Native Broadleaf / Mixed Woodland	1,000	ha per year
New Productive Coniferous Woodland	0	ha per year
Restored Peatland	0	ha per year
Agroforestry (improved grassland & cropland)	259	ha per year
New Hedgerows (improved grassland & cropland)	15	ha per year
Legumes (improved grassland)	1,159	ha per year
Cover Cropping (cropland)	852	ha per year
Associated Carbon Sequestration	**Value**	**Units**
New Native Broadleaf / Mixed Woodland	-18,456	tCO_2e per year per year
New Productive Coniferous Woodland	0	tCO_2e per year per year
Restored Peatland	0	tCO_2e per year per year
Agroforestry (improved grassland & cropland)	-607	tCO_2e per year per year
New Hedgerows (improved grassland & cropland)	-157	tCO_2e per year per year
Legumes (improved grassland)	-2,380	tCO_2e per year per year
Cover Cropping (cropland)	-999	tCO_2e per year per year

[52] Bossio, D. A., et al. (2020). The role of soil carbon in natural climate solutions. Nature Sustainability, 3(5), 391-398.
[53] 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.

Based on the target-setting assumptions outlined in 5 and in Appendix 10.8.8, South Downs National Park would achieve Net Zero emissions in 2041 and will act as a net carbon sink in subsequent years (Figure 18).

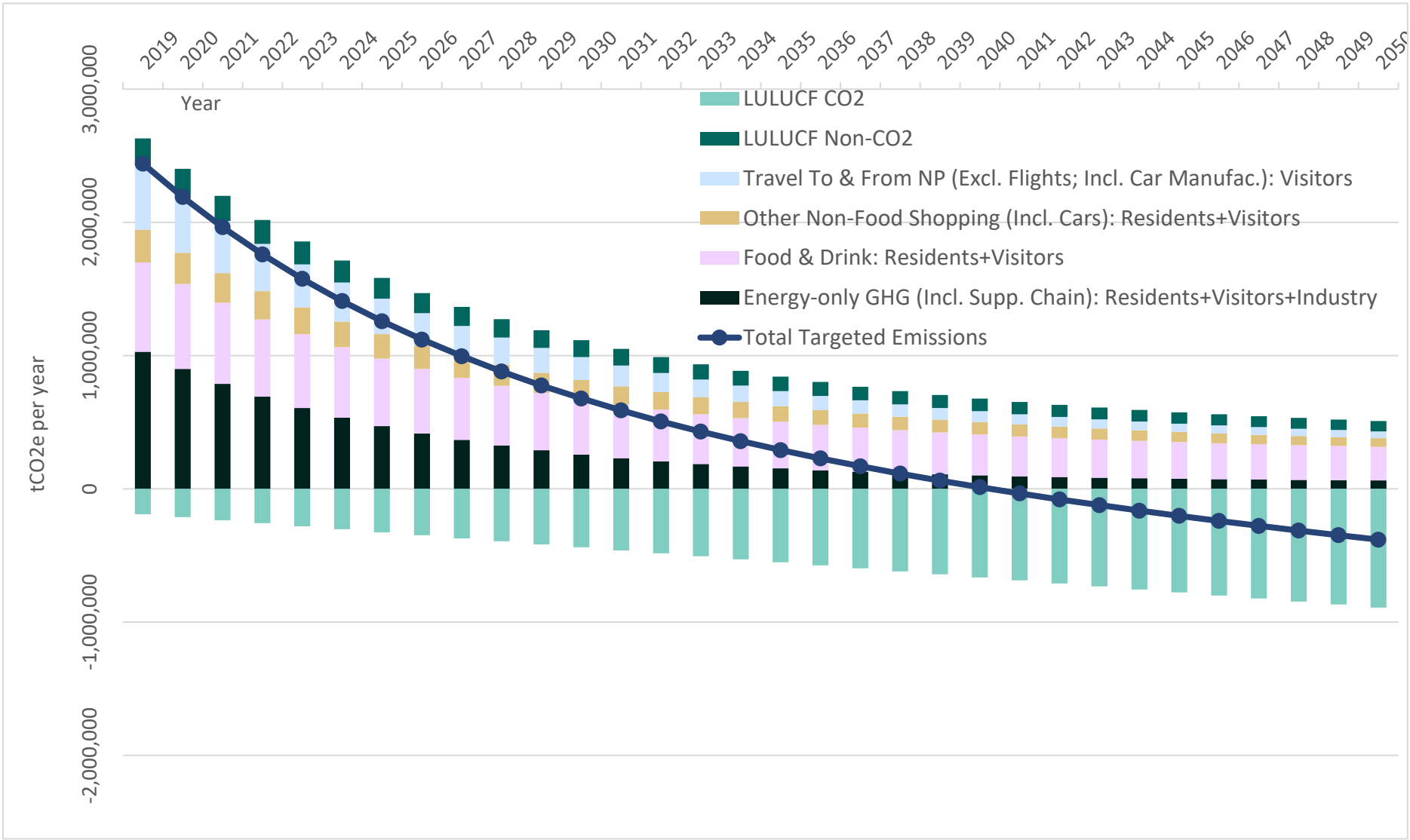


Figure 18. South Downs National Park: Pathway to Net Zero (Repeat of Figure 6)

7. Conclusions and recommendations

The emissions assessment in this report is designed to bring every relevant area of carbon management into perspective for policy makers. For the South Downs National Park to be undergoing transition to a low-carbon future entails strong action in many areas: construction, direct 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 that adds up to an enhanced experience of living, working and visiting the park.

The Planning powers that the Authority has, is one tool that can be used to push much harder in:

- The construction sector for zero carbon building (embodied GHG emissions);
- The energy efficiency and low/zero carbon energy supply for new buildings (operational energy/ GHG emissions);
- Encouraging low/zero carbon transport in new development (cycling, Electric Vehicles etc);
- Ecosystems Services-oriented policies and Biodiversity Net Gain initiatives in new build

Although it is accepted that the scale of opportunities for reduction of GHG emissions in new build are relatively small compared to those from existing buildings and residents, they are still important, as they:

- aggregate to the existing stock every year;
- minimise the need for future expensive retrofitting before 2040;
- demonstrate (more easily) that zero carbon construction and operation of buildings is technically possible;
- help stimulate and grow the market for more sustainable building techniques and products (which are also relevant to the retrofitting of existing buildings), bringing their cost down;
- encourage existing building owners and occupants to upgrade their properties.

If all the targets proposed in this report were met, South Downs would achieve net zero GHG emissions in 2041. It would subsequently reach negative emissions of approximately -380,548 tCO2e per year by 2050, with annual carbon sequestration in the park scaling up to around -890,212 tCO2e per year, and residual emissions dropping roughly to 509,664 tCO2e across the shortlisted policy priority areas (21% 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 South Downs net zero date of 2041 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, South Downs could act as one of the

'lungs' for South of England in the 2040s, making a vital and proportionate contribution to achieving nation-wide climate and broader environmental goals.

In meeting the targets, some help can be expected to come from outside the National Park, from anticipated change in the UK and global economy. For example, the electricity grid is endeavouring to decarbonise and there will be less fossil fuel powering all forms of road transport. On top of this, the public may increasingly care about carbon and choose more sustainable options, for example through 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 low-carbon transition by cutting their direct emissions, while simultaneously opting for suppliers with lower-embedded carbon in their products and services, thus accelerating the transition across the whole value chain.

A degree of help can be expected to come from government policies, and where this is not sufficient, part of the role of the South Downs National Park 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 neighbouring Local Authority Districts, 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 South Downs 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 South Downs, dominated by broadleaf woodland creation and grassland improvement, 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 CO_2 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.[54]

Furthermore, public perceptions of what a protected natural landscape should look like may also have to evolve. Most UK National Parks have considerable areas of low-grade grassland and moorland, which create the landscapes familiar to many in the UK and abroad. It may therefore sound surprising that at least some of these areas used to be covered by woodland centuries ago, which is where sizeable parts of the National Parks land ought to evolve back to in the coming years, in line with the climate goals. Visitors and residents alike ought to learn how to appreciate a more widespread woodland coverage alongside protected and restored peatland areas applying the 'right tree, right place' principle, even if this implies changes to perceptions of natural beauty and perceived reductions in the areas of moorland and uphill grazing.

[54] UK 6th Carbon Budget; Agriculture, Forestry and Other Land Use section

In assisting with 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 are being piloted during 2021 before launching in 2022 that will reward environmental land management namely: Sustainable Farming Incentive; Local Nature Recovery and Landscape Recovery[55] . Through these schemes, current public communications suggest 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; reduction of and adaptation to climate change; and beauty, heritage, and engagement with environmental law.

Woodland grants and incentives[56]

- Forestry Commission Local Authority Treescapes Fund
- Forestry Commission Urban Tree Challenge Fund
- Woodland Creation Planning Grant
- HS2 Woodland Fund (Land will need to 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 the National Park, its members and partners welcome this greenhouse gas emissions assessment, its findings and recommendations in helping the partnership support decarbonisation and action planning for change.

[55] https://www.gov.uk/government/publications/environmental-land-management-schemes-overview/environmental-land-management-scheme-overview

[56] https://www.gov.uk/government/publications/woodland-grants-and-incentives-overview-table/woodland-grants-and-incentives-overview-table

8. Acronyms

AFOLU	Agriculture and land use, land use change and forestry
BEIS	Department of Business Energy and Industry Strategy
CH4	Methane
CO_2	Carbon Dioxide
COA	Census Output Areas
DACCS	Direct Air Capture with carbon capture and storage
DEFRA	Department of Environment, Food and Rural Affairs
DOC	Dissolved organic carbon
EV	Electric vehicles
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
NUF	National Farm Union
N_20	Nitrous Oxide
ONS IDBR	Office of National Statistics Inter-Departmental Business Register
PFCs	Perfluorocarbon
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 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: Annexe 1: Glossary [Matthews, JB.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 9 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 produces an annual greenhouse gas inventory, a consistent time series of UK greenhouse gas emissions from 1990 onwards. (www.gov.uk, 2021)

Biodiversity (Net Gain): 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 (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: Is 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: Annexe 1: Glossary [Matthews, JB.R. (ed)].

Carbon flux: A carbon flux is the amount of carbon exchanged between Earth's carbon pools - the oceans, atmosphere, land, and living things.

CARBINE model: Is 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 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. We take a whole-systems view of the energy sector, helping us to 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 assessment: Means 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 (Small World Consulting, 2022).

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

Census Output Areas: 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 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 Fun (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)include company facilities and vehicles (Green House Gas Protocol (2013) Technical Guidance for Calculating Scope 3 Emissions Version 1.0).

Eco-system services: Ecological processes or functions having monetary or non-monetary value to individuals or society at large. These are frequently classified as (1) supporting services such as 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: Annexe 1: Glossary [Matthews, JB.R. (ed)].

Embodied emissions: This term (also called embedded carbon), refers to the collective of greenhouse gas emissions attributed in the whole production process of a product up to the point of usage.

Environmental land management: Through environmental land management, we can store carbon, reduce the risks from a changing climate and restore wildlife and habitats, whilst maintaining a thriving agricultural and forestry sector, growing quality food and timber and supporting the health and wellbeing of people.

Electric heat pump: An air, ground, or water heat pump is an electric heating system that absorbs internal heat energy either from the air, earth or water. The heat pump then uses a small amount of electricity to convert this energy into that of heated water with a suitably high temperature, ready to be used for domestic heating and hot water supply.

Extraction based emissions: These are the emissions that will result from the burning of any fossil fuels that are extracted from the ground in the National Park, wherever this takes place. 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 (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 EJ. Flexitarian Diets and Health: A Review of the Evidence-Based Literature. Front Nutr. 2017; 3:55. Published 2017 Jan 6. doi:10.3389/ fnut.2016.00055)

Fossil fuels: A fossil fuel is a hydrocarbon-containing material formed underground 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 (Wikipedia, 2022).

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 vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3) 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 the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O, and CH_4, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs) (IPCC AR5 Glossary Annex 11).

Greenhouse gas protocol: The GHG Protocol establishes comprehensive global standardized 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 standardized 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 15 April each year, to provide its annual GHG inventory covering emissions and removals of direct GHGs (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6) 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 a 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 (Green House Gas Protocol (2013) Technical Guidance for Calculating Scope 3 Emissions Version 1.0 p.6).

Industry sector: 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 are collected by the Office of National Statistics.

Standard industrial classification of economic activities (SIC) codes are used with industry being report against sectors (ONS, 2022).

Land Cover Map: The UK Centre for Ecology and Hydrology uses satellite imagery to map land cover from the first national Land Cover Map of Great Britain in 1990 to the current production of annual Land Cover Maps and land cover change data (presently 2020). The UKCEH land cover classes are based on UK Biodiversity Action Plan (BAP) Broad Habitats (Jackson, 2000). They do this by describing the physical material on 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 underpins 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 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: Annexe 1: Glossary [Matthews, JB.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 has a National Park Management Plan. This document is probably the most important for the National Park. It sets out how a range of organisations will work together to achieve shared objectives for the future management of the National Park. Each Management Plan will look 5-10 years ahead (National Park England, 2022).

Pollinator patches: A pollinator patch is a bed of annual flowers which may be native, non-native or a mixture of both. To be successful, the ground needs to be meticulously prepared which involves digging the site over, 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 the National Park, most notably by the burning of coal, oil and gas; those arising from the production of electricity used in the National Park (wherever that generation takes place), and direct emissions associated with land use within the Park (parts of agriculture, peatland degradation, etc) (Small World Consulting, 2021).

Paris Agreement: The Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) was adopted on 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 4 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. Additionally, the Agreement aims to strengthen the ability of countries to deal with the impacts of climate change. The Paris Agreement is intended to become fully effective in 2020. See also United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and Nationally Determined Contributions (NDCs). (IPCC, 2018: Annexe 1: Glossary [Matthews, JB.R. (ed)].

Paris-aligned greenhouse gas targets: Greenhouse gas emission reduction targets that are aligned with the warming targets of the Paris Agreement.

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. 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: Public health prevention 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 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 an 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: Means 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 (Wikipedia, 2022).

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

Rewilding: 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 we have altered. However, due to differing definitions and interpretations, the practice of rewilding has been both promoted and criticized 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 peoples 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)

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 (Wikipedia, 2022).

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

Supply Chains: Means the suppliers used by a company or organisation to produce and distribute products, goods and services.

Sustainable land management: Is defined as a knowledge-based procedure that helps integrate land, water, biodiversity, and environmental management (including input and output externalities)

to meet rising food and fibre demands while sustaining ecosystem services and livelihoods. SLM is necessary to meet the requirements of a growing population. Improper land management can lead to land degradation and a significant reduction in the productive and service (biodiversity niches, hydrology, carbon sequestration) functions 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) (Wikipedia, 2022).

Statutory Instrument: Statutory instruments are the most common form of secondary (or delegated) legislation. 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, and using the parliamentary procedure set out in the Act. SIs may follow affirmative or negative procedure, or have no procedure at all, but which to use is fixed by the Act (UK Parliament, 2022).

Toxic air: 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.

Viticulture: The cultivation and harvesting of grape vines.

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

Table 6: Key statistics for South Downs National Park

Output Variable	Value	Unit	Source		Output Variable	Value	Unit	Source
Resident Population	**140,881**	persons	ONS Mid-2019 LSOA Population; ONSPD 2019; BEIS 2019 Postcode Electricity Meters; Custom Postcodes		Average Visitors Per Day	**55,801**	persons	STEAM 2019
Annual Final Consumption (Households + Public Services)	**4,598,164,180**	£ per year	ONS 2019 Consumption; ONSPD 2019; ONS 2011 Census Demographics; Custom Postcodes		Annual Visitors Spend	**276,673,259**	£ per year	STEAM 2019
Annual Household Fuel per Resident	**5,434**	kWh per person per year	BEIS 2019 Postcode Gas; BEIS 2018 Residual Fuels; ONSPD 2019; Custom Postcodes		Annual Day Visitors	**18,291,055**	persons per year	STEAM 2019
Annual Household Electricity per Resident	**1,504**	kWh per person per year	BEIS 2019 Postcode Electricity; ONSPD 2019; Custom Postcodes		Annual Overnight Visitors	**673,270**	persons per year	STEAM 2020
Annual Vehicle Fuel per Resident	**5,333**	kWh per person per year	BEIS 2018 Road Fuels; ONSPD 2019; Custom Postcodes		Annual Visitors All Types	**18,964,324**	persons per year	STEAM 2019
Annual Personal Flights per Resident, Economy Class	**2.07**	fraction	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes; SWC Population Estimate		Percentage of Visitors Staying Overnight	**3.6%**	percentage	STEAM 2019
Annual Personal Flights per Resident, Business Class	**0.014**	fraction	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes; SWC Population Estimate		Average Duration of Stay for Overnight Visitors	**3.1**	days	STEAM 2020
Average Resident One-Way Mileage per Flight, Economy Class	**1,771**	miles	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes		Average Visitor Party Size	**2.5**	miles	Visitor Survey
Average Resident One-Way Mileage per Flight, Business Class	**4,038**	miles	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes		Average Visitor One-Way Road/Train/Boat Mileage to NP	**70.0**	persons	Visitor Survey
Average Visitor One-Way Mileage per Flight, Economy Class	**2,110**	miles	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes		Annual Business Turnover (Non-Surpressed), OA-based	**10,233,097,000**	£ per year	IDBR 2019; ONSPD 2019; Custom Postcodes
Average Visitor One-Way Mileage per Flight, Business Class	**1,376**	miles	CAA 2019 Passenger Survey; ONSPD 2019; Custom Postcodes		Percentage of Suppressed Turnover Output, OA-based	**0.00%**	percentage	IDBR 2019; ONSPD 2019; Custom Postcodes
Through Traffic Share of the Total Road Vehicle Fuel Footprint	**47.7%**	percentage	BEIS 2018 Road Fuels; DfT AADF 2019 Traffic Counts; ONSPD 2019; Custom Postcodes; STEAM 2019		GVA Reconstructed from IDBR Turnover, OA-based	**4,743,789,817**	£ per year	UK IDBR 2019; SWC EEIO 2019

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
BEIS Pollution Inventory (Large Emitters)	2018						■						High	High
BEIS CO2 Emissions	2018										■		High	Medium
BEIS Non-CO2 Emissions	2018										■		High	Medium
BEIS-DEFRA LULUCF GHG Emissions for NPs	2017; 2019 tbc											■	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 Land Cover Map	2019 or earlier			▒								▒	High TBC	Medium
6th 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: accommod. 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

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Residents GHG emissions: South Downs National Park

Consumer Expenditure Categories Summary	ALL Scopes	Units
Household Fuel	163,507	tCO2e per year
Household Electricity	71,825	tCO2e per year
Vehicle Fuel	280,717	tCO2e per year
Car Manufacture & Maintenance	68,411	tCO2e per year
Personal Flights	367,469	tCO2e per year
Ferry Crossings & Cruises	23,724	tCO2e per year
Trains, Buses & Other Transport	43,440	tCO2e per year
Food & Drink	491,434	tCO2e per year
Accommodation (Non Home) Excl. Food	9,627	tCO2e per year
Other Non-Food Shopping	137,340	tCO2e per year
Water, Waste & Sewerage	28,956	tCO2e per year
Other Bought Services	138,990	tCO2e per year
Housing	104,039	tCO2e per year
Health, Education, Other Public Services & Administration	191,734	tCO2e per year
Leisure, Recreation & Attractions	35,806	tCO2e per year
Total	**2,157,019**	**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

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Visitors GHG emissions: South Downs National Park

- *"Household Fuel" & Household Electricity" apply to visitors staying with friends and relatives*
- *"Accommodation" includes electricity, gas and other fuels used by hotels and B&Bs*

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

Consumer Expenditure Categories Summary	In NP	To & From NP	Units
Household Fuel	1,893	0	tCO2e per year
Household Electricity	832	0	tCO2e per year
Vehicle Fuel	115,505	348,040	tCO2e per year
Car Manufacture & Maintenance	29,244	88,117	tCO2e per year
Personal Flights	0	187,593	tCO2e per year
Ferry Crossings & Cruises	0	0	tCO2e per year
Trains, Buses & Other Transport	13,075	41,979	tCO2e per year
Food & Drink	179,343	0	tCO2e per year
Accommodation (Non Home) Excl. Food	12,381	0	tCO2e per year
Other Non-Food Shopping	10,432	0	tCO2e per year
Water, Waste & Sewerage	12,743	0	tCO2e per year
Other Bought Services	10,260	0	tCO2e per year
Housing	0	0	tCO2e per year
Health, Education, Other Public Services & Administration	0	0	tCO2e per year
Leisure, Recreation & Attractions	2,503	0	tCO2e per year
Total	**388,211**	**665,729**	**tCO2e per year**

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
Section A	Agriculture, Forestry and fishing
Section B	Mining and quarrying
Section C	Manufacturing
Section D	Electricity, gas, steam and air condition supply
Section E	Water supply; sewerage, waste management and remediation activities
Section F	Construction
Section G	Wholesale and retail trade, repair of motor vehicles
Section H	Transportation and storage
Section I	Accommodation and food services
Section J	Information and communication
Section K	Financial and insurance activities
Section L	Real estate activities
Section M	Professional, scientific and technical activities
Section N	Administrative and support service activities
Section O	Public administration and defence; compulsory social security
Section P	Education
Section Q	Human health and social work activities
Section R	Arts, entertainment, and recreation
Section S	Other service activities
Section T	Activities of households as employers; undifferentiated goods-and services-producing activities for own use
Section U	Activities of extraterritorial organisations and bodies

IDBR

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:

http://www.ons.gov.uk/ons/guide-method/classifications/current-standard-classifications/index.html

The broad industry group structure has been defined under UK SIC 2007 and is listed below:

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

Source: IDBR Meta Data

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

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Industry GHG emissions (IDBR-based): South Downs National Park

** Large emitters report Scope 1 only; depending on the underlying IDBR data quality, they may not be fully included in the industry figures*

*** Please note: LULUCF - This captures 2017 datasets, which do not fully include peatlands. More up to date BEIS data is expected by the end of 2021, with a new IPCC reporting methodology which assesses degraded peatlands as net emitters of CO2e.*

**** For information*

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

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Industry Categories Summary (IDBR sectors)	NP Industry Footprint, ALL Scopes	Units
Agriculture, forestry & fishing	**185,515**	tCO2e per year
Production	**596,112**	tCO2e per year
Construction	**139,922**	tCO2e per year
Motor trades	**9,954**	tCO2e per year
Wholesale	**38,720**	tCO2e per year
Retail	**39,591**	tCO2e per year
Transport & storage (inc. postal)	**38,657**	tCO2e per year
Accommodation & food services	**65,520**	tCO2e per year
Information & communication	**17,509**	tCO2e per year
Finance & insurance	**1,121**	tCO2e per year
Property	**11,371**	tCO2e per year
Professional, scientific & technical	**93,553**	tCO2e per year
Business administration & support services	**40,276**	tCO2e per year
Public administration & defence	**24,275**	tCO2e per year
Education	**103,116**	tCO2e per year
Health	**73,294**	tCO2e per year
Arts, entertainment, recreation & other services	**27,730**	tCO2e per year
Total	**1,506,237**	tCO2e per year
ENERGY-ONLY INDUSTRY (subset of INDUSTRY) South Downs National Park		
Industry Electricity	**35,554**	tCO2e per year
Industry Fuels Excl. Road	**141,120**	tCO2e per year
Industry Road Fuels	**205,271**	tCO2e per year
Total	**381,945**	tCO2e per year
LARGE EMITTERS * (subset of INDUSTRY unless IDBR data is supressed) South Downs National Park		
Large Emitters	**218,511**	tCO2e per year
INDUSTRY-RELATED FLIGHTS (subset of INDUSTRY) South Downs National Park		
Industry-related flights	**127,784**	tCO2e per year
LULUCF **– South Downs National Park		
LULUCF CO2	**-177,150**	tCO2e per year
LULUCF NonCO2	**207,304**	tCO2e per year
Total	**30,155**	tCO2e per year
Agriculture Combustion CO2 (Scope 1) ***	**48,238**	tCO2e per year

10.6.3. Appendix: IDBR vs GVA industry footprint estimates

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IDBR vs GVA Industry Footprint Estimates: South Downs National Park

Industry Sectors	NP OA-based IDBR Industry Footprint Estimates (per resident)	NP LA-based GVA Industry Footprint Estimates (per resident)	
Agriculture, forestry & fishing	1.32	0.36	tCO2e/person/year
Production	4.23	3.02	tCO2e/person/year
Construction	0.99	0.76	tCO2e/person/year
Motor trades	0.07	0.11	tCO2e/person/year
Wholesale	0.27	0.48	tCO2e/person/year
Retail	0.28	0.47	tCO2e/person/year
Transport & storage (inc. postal)	0.27	0.55	tCO2e/person/year
Accommodation & food services	0.47	0.35	tCO2e/person/year
Information & communication	0.12	0.28	tCO2e/person/year
Finance & insurance	0.01	0.19	tCO2e/person/year
Property	0.08	0.11	tCO2e/person/year
Professional, scientific & technical	0.66	0.26	tCO2e/person/year
Business administration & support services	0.29	0.37	tCO2e/person/year
Public administration & defence	0.17	0.43	tCO2e/person/year
Education	0.73	0.44	tCO2e/person/year
Health	0.52	0.42	tCO2e/person/year
Arts, entertainment, recreation & other services	0.20	0.18	tCO2e/person/year
Total	**10.69**	**8.78**	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 All National Parks (2018 data)					
National Park	**LAD14NM**	**Operator**	**Site**	**Postcode**	**CO_2 emissions (kt)**
The Broads National Park	Broadland	British Sugar Plc	Cantley	NR133ST	120.77
Peak District National Park Borders	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	1,048.88
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	201.6
New Forest National Park	New Forest	Cleansing Service Group Ltd	Poundbottom Landfill	SP52PU	13.4
North York Moors National Park	Redcar and Cleveland	Cleveland Potash Ltd	Saltburn-By-The-Sea	TS134UZ	13.7
New Forest National Park	Wiltshire	Renewable Power Systems Ltd	Poundbottom Landfill Site	SP52PU	3.8

10.7. Appendix: Emissions from major roads

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Emissions from major roads: South Downs National Park

- *This analysis of the impact of transit traffic has been included at the request of several NPs*
- *(*) Through Traffic refers to vehicles passing through the NP without visiting. It is not included in the residents', visitors' or industry footprints. It is estimated by comparing total traffic point counts with pump -level fuel sales within each NP*
- *(**) The Larger and Smaller subsets of selected A roads include elements of transit traffic as well as traffic from residents, visitors and industry.*

THROUGH TRAFFIC * -- South Downs National Park		
Cars, Buses & Motorbikes	336,785	tCO2e per year
Vans & Lorries	211,598	tCO2e per year
Total	**548,383**	**tCO2e per year**
SELECTED A ROADS - LARGER SUBSET ** -- South Downs National Park		
Road Names, Larger Subset	**M3 A26 A27 A31 A32 A23 A24 A272 A280 A283 A3**	
Cars, Buses & Motorbikes	439,692	tCO2e per year
Vans & Lorries	211,598	tCO2e per year
Total	**651,291**	**tCO2e per year**
SELECTED A ROADS - SMALLER SUBSET ** -- South Downs National Park		
Road Names, Smaller Subset	**M3 A26 A27 A31 A32**	
Cars, Buses & Motorbikes	168,579	tCO2e per year
Vans & Lorries	88,582	tCO2e per year
Total	**257,161**	**tCO2e per year**

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. 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, such 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 Lake District National Park, 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 Lake District National Park carbon assessment in 2017 and in 2020, extending the latter to the whole of Cumbria. Through this work, a Zero Carbon Cumbria Partnership was formed in 2021, funded by a successful heritage lottery funding bid. In 2021, SWC was subsequently commissioned to undertake a similar consumption-based carbon footprint assessment for all UK National Parks as well as several AONBs.

10.8.2. Appendix: Model development for National Park family

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

End of tranche 3 (December 2021) is considered to be the point by which all major model updates have been completed, pending LULUCF baseline update (see below). Subsequent updates, which will be applied to all NPs, are possible but are less likely at this stage.

The datasets and methodologies used in the December 2021 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; see Appendix) and National Park boundaries, which has been dealt with by constructing appropriate masks with mapping weights.

Another key addition is that of the traffic points data, which makes it possible to assess through traffic in each National Park and estimate footprints of the main A roads within its boundaries.

Another noticeable change in methodology concerns industry footprint estimates. An initial analysis was conducted using GVA datasets from Local Authorities, but it was recognised when applied across the National Parks that a better geographical representation of industry sectors within each Park is required.

As a result, additional licenses were purchased for ONS IDBR datasets for COA-level industry turnover to estimate the relevant footprint. By necessity, the turnover estimates include all COA geographies overlapping with the NP boundary, leading to marginal overestimates.

The agriculture & forestry sector emission estimates derived using IDBR data reflect on local enterprise turnovers but rely on UK-average carbon intensities of these sectors, which may not reflect on the unique farming and forestry characteristics within each NP.

Another key footprint category updated recently is Land Use, Land Use Change and Forestry (LULUCF) based on the latest version of Department of Business, Energy and Industry Strategy (BEIS) LULUCF CO_2 data for 2019.

The 2019 BEIS LULUCF CO_2 dataset includes, for the first time, emissions from different types of peatland and varying degradation levels (see Appendix). We also employ peat emissions factors from this dataset, alongside forestation and peatland restoration targets from the 6th Carbon Budget, as part of our net zero pathway recommendations for each NP.

A summary of 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 mid-2022.

- Household energy-related emissions were derived from consumption data available at postcode and local authority levels. The energy emissions factors used included supply chain components.

- Local authority level fuel use data was employed as the start point for estimating resident 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 at the postcode level, together with national household expenditure survey data.

- 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 visitor numbers and visitor spending estimates which we combined with emissions 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.

- Civil Aviation Authority survey data was used to estimate resident and visitor flight emissions. The emissions factors used take account of flight distances, 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 emissions factors that were drawn from the EEIO model. Separately, energy-related emissions from industry were derived from consumption data and energy emissions factors that included supply chain components.

- LULUCF emissions estimates were taken from data for UK National Parks, published by BEIS.

The data sources used are listed in Appendix 10.2.

10.8.4. Appendix: Target setting rationale

Each component of the overall emissions reduction target has been judged to be the minimum required to be aligned with limiting global temperature change to 1.5^0C from pre-industrial conditions, in line with the recommendations of the IPCC. Their 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 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 upon modelling by the Tyndall Centre for Energy and Climate Change Research for setting local authority targets. For food-related emissions we drew upon 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 change in future travel habits and the likely decarbonisation of land transport. LULUCF targets reflect the feasibility assessment in line with the 6th Carbon Budget UK 2050 net zero pathway.

Table 6 outlines the methodology used in this report (New Model for All National Parks 2021) and how it compares with an earlier iteration (Cumbria 2020). Methodological differences arose from new learning and knowledge transfer incorporated within 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 possible achievable emissions reductions for some sectors as it may not be entirely possible to achieve real zero emissions in these sectors given there will always be residual

emissions. We call this an 'asymptote' which describes graphically a straight line to which a given decarbonisation curve continually approaches but does not meet at any finite distance. Table 6 outlines the asymptote assumptions made for planning purposes.

Table 6: High level comparison between Cumbria and new National Park target setting methodology and assumptions used.

Category	Previous Model for Cumbria (2020)	New Model for All National Parks (2021) – used in this report	Asymptote (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[57]). Includes Scope 1 and 2 carbon dioxide emissions only (excluding motorways).	**13.4 %** (specific to South Downs National Park) per year reduction in energy-related CO_2 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_2e for residents, visitors and industry.	**5%** of present-day emissions. This is our expert judgement for embedded emission 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% per year from dietary change (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 6th Carbon Budget (AFOLU section), stating that UK agriculture emissions are set to halve from 54 $MtCO_2e$ today to 27 $MtCO_2e$ 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%** reductions per year. Includes 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. The 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 Cumbria (excluding international travel)	**10%** per year. Excludes flights but includes car manufacturing. This assumes a 4% per year increase in duration of stay (roughly	**7.5%** of present-day emissions. This is our expert judgement for embedded emission across various forms of renewable energy,

[57] A budget tool for 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		doubling after 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 model of transport from cars.	and from the sectors (via supply chains) such as cement and steel that will take time to decarbonise globally (affecting car manufacturing, buildings, etc).
LULUCF	Expert judgement based on discussions with stakeholders involved	We have split land use into LULUCF Non-CO_2 and LULUCF CO_2. See Table 7 for further details.	**30%** of present-day emissions for LULUCF Non-CO_2 only, which follows the arguments for the Food & Drink category. LULUCF 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 LULUCF targets are derived, and the relevant planning assumptions is included Appendix 10.8.8. Table 7 below provides a brief overview.

Table 7. Land Use target assumptions for National Parks.

LULUCF Non-CO_2	The Non-CO_2 component includes methane and N_2O emissions from livestock and fertiliser use within the National Park and need to be reduced in line with broader targets for the Food & Drink category. We therefore assume a 5% per year reduction for this component. Inevitably, there will be small double-counting when residents and visitors consume locally produced food in the Park.
LULUCF CO_2	The CO_2 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 measure are extended to bigger land areas and becomes negative when carbon sinks exceed carbon emissions from land. The assumed year on year changes to land use are based on the apportionment of the 6th Carbon Budget targets according to present-day land use makeup in each National Park see Table 12. The resulting rates of land conversion (e.g., forestation or peatland restoration) and/or application of new management practices (e.g., cover cropping nor grazing legumes) are then combined with the established carbon sequestration fluxes per hectare associated with these land use changes (established from field studies and desk-based research). In South Downs, the proposed land use measures are estimated to add 22,599 tCO_2e/year to the total carbon sequestration flux in the Park each year (22,599 tCO_2e removed per year).

10.8.5. Appendix: Assumptions for LULUCF sector

The Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse for National Greenhouse Gas Inventories (IPCC 2006, IPCC 2014) describes a uniform structure for reporting emissions and removals of greenhouse gases. Department for Business, Energy and Industrial Strategy (BEIS) compile annual Inventory of UK Greenhouse Gas Emissions for United Nations Framework Convention on Climate Change (UNFCCC). BEIS contract Ricardo Energy & Environment to compile the overall greenhouse gas emissions inventory. Ricardo subcontract 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 gases[58]. 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 pull out the key facts, logic and rationale applied to changes in either reporting or target setting as outlined in the Sixth Carbon Budget: Agriculture and land use, land use change and forestry report; see Table 8 and Table 9.

Table 8: UK baseline for Agriculture emissions (2018) using Global Warming Potential of IPCC AR5 for methane

	Percentage of UK emissions	**Million tonnes of CO_2**
Summary Agriculture	**10%**	**54.6 $MtCO_2$**
Breakdown		*SWC planning assumptions*
Methane (CH_4) from livestock	63%	34.4 $MtCO_2$
Nitrous oxide (N_2O) mostly from soil	26%	14.2 $MtCO_2$
Carbon dioxide from fossil fuel use	11%	6.0 $MtCO_2$
Total	**100%**	**54.6 $MtCO_2$**
Data Source: The Sixth Carbon Budget: Agriculture and land use, land use change and forestry, p.6		

[58] DEFRA (2021) UK Local and Regional Carbon Dioxide Emissions Estimates for 2005-2019 Technical Report p.62

“Emissions 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 9: Baseline for Agriculture emissions (2018) using Global Warming Potential of AR5 for methane

	Percentage of UK emissions	**Million tonnes of CO_2**
Agriculture Breakdown		*SWC planning assumptions*
Methane from livestock (Enteric fermentation digestion process of ruminant livestock)	53%	28.9 $MtCO_2$
Agricultural soils	21%	11.5 $MtCO_2$
Waste and manure management	16%	8.7 $MtCO_2$
Stationary machinery	8%	4.4 $MtCO_2$
Other	2%	1.1 $MtCO_2$
Total	**100%**	**54.6 $MtCO_2$**
Data Source: The Sixth Carbon Budget Agriculture and land use, land use change and forestry p.6 Figure M.7.1		

10.8.6. 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 period[59]. The six land classes are:

Land use category	**Sub-category**
4A: Forest Land	• Forest land remaining forest land • Biomass burning • Land converted to forest land • Drainage of organic soils • Direct N2Oemissions from N mineralisation/mobilisation
4B: Cropland	• Biomass burning • Cropland remaining cropland • Land converted to cropland • Direct N2Oemissions from N mineralisation/mobilisation
4C: Grassland	• Biomass burning • Grassland remaining grassland • Land converted to grassland • Drainage of organic soils • Direct N2Oemissions from N mineralisation/mobilisation
4D: Wetlands	• Wetlands remaining • Drainage of organic soils • Land converted to wetland
4E: Settlements	• Settlements remaining settlements • Biomass burning • Land converted to settlements • Drainage of organic soils • Direct N2Oemissions from N • mineralisation/mobilisation
4F: Other land	• Harvest wood • Indirect N_2O emissions

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

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

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

In 2017 the Centre for Ecology and Hydrology proposed changes to the methodology for emissions reporting of Peatlands[60]. Emissions from drainage and rewetting of peatlands, were included for first time in 1990-2019 LULUCF inventory (Brown et al. 2021). These are reported under all 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 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 peat extraction (onsite, and off-site for horticultural peat1), as well as organic soils affected by historical peat extraction are reported under Wetlands.

- Naturally occurring emissions and removals from pristine areas of bog and fen, and rewetted bog or fen from Forest Land, Cropland, peat extraction, and pre-1990 rewetted fen are now included in LULUCF reporting under Wetlands.

- Emissions of CO_2 from drained organic soils under Forest, Cropland and Settlement are reported in those respective categories.

- Other land category is predominantly made up of bare rock and scree and no emissions or removals are reported.

These recommendations were further refined for the current UK GHG Inventory 1990-2019[61].

Although more accurate than previous years, there remains considerable uncertainty pertaining to the latest (BEIS) LULUCF estimations (2019). This is due to an evolving methodology and process of refinement for measuring 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 10). The estimates for CO_2 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 CO_2 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. Tier 3 Forest Research

[60] 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

[61] Ricardo Energy & Environment UK NIR 2020 (Issue 1) UK GHG Inventory 1990-2019 Annex p. 854

CARBINE model was employed to derive emission factor for forested peatland between 1990 to 2019, and was tested using field data.

Table 10. 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 $tCO_2e\ ha^{-1}\ yr^{-1}$. 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_2O	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.

10.8.8. Appendix: Target setting methodology for land use change

The land use change and management targets in each National Park (NP), 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)[62] according to present-day land use distribution in each NP.

In the case of woodland creation, a more ambitious target has been introduced for each NP following conversations with the NP Authority teams on the ground, with a preference (in most cases) for native broadleaf or mixed species for most NPs in order to achieve broader environmental benefits across protected landscapes such as NPs and AONBs.

We consider four common land use types on mineral soils and eight types of degrading peat soils:

- 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 inventories[63], which is based on the Evans et al (2017) assessment[64].

As a default rule, we exclude marginal land such as calcareous grassland, acid grassland and heathland (the latter two are part of a commonly used umbrella term "moorland"). In is not uncommon, however, for relatively large areas of the heathland land cover to contain both deep and shallow peat, typically classified as modified bog dominated by heather/grass, either drained or undrained. We apply restoration targets to these types of peatland, in addition to degraded areas of peatland classified as blanket bog or peat under agricultural soils, if we have sufficient data from the National Park.

For the South Downs National Park, the current land use distribution is illustrated in Table 11, with the UK-wide areas of the selected cover types and the corresponding percentages accounted for by the South Downs NP shown for context in Table 12.

[62] UK's Sixth Carbon Budget: Agriculture and land use, land use change and forestry (AFOLU) report. Climate Change Committee, 2020.
[63] Ricardo Energy & Environment UK NIR 2020 (Issue 1) UK GHG Inventory 1990-2019 Annex p. 854
[64] 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

At roughly 165,000 ha, South Downs accounts for around 0.7% of UK's total land area, but its share of UK's broadleaf woodland is 4.5 times higher than its land share. This means the park is in a good position to expand the existing woodland cover, giving preference to native broadleaf trees that have multiple co-benefits rather that to productive coniferous woodland.

The South Downs share of improved grassland and cropland is marginally higher than the UK averages, with good 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. However, some of the least productive and lowest grade farmland would need to be taken off agricultural production to enable new woodland plantations.

Table 11. South Downs: Key land use types by area (present-day)

Land Cover Type	Percentage of NP Area
Broadleaf woodland on mineral soil	30.0%
Coniferous woodland on mineral soil	1.5%
Improved grassland on mineral soil	35.7%
Cropland on mineral soil	26.3%
Eroding modified bog (bare peat), drained	0.0%
Eroding modified bog (bare peat), undrained	0.0%
Modified bog (heather/grass dominated), drained	0.0%
Modified bog (heather/grass dominated), undrained	0.0%
Cropland on peat soil, drained	0.0%
Intensive grassland on peat soil, drained	0.0%
Extensive grassland (on bog/fen), drained	0.0%
Forest on peat soil, drained	0.0%

Table 12. South Downs: Areas of the main land cover 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	1,572,900	49,630	3.16%
Coniferous Woodland	1,637,100	2,529	0.15%
Improved Grassland (mineral soils only)	6,161,798	59,060	0.96%
Cropland (mineral soils only)	5,788,356	43,399	0.75%
Peatland (all types)	2,909,940	0	0.00%
Total Woodland Area (Broadleaf + Coniferous)	3,210,000	52,159	1.62%
Total Agricultural Area (Improv. Grassland + Cropland)	11,950,154	102,460	0.86%

Total Area of Selected Land Cover Types (above)	18,070,094	154,618	0.86%
Total Area (incl. urban, rough grassland, water, rock, etc)	24,249,500	165,268	0.68%

We consider the following seven land use change and management options to enable carbon sequestration (or emission reduction in the case of degraded peatland) and create wider environmental benefits (biodiversity gains, flood mitigation, air quality improvements, gains in recreational value, etc), which follow 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 form 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 as a percentage of the UK coverage (see Table 12 above). Woodland creation targets could, of course, be set differently, for example by projecting UK-wide targets onto a given National Park according to the park's total area, rather than by using the existing woodland land cover (LC) area within the park as an indicator of the future forestation potential.

As a default for this assessment, we assign a custom woodland creation target that exceeds both LC-based and area-based targets described above, which is illustrated for South Downs in Table 13. The current high level of woodland coverage in South Downs compared to national average results in a considerably more ambitious LC-based target of 812 ha/yr as opposed to 341 ha/yr apportioned according to the NP area alone. Following discussions with the South Downs team, it was agreed to increase the recommended level of ambition further to 1000 ha/yr. 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.

Table 13. Three ways of setting new woodland targets in South Downs NP.

Total Woodland Target Apportioned by Wood. LC Area in NP	812	ha/yr
Total Woodland Target Apportioned by NP Area	341	ha/yr
Total Custom Woodland Target in NP	1,000	ha/yr

The combined woodland target is then partitioned 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 NPs and/or those NPs 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 NPs, 80%-20% or 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 100%-0% woodland cover split in favour of native woodland for the South Downs NP, which is associated with broader environmental and social benefits than simply sequestering carbon.

Our woodland biomass carbon sequestration estimates employ yield class (YC) 8 for native broadleaf / mixed woodland and YC 18 for productive conifer trees as per the Sixth Carbon Budget recommendations[65]. We use 30-year average sequestration fluxes for trees from these yield classes inferred from the Woodland Carbon Code (WCC) to match with the timescales of the Net Zero target in 2050. Different trees will have ages between 0 and 30 years leading to the 2050 time horizon, which is why we adopt the 30-year average sequestration flux value in our calculations. We also add representative soil carbon sequestration estimates for woodland from a recent literature review by Bossio et al (2020)[66] to the biomass carbon sequestration inferred from the WCC.

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, up from 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/yr of peatland to be restored between now and 2050.

The UK-wide peatland restoration target is apportioned to each NP according to its total estimated area of peatland. The 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 10.8.7). The sub-targets are based on the estimated current areas of the relevant degraded peatland types (Table 11).

Unless bespoke information on peatland degradation levels has been provided by individual NPs, 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 NP. The rest of the peatland areas in each NP (75%) are assumed to be in various states of degradation. For the blanket bog habitats, the most common modification is peat dominated by heather/grass and drained, alongside comparatively small areas of eroding bare peat. For the heathland habitats, the peat is commonly dominated by heather/grass and could either be drained or undrained. In some NPs, there are also organic soils under agricultural and forested areas, which have their unique types of peatland degradation and the associated carbon fluxes.

[65] UK's Sixth Carbon Budget, AFOLU report, page 27.
[66] Bossio, D. A., et al. (2020). The role of soil carbon in natural climate solutions. Nature Sustainability, 3(5), 391-398.

As with the peatland classification, our peatland emissions factors follow the BEIS methodology (Section 10.8.7). Restoring certain amount of peatland means reducing emissions relative to present-day baseline in line with the adopted peat classification and emission factors. Because of the considerable uncertainties associated with reversing degradation of peatland so that it could become 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.

Peatland targets are irrelevant in the case of the South Downs NP since the 12 ha of lowland fens within its boundary have been restored in recent years and are deemed to be in a near-natural condition.

Agroforestry uptake

According to the Sixth Carbon Budget, a total of 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. Present-day uptake of agroforestry is assumed to be 1% of the current farmland area; 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.

Based on the assumptions above, the recommended UK-wide agroforestry uptake is just over 30,000 ha/yr between now and 2050, which applies to improved grassland and cropland areas. This target is apportioned to each NP according to the existing areas of improved grassland and cropland in the park.

When recommending agroforestry uptake for each NP, we use an average of the present-day UK agricultural land area, and of the projected UK agricultural land area in 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.

Our agroforestry-related carbon sequestration estimates are based on the figures from Bossio et al (2020) for 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 UK-wide hedgerows area by 2050, amounting to 1,725 ha/yr 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 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 (same as for agroforestry). New hedgerows could be created by partitioning larger fields and on field margins as part of a transition to smaller-scale and less intensive farming systems.

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

Grazing legumes for improved grassland

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

Based on the assumptions above, the recommended UK-wide grazing legumes uptake is just over 120,000 ha/yr between now and 2050, which applies to improved grassland areas only. This target is apportioned to each NP according to the existing areas of improved grassland in the park and is adjusted according to the projected decrease in the total area of the UK's agricultural land by 2050 (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, a total of 75% of UK cropland area may need to adopt winter cover cropping practice by 2050, with cover crops preventing soil erosion, improving landscape flood resilience, and enhancing carbon sequestration. Present-day uptake of winter cover crops is assumed to be 5% of the current cropland area; we do not have definitive figures at this stage.

Based on the assumptions above, the recommended UK-wide cover crops uptake is just under 114,000 ha/yr of between now and 2050, which applies to cropland areas only. This target is apportioned to each NP according to the existing areas of cropland in the park and is adjusted according to the projected decrease in the total area of the UK's agricultural land by 2050 (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 South Downs

Table 14 summarises the proposed land use change and management targets for the South Downs NP, which follow the principles outlined above.

Table 14. Land use targets and the associated additional carbon sequestration fluxes per year (emissions reduction for peat) for South Downs.

Land Use / Management Category	**Land Use Change Target (ha/yr)**	**Change in Carbon Flux (tCO_2e/yr/yr)**
New Native Broadleaf/Mixed Woodland	1,000	-18,456
New Productive Coniferous Woodland	0	0
Agroforestry (improved grassland & cropland)	259	-607
Hedgerows (improved grassland & cropland)	15	-157
Grazing Legumes (improved grassland)	1,159	-2,380
Cover Cropping (cropland)	852	-999
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	0	0
Restored Modified Bog (heather/grass dominated), Undrained	0	0
Restored Cropland Peat, Drained	0	0
Restored Intensive Grassland Peat, Drained	0	0
Restored Extensive Grassland Peat, Drained	0	0
Restored Forested Peat, Drained	0	0
Total	**3,284**	**-22,599**