Total Carbon Footprint of the South Downs National Park

A consumption-based greenhouse gas emissions estimate of the South Downs National Park's residents, visitors and industries

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1 Executive Summary

1.1 Local action on climate change

There is strong scientific consensus that greenhouse gas (GHG) emissions need to peak and then decline sharply over the next twenty years, in order to avoid dangerous climate change. In 2008, the UK set a target, enshrined by law, to reduce GHG emissions by 80% by 2050, and at least 34% by 2020. Significant GHG reductions will be met through national and European policy, but local areas will also need to act in order to meet these targets.

Consumption-based reporting includes emissions that take place in the supply chains of goods and services, wherever in the world those emissions take place. For a local area, this can be used to map out the climate change impacts of the lives of residents and visitors, including everything they buy and do. This consumption based approach opens up important areas of GHG management that are not reached through energy management alone, including food, purchased goods, and tourism.

This report, commissioned by the South Downs National Park Authority, presents the first estimate of the consumption-based GHG emissions generated from the products and services consumed within the South Downs National Park, so that it can contribute to national carbon reduction efforts and reap the benefits of a low-carbon economy and society. This report maps emissions from both residents and visitors, including a breakdown of visitors travel to and from the park. We have separately estimated the full impact of businesses within the Park, including their supply chains, up to the point of delivery of goods and services.

1.2 Results

For residents and visitors, the main points to note are:

- Total emissions, by residents and visitors combined, are estimated at around 5.7 million tonnes CO_2e per annum.
- Residents account for 34% of this (1.9 million tonnes CO_2e), which equates to approximately 16.9 tonnes CO_2e per capita per annum. Slightly higher than the UK average of 16.0 tonnes CO_2e per capita per annum.
- Visitors' consumption of goods and services during their stay, including travel to and from the Park accounts for 3.7 million tonnes CO_2e (64% of the total, or 81kg CO_2e per visitor day).

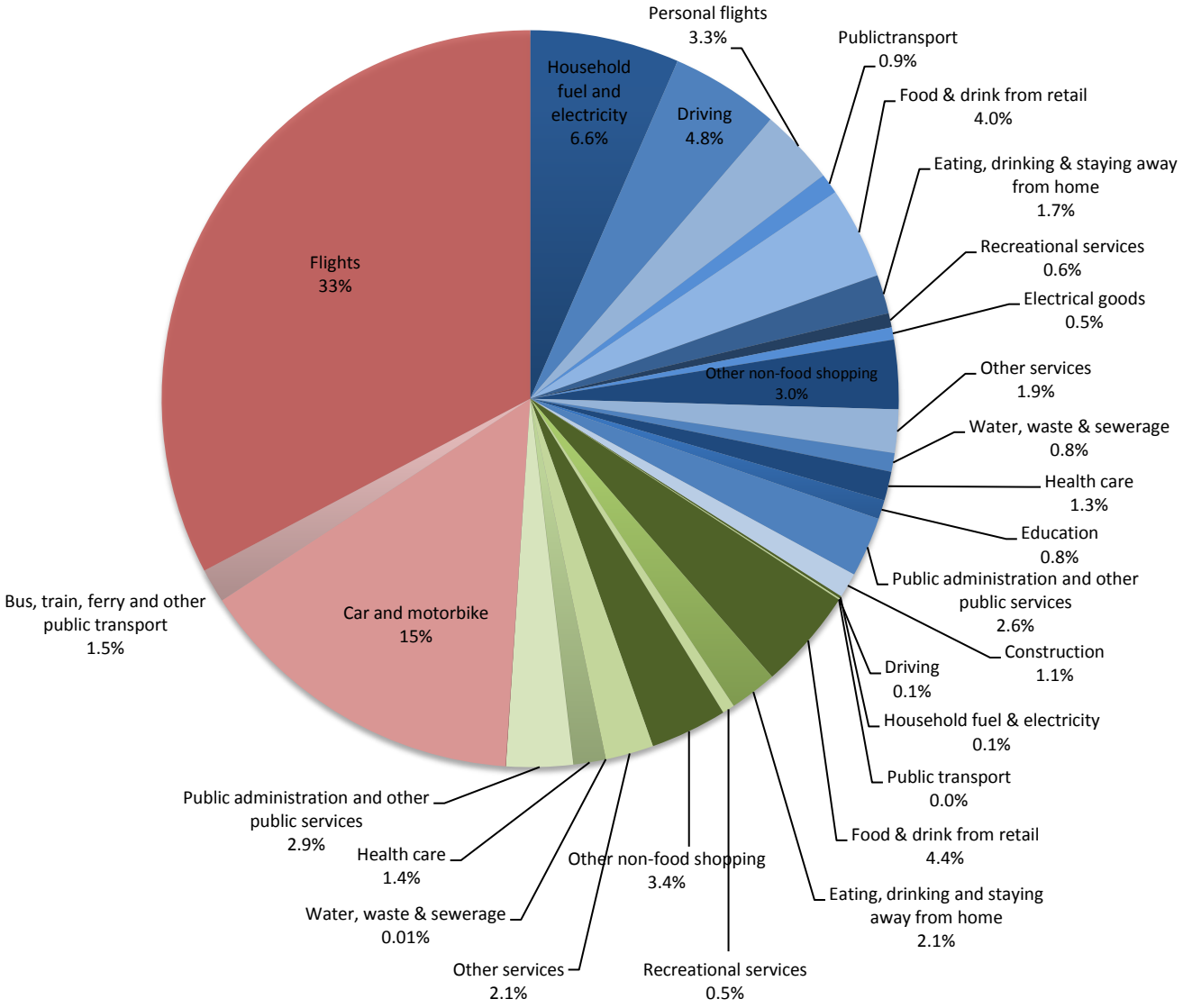

Figure 1: The total footprint of SDNP's residents and visitors; 5.7 million tonnes CO2e. (Blue represents the emissions from residents, green from visitors within the Park and red from visitor travel to and from the Park.)

Taking residents and visitors together, the largest categories of emissions (the most significant source of GHG emissions) are as follows:

- Domestic energy use (i.e. heating, lighting and electricity use in households) accounts for 6.7% of the total emissions.
- Driving by residents accounts for 4.8% of the total.
- Food, bought from shops, by residents accounts for 4%.
- Visitor accommodation and eating out accounts for 2.1%.
- Other, non-food shopping, by residents 3%.
- Flights by South Down residents (i.e. holiday flights) 3.3%.
- Visitors flying to and from the park accounts for 33% of the total.

The figure below shows this information graphically, highlighting the significance of four key areas; personal flights, accommodation (for residents and visitors alike), driving and food.

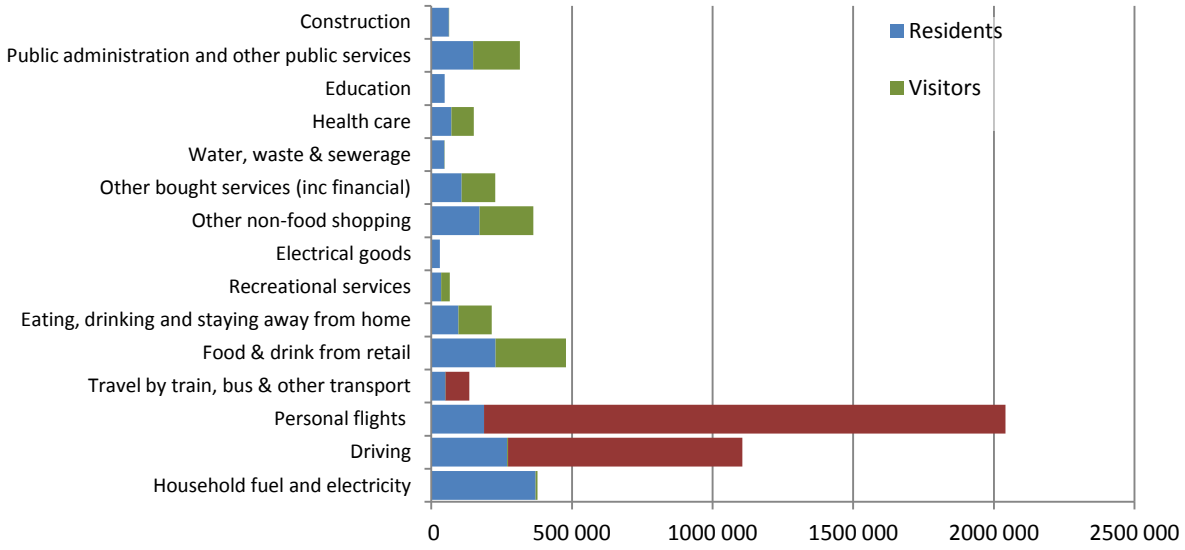

Figure 2: Cumulative totals of resident and visitor emissions by source (tonnes CO_2e *per annum*)

This report also examines the carbon footprint of industries within the Park industry. (Note that double counting occurs where one business lies within another's supply chain.)

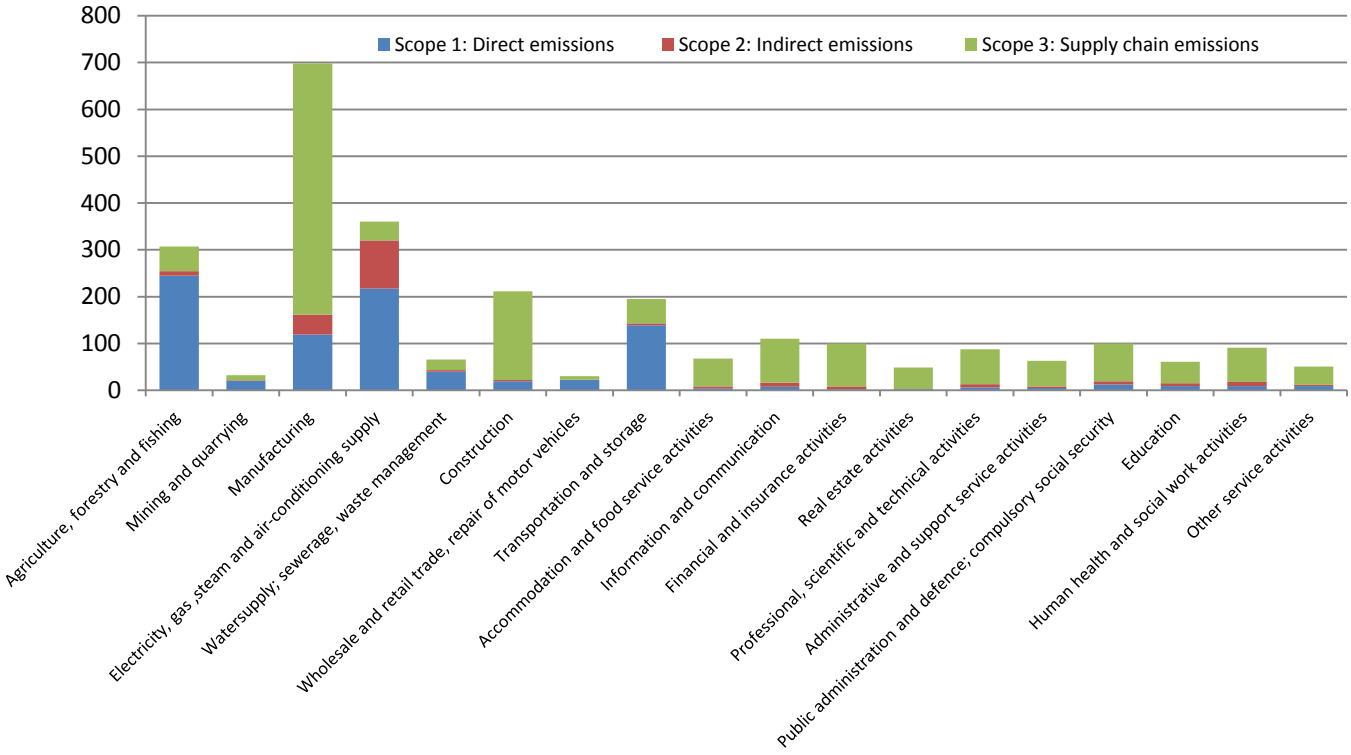

Figure 3: GHG footprint of SDNP's industry showing the relative contribution of scopes 1, 2 and 3 (thousand tonnes CO_2e).

1.3 Recommendations

In summary the following process is recommended in order to develop a comprehensive response to climate change:

- **Review internal capacity:** The SDNPA needs to consider how this work will be taken forward, and ensure that responsibilities are clear – with a named officer to manage the process; a senior staff member to lead; and ideally an Authority member acting as Champion.
- **Develop partnership working arrangements:** Many potential actions cannot be carried out by the SDNPA in isolation; they require input from partner organisations who have a stake in the National Park.
- **Develop a goal and outline strategy:** Share the evidence with partners, to determine an overall goal and set a clear direction for the work.
- **Assess major emission areas against a set of criteria:** Again, working in partnership, draw up a set of criteria against which to consider actions – this might include, for example, economic benefit; goals of partner organisations; social inclusion; promotion of tourism; availability of funding; etc.
- **Develop a more detailed action plan:** Using these criteria, an action plan can be developed.
- **Review and monitor:** In particular, the benefits (economic, social and environmental) of actions should be recorded, to develop an evidence base for future action.
- **Publicise and engage:** As the strategy develops, publicity by SDNPA and partners can help to bring in more stakeholders, which in turn will help to achieve aims. Publicising positive local initiatives may also help in persuading national government to provide better support for local climate change initiatives.

Future analysis. We recommend that the Park embarks upon land based carbon study, since the recent scoping study found that this would be a feasible and useful exercise within a reasonable budget[1] and since land based emissions and sequestration opportunities may be highly significant. Improvements in commuting and visitor data would also be valuable to feed into future studies.

[1] 'Land -based carbon accounting in the South Downs National Park: scoping study', Small World Consulting 2013

2 Introduction

2.1 Local action on climate change

There is strong scientific consensus that greenhouse gas emissions (hereby referred to as GHG emissions or emissions) need to peak and then decline sharply over the next twenty years, in order to avoid dangerous climate change[2]. In 2008, the UK government passed the Climate Change Act (hereafter referred to as 'the Act'), introducing a national GHG budget as a legal commitment. Through the Act, the UK committed to reducing GHG emissions by 80% (from a 1990 baseline) by 2050, and at least 34% by 2020. The Committee on Climate Change advises government on setting the budget, and on measures to meet it.

Some of this budget can be met through policy and incentives put into place by national government and the EU such as decarbonising electricity through renewables; carbon capture and nuclear power; tougher emissions standards for vehicles; carbon trading and so on. However, the budget will not be met unless local areas act too, putting the right incentives, infrastructure and advice in place at a local level to enable everyone to play their part in reducing GHG emissions. In 2012 a report by the Committee on Climate Change[3] (CCC) recommended a stronger role for Local Authorities in GHG mitigation, recommending that Local Authorities should be required to produce a low-carbon plan, and adequate resources to fund the work. Comprehensive local responses to climate change – in the form of local GHG budgets or 'Local Carbon Frameworks' – are a relatively new development but are supported by the Department for Energy and Climate Change (DECC), through its Local Carbon Frameworks programme.

As well as contributing to national efforts to curb emissions, actions to reduce emissions at a local level can have considerable benefits including greater business efficiency; reduced energy bills for householders; development of a low-carbon industrial sector; and improvements in prosperity and wellbeing.

2.2 Consumption-based GHG footprints

Consumption-based reporting includes emissions that take place in the supply chains of goods and services, wherever in the world those emissions take place. For a local area, this can be used to map out the climate change impacts of the lives of residents and visitors, including everything they buy and do, as well as the full impact of businesses up to the point of delivery of goods and services. For example, emissions from the production and transport of foods eaten in SDNP lie within the scope, whereas the 'footprint' of food produced within SDNP but exported is not included in this analysis. To give another example, in a consumption-based analysis, the carbon footprint of driving includes not only the direct emissions from the burning of fuel but also emissions resulting from the extraction, shipping and refining of the fuel, as well as a component for the manufacture of the vehicle itself.

This approach opens up important areas of GHG management that are not reached through energy management alone. These include food, purchased goods, and tourism. In doing so, consumption-

[2] For a summary of the science on climate change, see the briefing produced for MPs, *Climate Science Explained*, Green Alliance and Imperial College London http://www.green-alliance.org.uk/grea_p.aspx?id=5917

[3] House of Commons Energy and Climate Change Committee, 'Consumption-based emissions reporting', April 2012

based reporting directs attention to new policy opportunities where the potential for co-benefits may be greater and more diverse than the cost savings that may be achieved through direct energy savings alone. The adoption of a consumption-based approach is particularly important when seeking to understand and manage the impacts of lifestyles and of service economies, since in these cases, supply chain emissions often dwarf the direct emissions that would be included in an assessment of only direct emissions.

In April 2012 the House of Commons Energy and Climate Change Committee inquiry into consumption-based reporting concluded that the UK should adopt consumption-based metrics in order to report on the emissions embodied in overseas trade. It also drew strongly on case studies of policy applications of local authorities adopting the same approach[4].

2.3 This report

This project was commissioned by the South Downs National Park Authority (SDNPA) and presents the first estimate of the consumption-based greenhouse gas emissions generated from the products and services consumed within the South Downs National Park (hereafter referred to as SDNP or 'the Park').

We use the term 'GHG footprint' or 'footprint' to refer to the sum amount of CO_2e (carbon dioxide equivalent of greenhouse gases[5]) emissions resulting directly and indirectly from consumption of goods and services within SDNP by both residents and visitors. This is a mass, normally described as *kg* or *tonnes* of CO_2e.

The report sets out the emissions emanating from the consumption of goods and services, and from travel, for both residents and visitors. We also include a separate analysis of the emissions resulting from industry within the SDNP, including their supply chains.

Specifically the following are included in the footprint of residents:

- fuel and electricity consumed in homes;
- personal travel both within and outside the Park, including commuting;
- food and drink from both retail and from restaurants and other forms of catering;
- other, non-food, purchases;
- services (e.g. estate agency, financial and insurance services);
- water supply, sewage and waste;
- healthcare, education and other public services delivered both local and national level;
- construction, maintenance and improvement of dwellings; and
- the supply chains of all the above (e.g. fuel supply chains and embodied emissions).

The following is specifically excluded:

- business emissions including business travel (except in so far as the business output is consumed by residents).

4 House of Commons Energy and Climate Change Committee, 'Consumption-based emissions reporting', April 2012
5 This is described in more detail in section 6.1 The 'footprint' of consumption

The boundaries for the footprint of visitors are broadly similar to that of residents and include consumption of goods and services within the Park, travel to and from the Park and a broad estimate for travel within the Park during their stay.

For the footprint of industries the following are included:

- direct emissions;
- electricity;
- travel and transport;
- emissions from purchased goods and services;
- fixed capital formation; and
- the supply chains of all the above (e.g. fuel supply chains and embodied emissions).

The following is specifically excluded from the scope:

- commuting; and
- emissions from staff activity outside the workplace.

Note that where goods and services produced within the Park are consumed by residents and visitors, the associated emissions occur in both the residents & visitor's footprints, and the industry assessment. Similarly, where the output from one business lies within the supply chain of another, double counting occurs within the estimates of industry emissions.

This assessment follows the reporting principles of the Greenhouse Gas Protocol (GGP) published by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI)[6].

We therefore cover all the gases specified in the GGP expressed in terms of carbon dioxide equivalent (CO_2e), the sum of the weights of each gas emitted multiplied by their global warming potential (GWP) relative to carbon dioxide over a 100 year period.

The methodology, data sources and assumptions used are presented in Section 6.

6 Ranganathan et al., 2006.

3 The GHG footprint of residents and visitors

3.1 Overview

There are around 114,000[7] residents in SDNP and on average around 127,000 visitors at any given time[8]. We estimate that emissions resulting from their consumption of goods and services to be approximately 5.7 million tonnes CO_2e *per annum*. 34% of this (1.9 million tonnes CO_2e) is generated by resident consumption. This equates to approximately 16.9 tonnes CO_2e *per capita per annum*, slightly higher than the UK average of 16.0 tonnes CO_2e *per capita per annum*. Visitors' consumption of goods and services during their stay and travel to and from ('T&F') the Park account for 3.7 million tonnes CO_2e (64% of the total, or 81kg CO_2e per visitor day)[9].

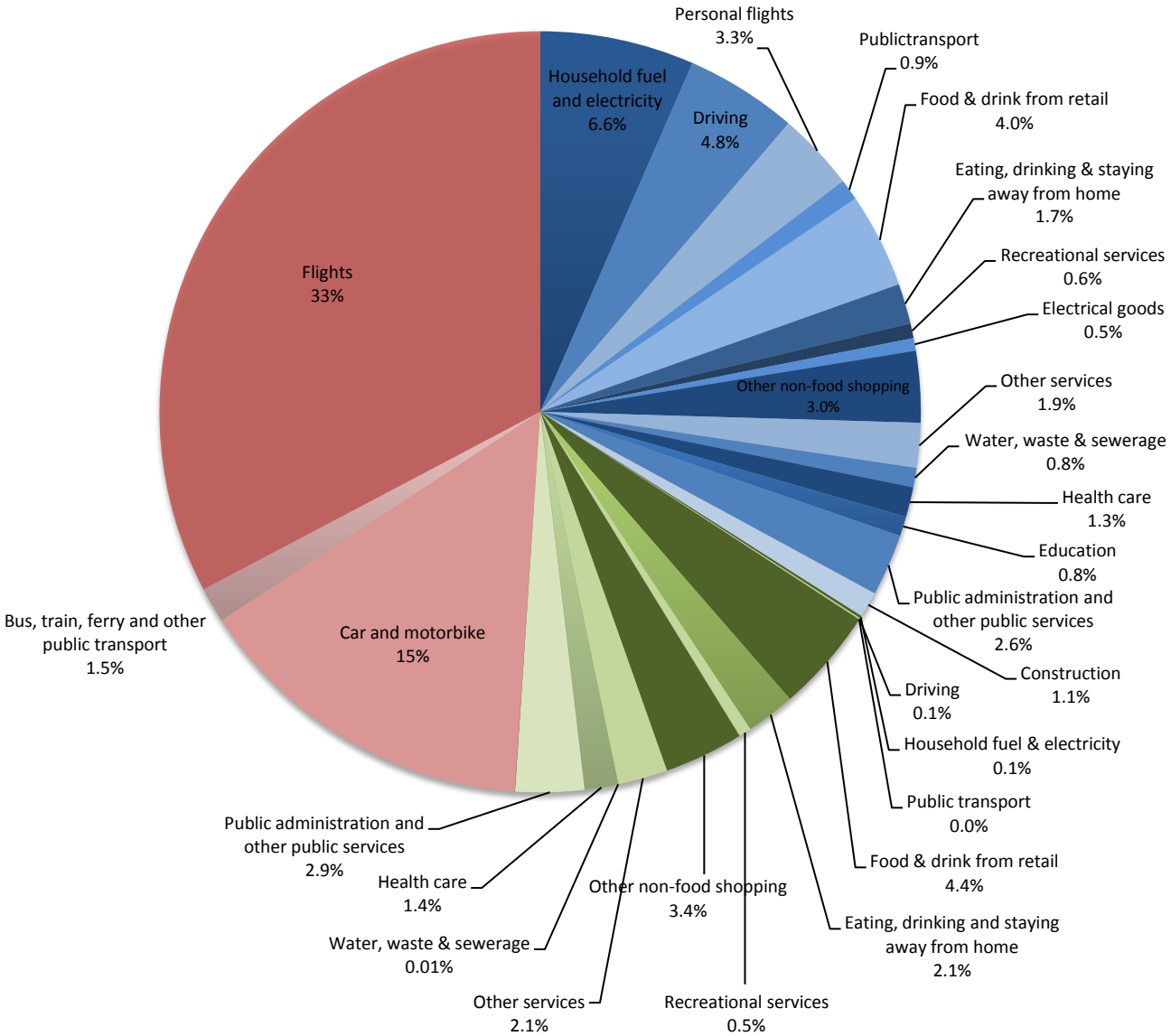

Figure 4: The total footprint of SDNP's residents and visitors; 5.7 million tonnes CO2e. (Blue represents the emissions from residents, green from visitors within the Park and red from visitor travel to and from the Park.)

7 Adapted from ONS, 2010, Mid-year population estimates and 2011 Census data.
8 Visitor full time equivalents (FTE) are based on estimates for tourist days averaged out across the year; source: South Downs Visitor & Tourism Economic Impact Study (Tourism South East Research - TSE, 2013).
9 Based on TSE 2013 estimates for number of visitor days. Source: South Downs Visitor & Tourism Economic Impact Study (TSE, 2013).

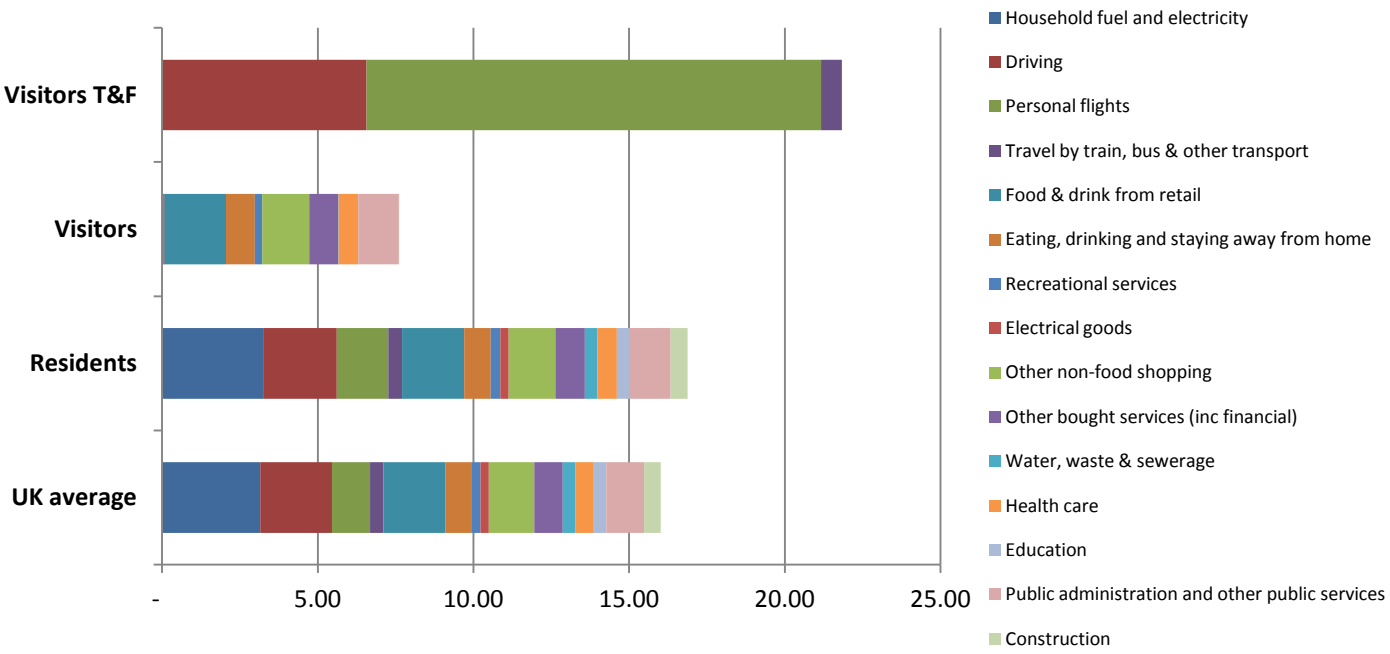

Figure 5: Comparison of *per capita* emissions of residents and visitors (as visitor FTE) to the UK average (tonnes CO_2e *per annum*)

Figure 5 shows the *per capita* emissions of residents and visitors to and from the Park. It is worth noting the relatively low emissions emanating from visitors stay within the Park but high contribution from visitor travel to and from the Park. This is based on the Tourism South East visitor survey[10] and reflects the relatively high proportion of day visitors who spend relatively little on goods and services during their visit. It also demonstrates the comparatively low impact of travel within the Park compared to the emissions from travel to and from the Park.

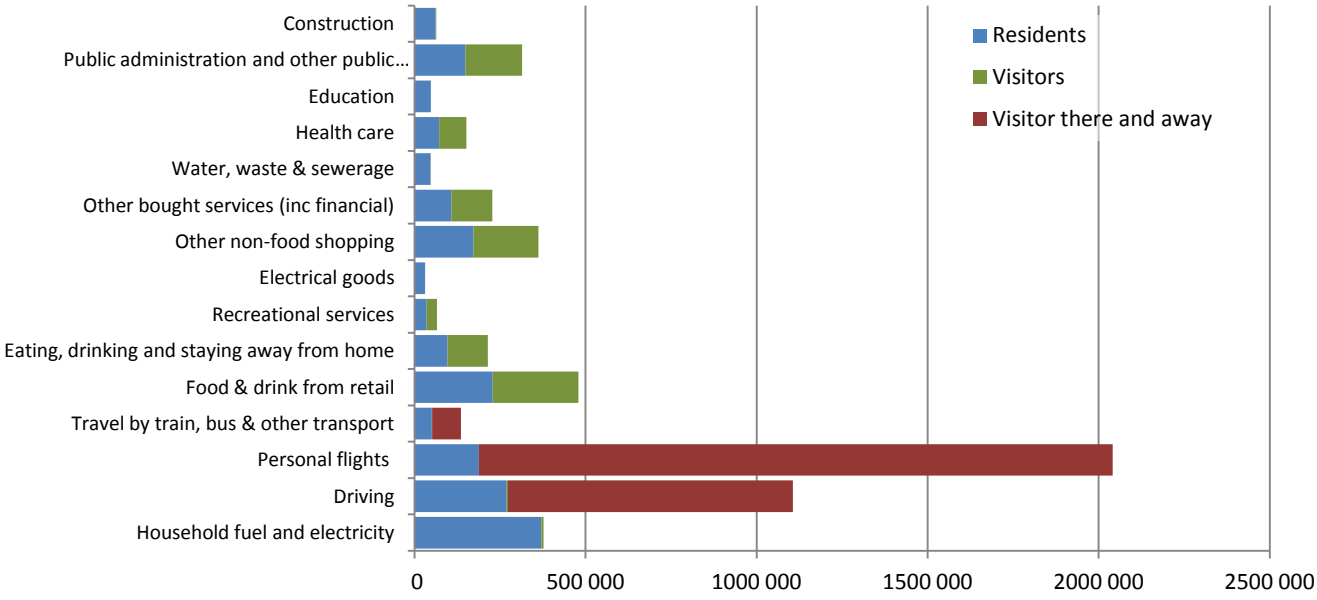

Figure 6: Cumulative totals of resident and visitor emissions by source (tonnes CO_2e *per annum*)

10 TSE, 2013

Table 1: Comparison of the annual *per capita* emissions for residents and visitors of SDNP against the UK average, and the total annual emissions (tonnes CO_2e *per annum* FTE)

	***Per capita* emissions (t CO_2e *per annum*)**				**Totals (t CO_2e *per annum*)**			
	UK average	SDNP resident	SDNP visitor (exc. T&F)	SDNP visitor T&F	SDNP resident	SDNP visitor (exc. T&F)	SDNP visitor T&F	All
Household fuel and electricity	3.16	3.25	0.05	-	370,889	6,206	-	377,096
Driving	2.30	2.36	0.03	6.56	269,658	3,511	832,516	1,105,685
Personal flights	1.23	1.65	-	14.61	188,176	-	1,853,057	2,041,234
Other transport	0.43	0.44	0.002	0.67	50,742	211	84,692	135,645
Food & drink from shops	2.00	2.00	1.97	-	228,339	250,250	-	478,589
Accommodation & eating out	0.82	0.85	0.93	-	96,680	117,893	-	214,573
Recreational services	0.30	0.31	0.24	-	35,251	30,337	-	65,588
Electrical goods	0.26	0.27	-	-	30,395	-	-	30,395
Other non-food shopping	1.46	1.50	1.50	-	171,574	190,725	-	362,299
Other bought services	0.92	0.94	0.94	-	107,626	119,639	-	227,265
Water, waste & sewerage	0.40	0.41	0.01	-	46,392	776	-	47,168
Health care	0.61	0.63	0.63	-	71,856	79,876	-	151,732
Education	0.40	0.41	-	-	47,336	-	-	47,336
Public administration and services	1.21	1.31	1.31	-	148,964	165,591	-	314,555
Dwellings construction	0.53	0.54	0.01	-	62,056	1,038	-	63,094
Total	**16.02**	**16.87**	**7.61**	**21.84**	**1,952,933**	**966,053**	**2,770,266**	**5,662,252**

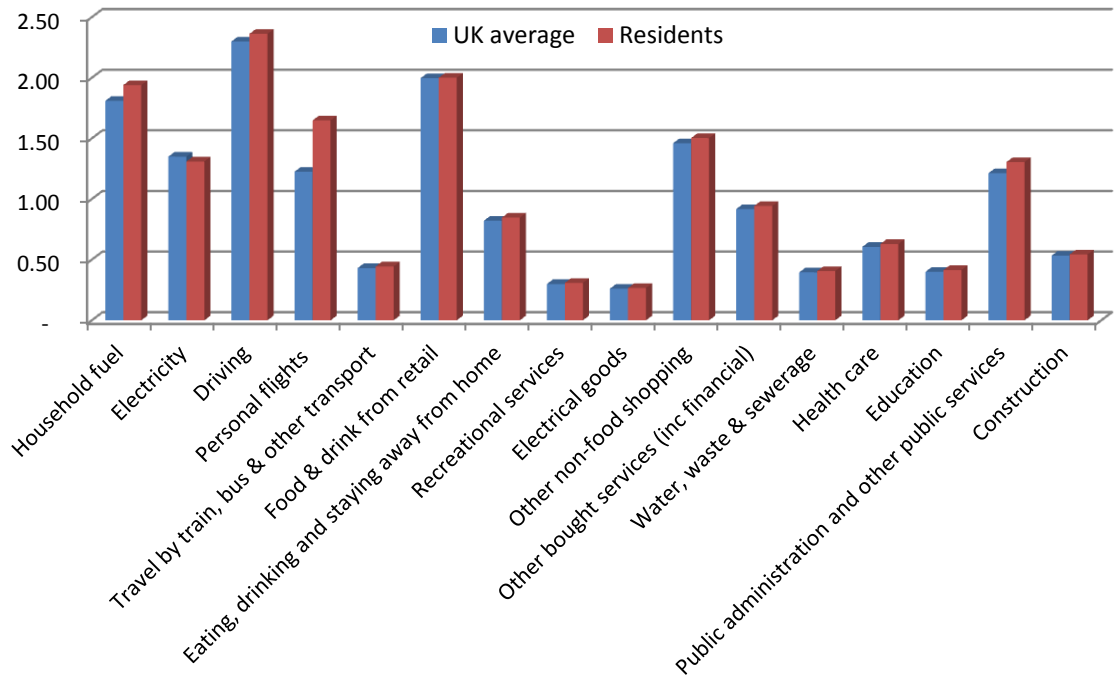

Figure 7: *Per capita* comparison of UK average and SDNP residents' footprint (tonnes CO_2e *per annum)*

3.2 Breakdown of the GHG footprint of residents

We estimate the footprint of residents to be 1.9 million tonnes CO_2e *per annum*, or 16.87 tonnes per average resident. This breaks down as follows:

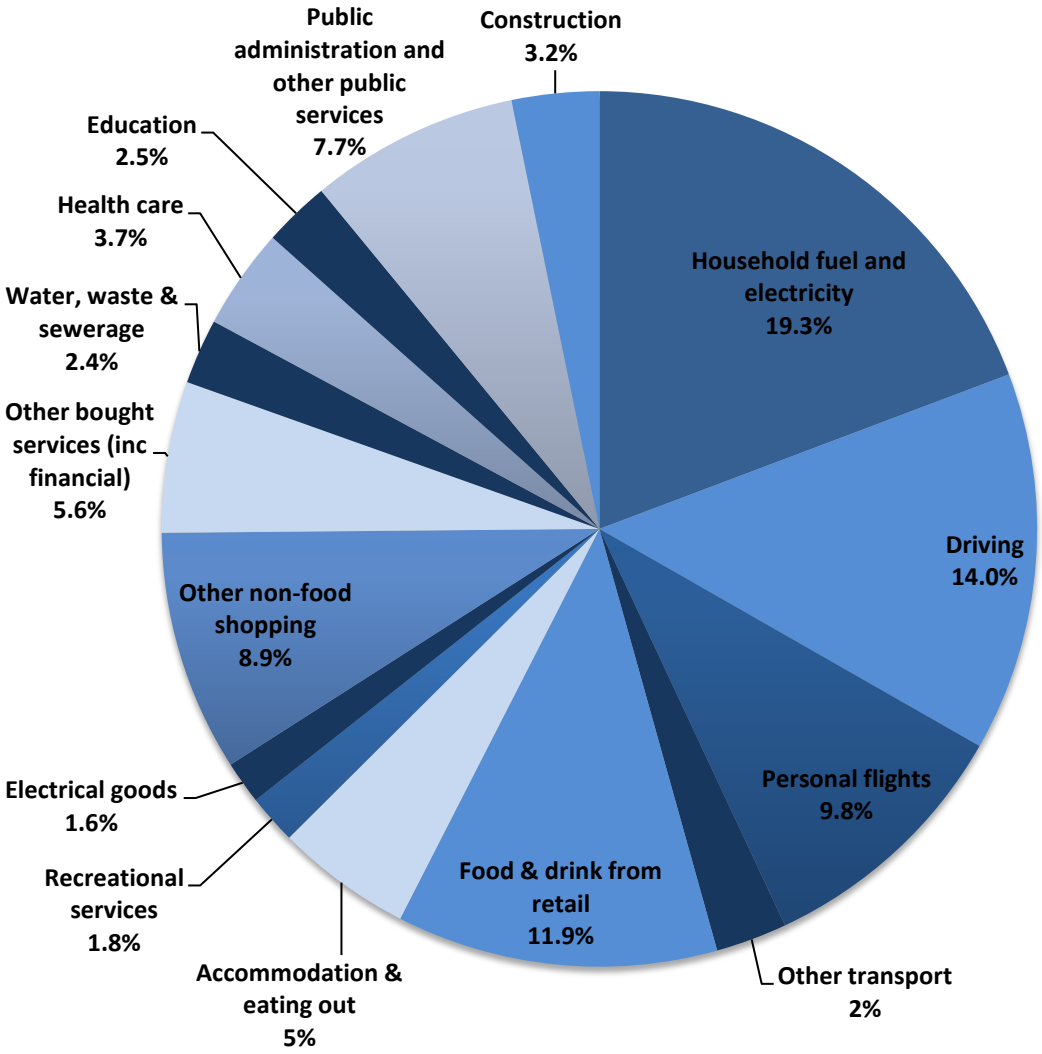

Figure 8: The total footprint of SDNP residents; 1.9 million tonnes CO_2e

3.2.1 Household energy (19% of total)

The domestic consumption of electricity and fuel contribute 370 thousand tonnes CO_2e *per annum* to the residents' footprint (19% of the total footprint).

This includes the emissions resulting from electricity, gas and other fuels. Electricity contributes 149 thousand tonnes CO_2e *per annum* (7.7% of the total), and household fuels (including coal, oil and gas) 222 thousand tonnes CO_2e (12% of the total).

This equates to roughly 3.25 tonnes CO_2e *per capita per annum,* slightly higher than the UK average of 3.16 tonnes CO_2e *per capita per annum* due to a higher per capita consumption of domestic fuel (7% higher than the UK average) despite slightly lower electricity consumption (3% lower than the UK average).

3.2.2 Driving (14% of total)

Driving contributes a further 269 thousand tonnes CO_2e to the footprint of SDNP residents (14% of the total footprint).

This includes emissions resulting from the combustion and supply chains of vehicle fuel as well as the emissions embodied in the retail, manufacture and maintenance of cars. The former contribute approximately 167 thousand tonnes CO_2e *per annum* (8.7% of the total footprint of residents 62% of all emissions from driving) Within this category around three quarters of the emissions are exhaust emissions resulting from the combustion of fossil fuels, with the remaining quarter arising from the extraction, transport and refining of fuel. The remainder contribute a further 102 thousand tonnes CO_2e (5.3% of the resident footprint and 38% of all emission from driving) comes from the retail, manufacture and maintenance of vehicles.

This equates to 2.36 tonnes CO_2e *per capita per annum*, slightly higher than the UK average of 2.30 tonnes CO_2e.

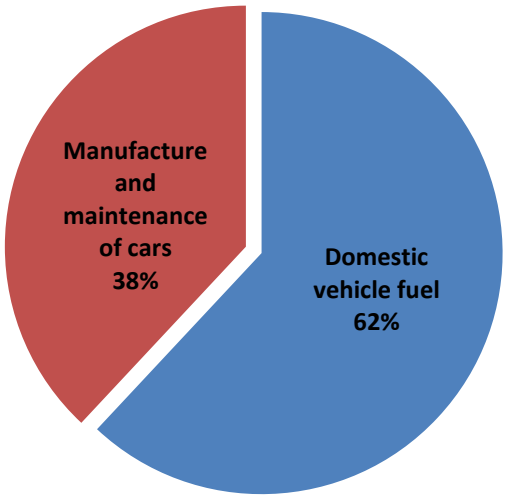

Figure 9: Breakdown of the footprint of emissions from resident's driving.

3.2.3 Food and drink from retail (12% of total)

Food and drink from retail results in approximately 228 thousand tonnes CO_2e *per annum* (12% of the total resident footprint) which equates to approximately 2.00 tonnes CO_2e *per capita per annum*, broadly in-line with the UK average of 2.00 tonnes CO_2e.

This section does not include food and drink purchased from restaurants, cafes, pubs, hotels; food consumed during business activities (for example, in business lunches) or food delivered through public services such as school and hospital meals. Nor does it include emissions resulting from the cooking or wasting of food[11]. If all these components were to be included in this category, emissions resulting from food would account for around 17% of the total footprint. If emissions from changes

11 The emissions resulting from cooking are represented in 'household fuel' and 'household electricity'. Those from waste appear in the 'water, waste and sewerage' category.

in land–use resulting from food demand are taken into account, food has been estimated to account for around 30% of the UK's GHG footprint[12].

The two most critical factors in determining the footprint of food are diet and waste. As a broad generalisation, the most GHG intensive diets are those with high meat and dairy contents, especially where there is high red meat content and most of all where the red meat is from ruminants (cows and sheep). Savings of up to 35% of the footprint of food may be achieved by shifting to vegetarian and vegan diets, while up to 18% may be achieved by switching meat consumption from more GHG intensive products (beef and lamb) to less GHG intensive products (chicken, pork and fish)[13]. Indeed for many there also are opportunities to save money and improve health by making these changes.

The average UK person is thought to waste around 12% of the edible food that they purchase[14]. Reducing this presents a clear opportunity to improve household prosperity whilst cutting GHG emissions.

Other factors in the footprint of food are the purchase of out-of-season produce (resulting in hot-housing or air-freighting) and excessive packaging (although some packaging is beneficial in helping to reduce waste). Food miles by ship are not usually an important factor in the footprint of foods.

3.2.4 Non-food shopping (11% of total)

Emissions from non-food shopping contribute 172 thousand tonnes CO_2e *per annum*, roughly 1.50 tonnes CO_2e *per capita* which compares favourably to the UK average of 1.71 tonnes CO_2e *per capita.*

This category includes a wide variety of goods, made up of electrical goods (1.6%) and other non-food shopping (8.9%). Some key components are worth noting:

- electrical goods;
- clothing and footwear;
- furniture, carpets and other household textiles;
- books, paper and published materials;
- soaps, toiletries and pharmaceuticals; and
- jewellery.

This part of the footprint might be reduced by supporting second hand markets and the repair and maintenance of goods of every kind. In addressing this section of the footprint there are opportunities for households to be better off and for relevant businesses to thrive as well as reducing manufacturing emissions and waste. This would take the SDNP closer to the concept of the circular economy.

3.2.5 Flights (9.8% of total)

We estimate that flying contributes approximately 188 thousand tonnes CO_2e *per annum* (9.8% of the total resident footprint), an average of 1.65 *per capita* somewhat higher than our estimates for the UK average of 1.23 tonnes CO_2e *per annum*.

12 Audsley et al., 2009.
13 Hoolohan et al., 2013 and Booths 2010
14 WRAP, 2008.

3.2.6 Public administration, defence and other public services (7.7% of total)

Consumption in this category results in 149 thousand tonnes CO_2e *per annum* (7.7% of the total resident footprint). This equates to roughly 1.31 tonnes CO_2e *per capita,* higher than the UK average (1.21 tonnes CO_2e *per capita)*.

Within this part of the footprint are allocations for nationally delivered services such as central government and the armed forces, both of which are outside the control of SDNP residents or local government. However, the Council and other local providers have an important role to play in managing their own footprints. Much of this can be aligned with resource efficiency and cost savings, especially through low-carbon procurement and energy efficiency.

3.2.7 Eating, drinking, recreation and staying away from home (6.9% of total)

This includes emissions from eating, drinking and staying away from home and recreational services totalling 132 thousand tonnes CO_2e *per annum* (6.9% of the total resident footprint) which equates to approximately 1.16 tonnes CO_2e *per capita,* which is slightly higher than the UK average (1.12 tonnes CO_2e *per capita)*.

Almost three quarters of this results from the provision of accommodation, food and drink outside the home (97 thousand tonnes CO_2e *per annum*; 5% of the total resident footprint). This equates to roughly 0.85 tonnes CO_2e *per capita,* slightly more than the UK average (0.82 tonnes CO_2e *per capita)*. Around half of the emissions in this category stem from food production, the rest are through the supply chains and provision of services. The most important considerations for reducing emissions in this category are improving the selection of less GHG intensive food choices available to customers, reducing waste (for example through attention to portion sizes and by minimising kitchen waste), improving energy efficiency and low-carbon procurement.

The remainder is from recreational services (35 thousand tonnes CO_2e *per annum*; 1.8% of the total resident footprint). These may be more difficult for either residents or local government to take action to reduce.

3.2.8 Other bought services (5.6% of total)

The use of services by the residents of the SDNP result in approximately 108 thousand tonnes CO_2e *per annum* (5.6% of the total resident footprint) which equates to approximately 0.94 tonnes CO_2e *per capita,* slightly more than the UK average (0.92 tonnes CO_2e *per capita)*. The largest components of this category are:

- letting of dwellings (1.8%);
- insurance and pension funds (0.96%); and
- banking, finance and insurance (0.83%).

These may be difficult parts of the consumption footprint for either residents or local government to take action to reduce.

3.2.9 Health care (3.7% of total)

Emissions resulting from healthcare are estimated at 72 thousand tonnes *per annum* (3.7% of the total resident footprint). As a predominantly nationalised service this figure is broadly similar to the UK average (0.63 tonnes CO_2e *per capita* compared to 0.63 tonnes CO_2e *per capita).*

Health improvement through, for example, increased cycling, walking and better diets also stand to bring about reductions in multiple parts of the footprint, as well as delivering wellbeing benefits.

3.2.10 Household construction (3.2% of total)

This category includes emissions from the construction, maintenance and improvement of homes within the South Downs National Park and results in approximately 62 thousand tonnes *per annum* (3.2% of the total resident footprint) or 0.54 tonnes CO_2e *per capita*, slightly higher than the UK average (0.53 tonnes CO_2e *per capita*).

Around 80% of this comes from the building of new homes and the rest from maintenance and home improvement. Reducing the emissions from home improvements should not be done at the expense of household energy efficiency measures. More importantly, planners have an important role in ensuring the sustainability of new builds in terms of in-use energy efficiency, as well as location and layouts that enable sustainable lifestyles. The materials used (for example, ensuring minimal waste and consideration of recycled materials) are another potential area for GHG savings without undermining the standard of the building.

3.2.11 Other travel (2.6% of total)

This includes travel by train, bus and other transport and contributes approximately 51 thousand tonnes CO_2e *per annum* (2.6% of the total resident footprint) which equates to approximately 0.44 tonnes of CO_2e *per capita,* approximately equal to the UK average (0.43 tonnes of CO_2e *per capita)*.

3.2.12 Education (2.5% of total)

Services within this category result in approximately 47 thousand tonnes CO_2e *per annum* (2.5% of the total resident footprint) which is roughly 0.41 tonnes CO_2e *per capita*, broadly in-line with the UK average (0.40 tonnes CO_2e *per capita*).

In addressing this section there are possibilities to save money through energy and resource efficiency, but perhaps more importantly, to educate for and about low-impact consumption.

3.2.13 Water, waste and sewage (2.4% of total)

Services within this category result in approximately 46 thousand tonnes CO_2e *per annum* (2.4% of the total resident footprint) which is roughly 0.41 tonnes CO_2e *per capita*, broadly in-line with the UK average (0.40 tonnes CO_2e *per capita*).

The majority of the footprint here comes from sewage and wastewater treatment rather than water supply and the GHG reductions from a lessening in household water usage are relatively limited, even though these actions are important in their own right.

3.3 Breakdown of the GHG footprint of visitors

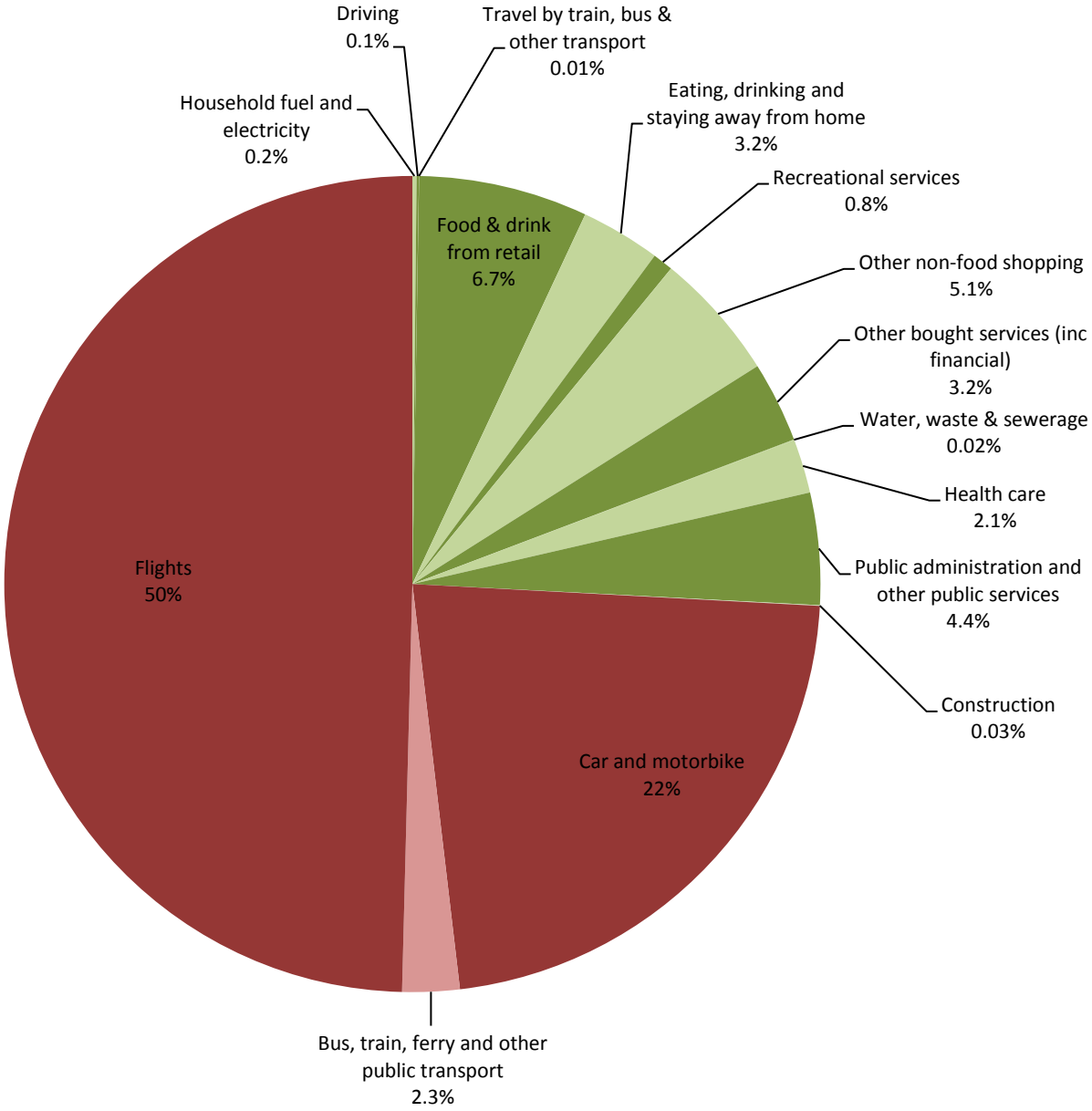

Figure 10: The total footprint of SDNP's visitors; 3.74 million tonnes CO_2e (green: visitor footprint during stay; red: visitor footprint travelling to and from SDNP).

3.3.1 Visitor travel to and from the Park (74% of the total footprint)

Visitor travel makes up the single largest contributor to the footprint at 2.77 million tonnes CO_2e *per annum*. Of this the vast majority is attributed to visitor travel to and from the Park with visitor travel within the Park contributing only 0.13% to the total visitor footprint. Although based on several assumptions (see: 6.7.3 *Travel within the Park*) our approximation highlights the relative importance of visitor travel to and from the Park.

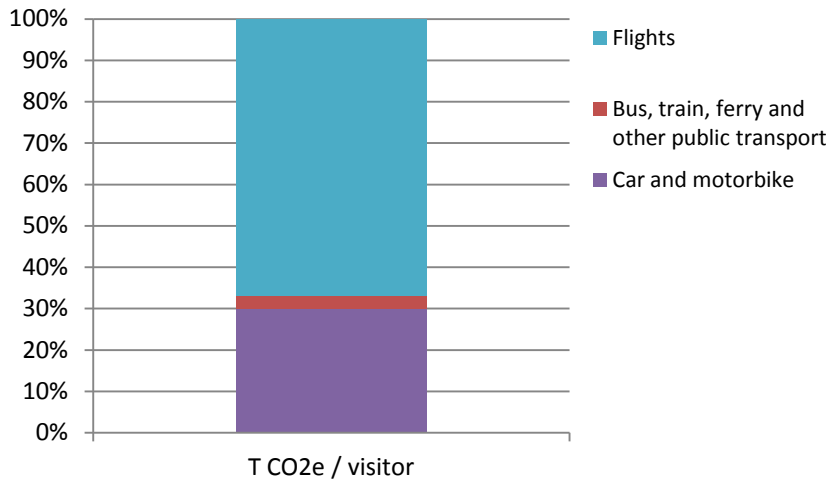

Figure 11: Breakdown of emissions from visitor travel to and from SDNP

3.3.2 Food and drink from retail (6.7% of the total footprint)

Visitor consumption of food and drink from retail results in approximately 280 thousand tonnes CO_2e *per annum* (6.7% of the total footprint of visitors).

3.3.3 Eating, drinking and staying away from home (3.2% of total)

In addition to the above a further 118 thousand tonnes CO_2e *per annum* result from visitors eating, drinking and staying away from home (3.2% of the total footprint of visitors).

Figure 12 provides a comparison of the emissions resulting from food and drink from retail and from visitors eating, drinking and staying away from home.

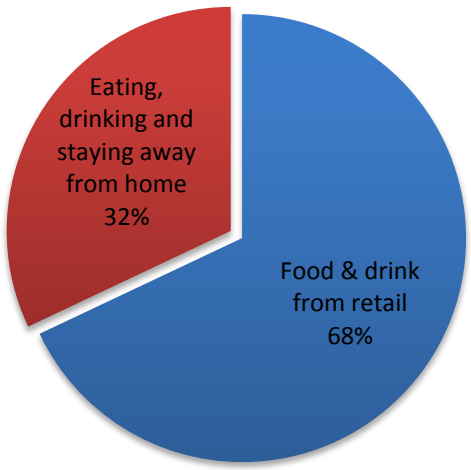

Figure 12: Breakdown of emissions from visitor accommodation, food and drink[15]

15 This figure is derived from spend data gathered in the TSE (2013) survey.

3.3.4 Recreational services (0.8% of total footprint)

Perhaps surprisingly visitor expenditure on recreation and leisure services results in only 30 thousand tonnes CO_2e *per annum,* only 0.8% of the total footprint of visitors. This reflects the relatively low expenditure on such services by visitors to the Park.

Other (~15% of total footprint)

Purchases of other non-food shopping amount to 5.1% of the total footprint. Household fuel and electricity; water, waste and sewerage; and dwellings construction are only small proportions of the footprint as these are largely covered in the footprint of the tourism industry.

Public services include both local service provision and a proportional allocation of national service provision. Management of procurement and resource efficiency in the SDNPA and other local services is likely to provide valuable but difficult to quantify savings in this area.

4 The GHG footprint of industry and the public sector

4.1 Overview

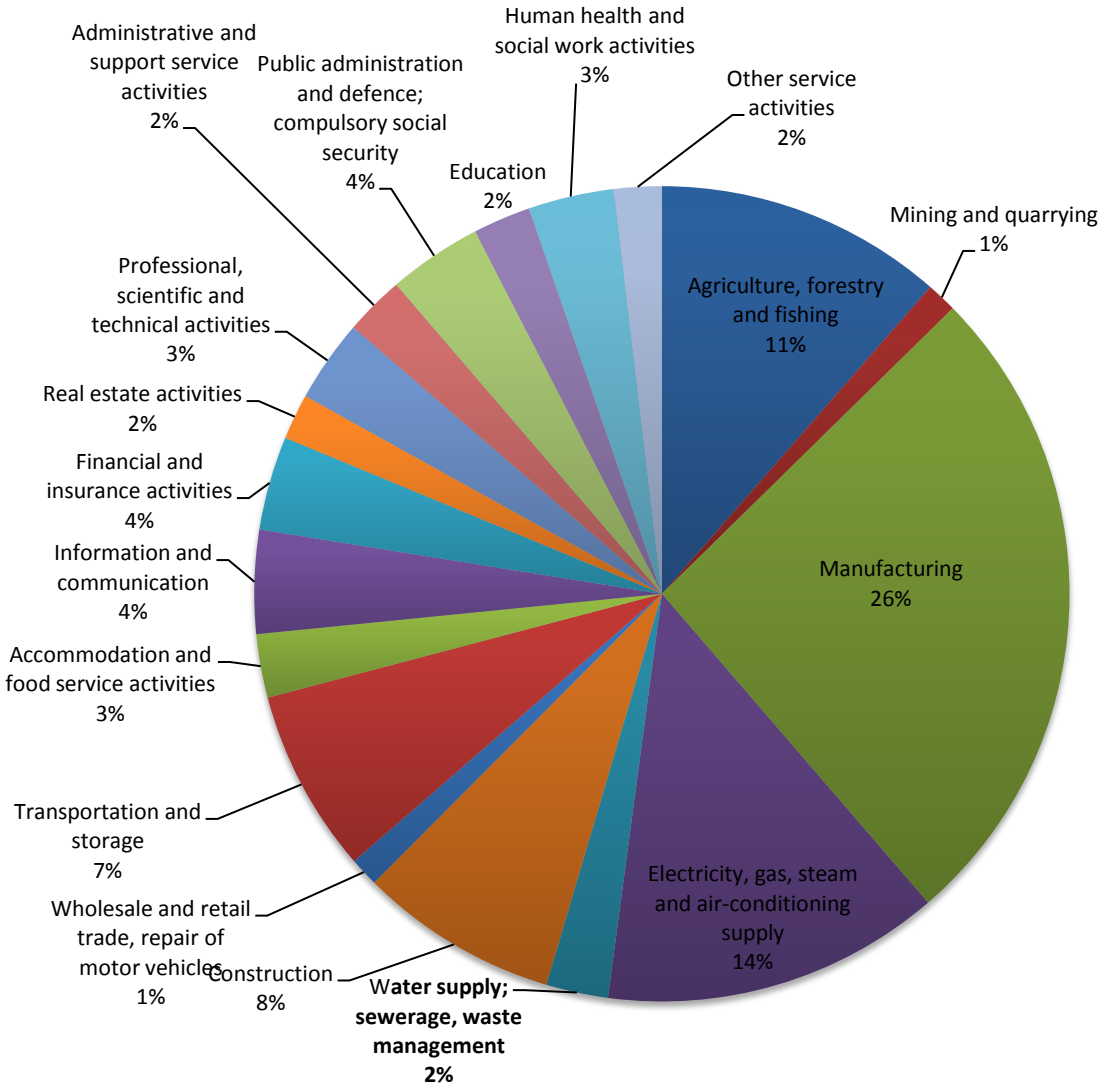

Figure 13: Breakdown of the GHG footprint of SDNP's industry by sector; 2.68 million tonnes CO_2e

Our estimate for the GHG footprints of industries operating within the SDNP is 2.68 million tonnes CO_2e *per annum*. This is derived by calculating the ratio of UK employment numbers against UK GVA and then applying this factor to SDNP employment numbers to give a best estimate for the Park.[16]

This figure includes direct emissions, emissions from electricity consumption and indirect emissions in the supply chains. It is important to note that these supply chains overlap somewhat, so the total figure includes some double counting, for example where the direct emissions for one industry are also in the supply chains of another. However, the total figure gives an indication of the scope for GHG management since where double counting exists; there are also multiple corresponding opportunities to manage emissions.

16 SDNP Local Economy Report (HCC, 2011)

The SDNP has been reported to have higher than regional agricultural and educational industries[16]. However, this does not appear to be reflected in the reported footprint which used the best available data (employment numbers) as a basis for the calculations. It is likely that more detailed data on SDNP industries may help reflect this better.

4.2 Detailed composition of the GHG footprint of SDNP industries

4.2.1 Manufacturing (26% of the total)

Manufacturing is a broad category covering different types of products with different GHG characteristics. For some goods (such as cement) the majority of emissions are released directly in the production process, whilst for others (such as processed foods) the overwhelming majority of emissions lie in the supply chains of purchased materials or ingredients.

4.2.2 Electricity, gas, steam and air conditioning supply (13% of the total)

Energy consumption makes up the majority of emissions in these industries.

4.2.3 Agriculture, forestry and fishing (11% of the total)

Within agriculture, forestry and fishing the majority of emissions occur on farms. In the case of sheep and cattle farming methane is the primary global warming gas, with emissions from rumination, as well as from manure and slurry. Nitrous oxide is also an important contributor, with emissions resulting mainly from the application of nitrogen fertiliser. Within horticulture, the primary source of emissions is as a result of hot-housing unseasonal produce outside the region. Supply chains are also significant for the agricultural sector, especially in the production of feed and fertiliser.

4.2.4 Construction (7.9% of the total)

The vast majority of the footprint of this industry lies in the supply chains of its materials. However, even more important than this, and not included in this study, are in-use emissions from buildings after construction and the contribution of this industry to sustainable infrastructure in SDNP. Well targeted energy efficiency retrofits are highly beneficial for GHG mitigation.

4.2.5 Transport and storage (7.3% of the total)

In transport based industries, energy use dominates the footprint. In the case of public transport, whilst energy efficiency is important, even more important is the improvement of alternatives to the car.

4.2.6 Public administration, education and health (3.7% of the total footprint, combined)

Within public administration, education and health, the majority of emissions take place in the supply chains. The implication for GHG management is that priority should be placed on low carbon procurement and resource efficiency. In a time of austerity, it is also worth noting that these measures also stand to yield significant cost savings.

Schools, colleges and universities have an important role to play in developing literacy in consumption-based GHG calculation. Actions taken in this sector are even more important for their educational value as their direct impact, GHG management should emphasise the importance of

indirect emissions. There is a strong case for visible initiative to tackle such things as food waste, diet and unnecessary use of resources.

4.2.7 Accommodation and food services (2.5% of the total)

Within hotels, pubs, restaurants and catering services food and drink accounts for around half of the footprint, energy use is typically less than 20%. GHG management in these businesses should reflect this, especially since the opportunities for cost savings through waste reduction are often far greater than those that are possible through energy savings.

4.2.8 Other (<28% of the total footprint)

The remainder of the footprint emanates from a complex mixture of industries, predominately service activities. With the exception of water supply, sewerage and waste management (2.5%) the majority of the footprint for these industries is embodied in their supply chains. Therefore businesses seeking to manage their emissions should be encouraged to focus on their procurement and resource efficiency, moving on from a purely energy efficiency focus.

Figure 14 shows the breakdown of the industries in SDNP by scope 1, 2 and 3 emissions. It is clear that the largest proportion of emissions emanate from the scope 3 supply chain emissions of the industries[17].

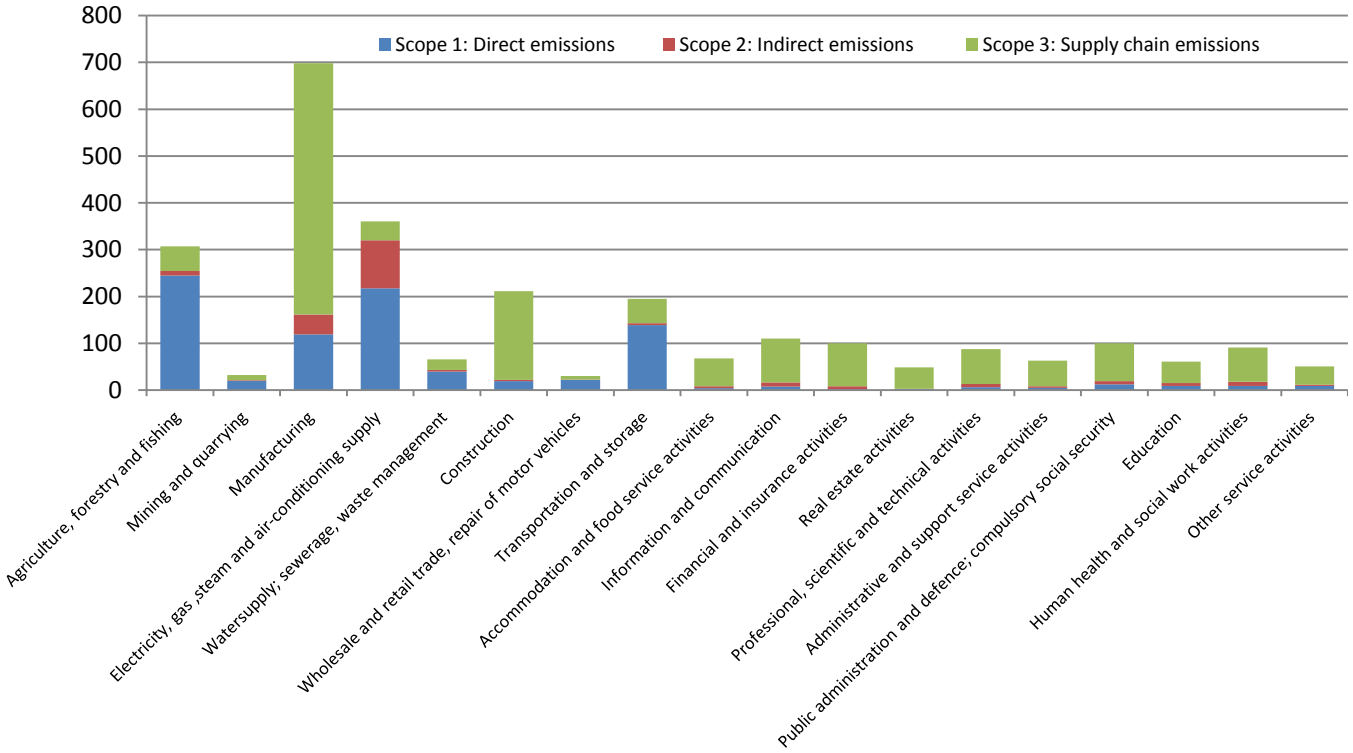

Figure 14: GHG footprint of SDNP's industry showing the relative contribution of scopes 1, 2 and 3 (thousand tonnes CO_2e).

17 Scope 1, 2 and 3 emissions are discussed in more detail in *6.3 Greenhouse Gas Protocol guidelines*.

5 Recommendations

This section addresses how the SDNPA should use the evidence presented above, and also the Review of National Park Climate Change Mitigation Policies and Strategies (published as a separate report), to develop a comprehensive response to climate change.

We also make recommendations for further analysis in the future.

5.1 Summary

In summary the following process is recommended:

- **Review internal capacity:** The SDNPA needs to consider how this work will be taken forward, and ensure that responsibilities are clear – with a named officer to manage the process; a senior staff member to lead; and ideally an Authority member acting as Champion.
- **Develop partnership working arrangements:** Many potential actions cannot be carried out by the SDNPA in isolation; they require input from partner organisations who have a stake in the National Park.
- **Develop a goal and outline strategy:** Share the evidence with partners, to determine an overall goal and set a clear direction for the work.
- **Assess major emission areas against a set of criteria:** Again, working in partnership, draw up a set of criteria against which to consider actions – this might include, for example, economic benefit; goals of partner organisations; social inclusion; promotion of tourism; availability of funding; etc.
- **Develop a more detailed action plan:** Using these criteria, an action plan can be developed.
- **Review and monitor:** In particular, the benefits (economic, social and environmental) of actions should be recorded, to develop an evidence base for future action.
- **Publicise and engage:** As the strategy develops, publicity by SDNPA and partners can help to bring in more stakeholders, which in turn will help to achieve aims. Publicising positive local initiatives may also help in persuading national government to provide better support for local climate change initiatives.

Throughout this process, it is important to look at the interaction between climate change goals (emissions reduction; adaptation and resilience) and other goals of the SDNPA and partner organisations. The action plan will only be successful if it helps to deliver a wider set of goals, not if it is seen as an additional burden or distraction.

This process is set out in detail below.

Future analysis. We recommend that the Park embarks upon land based carbon study, since the recent scoping study found that this would be a feasible and useful exercise within a reasonable budget[18] and since land based emissions and sequestration opportunities may be highly significant. Improvements in commuting and visitor data would also be valuable to feed into future studies.

[18] 'Land -based carbon accounting in the South Downs National Park: scoping study', Small World Consulting 2013

5.2 Review internal capacity

The *Review of National Park Climate Change Mitigation Policies and Strategies* (separate document) shows that success depends on having a clear internal structure and responsibility for climate change strategy. Although declining organisational budgets pose a challenge, the Review showed that those Authorities who have specialist staff (Exmoor, Lake District, Peak District) have succeeded in attracting significant external funding for their activities, mainly from other government sources, thereby repaying their investment. This is particularly the case when GHG reduction goals align with economic goals, given the funding available for low-GHG economic development. So an investment in specialist staff could result in considerable additional income for the SDNPA and partners. This is discussed in more detail below.

In addition to specialist staff, a senior staff member needs to oversee the work, and link it into organisational strategy. Having an Authority member as a climate change 'champion' will help to bring the work to the attention of Authority members. We would recommend briefing Authority members on the evidence presented in both reports, and involving them in the process of developing an action plan with partners.

5.3 Develop partnership working arrangements

With the exception of planning policy, a National Park Authority has few statutory levers that can influence climate change strategy. For this reason, it is important to work with partner organisations who have a stake in the National Park.

These will include:

- local Authorities and public agencies (Environment Agency, Natural England, Forestry Commission etc.) who have responsibility for GHG reduction and climate change adaptation;
- local businesses who could benefit from GHG reduction and climate adaptation projects. We recommend working directly with larger businesses, who may well have ambitions to reduce GHG already. Smaller businesses can be reached through groupings such as the Chamber of Commerce. There will be local businesses who already champion climate change issues – for example, Harvey's Brewery in Lewes works with local sustainable energy organisation OVESCo on community-owned renewable energy projects. These businesses can act as champions of an overall National Park strategy;
- groups with an interest in environment, sustainability and carbon reduction, such as local Friends of the Earth groups, community energy groups like OVESCo (see above), National Trust, etc.;
- third sector organisations representing local communities and social interests; and
- local Universities can often provide specialist support or advice.

West Sussex County Council has led on a strategic partnership commitment to reduce the carbon footprint of West Sussex overall by 50% before 2025. This is under the auspices of the West Sussex Environment and Climate Change Board of which the SDNPA is a member. Given that 41% West Sussex is in the SDNP (that comprises nearly half the total area of the Park) and that both authorities are committed to a programme of carbon reduction, the benefits offered by partnership working between WSCC and SDNPA on initiatives to achieve carbon reduction targets are significant and likely to be more effective than pursuing separate programmes.

5.4 Develop a goal outline strategy

The evidence in these reports should be shared with the partners identified above, as the basis for discussions about how to determine an overall goal and strategy. We would suggest a day or half-day workshop, to present the evidence; discuss how this links with the goals and aspirations of partner organisations; and work together on setting an overall goal and direction for the work. At this point, it will be important to stress the point that the aim is to concentrate on actions that will further the ambitions of partner organisations (see below re criteria).

There should be a clear overall goal for GHG reduction, linked to the UK's national GHG budget trajectory (see Section 2.1), consistent with the long-term goal of 80% reduction by 2050 and interim targets. This could be presented in the form of a 'local GHG budget', as adopted by the Lake District National Park, which translates the national budget into measurable, achievable targets for a local area.

5.5 Assess major emission areas against a set of criteria

This report sets out the GHG impact of the activities of residents, visitors and businesses in the SDNP. For example, the biggest GHG impact for residents is household energy use; for visitors, it is travel to and from the area. In drawing up a plan for GHG reduction, it obviously makes sense to concentrate on the most significant areas of emissions. However, this needs to be considered alongside other goals and ambitions of the SDNPA and other partner organisations. In short, action to reduce GHG should have additional benefits.

In prioritising GHG reduction activities, it is helpful to agree with partners a set of criteria, which incorporate these wider goals and ambitions. This was the approach taken by AGMA (Association of Greater Manchester Authorities). Criteria will depend on the goals of partner organisations but are likely to include:

- economic benefit, e.g. to local businesses;
- contribution to social goals such as reducing deprivation or increasing community resilience;
- contribution to other environmental goals, such as landscape or biodiversity;
- the availability of funding;
- match to partner goals and ambitions; and
- ability to act: some actions may not be practical at a local level, and can only be done through national or EU action (for example, changes to packaging standards for products).

Potential projects to reduce emissions should be assessed qualitatively against these criteria. Worthwhile projects will score well against a range of criteria. For example:

- A project to improve household energy efficiency will help to achieve social goals by reducing fuel poverty; funding is available through ECO (Energy Companies Obligation) and other sources; helps local authorities meet existing targets to protect vulnerable households; and tackles the largest area of emissions from SDNP residents.
- Developing a sustainable transport network helps to reduce emissions from resident and visitor travel, as well as improving the tourist offer of the South Downs. Funding has been available through Department for Transport (DfT) schemes like the Local Sustainable Transport Fund and further funding of this sort may be available in the future.

- Providing advice to small businesses to reduce their energy and resource use improves profitability. Experience of previous schemes such as ENWORKS in the North West shows that there are a range of no-cost or low-cost actions that reduce GHG and improve business performance. A small investment in advice and support reaps economic and environmental dividends.
- Actions to manage land for GHGs, through woodland creation or management, for example, have landscape and biodiversity benefits and link to goals of organisations like the Forestry Commission and National Trust.

Using these criteria, a set of potential actions can be developed for each major area of emissions listed in sections 2 and 3 above. There may be overlap between different categories – for example, a transport project may work for the resident and visitor populations.

5.6 Develop a more detailed action plan

The process above might result in a table of possible actions similar to the one below – we have filled in some example areas:

Table 2: Exemplar table of possible actions for SDNPA

Area / issue	Possible action	Economic benefit	GHG benefit	Other benefits e.g. social / environmental	Partners / organisations interested (& lead organisation)	Examples of similar projects elsewhere	Funding possibilities
Eating, drinking and staying away from home	Low-GHG advice service for tourism businesses	Increases business efficiency	Significant	Better business offer	Tourism businesses Lead = Chamber of Commerce	Cornwall – COAST project	Local Enterprise Partnership
Non-food shopping	Support for reuse and recycling industry	Money spent in local economy not on buying imported new goods	Significant	Social benefits if target low income households (e.g. white goods recycling)			Possibilities of funding for social enterprise / social investment

These projects can then be taken forward by the lead organisations identified, with support from the SDNPA, acting as co-ordinator.

There will be existing projects and work-streams which already contribute to GHG reduction – these should be identified and included explicitly in the overall plan.

Given resource constraints, many new projects will require external funding to proceed. This will result in significant time lags, so the overall aims and targets should reflect this.

5.7 Review and monitor

Experience elsewhere shows that plans will need refinement as they develop, and there is a need to retain flexibility. This can be achieved through involving partners in reviewing and monitoring progress. For GHG emissions, it will be necessary to analyse and assess progress – in the Lake District this is done yearly, using a methodology developed by Small World Consulting.

One of the benefits of careful monitoring of economic, social and environmental impacts is that it provides further evidence for future action, particularly for actions that require external funding.

As the strategy develops, publicity by SDNPA and partners can help to bring in more stakeholders, which in turn will help to achieve aims. Publicising positive local initiatives may also help in persuading national government to provide better support for local climate change initiatives.

5.8 Publicise and engage

The initiative can be publicised through local press, online and social media, and via partner organisations. Building up a transparent picture of successes and failures can help to engage wider stakeholders. The LGA's Climate Local initiative provides a useful portal to exchange experience and ideas. Work can also be discussed with national Government – Defra, as lead department for National Parks; CLG and DECC who have responsibility for local action on climate change – in order to encourage better policy and support for local action of this sort.

5.9 Further data and analysis

We recommend that the Park embarks upon land based carbon study, since the recent scoping study found that this would be a feasible and useful exercise within a reasonable budget[19] and since land based emissions and sequestration opportunities may be highly significant. This scoping study contains a costed outline plan.

In terms of the most critical areas of data improvements for further studies, these are:

- commuting into and from the park by distance and mode
- visitor travel to and from the park by origin and mode
- visitor behaviour within the park including travel by origin and mode.

[19] 'Land -based carbon accounting in the South Downs National Park: scoping study', Small World Consulting 2013

6 Appendix A: Methodology

6.1 The 'footprint' of consumption

In this report we use the term 'footprint' to mean the sum of the direct and indirect emissions that arise throughout supply chains of activities and products. As an example, the footprint of vehicle travel includes not only the direct vehicle emissions as covered by emissions factors issued by Defra[20], but also components for the extraction, shipping, refining and distribution of fuel, and components for the manufacture and maintenance of vehicles, and so on. Thus, in the case of car travel the final figure is typically around double that of the exhaust pipe emissions. To provide a further example, the footprint of electricity consumption includes components for the emissions associated with fossil fuel extraction, shipping, refining and transport to power stations, as well as those resulting from the electricity generation process itself. It is worth noting that the supply chain components are not included in standard conversion factors issued in Defra's *'Guidelines for Company Reporting on GHG Emissions'* (2011) and are accounted for using Environmental Input–Output (EIO) methods (See Section 6.5.1 Environmental Input–Output analysis (EIO) for details).

This inclusive treatment of supply chain emissions differs from more standard production-based assessments but gives a more complete and realistic view of impacts, despite the complexities and uncertainties involved. Footprints of this kind are essential metrics for responsible management.

6.2 Boundaries

6.2.1 Residents' footprint

The following is within the scope:

- fuel and electricity consumed in homes;
- personal travel both within and outside the Park, including commuting;
- food and drink from both retail and from restaurants and other forms of catering;
- other, non-food, purchases;
- services (e.g. estate agency, financial and insurance services);
- water supply, sewage and waste;
- healthcare, education and other public services delivered both local and national level;
- construction, maintenance and improvement of dwellings; and
- the supply chains of all the above (e.g. fuel supply chains and embodied emissions).

The following is specifically excluded:

- business emissions including business travel (except in so far as the business output is consumed by residents).

6.2.2 Visitors' footprint

The boundaries for the visitor footprint are the same as for residents and include both travel to and from SDNP and estimate travel within the Park.

20 Defra, 2011.

6.2.3 Industry footprints

The following is within the scope:

- direct emissions;
- electricity;
- travel and transport;
- emissions from purchased goods and services;
- fixed capital formation; and
- the supply chains of all the above (e.g. fuel supply chains and embodied emissions).

The following is specifically excluded from the scope:

- commuting;
- emissions from staff activity outside the workplace.

6.3 Greenhouse Gas Protocol guidelines

The assessment follows the reporting principles of the GGP published by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI)[21].

We therefore cover all the gases specified in the GGP expressed in terms of carbon dioxide equivalent (CO_2e), the sum of the weights of each gas emitted multiplied by their global warming potential (GWP) relative to carbon dioxide over a 100 year period.

The GGP provides three choices for emissions reporting. Scope 1 covers direct emissions from company-owned vehicles and facilities. Scope 2 includes net emissions from energy imports and exports, such as electricity. Scope 3 includes other indirect emissions resulting from company activities, as detailed by the boundaries of the study. This report includes all Scope 1 and 2 emissions and comprehensive treatment of Scope 3 supply chain emissions within the boundaries laid out above.

6.4 Treatment of high-altitude emissions

High-altitude emissions from aircraft are known to have a higher global warming impact than would be caused by burning the equivalent fuel at ground level. Although the science is still poorly understood, we have applied an emissions weighting factor of 1.9 to aircraft emissions, to accommodate this. This is the figure suggested in Defra's *Guidelines for company reporting on greenhouse gas Emissions*[22]. The figure can also be inferred from the Intergovernmental Panel on Climate Change's *Fourth Assessment Review*[23].

6.5 Reporting approach

The start point for this work is a model of GHG emissions *per capita* from UK consumption. For this we used an Environmental Input–Output model (EIO) based on 2010 ONS '*combined supply and use tables'* and *'UK environmental accounts'*. The specific model used was developed by Small World

21 Ranganathan *et al.*, 2006.
22 Defra, 2011; more recently DECC has published supply chain emissions factors for energy use. We have not used these since they include only certain parts of the supply chains.
23 IPCC, 2007.

Consulting with Lancaster University (see below). The categorisation of emissions into 124 consumption categories was simplified into a 15 category model.

The methodology draws upon and combines two basic approaches:

- Use of 'bottom up' data, where available, to estimate consumption, combined with emissions factors to estimate the associated emissions.
- Use of 'top down' macro-economic modelling; Environmental Input–Output analysis (EIO).

A first approximation of the emissions from each consumption category was obtained by multiplying the population of SDNP by a general figure for the average UK resident derived from 'top down' EIO (see section 6.5.1). We then improved upon our first estimate through a series of adjustments wherever available data provided a reasonable basis for doing so based on local data (normalised *per capita* to the national average) and plausible assumptions. These data sets and assumptions are detailed in section 6.6.

6.5.1 Environmental Input–Output analysis (EIO)

EIO combines economic information about the trade between industrial sectors with environmental information about the emissions arising directly from those sectors to produce estimates of the emissions per unit of output from each sector. The central technique is well established and documented[24]. In the UK, the main data sources are the *'Combined Supply and Use Matrix for 123 sectors'* and the *'UK environmental accounts'*[25], both provided by the Office of National Statistics (ONS).

The specific model used for this project was developed by Small World Consulting with Lancaster University and is described in detail below and elsewhere[26]. This model takes account of such factors as the impact of high altitude emissions that are not factored into the environmental accounts and the effect of imports. In order to use more up to date (2008 rather than 1995) data, we have employed a simple algorithm for converting between basic and purchasers prices. We have used consumer industry specific consumer price indices to adjust for price changes since the date to which the supply and use tables relate.

Three main advantages of EIO over more traditional process-based life-cycle analysis (LCA) approaches to GHG footprinting are worth noting:

- EIO attributes all the emissions in the economy to final consumption. Although, as with process-based LCA, there may be inaccuracies in the ways in which it does this, it does not suffer from the systematic underestimation (truncation error) that process-based LCAs incur through their inability to trace every pathway in the supply chains[27].
- EIO has at its root a transparently impartial process for the calculation of emissions factors per unit of expenditure, whereas process-based LCA approaches entail subjective judgements over the setting of boundaries and the selection of secondary conversion factors.

24 For example Leontief, 1986; Miller and Blair, 2009.
25 ONS, 2010a; ONS, 2010b.
26 Berners-Lee *et al.*, 2011.
27 Lenzen, 2001; Nässén *et al.,* 2007.

- Through EIO, it is possible to make estimates of the footprints resulting from complex activities such as the purchase of intangible services that LCAs struggle to take into account.

One of the limitations of EIO in its most basic form is that it assumes that the demands placed upon (and therefore the direct emissions from) other sectors by a unit of output within one sector are homogeneous. As an example, a basic EIO model does not take account of the GHG efficiencies that may arise from switching the expenditure on paper from a virgin source to a renewable source without reducing the actual spend. In this report, the GHG intensity per unit turnover of, for example, the hotels, pubs and catering establishments within the SDNP are assumed to be 'UK typical'. It is possible, with additional resource, to make bespoke adjustments to these generalities given relevant local data and a defendable basis for relating that data to emissions. A further assumption in the model used here is that goods from overseas are produced with the same GHG efficiency as they would have been in the UK. Overall, this assumption usually results in an underestimation of the footprint of purchased goods. A further omission for this and all EIO models that we are aware of is that the impact of land-use change around the world has not been taken into account. This would be likely to result in an increased assessment of the footprint of foods, especially animal products[28].

6.5.2 EIO methodology detail

The specific methodology and sources underpinning our model are outlined below in steps, along with some brief discussion.

Throughout the following matrices and vectors are written in capitalized bold font, while the individual elements of a matrix are denoted by the small cap of the name of the matrix and are not bolded. The operations in equations involving matrix or vector elements are standard mathematical operations while those in equations involving matrices are the corresponding matrix operations.

Step 1: A technical coefficients matrix of inputs from each sector per unit output of each sector (**A**) has been derived from an update to the UK Input–Output Analyses 2010 edition, Table 3 'Demand for products in 2008 Combined Use Matrix', based on 2008 data and obtained from the ONS[29]. (The ONS publishes on only 93 sectors for 2007, but released to us a 123 sector breakdown of 'unbalanced' figures. We used these judging that the benefit of disaggregation outweighs the risks from not going through the balancing process. Encouragingly, the disaggregated data set was in line with estimates based on extrapolation from the 2008 data set.) This matrix deals with the UK economy broken down into 123 industry groups. The process assumes that the output stimulated in each sector per unit demand at purchaser's prices is homogeneous and independent of the purchaser.

The matrix is usually derived from use tables of inputs at basic prices, which are output prices before distributers' margins, taxes or subsidies have been applied. However, for the UK these have not been published since 1995. By using purchasers' prices rather than basic prices to determine the technical input coefficients more recent data from 2008 data can be used rather than 1995 data. The trade-off is that it entails the assumption that demand at purchasers prices (including taxes,

28 Audsley *et al.,* 2009; This report estimates that emissions from red meat production outside Europe rises by a factor around five when land-use change is taken into account.
29 ONS, 2010a.

subsidies and distributors margins) is as good a guide to industry activity as demand at basic prices. Both of these values are surrogates for the stimulation of emissions-causing activity.

Step 2: Gross fixed capital formation is reallocated from final demand to intermediate demand, since the ongoing formation of capital is required to support the supply of goods and services, and is therefore instrumental in enabling the production of goods and services.

Step 3: The Leontief inverse (**L**) of the technical coefficients matrix consists of a matrix of sectoral output coefficients as stimulated per unit final demand, all at basic prices.

$$\mathbf{L} = (\mathbf{I}\text{-}\mathbf{A})^{-1} \qquad \text{Equation 1}$$

Where **I** is the identity matrix.

Step 4: The UK Environmental Accounts[30] give the GHG emissions in 2008 arising directly from 93 SIC (Standard Industrial Code) sectors. These are mapped onto the 123 ONS IO Table industry groups by a process of splitting out SIC code emissions into IO industry groups in proportion to total output at basic prices and where necessary combining SIC codes into single Input–Output industry groups.

Step 5: Emissions from aviation at altitude are known to have a higher impact than the same emission at ground level. An emissions weighting factor of 1.9 was applied to the CO_2 emissions associated with the air transport sector to reflect additional radiative forcing per unit of GHG emitted. This simple mark-up factor is the figure proposed by Defra[31], based on the IPCC's discussion of aviation in its Fourth Assessment Report[32]. The application of this multiplier provides a first approximation to the impact of a complex and as yet poorly understood set of scientific phenomena surrounding aviation emissions.

Step 6: UK output by sector at basic prices[33] was combined with UK GHG emissions arising directly from each sector to derive a vector of coefficients of emissions per unit (£) of UK output from each sector at basic prices ($\mathbf{G}_{\mathbf{UK}}$). This is the vector of GHG intensity of each sector per unit financial output.

For each industry,

$$g_{UK_i} = e_{D_i} / o_{BP_i} \quad \text{i = 1 to 123 (industrial sectors)} \qquad \text{Equation 2}$$

where $\mathbf{O_{BP}}$ is the vector of UK sector-specific output at basic prices and $\mathbf{E_D}$ is the vector of sector specific direct emissions.

Step 7: The matrix (**E**) of GHG emissions arising from each industry (i) per unit of final demand for each industry (j) at 2008 basic prices is calculated as:

$$e_{ij} = l_{ij} \cdot g_i \quad \text{i= 1 to 123 (industries), j= 1 to 123 (industries)} \qquad \text{Equation 3}$$

30 ONS, 2010b.
31 Defra, 2010a.
32 IPCC, 2007.
33 ONS, 2010a.

Emissions intensity matrices based on different levels of import from within and beyond the EU can be constructed. In particular, we can substitute for g_i in the above equation to explore emissions intensities that might result where supply chains are typical of UK supply ($\mathbf{G_{UK\ Mix}}$), are based solely in the UK ($\mathbf{G_{UK}}$), solely in the EU ($\mathbf{G_{EU}}$), or solely outside the EU ($\mathbf{G_{Non\ EU}}$).

Step 8: Total emissions from each industry (i) arising from UK final demand for each industry (j) is given by

$$e_{Total_{ij}} = e_{ij}.f_{BP_j} \qquad \text{Equation 4}$$

Where $\mathbf{E_{Total}}$ is the matrix of total emissions from each sector arising from final demand for each sector, and $\mathbf{F_{BP}}$ is the vector of final demand at 2008 UK basic prices.

Note that $\mathbf{F_{BP}}$ includes exports. To understand the impact of UK final demand, emissions from exports can be subtracted from each sector on a proportional basis.

Step 9: To obtain $\mathbf{F_{BP}}$, the final demand at purchasers' prices is adjusted by subtracting distributors' margins taxes and subsidies, based on the assumption that these are split between domestic outputs at basic prices and imported products in the ratio of their respective monetary values

For industry i,

$$f_{BP_i} = f_{PP_i} - (d_i + t_i - s_i).(o_{BP_i}/(o_{BP_i} + b_i)) \qquad \text{Equation 5}$$

Where:

$\mathbf{F_{BP}}$ = Final demand at Basic Prices,

$\mathbf{F_{PP}}$ = Final Demand at Purchasers prices and

D,T,S, O_{BP} and **B** are the vectors of distributors' margins, taxes, subsidies, total output at basic prices and imports respectively.

A key assumption here is that distributor's margins, tax and subsidies are applied to domestic production and imports at the same rates, and can therefore be apportioned according to monetary value.

The data are obtained from Tables 2 and 3 in the UK Input–Output Analysis Tables[34].

Step 10: This step converts emissions factors from basic prices to purchasers' prices**.** The majority of this conversion is done simply by dividing by the ratio of final demands at purchasers and basic prices. However, there remains the question of allocating emissions arising from distribution services to the sectors whose products use those sectors.

In the UK IO tables, three distributor sectors require special treatment, since the products they deal with are not counted as inputs and only the marginal increase in their value is counted as outputs for

34 ONS, 2010a.

those sectors. These sectors are 'Motor vehicle distributors', 'Wholesalers' and 'Retail'. The emissions associated with these three sectors have been aggregated and redistributed between the industries they serve in proportion to the distributor's margins that are associated with their products.

The core assumption here is that emissions arising from distribution services are in proportion to the margins they generate for the products of each other industry.

6.6 Adjustments based on bespoke national and local data

The result based on EIO and UK averages was then adjusted to take account of key differences in consumption patterns for both visitors and residents from the UK average, wherever available data provided a reasonable basis for doing so. Estimates were also added for visitor travel to and from SDNP. Specifically, the following adjustments were made.

6.6.1 Estimating resident's consumption

The data were collected for each of the 12 districts that make up the SDNP area. Based on the proportion of SNPA residents living within the Park boundaries in each district an average on this basis was made to estimate resident consumption.

Household energy

Consumption of household fuel and electricity in each constituent district was taken from DECC's sub-regional energy data sets[35].

Food & drink from retail

Defra's 'family food survey'[36] profiles consumption of food types against income deciles and we mapped this against the GHG footprint of food types based on Small World Consulting's model of the GHG in food categories at Booths Supermarkets[37] and adjusted by the proportion of residents within each UK income decile[38].

Note: Transport miles in this category are included up to the point of sale, consumer vehicle miles incurred to purchase food fall under the footprint of 'driving', or 'public transport'.

Household goods and services

Household income deciles[39] for each district were used to model the proportion of residents within each UK income decile. Expenditure on household goods and services by each UK income decile as a proportion of the UK average was derived from UK household expenditure survey[40].

Note: The consumption of public services such as healthcare, education and public and administration refer to the emissions resulting from the provision of services themselves not for example, vehicle miles involved in the school run. These instead fall under 'driving'.

35 DECC, 2009a,b&c
36 Defra, 2010b
37 Booths, 2010
38 ONS, 2010d
39 ONS, 2010d
40 ONS, 2010d

Personal air travel

Rather than beginning from a top down, Input–Output based UK average and adjusting, we adopted a bottom up approach based on Civil Aviation Authority Passenger Survey data[41] on flights by SDNP residents from all major UK airports.

Driving

As with household goods and services, family expenditure on personal motor vehicles and motor vehicle fuel by each UK income decile as a proportion of the UK average was derived from UK household expenditure survey[42]. In this way expenditure *per capita* as a ratio of the UK average was derived for each District and then calculated for the National Park.

Public Transport

Household income deciles[43] for each district were used to model the proportion of residents within each UK income decile. Expenditure on public transport by each UK income decile as a proportion of the UK average was derived from UK household expenditure survey[44].

6.7 Estimating visitors' consumption

6.7.1 Overseas visitor travel to and from the Park

The Tourism South East (TSE; 2013) report gives an estimate of the average length of stay in the UK of overseas visitors. Data from the International Passenger survey (IPS) provides the number of visitors by origin (country) of visitor travelling by air, land and sea. This data is an average for visitors to the south east of Great Britain and with no available data to suggest otherwise, this is the best available method of estimating overseas visitors. It also provides the average length of stay of the visitors; this can be compared with the figure given in the TSE (2013) which allows us to attribute only a proportion of a visitors' overall journey to their stay in the SDNP.

To do this, TSE (2013) estimates of time spent in the SDNP by overseas visitors were divided by IPS estimates of the length of overseas visitor trips in the UK to give the proportion of each journey to the UK that should be allocated to the SD visit. By using Webflyer distance calculator to determine the journey lengths the footprint of the overseas visitors' journeys were calculated for air, land and sea. The final overseas visitors' footprint was calculated based on the number of visitors coming by each mode, from each reported country as a proportion of the total.

The manner by which the IPS produces and collects its data sometimes results in data implying implausible travel scenarios, such as an Australian arriving to the UK by tunnel. As we suspect these to be inaccurate, we assume it is more likely that an Australian arriving by tunnel has done so as part of a longer journey, thus we treat their journey as similar to a European visitor arriving by tunnel.

6.7.2 Domestic visitor travel to and from the Park from within the UK

Data on visitor travel from within the UK (i.e. travel to and from SDNP) was obtained from survey data in the TSE (2013) report. This provides a percentage of total visitors by county of origin; this is

41 CAA, 2011.
42 ONS, 2010d.
43 ONS, 2010c.
44 ONS, 2010d.

then used to estimate journey length (using Google distance calculator) along with data on modes of travel which are combined to estimate the emissions from all other visitor travel. A breakdown of the modes of travel by county origin was not available, thus we assume that all visitors are similar by mode. This is a poor assumption but is the best available with the current data. Car occupancy is estimated at 2.5 persons per car, again further data could improve this assumption.

6.7.3 Travel within the Park

Sufficient data was not available to make a bespoke calculation regarding travel within the Park. However, with a number of assumptions, a best estimate has been made based on previous work with Cumbria visitor data. We assumed a similar travel pattern of approximately 8 miles of travel per day split by car (73%), bus (20%) and train (7%). In addition we have assumed that is applicable to staying visitors only, as day visitors will likely drive to their intended destination as part of their overall journey. This is the best estimate that can be made at this level without further, more detailed data on visitor travel habits.

6.7.4 Consumption of goods and services

Consumption of accommodation, food and drink, leisure and recreation activities and other purchased goods and services were estimated from expenditure, using data from the TSE (2013) report.

The visitor emissions from household fuel and electricity; water, waste and sewerage; and construction are reported only where visitors are staying with friends and family, otherwise they fall under the footprint of visitor eating, drinking and staying away from home as services provided as part of the accommodation and catering business.

Some types of goods and services were assumed not to be bought or directly consumed by visitors. Examples include education and electrical goods. These are therefore excluded from the visitor footprint.

6.8 Uncertainties

The complexity of supply chains and the difficulties in obtaining accurate data dictate that footprinting can only offer a best estimate rather than an exact measure, and the figures in this report should be viewed in that context. We have operated from the principle that it is more informative to make best estimates of even the most poorly understood components of the footprint, and to discuss the uncertainty openly, than to omit them from the analysis.

Overall, the results in this report should be viewed as offering a broad guide to the size and relative significance of different components

6.8.1 Uncertainties over data

The assumptions made to estimate the residents' footprint relies largely on national surveys of household expenditure[45]. Sample sizes for both these are high and statistical techniques have been used to represent populations. However, the surveys rely on self-reporting.

45 Defra, 2010b; ONSc, 2010.

Sub-regional energy consumption estimates from DECC[46] are probably high enough quality not to contribute significantly to the overall uncertainty.

Available industry data was somewhat sparse and we had to fall back on Office of National Statistics' regional accounts, breaking down into just ten categories.

For the GHG footprint of visitors there is a far greater level of uncertainty, much of the data was drawn from visitor surveys, in which responses may have been systematically inaccurate, the sample group not fully representative and sample sizes were not always ideal.

6.8.2 Uncertainties over conversion factors

The areas in which the relationship between consumption and footprints is best understood are gas and electricity consumption. There is relatively good consensus over conversion factors to within around 5% in these areas. The next most certain group of conversion factors are those for travel and transport. In this category, there is uncertainty over the impact of high altitude emissions and the embodied emissions in the manufacture and maintenance of vehicles, roads and other infrastructure.

Supplies and services are the areas of greatest uncertainty. As an example, credible process based life cycle analyses of a particular specification of paper typically differ by factors of around 50% depending on the specific practices employed in the particular mill in which it was manufactured. It would also be possible for two detailed studies of exactly the same process to arrive at significantly different estimates, depending on the precise assumptions made. The EIO approach that we have adopted overcomes the truncation error that process-based approaches incur, but does suffer its own series of problems, most notably errors of generalisation – the failure to look at the particular circumstances of a supply chain rather than an industry average.

6.8.3 Other modelling uncertainties

The use of local data to make adjustments from UK averages has involved a series of judgements in consultation with academics and others. The modelling itself has required complex calculations. Despite careful checking of formulae and sense checking of results, the possibility of human error can never be wholly eliminated.

46 DECC, 2009a,b&c.

7 Appendix B: Sources

Source	Weblink
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