Agenda Item	**4**
Report No	**CCWG/15/20**

HIGHLAND COUNCIL

Committee: **Climate Change Working Group**

Date: **6th November 2020**

Report Title: **Greenhouse Gas Baseline Inventory Report for Highland**

Report By: **Executive Chief Officer – Infrastructure & Environment**

1. Purpose/Executive Summary

1.1 This report provides a summary of a report commissioned by The Highland Council to provide a greenhouse gas baseline inventory report for the Highland region, following the Council's declaration of a climate and ecological emergency in May 2019.

2. Recommendations

2.1 Members are asked to:

i. note the contents of this report.

ii. agree that a workshop should be held to discuss and agree priorities for action, which could potentially be supported and enabled by the Council, to reduce emissions across the region.

3. Implications

3.1 Resource – there are no direct resource implications arising from this report. However, the need for accelerated climate action to support regional emissions reduction programmes are likely to have resource implications over the coming months and years.

3.2 Legal – The Council has a legal requirement to report on its carbon emissions in accordance with the information requested by the Scottish Government. This includes complying with any deadlines or monitoring and verification standards that are imposed. In addition, the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 places a legal duty on the Council to contribute to the delivery of national emissions reduction targets of 75% by 2030 and to end Scotland's contribution to climate change by 2045, whilst acting in the way best calculated to help deliver any statutory climate change adaptation programme..

3.3 Community (Equality, Poverty and Rural) – there are no community implications arising from this report.

3.4 Climate Change/Carbon CLEVER – Accurately monitoring and reporting on carbon emissions and climate change will help to focus attention on action to reduce carbon emissions across the Council and the wider Highland region, and becomes increasingly important following on from the Council's declaration of a climate and ecological emergency in 2019.

3.5 Risk – There is a significant reputational risk to THC of not being seen to deliver on its commitment to achieving a carbon neutral Highlands by 2025. Climate change is now recognised as a Corporate Risk, and it is therefore important that its impacts are properly assessed. The Council should plan to mitigate against and adapt to the effects of climate change across all service functions.

3.6 Gaelic – There are no Gaelic implications arising from this report.

4. Background

4.1 At a meeting of The Highland Council on 9th May 2019, following a motion brought by the Leader of the Council, Cllr Margaret Davidson, Members agreed that the Council declare a climate and ecological emergency.

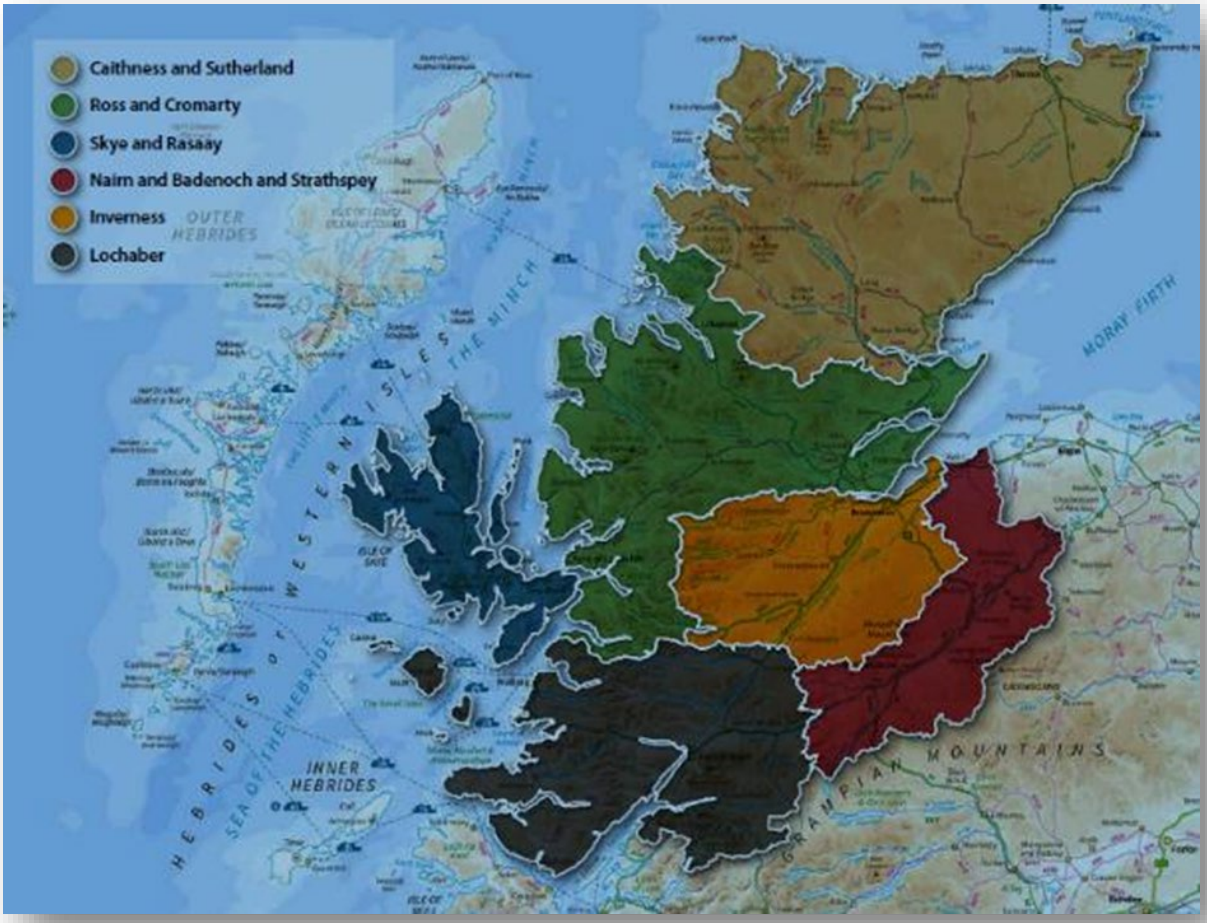
4.2 One of the key commitments made as part of this declaration was to revisit the Carbon CLEVER ambition to achieve a carbon neutral Inverness in a low carbon Highland by 2025, and work towards a carbon neutral region by 2025.

4.3 In order to develop policies and interventions which support this ambition, it is first necessary to understand what the current carbon footprint of the region is. To this end, at a meeting of The Highland Council on 9th December 2019, Members agreed to fund a greenhouse gas baseline inventory report through the Change Fund. In February 2020, this work was commissioned by the Council, and the draft report, attached at **Appendix 1**, sets out the calculated net carbon balance for the Highland region.

5. Scope & Methodology

5.1 The greenhouse gas inventory report for Highland provides baseline emissions data for the most recent full reporting year for which substantially up-to-date datasets were available (2018), and covers the area outlined in figure 1 below. Recently, the Council developed an operational disaggregation for the Highlands, dividing the area into smaller administrative zones, allocated to individual Executive Chief Officers (ECO). Where possible, the report has disaggregated analysis to these smaller ECO areas and has provided a separate summary GHG report for each of them:

Fig. 1 – Highland Council Executive Chief Officer Areas



5.2 The inventory report covers emissions generated directly and indirectly by the people living and working in THC area. This includes emissions from several different sectors, such as Stationary Energy use, Transport, Waste Treatment, Industrial Processes and Product Use, Agriculture and Forestry. The inventory covers the following six greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Emissions, unless stated in the Land Use and Land Use Change section, are reported as CO_2e, the collective term for GHG emissions.

5.3 To provide consistent greenhouse gas measurements for different areas, the descriptive term "Scopes" is used. The report distinguishes between emissions that physically occur within the inventory area (Scope 1), from those that occur outside the inventory area but are driven by activities taking place within the area's boundaries (Scope 3), and from those that occur from the use of electricity, steam, and/or heating/cooling (Scope 2). Scope 1 emissions may also be termed "territorial" emissions, because they are produced solely within the territory defined by the geographic boundary.

5.4 For the purposes of this report, data were obtained from a variety of sources. A key source of data was from the Department for Business, Energy & Industrial Strategy (BEIS) annual reporting of

Local Authority GHG emissions. Other data, for example on agriculture, forestry and other land use has been sourced from specific audits of, for example, animals and areas of cropping, woodland cover etc. Transport emissions information has been informed by a combination of nationally available emissions information as well as local vehicle/road use counts and direct data collection from transport providers, for example, ferry operators.

5.5 Emissions used in this report were classified into six main sectors, highlighted below. Emissions from these sectors were sub-divided into subsectors, and where beneficial, into sub-categories. Sectors define the topmost categorisation of Highland Council-wide GHG sources, distinct from one another, that together make up THC area's GHG emission sources activities. Sub-sectors are divisions that make up a sector – for example transport modes such as aviation or on-road. These in turn can be divided into sub-categories where appropriate to provide more detail:

- Stationary energy use
- Transportation
- Waste
- Industrial processes and product use (IPPU)
- Agriculture, forestry, and other land use (AFOLU)
- Any other emissions occurring outside the geographic boundary as a result of city activities (collectively referred to as Other Scope 3).

6. Emissions Baseline and Key Findings

6.1 The emissions estimates per category are combined below to provide totals with and without an adjustment for net carbon sequestration from forestry - carbon is absorbed from the atmosphere by growing trees, and is also sequestered into the soil through the accumulation of organic litter on the ground. Totals are given in tonnes of carbon dioxide equivalent (tCO_2e) for the emissions scoped highlighted at para 5.3:

Sector	Scope 1 tCO_2e	Scope 2 tCO_2e	Scope 3 tCO_2e	Total tCO_2e
Stationary Residential	198,546	63,291	5,367	267,205
Stationary Commercial*	699,094	260,643	22,104	981,841
Road Transport Petrol	142,532	0	0	142,532
Road Transport Diesel	414,736	0	0	414,736
Rail	10,095	0	0	10,095
Water transport	60,308			60,308
Industrial Processes and Product Use (IPPU)	189,141		9,930	199,071
Waste	20,331	0	7,294	27,625
Agriculture & Other Land Use	493,546	0	0	493,546
Other Land Use – Net of Improvements	55,357			55,357
Total, excluding Forestry Sequestration	**2,283,686**	**323,934**	**44,695**	**2,652,316**
Per Capita, excl Forestry Sequestration				11.3
Forestry Sequestration				-1,647,060
Total, incl Forestry Sequestration				**1,005,256**
Per Capita, incl Forestry Sequestration				4.3

6.2

The gross emissions for the Highland region in 2018 were calculated to total 2,652ktCO_2e. The area's population in 2018 was officially estimated at 234,718, giving a gross per capita figure of 11.3tCO_2e. However, the annual sequestration of carbon in Highland's woodlands was estimated to be 1,647ktCO_2e, which would reduce the inventory area's net emissions to 1,005ktCO_2e, the equivalent of 4.3tCO_2e per resident in 2018. These figures reflect the extremely important role that Highland's forests play in mitigating the overall climate change impact of the region, and supports increasing efforts to expedite forestry planting in appropriate locations.

6.3 It is important to highlight that there is growing awareness of the levels of carbon stored in the area's peatlands. The Intergovernmental Panel on Climate Change issued guidance in 2013 on estimating emissions from wetlands and a group of UK scientists produced the first estimate for UK peatlands in 2017. Their data has been used to develop an estimate for Highland for this report which gives a total of 897,916tCO_2e per year. This research and methodology is under review and will be incorporated into the UK National Inventory in some form in the near future. This is an important area for the Council to continue to monitor, as peatland and associated emissions have such an impact on the appearance of the area and also the region's GHG Inventory figures. Due to the emerging nature of this analysis, it has been excluded from the 2018 inventory.

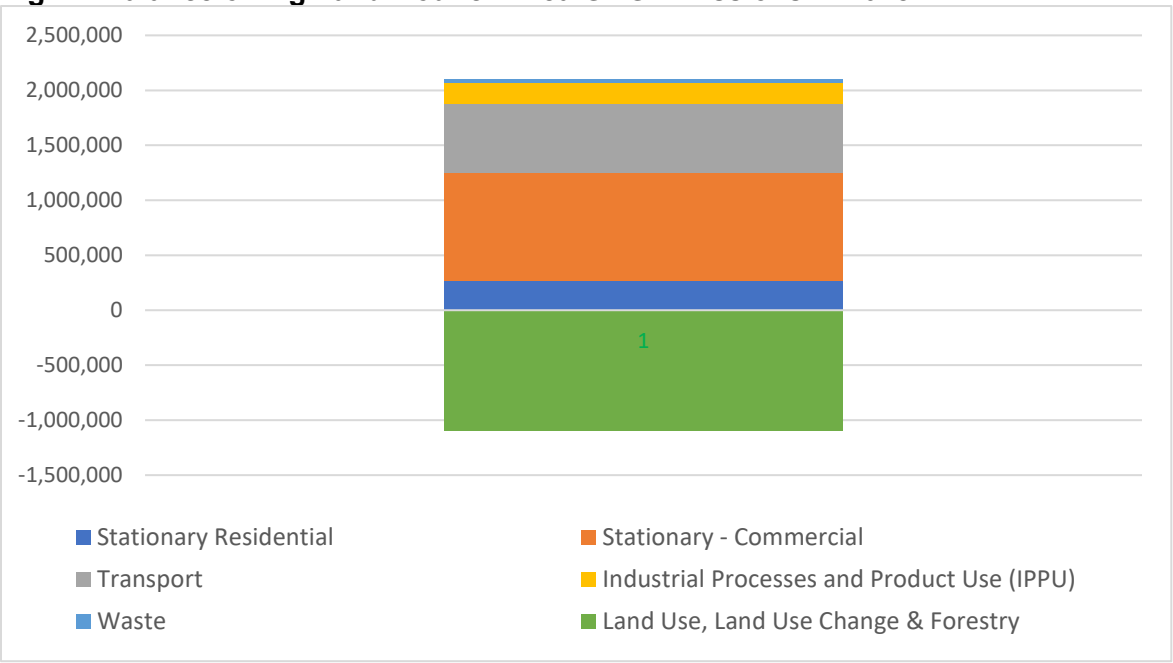
6.4 The key findings from the report can be summarised as follows:

- Stationary commercial energy use is the largest contributor to the Council area's overall GHG emissions. Emissions are arising from the consumption of gas, heating oil, electricity and liquid fuels. Agriculture and other land use are the next largest source of emissions in the area. There is growing recognition of the global contribution of agriculture and food production related emissions. Consumption of diesel for road transport are the next largest proportion of the area's emissions.

- While the area is home to a significant levels of renewable energy production, these have not been included as an element of the GHG inventory. The Scottish Government have agreed an accelerated trajectory of GHG emission reductions, allowing the country to reach net zero at an earlier date than the rest of the UK. Renewable energy will play an increasingly important role in achieving this target and also helping to reduce the carbon intensity of grid supplied mains electricity. Current accepted practice is for Highland-area renewable energy to supply the national grid. This helps to reduce the carbon intensity of electricity, across the UK. However, it also dilutes the prospective emissions reduction if this energy was produced in the Highlands and all used locally. There is therefore an argument to pursue and lobby for a specific Highland conversion factor for grid supplied electricity, or at the very least, a Scottish grid conversion factor to better reflect the renewable nature of power produced here.

- The following chart provides a useful snapshot of the Highland Council area's position regards net zero. Sequestration of emissions in the area's forests, helps to cancel out nearly half the area's emissions. The chart combines emissions producing activity with emissions sequestration, below the line:

Fig.2 – Balance of Highland Council Area GHG Emissions in 2018



- The COVID-19 pandemic in 2020 has had a significant impact on levels of homeworking. While this may have more of an impact in urban areas, increased homeworking will displace a proportion of emissions from commercial to domestic premises. Even with a vaccine for COVID-19, there is unlikely to be a complete return to historical working environments in commercial premises. A key opportunity for THC and stakeholders, for example Home Energy Scotland, will be to maintain oversight of existing and emerging sources of public funding that will be made available to help improve residential properties, especially where there is an increased level of homeworking.

- The commercial sector, during 2020, is being considerably exposed to the impacts of COVID-19. Cost reduction and minimisation has been and is likely to continue to be a key focus for the foreseeable future. Reducing energy consumption, with the subsequent benefit in emissions reduction, is a key opportunity for organisations to reduce costs. However, there is likely to be a challenge in justifying more expensive energy efficiency interventions that may have a longer payback.

- The report highlights the significant level of emissions being produced by transport, especially vehicles consuming diesel. Emissions arising from diesel car use increased by 35% between 2011 – 18. For a comparison, petrol consumption in cars and resulting emissions declined by 28% over the same period. There has also been significant growth over the same period, in the fuel consumed and emissions arising from diesel powered light goods vehicles. There is a small but growing number of electric vehicles in the area and this is being supported by a growing number of charging points.

- The extensive size of the Council area results in a range of land use emission interest and challenges. Agriculture will continue to evolve with an ebb and flow of emissions arising

from different land management practices, animal husbandry etc. The role of woodland for carbon sequestration has been well documented and this provides a significant resource in the Highlands. There is a need to at least maintain woodland cover in the area, while ideally increasing planting to create an expanding resource to help support future carbon sequestration.

- While the following is a repeat of a recommendation in a previous Highland Council-commissioned report on emissions for Inverness district, the rationale for this suggestion remains and is perhaps even greater now. The Scottish Government is required to deliver a net zero Scotland by 2045. This will involve reducing emissions while increasing levels of sequestration and storage in soils etc. Covering a third of Scotland, Highland will be well placed to become a major player in helping the Scottish Government meet its targets. There may be scope to establish a working group/initiative/ALEO to help collaboration amongst key local stakeholders and build a programme of concerted action to maximise carbon sequestration and storage in the Highlands, and this should be explored as a priority action.

7. Next Steps

7.1 The greenhouse gas inventory report for Highland identifies several key recommendations (pp. 56 – 59) to consider in order to further reduce the emissions arising from Highland. The report recognises that achievement of carbon reduction targets is not simply a responsibility for, nor within the sole control of, The Highland Council. Efficient and effective projects and initiatives to meaningfully reduce the emissions arising within the region will require actions from a range of stakeholders, alongside much better partnership working.

7.2 It is clear that one of the areas in which the Council can play a leading role in reducing the overall emissions arising within Highland is transport; petrol and diesel consumption for road travel make up 21% of the region's total emissions, and there is therefore a clear role for the Council to develop more enabling policies and strategies to aid the region's transition to lower carbon transport. Work is well underway to develop a strategic control plan to facilitate improved performance and expedited delivery of publicly-accessible EV charging infrastructure going forward, but there are also clear opportunities for Planning to better support increased numbers of charging units, potentially through developer contributions, but also for the Council to work with both public and private sector partners to support more shared-asset, car club-type schemes across the region.

7.3 There is a huge amount of data contained within the inventory report, and much to digest. In addition, the inventory is a parallel piece of work to the Programme Alignment work, and provides a solid evidence base for many of the outline recommendations contained within that report (to be presented at the next meeting of the Climate Change Working Group). It is therefore proposed that officers spend some time pulling out some of the most pertinent data and potential areas for focus from both reports, with a view to then leading a workshop with Members to identify and agree priorities for action, which can be best supported and enabled by the Council, across the region. A formal paper will then be prepared alongside recommendations for full Council.

Designation: Executive Chief Officer – Infrastructure & Environment

Date: 20th October 2020

Author: Keith Masson

Appendix 1

HIGHLAND COUNCIL AREA GREENHOUSE GAS INVENTORY 2018

October 2020

Contents

Figures

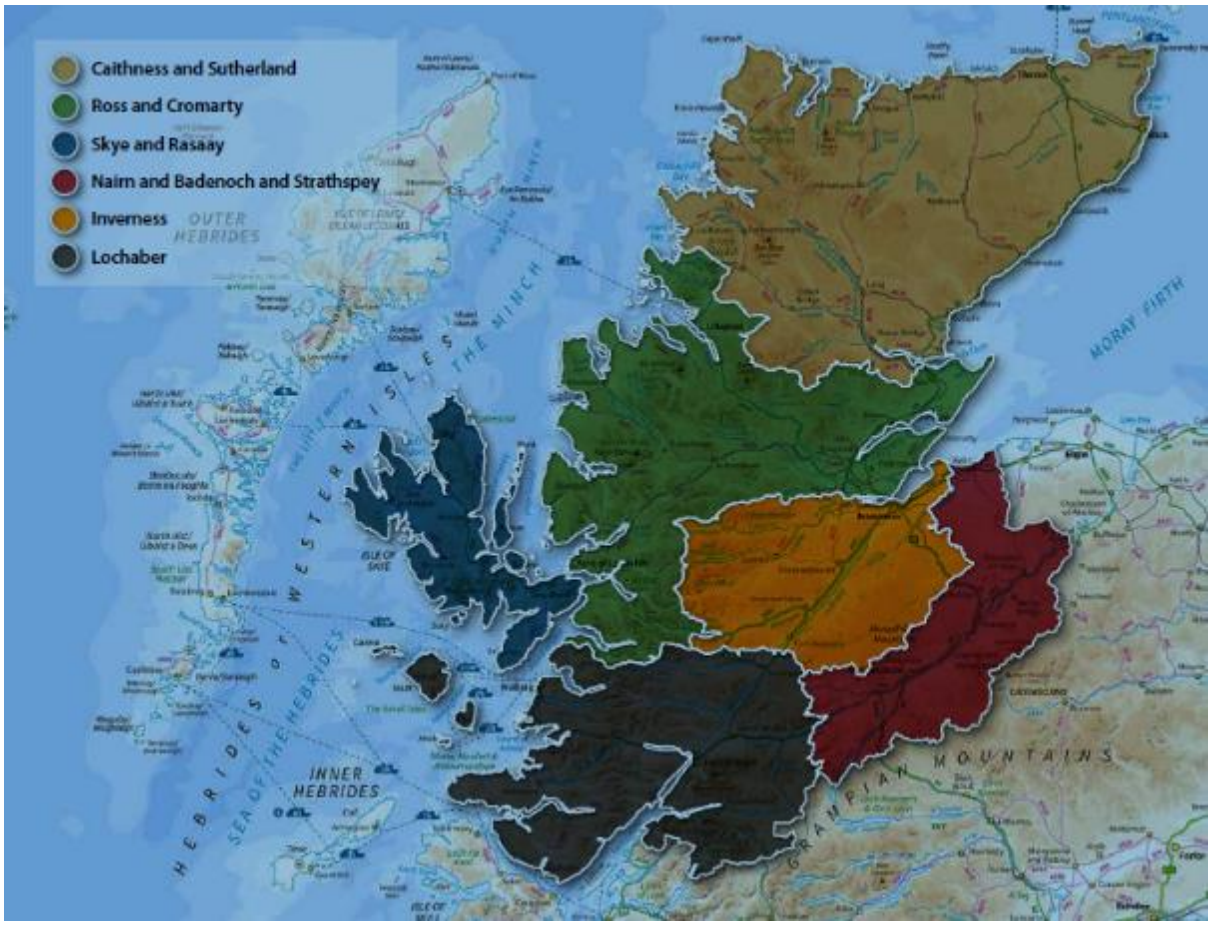
Tables

EXECUTIVE SUMMARY

ES1 This report was commissioned by Highland Council to provide a Greenhouse Gas (GHG) inventory for the area. This Inventory provides a comprehensive insight and baseline to help facilitate future interventions to reduce the area's emissions. It is the first GHG Inventory to have been produced specifically for the whole Highland Council area.

ES2 Highland Council has developed an operational disaggregation for the highlands, dividing the area into smaller administrative zones, allocated to an Executive Chief Officer (ECO). Where possible, we have disaggregated analysis to these smaller ECO areas and will be providing a separate summary GHG report for each of them. Where pertinent, we have included reporting for the ECO areas, in this main report.

Highland Council ECO Areas.



ES3 This work was commissioned at the start of 2020, ahead of the outbreak of COVID-19. The subsequent lockdown in the spring and early summer of 2020 has had an impact on the ability to complete primary research. A number of the organisations contacted for confirmation of specific issues or questions about data, were not able to respond. This disruption to the research and primary data collection process continued throughout the contract as the impacts and disruption of the COVID-19 outbreak became more sustained.

ES4 Our core analysis utilised official energy consumption and emissions data produced by the UK Government Department for Business Enterprise and Industrial Strategy. We have used data that has been accessed for different spatial levels. When accessing data at smaller statistical areas, for example Middle Layer Super Output Area (MSOA), we have encountered data confidentiality issues. Accessing data, especially for commercial consumption, at too small a geographical area, runs the risk of identifying larger consumers. This has created a challenge when comparing a single Highland Council area emissions figure with one grossed up from combining emissions from smaller areas. The two figures are different. This is a significant challenge when trying to undertake analysis for the smaller Eco areas.

ES5 Waiting for the most recent data release in the summer of 2020 allowed us to use 2018 as the year for this comprehensive Highland Council GHG Inventory. Analysis identified a GHG emissions total for the Highland Council area in 2018 of 2,652,316 tCO_2e, and the counterbalancing sequestration of carbon in forestry plantations at 1,647,060 tCO_2e. This would reduce the net emissions to 1,005,256 tCO_2e, the equivalent of 4.3 tCO_2e per resident.

Sector	Scope 1	Scope 2	Scope 3	Total tCO2e
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*We have used the official commercial energy consumption figures, electricity and gas for 2018 rather than the modelled energy use per sector.

ES5 Stationary commercial energy use is the largest contributor to the Council area's overall GHG emissions. Emissions arise from the consumption of gas, heating oil, electricity and liquid fuels. Agriculture and other land use are the next largest source of emissions in the area. There is growing recognition of the global contribution of agriculture and food production related emissions. Consumption of diesel for road transport and the subsequent and emissions are the next largest proportion of the area's emissions.

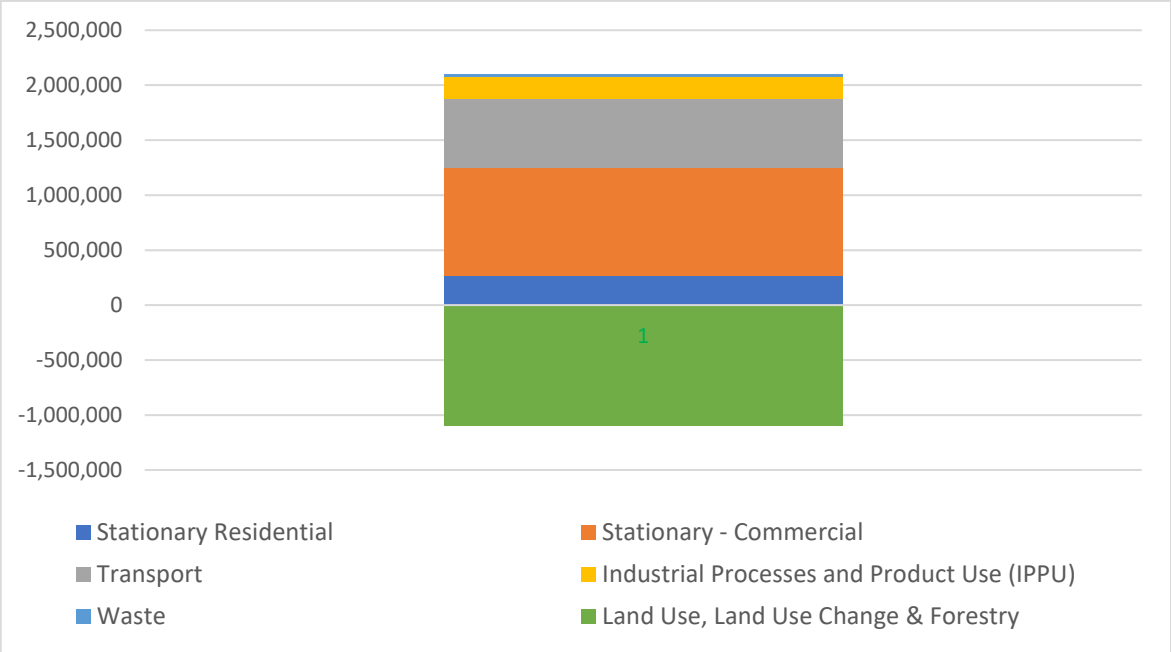
ES6 The area's land resource is also a source of carbon storage. Each year there is carbon sequestration and absorption to the soil as well as releases. This complements the significant stocks already stored in the area's soils. Overall, there was a net absorption of carbon to the area's soils in 2018. An emerging area of emissions analysis considers the release of carbon from peatland. We have

calculated the possible distribution of peat released carbon emissions for the whole Council area as well as the individual ECO areas. However as this is very much a developing area of emissions analysis, we have not included it in the final Highland Council area figures.

ES7 While the area is home to a significant level of renewable energy production, we have not included that as an element of the GHG inventory. The Scottish Government have agreed an accelerated trajectory of GHG emission reductions, allowing the country to reach net zero at an earlier date than the rest of the UK. Renewable energy will play an increasingly important role in achieving this target and also helping to reduce the carbon intensity of grid supplied mains electricity. Current accepted practice is for highland area renewable energy to supply the National Grid. This helps to reduce the carbon intensity of electricity, across the UK. However, it also dilutes the prospective emissions reduction if this energy was produced in the highlands and all used locally.

ES8 The following chart provides a useful snapshot of the Highland Council areas position regards net zero. Sequestration of emissions in the area's forests, helps to cancel out nearly half the area's emissions. The chart combines emissions producing activity with the emissions sequestration, below the line.

Balance of Highland Council Area GHG Emissions in 2018



ES9 The report has been completed alongside a separate commission. This additional work assesses how the Highland Council can establish an improved focus on emissions reduction in the organisation's own estate as well as work with partners to maximise the emission reduction potential in the Highlands. The following recommendations combine commentary from this Inventory report and link to key findings from the parallel report.

ES10 Across the Highland Council area, there remains a broad mix of housing stock, which has different energy requirements, and subsequent GHG emission profiles. While newer housing is more energy efficient and has a lower emissions profile, older properties are less energy efficient. A key challenge for residents in these properties is the cost of interventions that will make the properties

more energy efficient. This can be a concern for low income households where there is a greater prominence of fuel poverty. But for a significant proportion of residents in the area, fuel spend is likely to be less of a concern. This potentially undermines the incentive to reduce residential emissions. However, it does suggest the focus of public interventions to reduce domestic stationary energy should be targeted at older, higher emissions properties occupied by lower income residents.

ES11 The COVID 19 pandemic in 2020 has had a significant impact on levels of homeworking. While this may have more of an impact in urban areas, increased homeworking will displace a proportion of emissions from commercial to domestic premises. Even with a treatment for COVID 19, there is unlikely to be a complete return to historical working environments in commercial premises. A key opportunity for THC and stakeholders, for example Home Energy Scotland, will be to maintain oversight of existing and emerging sources of public funding that will be made available to help improve residential properties, especially where there is an increased level of homeworking.

ES12 The commercial sector, during 2020, is being considerably exposed to the impacts of COVID 19. Cost reduction and minimisation has been a key focus. Reducing energy consumption, with the subsequent benefit in emissions reduction, is a key opportunity for organisations to reduce costs. However, there is likely to be a challenge in justifying more expensive energy efficiency interventions that may have a longer payback.

ES13 There is existing support available from Zero Waste Scotland, to help reduce commercial energy consumption and associated GHG emissions. While the Council may have limited scope to engage with occupiers of commercial premises, where they do, there is opportunity to help promote the likes of Zero Waste Scotland and the Business Energy Efficiency Service.

ES14 The report highlights the significant level of transport emissions, especially vehicles consuming diesel. Emissions arising from diesel car use increased by 35% between 2011 – 18. For a comparison, petrol consumption in cars and resulting emissions declined by 28% over the same period. There has also been significant growth over the same period, in the fuel consumed and emissions arising from diesel powered light goods vehicles. There is a small but growing number of electric vehicles in the area and this is being supported by a growing number of charging points. There is now a requirement that new houses being built to have a specific connection that will facilitate electric vehicle charging equipment

ES15 An interesting transport consideration that emerged during the preparation of this report is the COVID 19 generated move towards more active travel. This also coincided with a significant switch from commuting to working from home. Transport counts will be able to identify how these developments during 2020 helped to reduce vehicle journeys and their associated emissions. Bus fuel consumption and emissions increased 8.5% over the period 2011-18. Again, it will be interesting in future updates of this inventory, to assess the impact of the COVID 19 outbreak, on public transport.

ES16 There is increasing knowledge of how the production and release of GHG emissions can be minimised when processing waste. There has been a steady decline in the amount of biodegradable waste sent to landfill. This will help to reduce the future production of GHG emissions. There is also increasing knowledge of how to address the production of emissions by existing landfill materials.

ES17 The extensive size of the Council area results in a range of land use emission challenges. Agriculture will continue to evolve with an ebb and flow of emissions arising from different land

management practices, animal husbandry etc. The role of woodland for carbon sequestration has been well documented and this provides a significant resource in the highlands. There is a need to at least maintain woodland cover in the area, while ideally increasing planting to create an expanding resource to help support future carbon sequestration.

ES18 Peatland is increasingly recognised as playing a significant role in carbon storage in the highlands and also Scotland. Due to the emerging nature of the analysis, we have not included the figures for carbon arising from different uses of peat soils. This will become a more accepted process in the near future, and this will raise some interesting debate about peatland and why and how we manage and maximise the benefit of this resource.

ES19 While the following is a repeat of a recommendation in a previous Highland Council commissioned report on emissions for Inverness district, the rationale for this suggestion still remains and is perhaps even greater now. The Scottish Government is required to deliver a net zero Scotland by 2045. This will involve reducing emissions while increasing levels of sequestration and storage in soils etc. Covering a third of Scotland, the highlands will be well placed to become a major player in helping the Scottish Government meet its targets. There may be scope to establish a working group/initiative to help collaboration amongst key local stakeholders and build a programme of concerted action to maximise carbon sequestration and storage in the Highlands.

Chapter 1 – Introduction

1.1. It is now widely accepted that climate change is impacting across the planet and climate change is accelerating, the result of increased greenhouse gas (GHG) emissions, caused by human activity. The continued release of GHG is expected to sustain and exacerbate climate change. Subsequent impacts will increase in the future. Action to limit future global GHG emissions will help restrict future changes in the climate system.

1.2 There is no clear threshold where climate change moves from safe to dangerous. We can expect some disruptions and irreversible losses of natural habitats and resources, even with a 1.5 or 2°C temperature rise. However, with rapid global action to cut GHG emissions, we can still reduce the likelihood of global temperatures increasing by more than 1.5 – 2°C. On the other hand, if we take no action, global temperatures could increase by 4°C or more by the end of the century. To limit the most damaging impacts of climate change, we need to reduce GHG emissions globally and adapt to the current and future changes in the climate

1.3 The Climate Change Act (2009) made the UK the first country to establish a long-term legally binding framework to cut carbon emissions. A wider legal commitment, the Paris Agreement also exists, spanning 175 parties, committing them to action to tackle climate change.

1.4 The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2^{o}C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5^{o}C. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place. This will help to support action by developing countries and the most vulnerable countries, in line with their own national objectives.

1.5 The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 received Royal Assent on 31 October 2019. The Act amends the Climate Change (Scotland) Act 2009 setting targets for the reduction of greenhouse gases emissions and makes provision about advice, plans and reports in relation to those targets. A key target in the Act is to reduce Scotland's emissions of all greenhouse gases to net-zero by 2045 at the latest, with interim targets for reductions of at least 56% by 2020, 75% by 2030, 90% by 2040. This is a more ambitious target than for the UK, reflecting the progress being made in Scotland as well as the natural reserves that facilitate carbon sequestration and storage. Public organisations like the Highland Council (THC) are now required to support the achievement of Scotland's Net Zero commitments.

1.6 In May 2019, THC declared a climate and ecological emergency. Whilst THC has been working to reduce its climate change impact for several years, Elected Members recognised the urgency of the problem and that the Council needs to increase efforts to reduce emissions whilst also adapting to the change which is already locked in to the climate system. To facilitate this reduction in emissions, Elected Members agreed to;

- Raise awareness of activity THC is undertaking to reduce emissions,
- Revisit the Carbon Clever declaration made by THC in 2012 with a view to updating and working towards a carbon neutral Highlands by 2025,
- Consider and recommend any new targets and priorities for the THC's Corporate Plan, including the preparation of a GHG emissions inventory for the wider Highland Council area,

- Realise we can achieve far less by working alone so we commit to listening to and involving Highland citizens in all that we do and to involve them in the preparation of our new carbon reduction plan, and
- Target areas for behavioural change, such as plastic reduction. These areas to be selected by public consultation."

1.7 This report addresses one of these commitments, the preparation of a GHG emissions inventory for the Highland Council area. The work has been completed by;

- Archie Prentice of Practically Green Ltd, supported by Susan Carstairs has provided overall project management as well as preparing reports and completing specific areas of emission analysis.
- Tom Matthew at Reference Economics Ltd has provided specialist input for assessing transport emissions
- Pam Reid of ekosgen has provided specialist input on socio economic modelling and also the provision of energy consumption modelling.

Chapter 2 – Calculating and Reporting Regional Greenhouse Gas Inventories

2.1 This GHG emissions inventory for THC area follows the methodology outlined in the Global Protocol for Community-Scale Greenhouse Gas Emissions[1] (GPC). The contractors involved in this project have previous experience of working with this Protocol.

2.2 The GPC provides a robust framework for accounting and reporting city and region wide GHG emissions. It seeks to:

- Help cities and regions develop a comprehensive and robust GHG inventory in order to support climate action planning
- Help cities and regions establish a base year GHG emissions inventory, set reduction targets, and track their performance
- Ensure consistent and transparent measurement and reporting of GHG emissions between different geographies, following internationally recognised GHG accounting and reporting principles
- Enable city inventories to be aggregated at subnational and national levels
- Demonstrate the important role that cities and regions play in tackling climate change, and facilitate insight through benchmarking – and aggregation – of comparable data

2.3 This Inventory covers emissions generated directly and indirectly by the people living and working in THC area. This includes emissions from a number of different sectors, such as Stationary Energy use, Transport, Waste Treatment, Industrial Processes and Product Use, Agriculture and Forestry. The Inventory covers the following six greenhouse gases: carbon dioxide (CO_2), methane (CH4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Emissions, unless stated in the Land Use and Land Use Change section, are reported as CO_2e, the collective term for GHG emissions.

2.4 To support this best practice approach, inventory preparation methodology is adopting the five key principles now expected in GHG measurement and analysis:

- ***Relevance:*** Reported emissions reflect those occurring as a result of activities and consumption patterns of the inventory area. The principle of relevance applies when selecting data sources and determining and prioritising data collection improvements.
- ***Completeness***: Analysis accounts for all required emissions sources within the inventory boundary. Any exclusion of emission sources shall be justified and clearly explained.
- ***Consistency***: Calculations are consistent in approach, boundary, and methodology. Using consistent methodologies for calculating GHG emissions enables meaningful documentation in changes of emissions over time, trend analysis, and comparisons between cities. Calculations follow the methodological approaches provided by the GPC.
- ***Transparency:*** Activity data, emission sources, emission factors, and accounting methodologies are documented to enable verification. All exclusions shall be clearly identified, disclosed and justified.
- ***Accuracy***: The calculation of emissions shall not systematically overstate or understate emissions. Accuracy should be enough to give decision makers and the public reasonable

[1] https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities Global Protocol for Community-Scale Greenhouse Gas Emission Inventories, World Resources Institute, 2014

assurance of the integrity of the reported information. Uncertainties in the quantification process shall be reduced to the extent that it is possible and practical.

2.5 To provide consistent GHG measurement for different areas, the descriptive term "Scopes" is used. The GPC distinguishes between emissions that physically occur within the inventory area (Scope 1), from those that occur outside the inventory area but are driven by activities taking place within the area's boundaries (Scope 3), and from those that occur from the use of electricity, steam, and/or heating/cooling (Scope 2). Scope 1 emissions may also be termed "territorial" emissions, because they are produced solely within the territory defined by the geographic boundary[2]. A methodological question that arises where only one part of a country is being assessed for its emissions is that its Scope 1 emissions might be Scope 3 emissions for another area – i.e. if the whole country were being covered by a regionalised analysis, it would be necessary to adjust across areas to avoid double counting.

Table 1 - Greenhouse Gas Emisison Scopes

Scope Definition	Definition
Scope 1	Emissions from sources located within the inventory boundary
Scope 2	Emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the Inventory boundary
Scope 3	All other emissions that occur outside the Inventory boundary because of activities taking place within the area

2.6 Data collection is fundamental in preparing the inventory. For this report, data were obtained from a variety of sources. A key source of data was from the Department for Business, Energy & Industrial Strategy (BEIS) annual reporting of Local Authority GHG emissions. Other data, for example on agriculture, forestry and other land use has been sourced from specific audits of for example animals and areas of cropping, woodland cover etc. Transport emissions information has been informed by a combination of nationally available emissions information as well as local vehicle/road use counts and also direct data collection from transport providers, for example ferry operators.

2.7 Emissions used in this report were classified into six main sectors:

- Stationary energy use
- Transportation
- Waste
- Industrial processes and product use (IPPU)
- Agriculture, forestry, and other land use (AFOLU)
- Any other emissions occurring outside the geographic boundary as a result of city activities (collectively referred to as Other Scope 3).

2.8 Emissions from these sectors were sub-divided into subsectors, and where beneficial, into sub-categories. Sectors define the topmost categorisation of Highland Council wide GHG sources, distinct from one another, that together make up THC area's GHG emission sources activities. Sub-sectors are divisions that make up a sector – for example transport modes such as aviation or on-road. These in turn can be divided into sub-categories where appropriate to provide more detail.

[2] Global Protocol for Community-Scale Greenhouse Gas Emission Inventories, Page 11

Table 2 - Greenhouse Gas Inventory Sectors

Sectors and sub-sectors
STATIONARY ENERGY
Residential buildings
Commercial and institutional buildings and facilities
Manufacturing industries and construction
Energy industries
Agriculture, forestry, and fishing activities
Non-specified sources
Fugitive emissions from mining, processing, storage & coal transportation
Fugitive emissions from oil and natural gas systems
TRANSPORTATION
On-road
Railways
Waterborne navigation
Aviation
Off-road
WASTE
Solid waste disposal
Biological treatment of waste
Incineration and open burning
Wastewater treatment and discharge
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)
Industrial processes
Product use
AGRICULTURE, FORESTRY AND Other LAND USE (AFOLU)
Livestock
Land
Aggregate sources and non-CO2 emission sources on land
OTHER SCOPE 3

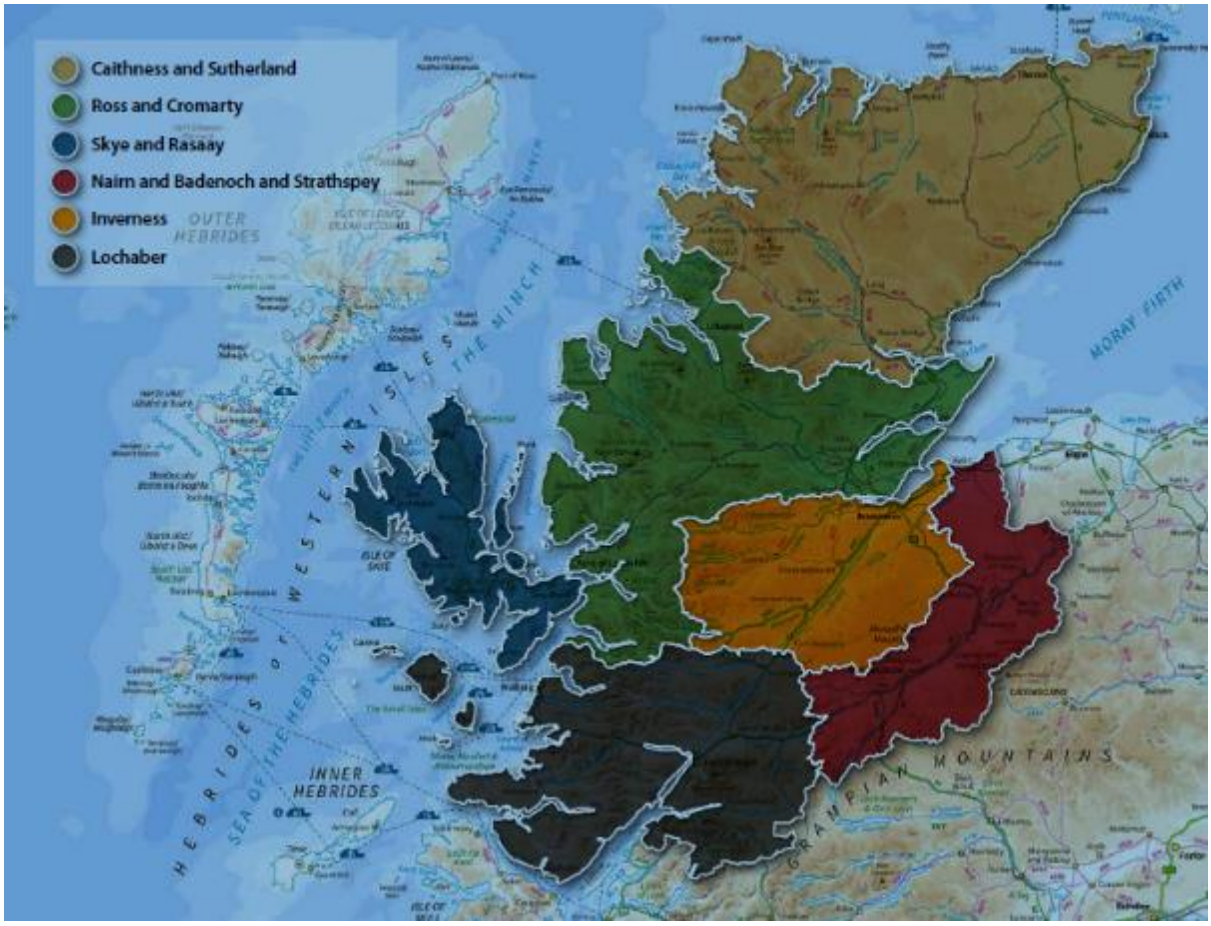
Chapter 3 – Study Area and Data

3.1 The Highland Council is the largest local government area in the United Kingdom. It was the 7th most populous council area in Scotland at the 2011 census. It shares borders with the council areas of Aberdeenshire, Argyll and Bute, Moray and Perth and Kinross. The Council area covers an area of 25,657 km^2 (9,906 m2), which is 11.4% of the land area of Great Britain, 32.9% of the land area of Scotland and an area 20% larger than Wales.

3.2 Though relatively populous for a Scottish council area, it is also sparsely populated. At 9.0 people per km^2 in 2019, the population density is less than one seventh of Scotland's as a whole. Inverness is by far the largest settlement, with a population of 69,751 in 2019.

3.3 To provide more regional context on THC area GHG emissions we have used 6 internal boundaries, known as Executive Chief Officer (ECO) areas. Reporting GHG emissions for these areas will help to raise awareness of ECO area specific opportunities and challenges as THC increases activity to reduce GHG emissions.

Figure 1 - Highland Council ECO Areas



3.4 The following table identifies the number of employees in THC area in 2018, comparing this to Scotland. The table highlights the greater role made by the primary sector in the highlands. This sector will also play a vital role in helping to maximise carbon sequestration, essential if Scotland is to meet its statutory net zero carbon commitments. Accommodation and food service employ a larger

proportion of staff in THC area compared to Scotland as a whole, linked to the prominence of the service sector. This provides facilities for local residents as well as a significant tourism sector and number of visitors to the area each year. Health care employs the greatest proportion of THC area employees, reflecting the importance of this activity nationwide. While this GHG Inventory covers 2018, it was prepared during 2020 when the area was affected by the COVID 19 outbreak. The turmoil of the outbreak is likely to have a significant influence on a number of sectors, associated employment as well as future opportunities and developments.

Table 3 - Employment by Industry 2018, Highland Council Area and Scotland

	Highland		Scotland
	Employees	%	%
Agriculture, forestry & fishing	12,500	10.0%	3.2%
Mining, quarrying & utilities	3,500	2.8%	2.5%
Manufacturing	6,500	5.2%	6.9%
Construction	8,000	6.4%	5.5%
Motor trades	2,375	1.9%	1.7%
Wholesale	3,250	2.6%	2.9%
Retail	11,500	9.2%	8.9%
Transport & storage (inc postal)	5,500	4.4%	4.2%
Accommodation & food services	13,500	10.8%	7.9%
Information & communication	2,250	1.8%	3.1%
Financial & insurance	1,125	0.9%	3.4%
Property	1,625	1.3%	1.5%
Professional, scientific & technical	6,500	5.2%	7.0%
Business administration & support services	6,500	5.2%	7.9%
Public administration & defence	6,500	5.2%	6.0%
Education	7,500	6.0%	7.4%
Health	20,500	16.4%	15.1%
Arts, entertainment, recreation & other services	6,000	4.8%	4.8%
Total	125,000		2,611,500

Source: Business Register and Employment Survey 2018 figures

3.5 The 6 ECO areas have distinct socio economic and environmental characteristics. These influence the type and volume of GHG emissions. Appendix 1 identifies employment in each of the ECO areas as a proportion of the overall HC area employment total. The top three employment sectors in each ECO area have been highlighted. This consistently illustrates the importance of the accommodation and food service and also health sector for employment across the 6 ECO areas.

Data Availability - Residential

3.6 The collection and analysis of relevant data is critical in developing the GHG Inventory. Our analysis involved use of both national and regional statistics, as well as the collation of some primary data from key businesses. National and regional statistics were primarily sourced from publications and analysis produced by the Department for Business, Energy & Industrial Strategy (BEIS).

3.7 Where available, domestic electricity use was collected for specific meter points. Our analysis based on electricity consumption has a high degree of accuracy. In Scotland, this information is available for Lower Layer Super Output Area (LSOA). Using this data allows us to build up a more accurate of domestic energy consumption across the HC area as well as the individual ECO areas.

https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-electricity-consumption

3.8 Gas consumption is also recorded by specific meter points and cross-referenced with volumes of gas distributed by national and major transporters. Within THC area, natural gas mains infrastructure is limited to urban centres with significant use of alternative fuels used in rural properties.

https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-gas-consumption

Data Availability – Commercial

3.9 Commercial energy consumption is more challenging to identify at smaller geographies. This is a result of needing to protect the identity of large local users, especially at very small geographies. To protect the identity of large consumers, their consumption is grossed up to an "unallocated" category for a larger area, for example the overall Council area.

At the local authority level, commercial electricity and commercial gas consumption figures are available to the following sources.

Electricity

There is a small variation between different publicly available non-domestic energy consumption figures for THC area.

https://www.gov.uk/government/statistical-data-sets/regional-and-local-authority-electricity-consumption-statistics

This data source provides a single entry and identifies that for 2018, non-domestic electricity consumption was 921,000,000 kWh

An alternative source of non-domestic electricity consumption, available for smaller areas that are then combined to prove the total Highland Council area non-domestic electricity consumption is available at the following address.

https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-electricity-consumption

This data source identifies total non-domestic electricity consumption at 917,817,302 kWh.

Natural Gas

The same challenge arises with non-domestic gas consumption, where there is a need to protect commercial consumption information, once data is available at small areas.

https://www.gov.uk/government/statistical-data-sets/gas-sales-and-numbers-of-customers-by-region-and-local-authority

This data set provides a single figure of 497,000,000 kWh for non-domestic gas consumption in the area.

An alternative source of non-domestic gas consumption, available for smaller areas identified non domestic gas consumption as 307,190,158 kWhs.

https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-gas-consumption

This difference arises as at the smaller area level, it will be possible to identify large consumers so their data has been added to an unallocated category.

3.10 Transport fuel consumption and subsequent emission estimates were derived through a combination of approaches and data and this is discussed in more detail in the relevant sections.

3.11 Agriculture and Land Use emissions have been calculated by the use of detailed agriculture and forest census data and also analysis of the different soil type and land classes in the area. Land is both an emitter and sequester of GHGs. In THC area, this sequestration role is of national significance as it makes a major contribution to national and regional aspirations for Net Zero GHG emissions.

3.12 We have included more commentary about data availability, modelling etc, in the subsequent chapters of this report.

Chapter 4 – Sources of Emissions and Inventory Calculations

4.1 In addition to the GPC, the Highland Council GHG inventory has been informed by the process for emission calculations described in the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. The IPCC guidelines provide three levels of methodological complexity for the calculation of each emission source.

- Tier 1 is the basic calculation method, designed to use readily available national or international statistics in combination with the provided default emission factors.
- Tier 2 is an intermediate approach, applying more sophisticated emission calculations and emission factors.
- Tier 3 is the most demanding in terms of complexity and data requirements.

4.2 In general, Tier 1 emissions are estimated based on the activity data and the use of a default emission factors. Activity data is a quantitative measure of a level of activity that results in GHG emissions taking place during a given period, for example the volume of gas or kWh or electricity consumed, kilometres driven, or tonnes of solid waste sent to landfill. Tier 2 emissions calculations require more detailed activity data and national/regional specific emissions factors. Tier 2 analysis has been used where possible. Calculating emissions according to Tier 3 requires even more detail and specific information on combustion technology, control technology, etc.

4.3 We have used Tier 1 to calculate the majority of GHG emissions and Tier 2 methodology to calculate some Agriculture, Land Use and Waste GHG emissions. Emission factors are produced for the UK annually[3], and emission factors for 2018 have been used in our analysis.

Stationary Energy

4.4 Within THC inventory area, Stationary Energy emissions arise from residential, commercial and industrial buildings and facilities, as well as onsite use of fossil fuels in plant and equipment, etc.

- Scope 1 emissions include all direct emissions from burning fuel (gas, LPG, heating oil etc).
- Scope 2 emissions include emissions associated with the consumption and generation of electricity which may be generated within or outside the inventory boundary.
- Scope 3 emissions include distribution losses from grid-supplied electricity.

4.5 To inform analysis of Stationary Energy GHG emissions, data produced by BEIS was used. Data is available for all UK Local Authorities as well as lower Layer Super Output Areas which correspond in Scotland to Data Zones.

4.6 To facilitate detailed analysis and reflecting guidance from the GPC, the Stationary Energy sector was divided into the following sub-sectors:

- Residential buildings
- Commercial buildings
- Institutional buildings and facilities
- Manufacturing industries
- Construction
- Energy industries/utilities
- Agriculture, forestry and fishing activities
- Non-specified sources

[3] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2018

4.7 A small volume of emissions from the energy sector frequently arise as fugitive emissions, which typically occur during extraction, transformation, and transportation of primary fossil fuels. Small amounts of liquids and gases can be lost during this process. As there is limited fossil fuel extraction, transformation and transportation in THC inventory area, it was excluded from our analysis.

4.8 The following fuels are consumed in properties in THC inventory area and subsequently release emissions:

- Mains supplied natural gas is used primarily in the settlements of Nairn, Inverness, Dingwall and around the north shore of the Cromarty Firth, Thurso and Wick. Gas is consumed mainly for heating in the domestic sector. Natural gas is also consumed in the commercial sector.
- LPG and heating oil provide domestic and commercial space and water heating in properties that do not have access to mains gas. Several local and national commercial suppliers provide this fuel.
- Coal is primarily used to provide space and water heating in domestic and commercial properties that do not have access to mains gas.
- Biomass is consumed in domestic, commercial and institutional properties. More comprehensive records of installations and output are now being produced by the Department for BEIS.

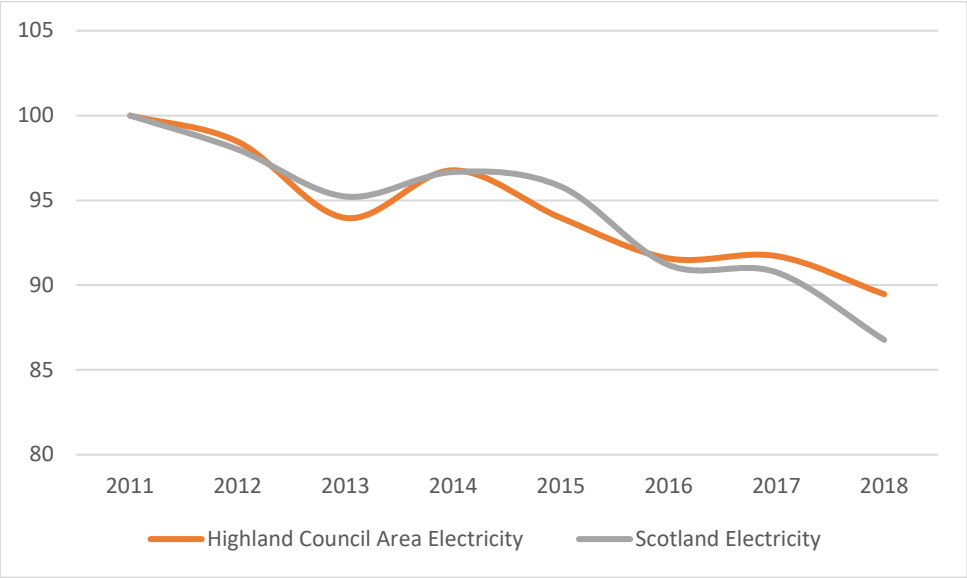
To avoid double counting of emissions already captured, only emissions associated with the generation of grid-supplied electricity imported into THC inventory area are included in Scope 2.

Residential Buildings

4.9 Two primary sources of energy are used in residential properties – electricity and mains supplied natural gas (or alternative heating system fuels). The former can provide heating as well as powering appliances etc. The latter is primarily used for heating in residential properties in more urban locations. The following charts index domestic electricity and mains supplied natural gas consumption for the Highland Council area and Scotland for the period 2011 to 2018.

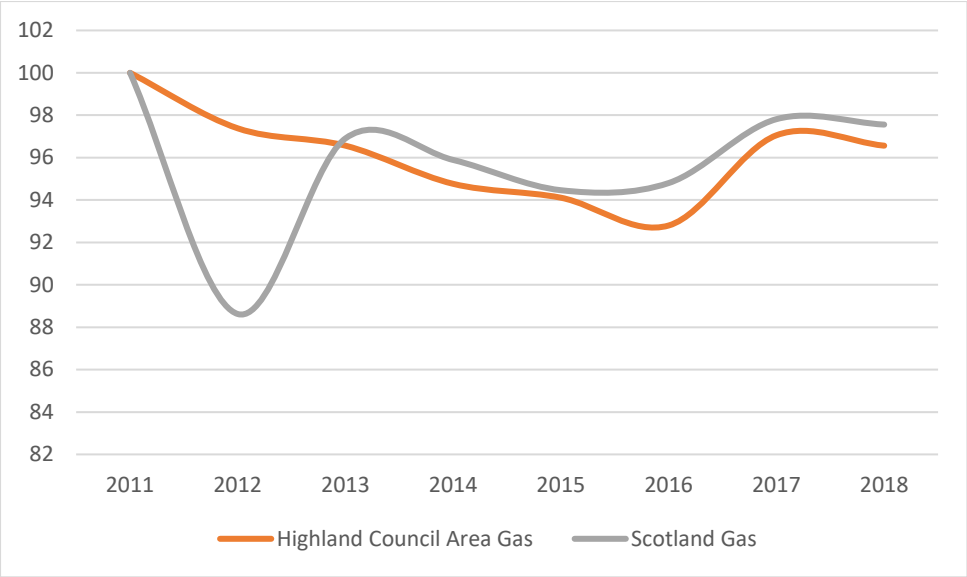
4.10 Over the period, domestic electricity consumption declined from 712 GWh and 11,141 GWh to 637 GWh and 9,667 GWh for the Highland Council area and Scotland, respectively. Gas consumption for the same period fluctuated from 611 GWh and 28,873 GWh to 590 GWh and 28,168 GWh for the Highland Council area and Scotland, respectively.

Figure 2 – Index of Residential Electricity Consumption (GWh) Highland Council Area and Scotland 2011 - 2018 (2011 = 100)



Not only has the overall level of electricity consumption declined, there has been an added emissions impact through the steady and consistent reduction in the carbon intensity of grid supplied electricity. This grid supplied electricity emissions figure has declined 37% between 2011 and 2018.

Figure 3 – Index of Residential Gas Consumption (GWh) Highland Council Area and Scotland 2011 - 2018 (2011 = 100)



4.11 In urban locations like Inverness and Nairn it has been cost effective to install a mains gas network. However, in more rural locations, the cost of installing a mains gas supply is prohibitive. In these more rural properties, space and water heating can be provided by electric, coal, LPG and oil heating systems. In is anticipated that electricity will increasingly become the fuel of choice for space and water heating in rural areas in the coming years. Appendix 2 identifies the distribution of different space heating fuels and systems for the HC area as well as the individual ECO areas.

4.12 The following table identifies the domestic energy use and subsequent emissions for THC inventory area. Electricity and natural gas consumption figures have been derived from national statistics which are collected for each meter point and are therefore robust. Coal, heating oil and manufactured fuels have been allocated on a percentage of central heating type.

Table 4 - Highland Council Area Residential GHG Emissions

	Residential kWh	Scope 1 TCO_2e	Scope 2 TCO_2e	Scope 3 TCO_2e	Total TCO_2e
Electricity	637,177,996		180,321		180,321
Natural Gas	611,331,087	111,874			111,874
Heating Oil	585,021,076	143,915			143,915
Coal	113,296,420	38,974			38,974
Manufactured Fuels	59,122,294	20,456			20,456
T&D Losses				15,292	15,292
Total	**2,005,622,083**	**315,219**	**180,321**	**15,292**	**510,833**

Source: Department for Business, Energy & Industrial Strategy Lower and Middle Super Out Areas Electricity and gas Consumption, 2020; Department for Business, Energy & Industrial Strategy Sub-national residual fuel consumption in the United Kingdom. NB figures for Heating Oil, Coal, Manufactured Fuels available for 2017 only. Extrapolating these figures for 2018, using data from the previous 10 years indicates declines in consumption of 8.9%, 3.7% and 6.5% for Heating Oil, Coal, Manufactured Fuels in 2018. However as annual consumption fluctuates in response to weather conditions, we have included the official 2017 figures.

Notes on Table 4 Methodology

Electricity – Figures for domestic electricity consumption are produced by Local Authority and the figure of 637 GWh is sourced from the June 2020 release of 2018 emissions data for Local Authorities. This data is available as a single figure for LA area and also for LSOA. The latter data set for the LSOA boundaries has been used and grossed up to produce figures for the Highland Council ECO areas.

Natural Gas – Figures for domestic gas consumption are produced by Local Authority and the figure of 611 GWh is sourced from the June 2020 release of 2018 emissions data for Local Authorities. This data is available as a single figure for the LA area and also for the LSOA. The latter data set for the LSOA boundaries has been used and grossed up to produce figures for the Highland Council ECO areas.

Heating Oil – Domestic petroleum consumption in Highland in 2017 was 50,300 tonnes of oil equivalent (TOE). This TOE figure can be converted to kWhs and then using the 2017 UK Government produced emissions factor for burning oil converted to tonnes of CO_2e for THC area. This consumption data is not produced below the Local Authority level. The 2011 census identifies the main types of fuel used in central heating systems in Highland domestic properties. This census data is available for each of the Highland Council ECO areas and allows a relatively robust assessment of each of the different types of heating.

Coal – Domestic coal use in Highland in 2017 was 9,700 tonnes of oil equivalent. Using the 2017 UK Government produced emission factors for coal converts this to 113 GWh. This consumption data is not produced below the Local Authority level. The 2011 census identifies the main types of fuel used in central heating systems in Highland domestic properties. This census data is available for each of the Highland Council ECO areas and allows a relatively robust assessment of each of the different types of heating.

Manufactured Fuels (such as barbecue fuel, coal briquettes and firelighters) – During 2017, there was 5,100 tonnes of oil equivalent consumed in THC area. The 2017 UK Government produced emission factors (coking coal as a proxy) is used to convert this 59 GWh to the appropriate emissions figure.

T&D Losses – Transmission and distribution (T&D) factors are used to report the Scope 3 emissions associated with grid losses (the energy loss that occurs in getting the electricity from a power plant to the consumer). It is derived by multiplying the purchased units of electricity by the appropriate TAD emission factor for that specific year.

4.13 There is information available on the growing contribution of smaller onsite renewable, low carbon heat and energy generation in each Scottish Local Authority. There are current challenges accessing a robust and comprehensive time series of installs, especially small <45kW domestic installations, in a manner that protects the privacy of individuals and smaller businesses. At a Highland Council area level, renewable heat installations were responsible for 904 GWh of heat being produced in 2018, 17% of the Scottish total.

Commercial Buildings

4.14 Energy consumption and associated GHG emissions from non-domestic activity has been consistently declining in recent years. Two primary sources of energy are used in commercial properties – electricity and mains supplied gas.

4.15 While there is a high level of disaggregation of energy consumption information and data available for domestic properties, the same is not the case for commercial premises. The middle layer super output area (MSOA) combines both commercial and industrial electricity consumption, to provide a single non-domestic source of energy consumption information. This data source identifies that non-domestic gas consumption was 497,000,000 kWh in 2018. In Table 5, the non-domestic gas consumption is lower. This difference arises as the data in table 5 is built up by retrieving data from small areas and building this up to provide analysis for the ECO areas. In these smaller ECO areas, there are large gas consumers that will be consuming a significant proportion of natural gas. There is a risk of being able to identify these users, especially in a small area with very low consumption. To protect confidentiality, the consumption of these larger operators is collated in an "unallocated" heading. This is the trade off we have faced by aspiring to produce detailed ECO area analysis. Gas consumption will be underreported due to the need to protect the identity of large consumers. However, there is nothing to stop use of the larger figure when quoting overall emissions for THC area.

4.16 Commercial energy consumption in Highland was calculated using a number of different published data sources:

- Commercial electricity[4] and gas[5] consumption for the Highland Council area and its six ECO areas were taken from data published by the Department for Business, Energy & Industrial Strategy (BEIS).
- Data on kWh consumed published at the intermediate zone level were aggregated up to ECO areas and to the Highland Council level using spatial boundary data from the Scottish Government.
- Energy consumption for petroleum and coal was taken from data published by BEIS at the local authority level.

[4] https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-electricity-consumption

[5] https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-gas-consumption

- Consumption estimates at the ECO area level were calculated by converting thousand tonnes of oil equivalent (kToe) consumption to kWh by applying a UK Government GHG conversion factor[6]. The data on GWh was then applied to information on share of businesses and business units taken from UK Business Counts data published on NOMIS.

Table 5 - Highland Council Area Commercial Property GHG Emissions 2018

	Commercial Property kWh	Scope 1 TCO_2e	Scope 2 TCO_2e	Scope 3 TCO_2e	Total TCO_2e
Electricity	319,689,186		90,472		90,472
Natural gas	244,656,021	44,772			44,772
Petroleum	102,343,448	25,791			25,791
Coal	423,687	146			146
T&D Losses				7673	7,673
Total	**667,112,342**	**70,708**	**90,472**	**7,673**	**168,853**

Source: Department for Business, Energy & Industrial Strategy Lower and Middle Super Out Areas Electricity and gas Consumption, 2020; Department for Business, Energy & Industrial Strategy Sub-national residual fuel consumption in the United Kingdom. NB figures for Petroleum and Coal available for 2017 only

To provide the required level of disaggregation, we adopted a modelled approach for the commercial energy analysis and emissions calculations. To facilitate this modelling, we have applied the energy intensity per employee for the UK to the HC area using employee per sector information.

4.17 Whilst the energy efficiency of equipment in commercial buildings has improved, there are also several structural issues which have helped to reduce commercial building fossil fuelled energy use; greater levels of renewable energy (especially heat), buildings used to deliver more service related activity and operations which are undertaken in more insulated, better heated, managed and constructed properties.

Institutional Buildings and Facilities

4.18 There is an extensive public sector estate in THC area. This ranges from healthcare facilities; hospitals, local medical practices, dental surgeries etc to regional office-based activity. There are also a range of leisure and recreation facilities managed by the public sector.

4.19 Sustained policy interventions and funding have supported the evolution of this public sector estate to be more energy and resource efficient. The displacement of traditional fossil fuelled heating systems with for example biomass has helped to reduce levels of GHG emissions. In the future, this estate will be incorporating vehicle and bike charging facilities to help support the transition towards lower carbon transport.

4.20 The following table identifies the emissions arising from public sector and institutional buildings and facilities in the inventory area

[6] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020

Table 6 - Highland Council Area Public Sector and Institutional Building GHG Emissions 2018

	Public Sector & Institutional Building kWh	Scope 1 TCO_2e	Scope 2 TCO_2e	Scope 3 TCO_2e	Total TCO_2e
Electricity	78,200,196		22,131		22,131
Natural gas	202,324,329	37,025			37,025
Gas Oil	11,256,843	3,107			3,107
Coal	946,372	236			236
T&D Losses				1,877	1,877
Total	**292,727,740**	**40,368**	**22,131**	**1,877**	**64,375**

Sources: ONS Fuel use industry group in the United Kingdom, 1990 to 2018; Department for Business, Energy & Industrial Strategy Energy Consumption in the UK, 2019; UK Government GHG Conversion Factors, 2020; BRES, 2018[7]

4.21 The role of natural gas and also solid and liquid fossil fuels to provide space and water heating is highlighted in the table. There has been a programme of heating unit replacement with wood pellet and wood chip biomass boilers, especially for schools in THC area. This has helped to displace previously fossil fuel heating systems, with onsite renewable energy. This is likely to continue as new and refurbished buildings incorporate the likes of solar PV panels and heat pumps to increase levels of onsite, low carbon, renewable energy. A significant challenge emerging during the preparation of this report will be the impact of COVID 19. This is likely to drive significant change in working practices in the area which in turn is likely to have an impact on the need for and use of public sector buildings.

Manufacturing Industries

4.22 There is a range of manufacturing activity taking place across THC area. The definition used for GHG analysis in the following table includes mechanical engineering and metal products, electrical and instrument engineering, food & beverages and textiles. There are different aspects of this sectoral activity undertaken at different locations in THC area. For example, there remains an element of engineering and metal products around the Cromarty Firth, and further north on the east coast, servicing the oil industry but increasingly the renewables sector. There are a range of food and drink producers spread across THC area, with concentrations in major population centres, for example Nairn, Inverness, Wick etc.

[7] Sources used for all subsequent tables

Table 7 - Highland Council Area Manufacturing Activity GHG Emissions 2018

	Manufacturing process kWh	Scope 1 TCO_2e	Scope 2 TCO_2e	Scope 3 TCO_2e	Total TCO_2e
Electricity	223,644,671		63,291		63,291
Natural gas	361,118,791	66,085			66,085
Petroleum	65,575,243	16,638			16,638
Coal	100,698,336	34,842			34,842
Other	294,299,986	80,982			80,982
T&D Losses				5,367	5,367
Total	**1,045,337,027**	**198,546**	**63,291**	**5,367**	**267,205**

Source: Department for Business, Energy & Industrial Strategy Lower and Middle Super Out Areas Electricity and gas Consumption, 2020; Department for Business, Energy & Industrial Strategy Sub-national residual fuel consumption in the United Kingdom. NB figures for Petroleum and Coal available for 2017 only

4.23 Recent years have witnessed the expansion of small food and drink businesses, for example craft breweries in the area. This has occurred at the same time as employment and energy consumption in traditional heavy engineering related to the oil and gas sector has declined. A developing opportunity for the area is the storage, maintenance and ultimately decommissioning of redundant fossil fuel sector infrastructure that is increasingly redundant due to age or changing sector economics.

Construction

4.24 Across the construction sector, GHG emissions arise from site preparation, construction installation, building completion, and the operation of construction equipment. For many of the more remote and rural sites developed for transport or energy production or transmission, this work can involve significant civil engineering. The use of large civil engineering plant is often the largest source of onsite energy consumption and resulting GHG emissions. Under the Stationary heading though, only the energy consumed, and subsequent GHG emissions, from Construction sector buildings and stationary plant is included.

Table 8 - Highland Council Area Construction GHG Emissions 2018

	Construction activity kWh	Scope 1 TCO_2e	Scope 2 TCO_2e	Scope 3 TCO_2e	Total TCO_2e
Electricity	7,765,572		2,198		2,198
Natural gas	47,821,535	8,751			8,751
Gas oil	68,593,811	16,463			16,463
Other	12,683,384	3,490			3,490
T&D Losses				186	186
Total	**136,864,302**	**28,704**	**2,198**	**186**	**31,088**

Sources: ONS Fuel use industry group in the United Kingdom, 1990 to 2018; Department for Business, Energy & Industrial Strategy Energy Consumption in the UK, 2019; UK Government GHG Conversion Factors, 2020; BRES, 2018[8]

[8] Sources used for all subsequent tables

4.25 The construction sector in the area has recovered from the slowdown in activity that resulted from the credit crunch. The energy sector continues to sustain a level of activity, installing new infrastructure to support the transition to low carbon energy. Roads improvements continues to support employment and GHG emissions production in both urban and rural locations in the area. And there continues to be a relatively buoyant domestic construction sector, supported by construction of both private and public funded social housing.

Energy Industries and Utilities

4.26 To provide an accurate assessment of GHG emissions from the energy industries and utilities sector involved developing a focussed definition of commercial activity. To facilitate this definition, we have removed a number of SICs that were not relevant. The data is now based on economic activity that includes Water collection, treatment and supply (SIC 36) and Waste collection, treatment and disposal activities; materials recovery (SIC 38).

4.27 There are an increasing number of renewable energy generation facilities in the Inverness GHG Inventory area. Large hydro schemes established in the 1950s and 1960s are now complemented with new pumped hydro and wind generated electricity. A desk review of these developments identified that on-site electricity consumption for the operation and maintenance of these facilities, where occurring, was not a significant source of emissions.

4.28 A number of landfill sites operate in the HC area. A large landfill site was operated on the outskirts of Inverness until 2003. Following its closure and capping, over 2 million m^3 of methane was flared from the site; 284.3m^3 per hour, running for approx. 8,400 hours in 2014. In early 2017, a 50kW turbine was installed to produce energy from burning the methane. A main by-product of this flaring is the production of CO_2 which has a lower global warming impact. The methane emissions for this site are therefore excluded from this analysis. There will be emissions arising from the physical collection and transport of waste. However, the figures for those emissions will be presented in the Transport section.

Table 9 - Highland Council Area Utilities Activity GHG Emissions 2018

	Utilities activity kWh	Scope 1 TCO_2e	Scope 2 TCO_2e	Scope 3 TCO_2e	Total TCO_2e
Electricity	59,274,750		16,775		16,775
Natural gas	5,088,230	931			931
Gas Oil	3,904,921	972			972
Other	25,322,819	6,964			6,964
T&D Losses				1,423	1,423
Total	**93,590,720**	**8,867**	**16,775**	**1,423**	**27,065**

Sources: ONS Fuel use industry group in the United Kingdom, 1990 to 2018; Department for Business, Energy & Industrial Strategy Energy Consumption in the UK, 2019; UK Government GHG Conversion Factors, 2020; BRES, 2018

Agriculture, Forestry and Fishing Activities

4.29 This sub-sector covers emissions produced by fuel combustion in primary sector activities, including plant and animal cultivation, afforestation and reforestation activities, and fishery activities. These emissions are typically from the operation of farm machinery, generators to power lights, pumps, heaters, coolers, boat engines etc.

Table 10 - Highland Council Area Agriculture, Forestry and Fishing GHG Emissions 2018

	Agriculture, Forestry and Fishing activity kWh	Scope 1 TCO_2e	Scope 2 TCO_2e	Scope 3 TCO_2e	Total TCO_2e
Electricity	252,363,515		71,419		71,419
Natural gas	6,794,431	1,243			1,243
Petroleum	6,794,431	1,631			1,631
Derv	181,411,299	45,171			45,171
T&D Losses				6,057	6,057
Total	**447,363,676**	**48,045**	**71,419**	**6,057**	**125,521**

Sources: ONS Fuel use industry group in the United Kingdom, 1990 to 2018; Department for Business, Energy & Industrial Strategy Energy Consumption in the UK, 2019; UK Government GHG Conversion Factors, 2020; BRES, 2018

Non-specified Sources - Miscellaneous

4.30 This subcategory includes all remaining emissions from Stationary Energy sources that are not specified elsewhere.

Table 11 - Highland Council Area Miscellaneous, Mining, Quarrying GHG Emissions 2018

	Miscellaneous, Mining and Quarrying activity kWh	Scope 1 TCO_2e	Scope 2 TCO_2e	Scope 3 TCO_2e	Total TCO_2e
Electricity	35,136,695		9,944		9,944
Petroleum	1,450,559,354	397,649			397,649
T&D Losses				843	843
Total	**1,485,696,049**	**397,649**	**9,944**	**843**	**408,436**

Summary

4.31 Our calculation of commercial energy consumption has relied on modelling to provide a disaggregation of UK sector energy use and applying this to the Highlands. Using this modelled energy consumption approach has resulted in a total gas consumption figure that is roughly twice the official figures for the Highlands and the electricity consumption two thirds the official figures.

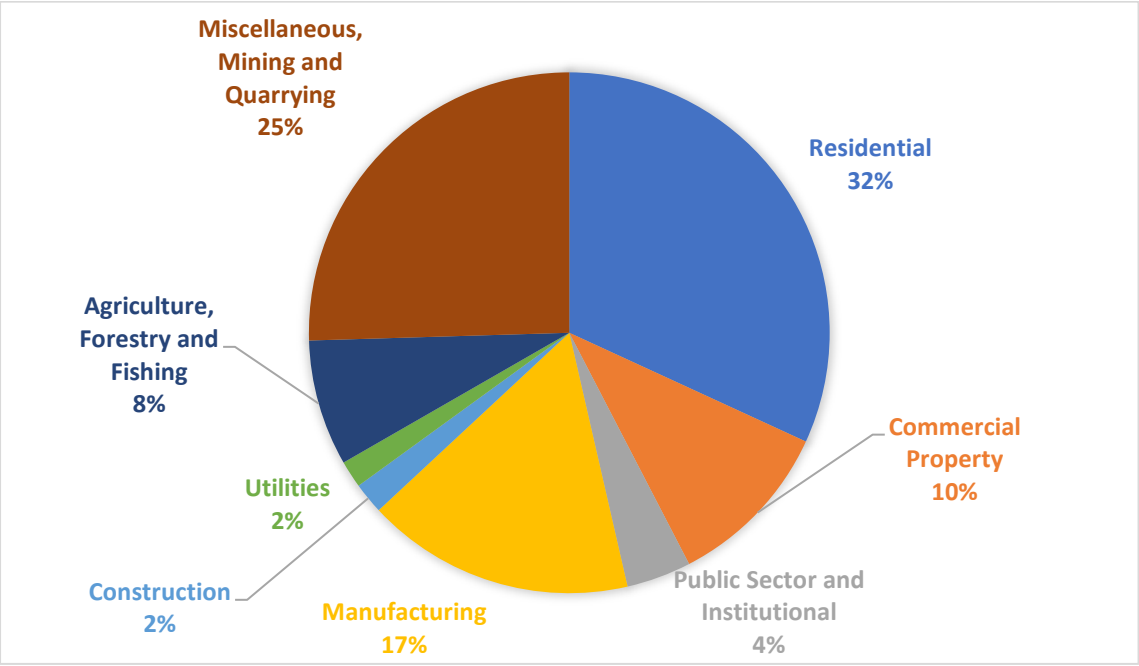
4.32 Gas consumption is likely to have a far lower penetration in businesses and sectors in the area, by the nature of the limited mains gas supply network. Our modelling has used national figures for shares of gas consumed per employee. In the UK there is a far more comprehensive gas supply network. In actuality, in the Highlands, there will be employees in sectors that do not have access to the main gas supply that their peers will have in other areas of the UK. So, in reality, they will be using other sources of energy, and this could primarily be electricity.

4.33 In the Highlands there is a greater proportion of micro and SME businesses which operate from smaller premises. These smaller premises are not able to benefit from the energy efficiencies available to larger premises through for example building and energy management systems. There is also scope in these larger premises to operate more efficient electric heating and lighting systems.

And as illustrated in the gas commentary, there is likely to be an inflated level of commercial electricity consumption to compensate for the lack of a mains gas supply in the Highlands.

4.34 The following chart illustrates the distribution of Stationary GHG emissions in 2018. Total Stationary emissions were 1,603,375 tCO_2e. Residential activity was responsible for 32% of all stationary emissions. Commercial property: retail, offices etc and the public sector estate, were responsible for 14% of the emissions produced in the Highlands. With exposure to a range of facilities from engineering in the north east coast, Cromarty Firth and Lochaber, manufacturing is responsible for 17% of the emissions. As indicated earlier, there needs to be a degree of caution interpreting this analysis due to the risks when applying national energy consumption benchmarks, to a smaller geography where there are unique energy consumption characteristics.

Figure 4 - Distribution of GHG Emissions from Stationary Energy Consumption in Highland Council Area - 2018



Transport

4.32 The Highlands area is characterised with a wide dispersal of settlements, and sparsity of population and businesses. This creates a number of challenges for the transport network, especially:

1. Cost effective delivery of public transport. There is limited frequency of bus and train services, where these services can actually be provided. This means that for many residents and communities, car ownership is a necessity rather than an option. The cost of road fuel is a key issue for many communities.

2. Long distances involved in travelling in the around the area. There are nearly 8,000 kms of roads in the area. This distance is the equivalent of driving on roads from Inverness to Moscow, and back.

4.33 As a result of these features, the Highlands are more reliant on road transport than elsewhere in Scotland. For example, vehicle ownership in the Highlands and Islands Transport Partnership region is 18% higher, and average distances travelled by road are estimated to be around 20% higher than the Scottish average.

4.34 The area also supports a range of water transport links, ferry terminals that provide transport to offshore island groups, ferries to provide short crossings which remove the need to take longer car journeys and a range of recreation and commercial water transport. In addition, there is one main airport at Inverness, complemented with several smaller airfields in the area.

4.35 Journeys via road, rail, water or air can either be wholly contained within THC area or cross boundaries into neighbouring local authority areas. Crossing from, or into THC area is known as transboundary travel. There are 3 types of transboundary trips:

1. Trips that originate in THC Council area but terminate in another local authority area.
2. Trips that originate outside, but terminate within THC area
3. Trips that pass-through THC area

4.36 A key challenge in calculating the emissions impact of an area's transport, is the very mobile nature of the production of these emissions. This is compounded by the challenge of identifying transboundary emissions in a meaningful manner. As a consequence, there can be differences in the degree of confidence and accuracy arising from emissions derived from accurate road count and fuel use data and modelled assumptions concerning the origin and destination of transboundary travel. However, with growing uptake of low emission and non-internal combustion engine vehicles, there is increasing value in understanding the source of transport emissions and how these will be addressed as we reduce transport reliance on fossil fuels.

4.37 The GPC defines emissions from road transport as all emissions associated with the combustion of fossil fuels for transport vehicles and mobile equipment. Emissions from these sources can be calculated directly from the fuel consumed or vehicle km travelled. A key challenge for estimating transport related GHG emissions for THC area inventory relates to the issue of cross-boundary travel. The GPC divides transport emissions into within-boundary trips (Scope 1) and cross-boundary trips (Scope 3).

Scope 1 – Scope 1 includes all GHG emissions from the transport of people and freight occurring within the Inventory boundary.

Scope 2 – Scope 2 includes all GHG emissions from the generation of grid-supplied electricity used for electric-powered vehicles.

Scope 3 – Scope 3 comprises emissions from the portion of transboundary journeys occurring outside the Inventory boundary, and transmission and distribution losses from grid-supplied energy for electric vehicle use. This includes the out-of-Inventory portion of all transboundary GHG emissions from trips that either originate or terminate within the Inventory boundary.

4.38 To facilitate detailed analysis and reflecting guidance from the GPC, the Transport Sector was divided into five sub-sectors:

- On-road transportation
- Railways
- Water transport
- Aviation
- Off-road transportation

On Road Transport

4.39 There is a significant road network in the Highland Council area. Data from the 2019 Edition of Scottish Transport Statistics show 7,712 kilometres of roads in Highland. That is the largest of any Scottish local authority and represents around 14% of the total length of the Scottish road network. The Highland road lengths comprise:

- Trunk roads: 960 km.
- Other A Roads: 1,400 km.
- B Roads: 970 km.
- C Roads: 1,440 km.
- Unclassified Roads: 2,942 km.

Use of this network by a dispersed population is compounded by several harbours in the area providing ferry links to island groups, Orkney and the Western Isles. There is a proportion of road use and subsequent emissions associated with transboundary through-travel to and from these harbours and ferry terminals. The following table identifies the associated emissions from different vehicle classes using these roads in 2018.

Table 12 - GHG Emissions for Road Travel in the Highland Council Area 2018

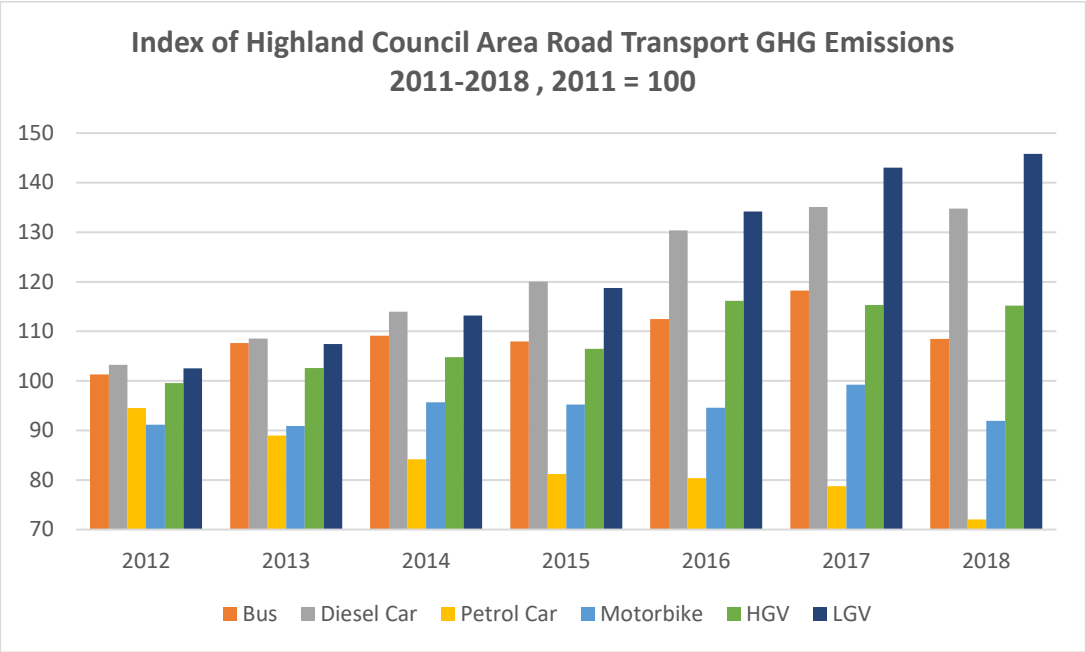
Mode of Travel		Highland Council Area – Tonnes of CO_2e
Buses	A roads	21,270
	Minor roads	6,345
	Total consumption	27,614
Diesel Cars	A roads	123,348
	Minor roads	36,437
	Total consumption	159,785
Petrol Cars	A roads	106,765
	Minor roads	29,002
	Total consumption	135,768
Motorcycles	A roads	3,194
	Minor roads	523
	Total consumption	3,717
HGV	A roads	109,722
	Minor roads	6,056
	Total consumption	115,779
Diesel LGV	A roads	86,880
	Minor roads	24,678
	Total consumption	111,558
Petrol LGV	A roads	2,336
	Minor roads	712
	Total consumption	3,048
Personal		326,883
Freight		230,384
Total		**557,268**

Source: BEIS Sub-national road transport fuel consumption, 2018

Notes: Buses, cars and motorbikes are classed as personal.

4.40 The following chart illustrates the changes in different vehicle emissions over the period 2011 – 2018 in tonnes of CO_2e. With the exception of petrol fuelled cars, the GHG emissions of all other forms of road transport increased. The largest increases were for diesel cars and also light goods vehicles. The use of petrol fuelled lights good vehicles declined over the period. The increase in light good vehicles is therefore a result of growing diesel consumption, possibly linked to the growth in online shopping and subsequent increase in local deliveries.

Figure 5 - Index of Highland Council Area Road Transport Emissions 2011 - 2018 (2011=100)



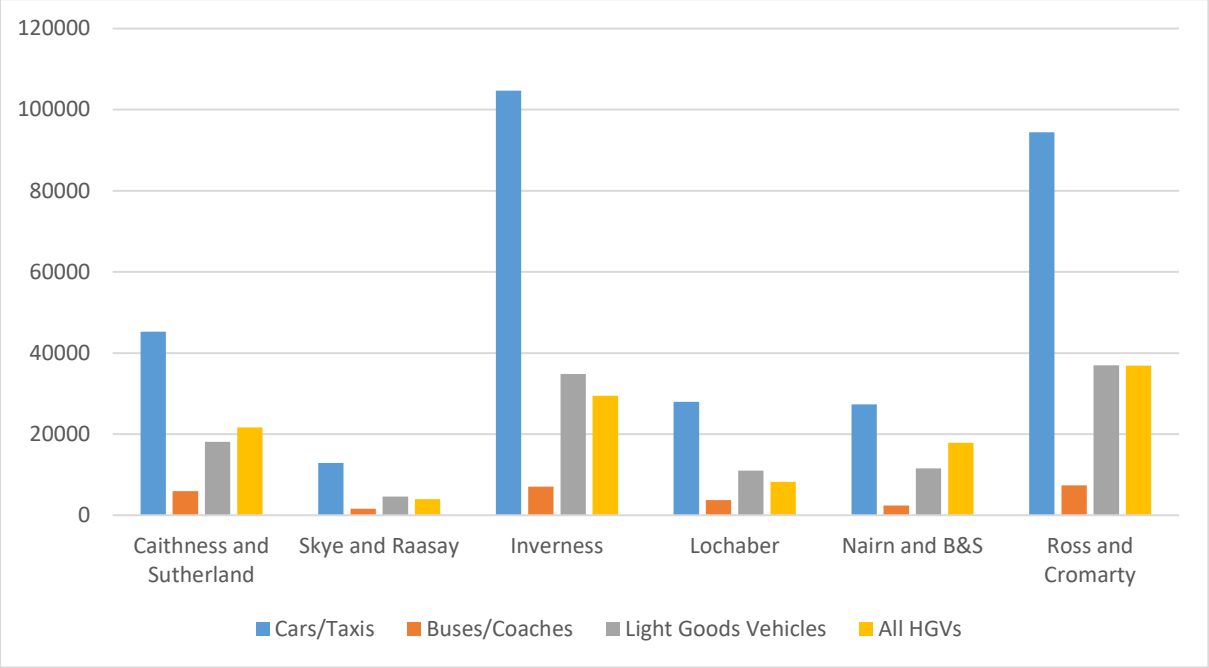
4.41 A key characteristic of the last decade has been growth in the amount of goods transported into, throughout and out of the HC area. The following chart illustrates how personal travel fuel consumption has remained relatively static over the period 2011 – 2018. However, freight transport fuel consumption has increased by just over 20% during that period.

Figure 6 - Index of Highland Council Area Personal and Freight Fuel Consumption (TOE) 2011 - 2018 (2011=100)

4.42 Within the HC area, road count data are undertaken to provide a more detailed picture of vehicle movement. There are 224 count points in Highlands for which 2018 data are available from the UK Department of Transport. These are in the form of average daily vehicle flows by vehicle type.

These were used to estimate the share of vehicle numbers across each of the six Highland ECO areas and the resulting GHG emissions.

Figure 7 - Main Sources of Road Transport Emissions (T CO_2e) in Highland ECO Areas 2018



The figures illustrate a number of interesting aspects of THC area's road transport emissions.

- The significant role played by personal travel in cars (majority of personal travel vehicles) and taxis
- The relatively low level of emissions from bus travel, especially in more rural locations. This reflects a lower level of demand and services outside urban centres
- The role played by Inverness as the main service centre for the Highlands with a significant amount of commuting and also the main north south, east west interchange at the city.

4.43 Calculating local road transport emissions involved a combination of using national statistics and assessing local road count data to disaggregate emission figures to smaller area profiles. The following text summarises the approach used to calculate road transport emissions.

Critique of Data Sources and Allocation to Highland

<u>Sub-National Road Transport Consumption Data</u>

Fuel consumption by road vehicles is calculated by the methodology used to estimate total UK emissions for road transport in the National Atmospheric Emissions Inventory (NAEI) and Greenhouse Gas Inventory (GHGI), and is consistent with internationally agreed procedures and guidelines for reporting emission inventories.

The methodology for calculating fuel consumption combines traffic activity data (from Department for Transport's national traffic census) with fleet composition data and fuel consumption/emission factors.

The base map of the UK road network is derived from the Ordnance Survey Meridian 2 dataset, which provides locations of all roads in Great Britain. The base maps and traffic flow census count

data were combined in order to map vehicle movements, and fuel consumption factors were then applied to map overall fuel consumption, as well as consumption in regions and local authority areas.

The estimates are therefore based on where the fuel was consumed rather than where it was purchased. Road fuel purchased abroad and consumed in the UK is included whereas road fuel purchased in the UK and consumed abroad is excluded.

This dataset covers road transport consumption of petrol and diesel only – Biofuels, LPG and electric cars are excluded.

The DUKES and ECUK figures derive fuel consumption based on fuel sales. The difference between sub-national and DUKES and ECUK figures varies year by year but the difference is considered well within the uncertainty of the factors used to derive the fuel consumption from traffic activity. The DUKES and ECUK fuel consumption figures are not available below the UK level.

For more information see:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/609332/Sub-national_Methology_and_Guidance_Booklet_2016.pdf

Traffic Counts

The frequency and accuracy of counts is another consideration for the robustness of these data. In the Inventory area, count points were available for 208 sites on A Roads. Only some 15% had actual counts (manually or automatically) in 2018, and thus the figures for the remaining 85% of sites were estimated based on count data from previous years. For B and Minor Roads, only 16 count sites were available, although the vast majority (14) of them had counts undertaken in 2018.

4.44 A challenge when using this methodology is the allocation of Highland data (deemed to be relatively robust) to the local ECO areas through traffic counts, especially due to the small number of traffic counts for the B and minor roads. Obtaining good coverage of traffic counts on a variety of representative points in the study area would improve the robustness of the figures.

4.45 The approach outlined in the previous critique estimated petrol and diesel use by vehicles travelling on roads in the HC area in 2018. The Scope 1 emissions that arise from the consumption of these fuels are calculated to equate to 142,532 tCO_2e for petrol and 414,736 tCO_2e for diesel.

4.46 While analysis has focused on the emissions arising from consumption of fossil fuels in internal combustion engines, there is growing number of vehicles on Highland roads with an electric drivetrain. There are also a range of hybrid vehicles that combine internal combustion engines with an element of battery power. These vehicles have the option to be charged from grid supplied electricity. While the combustion of fuels in internal combustion engines gives rise to Scope 1 emissions, the electricity required for electric vehicles is reported under Scope 2. The following table illustrates the number of plug in vehicles licensed in THC area and Scotland at the end of quarter 4 in 2018.

Table 13 - Number of Plug in Vehicle Registrations at the End of Quarter 4, 2018

	Number of Vehicles	Population - 2018	Per 000 inhabitants
Highland Council Area	306	235,540	1.3
Scotland	10,858	5,438,100	2.0

Railways

4.47 The rail network is an important aspect of Highland transport infrastructure. Data from the UK Office of Road and Rail show the number of station entries and exits by passengers at all Highland railway stations in 2018-19 at around 2.4 million. That represents a decline of around 3% compared to 2015-16. The main recent development in rail service provision has been an increased number of local train services between Inverness and Elgin which was introduced in late 2018.

4.48 All rail power units in THC area are fuelled by diesel. In 2017, 10,095[9] tCO_2e was allocated to rail transport in THC area. In order to allocate this to the ECO areas, a detailed analysis of the rail network and train frequency was conducted using Network Rail's Working Timetable (WTT). The 2019 Timetable was used as the 2018 one was not available. In order to allocate the Highland rail emissions figure between the ECO areas, a detailed analysis of rail network distances, engine type and train service frequency was conducted. This used information from Network Rail's Working Timetable. This calculated the average train kilometres run per week (both passenger and freight) in each of the ECO areas. The analysis found that, per week, all trains (both passenger and freight) travelled 60,482 kilometres on the rail tracks of Highland. The detailed analysis of movements indicates the distribution across each of the Highland ECO areas (that have access to the Rail network) as follows:

- Nairn, Badenoch and Strathspey: 25%.
- Inverness: 23%.
- Ross, Cromarty and Lochalsh: 21%.
- Caithness and Sutherland: 18%.
- Lochaber: 13%.

4.49 As there is no electrification of the railway network in Inverness or the wider Highlands, Scope 2 emissions will arise from electricity use in various stations, with this being accounted for in Stationary Energy.

4.50 As with all forms of travel in THC area, there is a contribution from transboundary movement; people starting journeys in the area and leaving and vice versa. These would be recorded as Scope 3 emissions. HITRANS commissioned a Rail Passenger survey in Autumn 2010[10] to collect data on passengers using the Highland rail network. While this research provides analysis of travel within the area, there is insufficient data to calculate Scope 3 emissions. As a result, transboundary rail Scope 3 emissions have been excluded from this report.

Water Transport

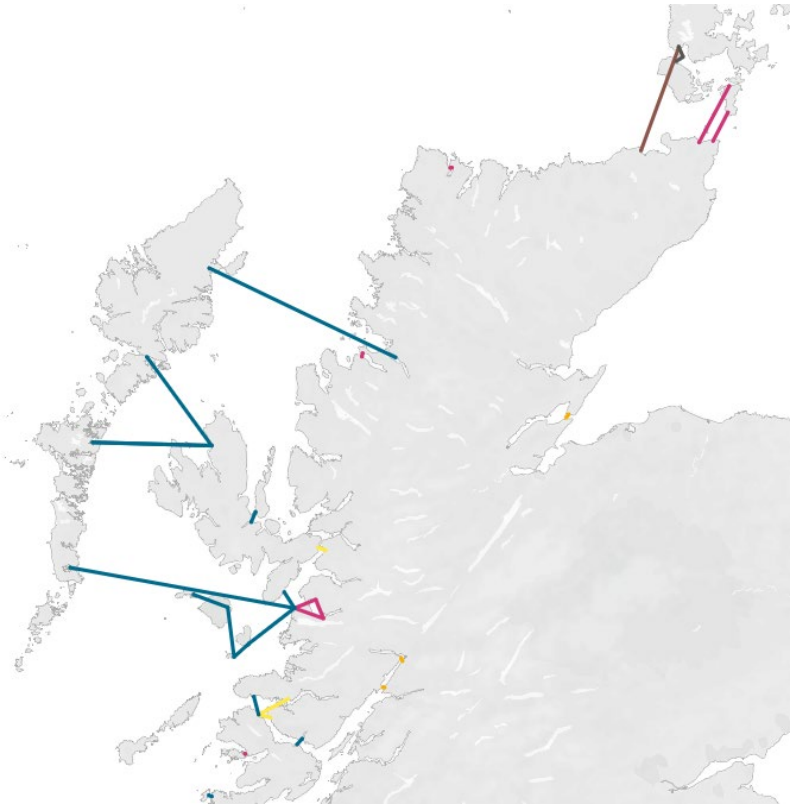
4.51 The provision of water transport is an essential element of THC area's transport network. Ferries transport essential goods to remote communities and help export large amounts of island produce, including seafood and whisky. There are also ferries, for example Corran and Cromarty, that cover short water crossings and remove the need for a longer road journey. Several larger harbours provide the opportunity for freight transport as well as broader commercial activity; lumber and timber transport, energy sector developments, etc. Some of the smaller harbours provide berthing and fuelling for fishing activity. And there is a range of water-based leisure transport; marinas, wildlife watching and sightseeing and leisure cruises.

[9] Sub-national residual fuel consumption in the United Kingdom 2005 - 2017

[10] HITRANS Rail Passenger Survey April 2011

4.52 A key challenge for calculating the emissions arising from water transport is the attribution of fuel consumption in activity attributed to the inventory area. For example, some of the ferry routes identified in Figure 8 transport passengers, freight, vehicles to and from THC area. However, it is likely a significant proportion of that transport activity is transboundary, with vehicles moving through and out of THC area. The harbour and pier at Uig in Skye are a perfect example. This infrastructure provides facilities for the local and visiting fishing fleet. It also provides the pier infrastructure for the Calmac ferry to the Western Isles. This service will allow businesses and visitors from out-with THC area, to travel to and from the islands. However, without more detailed analysis of the origin and destination of ferry traffic, it is challenging to allocate the fuel use and subsequent emissions to THC area Inventory. And this transboundary travel would be recorded as Scope 3 emissions, which the HC has less ability to influence. However, it is important to recognise the significant local employment role provided by these ferry terminals and their associated infrastructure, ticket office, parking, local food and drink and accommodation provision. We have therefore calculated the emissions associated with this ferry traffic for reference. There will be scope to use future work to provide a more robust allocation of these emissions to the local area inventory.

Figure 8 - Ferry Routes, To, From and Within, Highland Council Area 2018



*While the map identifies 2 routes to Mull from Lochaline and Kilchoan these were excluded from analysis due to their small size and also the fact they were providing transport out of and into the area.

4.53 The following table assesses the levels of fuel consumption and subsequent emissions arising in water-based transport in THC area. While the emissions arising from large ferry traffic has been excluded from our inventory reporting, where viable, we have included the figure in the following table for reference. The transboundary figures have been highlighted in red.

Table 14 - Water Transport Emissions in Highland Council Area 2018

Harbour/Transport Route	Nature of fuel consumption	T CO_2e Excluded	T CO_2e included
Commercial Ports			
Inverness	Own pilot boats consuming 8,539 litres		26
	Commercial merchant vessels fueling consuming 332,982 litres	**1,035**	
Highland Council Managed Harbours			
Helmsdale,	Mainly inshore/local fishing fleet consuming 22,225 litres		69
Gairloch	Mainly inshore/local fishing with pontoons for leisure craft consuming 466,376 litres		1,450
Uig,	Mainly local shellfish boats consuming 865,521 litres		2,691
Elgol	Mainly local fishing and local and visiting leisure craft consuming 158,090 litres		491
Old Dornie (Achiltibuie),	Mainly local fishing fleet consuming 93,448 litres		290
Lochinver	Principally UK whitefish fleet and foreign fishing vessels consuming 10,969,644 litres		34,115
Nairn	Provides a limited number of visitor and local fishing boat berths consuming 4,396 litres		13
Kinlochbervie	Similar services to Lochinver consuming 5,742,357 litres		17,858
Portree	Local fishing fleet, visiting leisure craft and also fish farming boats consuming 349,090 litres		1,085
Kyle,	**Mixture of fishing, commercial vessels, Royal Navy etc consuming 3,823,999 litres**	**11,892**	
Non Calmac Ferries*			
Corran Ferry	While fuel information has been provided, it is not reproduced for confidentiality reasons.		939
Camusnagaul-Fort William (passenger only)			10
Mallaig-Inverie/Knoydart			180
Cromarty-Nigg			52
Glenelg-Kylerhea			19

Harbour/Transport Route	Nature of fuel consumption	T CO_2e Excluded	T CO_2e included
Northlink-Scrabster-Stromness		**30,872**	
Pentland Ferries-Gills Bay-St Margaret Hope		**5,983**	
Calmac Ferries			
Mallaig – Armadale	Figures provided by Calmac identified the GHG emissions per foot passenger per route. This has been multiplied by the number of foot passengers to provide an indicative emissions figure. Where one boat can make different journeys, e.g. MV Loch Nevis, the emission by passenger figures of all the routes have been averaged		350
Sconser – Raasay			71
MV Loch Nevis - Small Isles			589
Uig – Tarbert/Lochmaddy		**979**	
Mallaig – Lochboisdale		**398**	
Ullapool – Stornoway		**1431**	
Total of non transboundary marine transport emissions			**60,307**

4.54 Our analysis provides an initial assessment of the role of water transport emissions in the THC area in 2018. Analysis has focused on the marine environment as that supports the largest proportion of water transport GHG emissions. There is a proportion of freshwater transport emissions, especially around for example tourism businesses providing trips on Loch Ness. However, at the time of preparing this report, very many of these businesses were either closed or operating with restricted staffing levels as a consequence of the COVID 19 outbreak. It was not possible to access data on fuel use for these businesses. However, their contribution to overall water transport emissions, would be small.

4.55 The water transport sector is undertaking a range of activity to reduce the production of GHG emissions:

- The scope for hybrid, hydrogen and electric powered as well as more efficiently operated fossil fuelled vessels is an ongoing area of investigation for the commercial and public sector water transport operators in the area. It is also an area of interest for visiting cruise ships from out with the area
- There is increasing investigation of the scope for onsite renewable energy production that could either provide stationary energy use in onshore marine transport infrastructure or can provide power directly to moored vessels. This reduces the need for the vessels to be consuming fossil fuels in onboard internal combustion engines.

Aviation

4.56 In 2018, within THC area there were 2 main operational airports, Wick John O' Groats and Inverness. There were also several smaller airfields, for example Broadford, Plockton and Glen Feshie. All flights from Wick are for travel out of and to THC area. At Inverness airport there are a range of flights by helicopter to other areas in the Highlands and Islands though no scheduled flights from Inverness to Wick John O' Groats. All the scheduled fixed wing flights from Inverness are to airports out with the area. A key challenge is trying to allocate fuel consumption and therefore emissions, to this portfolio of journeys.

4.57 Aviation is a challenging area of inventory emissions measurement. Civil aviation, or air travel, includes emissions from airborne trips occurring within the Inventory area, for example air ambulance flights to and from Raigmore Hospital. There are no fixed wing flights departing Inverness airport to Wick John O' Groats. A significant amount of emissions associated with air travel occur outside the THC inventory area. These complexities make it challenging to properly account for and attribute aviation emissions. For simplicity, scope 3 includes all emissions from departing flights. It is possible to report just the portion of scope 3 aviation emissions produced by travellers departing the Inventory area. However, this requires a detailed understanding of the origins of flight passengers which in turn requires detailed passenger research. There is also a need to disaggregate data between domestic and international flights to improve integration with national GHG inventories.

4.58 To prepare an accurate emissions assessment for aviation in THC Inventory area would involve the following activity:

- Scope 1 includes emissions from the direct combustion of fuel for all aviation trips that depart and land within THC Inventory area (e.g., local helicopter, light aircraft, sightseeing and training flights). To inform Scope 1 analysis, we approached businesses supplying fuel from their premises at Inverness airport. Due to commercial sensitivity and also Covid 19, we were unable to access a realistic profile of fuel sales for 2018. The Covid 19 turmoil also compromised the ability to approach local businesses flying in the area, to request information.
- Scope 2 emissions arise from grid supplied electricity used in airport buildings etc and are collected in the Stationary Energy chapter.
- Scope 3 includes emissions from departing flights. This involves identifying the types of fuels consumed in departing aviation trips, the quantity (volume or energy) of each type of fuel consumed by the aircraft associated with these flights, and whether the trips are domestic or international. Due to the challenges of Covid 19 on the aviation industry we avoided contacting operators to request data.

4.59 Due to these complexities, it has not been possible to identify the emissions arising from the operation of Inverness Airport in 2018. A review of emissions for Glasgow Airport[11] identified that scope 3 emissions represented 98% of the airport's overall GHG emissions. These are the emissions that can be least influenced by the airport management.

Off Road Transport

4.60 Off-road vehicles are those designed or adapted for travel on unpaved terrain. This category typically includes all terrain vehicles, landscaping and construction equipment, tractors, bulldozers, amphibious vehicles, snowmobiles and other off-road recreational vehicles. When preparing an area GHG Inventory, emissions from off-road transportation activities within transportation facility premises such as airports, harbours, bus terminals, and train stations should be included. It is likely airport operations are the largest element of off-road transport, moving baggage trailers and the use of pushback tractors or tugs to move planes away from terminal buildings.

4.61 This has been excluded from analysis due to the challenge of accessing historical data that was specifically linked to off road transport activity.

[11] Glasgow Airport Carbon Footprint 2019, Glasgow Airport Limited

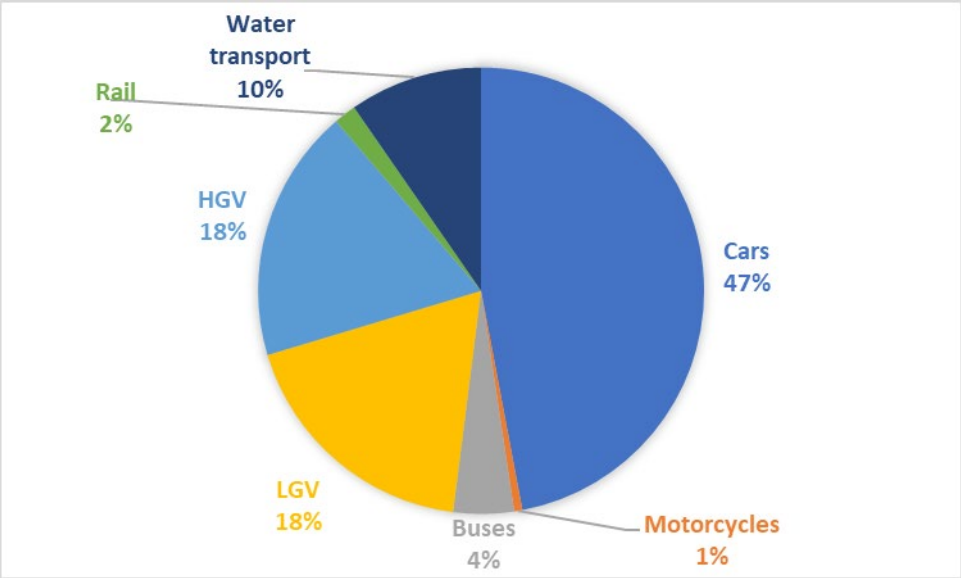
Transport Emissions Summary

4.62 The following table and chart illustrate the distribution of Inventory Area transport GHG emissions that we have identified (noting the exclusions above). Road transport and the resulting consumption of petrol and diesel was responsible for 97% of the transport emissions.

Table 15 - Summary of All Highland Council Area Transport Derived GHG Emissions

	Total tCO_2e
Cars	295,552
Motorcycles	3,717
Buses	27,614
LGV	114,606
HGV	115,779
Rail	10,095
Water transport	60,308
Aviation	No data
Off Road	No data

Figure 9 - Distribution of Highland Council Area Transport Derived GHG Emissions



Industrial Processes and Product Use (IPPU)

4.63 Within THC area, there is non-energy related industrial activities and product uses that result in the production of GHG emissions. The GHG emissions occurring from industrial processes, product use, and non-energy uses of fossil fuel, are assessed and reported under the heading of Industrial Processes and Product Use (IPPU).

4.64 A combined desk and online review of key sources of potential emissions involved assessing the Scottish Environmental Protection Agency's Scottish Pollutant Release Inventory (SPRI). The SPRI provides GHG emission values when they exceed reporting thresholds. Analysis for 2018 identified eight entries in the SPRI. Four of these relate to waste disposal landfill sites. One relates to agriculture activity and these emissions are recorded in the agriculture section. The remaining 3 records are

identified in the following table. We have allocated these emissions as Scope 1 for the carbon dioxide and scope 3 for the PFCs. It was not possible to obtain feedback from the businesses on these allocations.

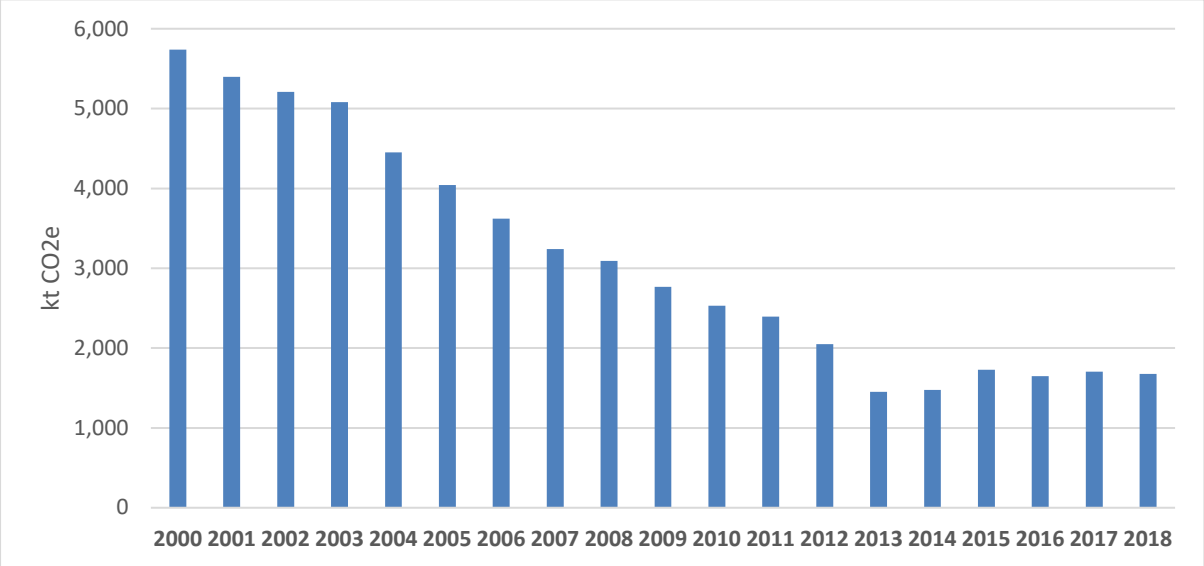
Table 16 - GHG Emissions from Industrial Processes 2018

Site	Activity	Emission	Amount (kgs)	Tonnes CO_2e
Norbord Europe Limited.	Wood products	Carbon dioxide	111,304,268	111,304
Simec Lochaber Hydropower 2 Ltd.	Metal materials	Carbon dioxide	77,837,343	77,837
Simec Lochaber Hydropower 2 Ltd.	Metal materials	Perfluorocarbons (PFCs)	1,324	9,930
Total				**199,071**

Waste

4.65 A range of waste material is produced in THC area. This can be disaggregated into solid waste and wastewater that will be disposed of and/or treated at facilities in THC area or removed and treated/disposed elsewhere in Scotland. The waste management sector constituted just over 4% of all GHG emissions in Scotland in 2018. Emissions from the waste management sector in Scotland had been steadily declining, by 44% since 2000 as illustrated in the following chart. This has been driven by reductions of emissions from landfill, achieved by the progressive introduction of methane capture and oxidation systems within landfill management. There has been a small rise in these emissions over the period 2015 – 2018.

Figure 10 - Total GHG Emissions from Waste management In Scotland 2000 - 2018



Source - Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2018 Department of Energy and Climate Change, The Scottish Government, The Welsh Government, The Northern Ireland

4.66 There has been an increasing focus on the amount and types of waste being generated in Scotland, supported by the Government's Zero Waste Scotland Plan. To assess detailed waste analysis in this report, the following guidelines were adopted:

- **Scope 1**: Emissions from waste treated inside THC area. This includes all GHG emissions from treatment and disposal of waste within the area regardless of whether the waste was generated within or outside the area.
- **Scope 2**: Emissions arising from grid supplied electricity consumed in waste treatment facilities within the Inventory area are reported under Scope 2 in Stationary Energy, commercial and institutional buildings and facilities.
- **Scope 3**: Emissions from waste generated by businesses, residents and visitors in the Inventory area, but treated at a facility outside the area.

Solid Waste Disposal

4.67 There are two specific waste streams produced in the area: commercial and domestic. In 2018, there were 148,486 tonnes of commercial waste produced in the area. Of this, 48% or 71,706 was vegetal waste. For the same period, there were 127,880 tonnes of domestic waste produced, of which 55% was landfilled. The remainder was recycled, incinerated, and also composted. There is a complex mix of distribution of wastes which will be handled and treated in different ways. It is not possible at this stage to provide a complete profile of the different waste weights, treatment and subsequent emissions. The following sections estimate waste emissions, where it has been possible to identify final disposal/treatment.

4.68 Online assessment of the Scottish Pollutant Release Inventory identified the production of methane during 2018 from a number of landfill and waste treatment sites in THC area. This is a database of annual mass releases of specified pollutants, including GHG's, to air, water and land from SEPA regulated industrial sites. These records identify the volume of waste related emissions in 2018 and these are recorded in the following table.

Table 17 - GHG Emissions for Highland Council Area Landfill Sites - 2018

Site	Activity	Emission	Amount (Kgs)	Tonnes CO2e
The Highland Council - Granish Landfill	Waste	Methane	40,800	
The Highland Council - Portree Landfill	Waste	Methane	97,800	2,445
The Highland Council - Seater Landfill	Waste	Methane	83,900	
Locheil Logistics Ltd. Duisky Landfill	Waste	Methane	189,000	4,725
Total				**7,294**

*It has not been possible to get confirmation from Locheil Logistics Ltd of how their waste is processed. As a result of the confirmed flaring at Granish and Seater, their emissions are not recorded in the Inventory total.

4.69 The methane produced at these sites has 25 times more impact than the same volume of CO_2. To reduce the release of methane to the environment, emissions are often flared at site and this process can be integrated with a turbine to produce energy. The flaring process converts the methane to CO_2, and this emission is considered a natural process and not part of the GHG inventory[12].

4.70 There will be a proportion of the solid commercial and domestic waste that is disposed out with the area, likely in landfill, which subsequently results in the release of emissions. However more

[12] UK Greenhouse Gas Inventory 1990 to 2014: Annual Report for submission under the Framework Convention on Climate Change, DECC 2016, Page 414

detail would be required from waste contractors on for example where waste is being disposed, to help inform accurate analysis. For example, some of the domestic waste taken from the Highlands, is processed elsewhere in Scotland, with a proportion exported to Scandinavia for incineration.

Biological Treatment of Waste

4.71 In THC area, garden and food waste and also waste from the food and drink sector is collected and transferred out of the area for processing/composting etc. In 2018, 71,606 tonnes of commercial and 21,739 tonnes of domestic vegetal waste was treated out with the area. This has helped to inform our calculations for the emissions arising from treatment of this waste as follows:

- Methane = 93,345t x 4g/kg x 10-3 – 0 = 373t CH_4. Considering methane's GWP, this equates to 9,334t CO_2e.

- Nitrous Oxide = 93,345t x 0.3g/kg x 10-3 = 28t N_2O. Nitrous Oxide has a 100-year GWP 298. This equates to 8,345t CO_2e.

The total emissions arising from the biological treatment of waste are thus calculated as 17,679t CO_2e. This is a Scope 1 emission.

Incineration and Open Burning

4.72 During 2018, there was 7,370 t of waste sent for incineration in Sweden: 6,160t of the residual waste and 1,210t of the residue from the comingled recyclate. There are both methane and nitrous oxide emissions that arise from this combustion process. However, to accurately calculate these emissions requires detailed information on the volumes of the different wastes sent for incineration and also the type of incinerator process used. Identifying this type of detail is beyond this current Inventory project and would require more detailed waste analysis. We have therefore excluded the emissions arising from waste incineration.

Wastewater Treatment and Discharge

4.73 Wastewater treatment gives rise to methane and nitrous oxide from the storage, settlement, processing and spreading of sewage sludge. While there are numerous wastewater treatment facilities across the area, there are also a significant number of rural domestic properties with their own private drainage and treatment arrangements. Scottish Water have indicated that across THC area, their facilities serve a population equivalent of 255,000. Using a Scottish Water provided Scotland wide average figure of 0.19g CO_2e per litre of wastewater treated and an average of daily wastewater flows of 150 litres person suggests water treatment emissions in 2018 of 2,652t CO_2e.

Waste Emissions Summary

4.74 Calculating waste emissions for THC Inventory area has required different methodologies from those used to determine, for example, stationary energy and transport emissions. This is an emerging area of analysis, informed by developing an understanding of a range of biological processes. There are gaps in our analysis where we have been unable to confirm in sufficient detail, volumes of waste treated, the constituents of this waste and also the processes and efficiencies of the actual treatment process. There is scope in future work to assess these aspects in more detail to help provide a more complete picture of waste emissions. The following table summarises the sources of waste GHG emissions for the Inventory area.

Table 18 - Sources of Waste Related GHG Emissions for the Highland Council Area - 2018

	tCO_2e

Waste to Landfill	7,294
Waste Composted	17,679
Incineration and Open Burning	Insufficient data
Wastewater Treatment and Discharge	2,652
Total	**27,625**

Agriculture, Forestry and Other Land Use

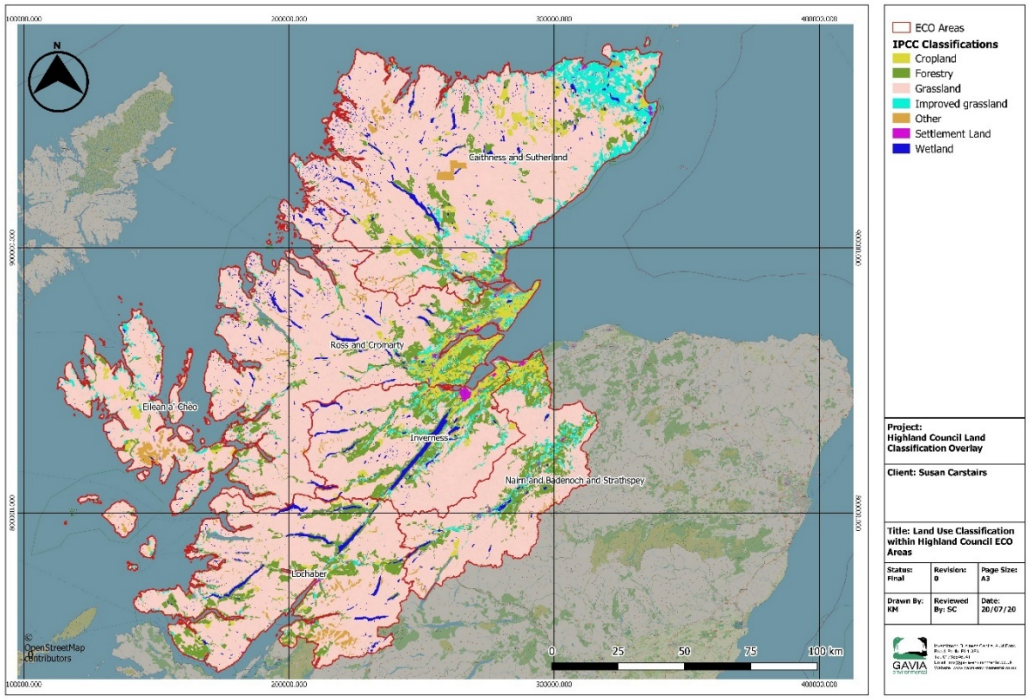
4.75 This section reviews the GHG emissions arising from land use activity and land use change in the Inventory area. This is a key aspect of the GHG Inventory as land plays a vital role in supporting local economic activity as well as providing a resource that helps differentiate Highland from the rest of Scotland. Agricultural data has been obtained from the Rural and Environment Science and Analytical Services team at the Scottish Government and other land use data has been supplied by digital mapping carried out by Highland Council and Gavia Environmental Ltd. The Intergovernmental Panel on Climate Change (IPCC) considers emissions separately for different forms of land use based on an estimate of annual change in carbon stocks. Some emissions arise due to the way land is managed and others due to a change in land use which provokes a transition between one level of carbon and another.

Agriculture

4.76 To calculate emissions from Agriculture, we have used the guidance issued by the IPCC to provide an assessment of land use and land use change greenhouse gas emissions for 2018. Where feasible, we have used UK figures and emission factors and we have taken advice from SAC experts on local conditions in Highland farms.

4.77 Emissions in the agricultural sector are mainly composed of methane (CH_4) and nitrous oxides (N_2O). As explained in the waste section, these gases have a greater global warming potential than carbon dioxide. Emissions from agriculture occur from stock and from soils. Animals produce methane emissions from enteric activity and manure. Almost all other emissions are from nitrogen, from manure directly, from its application to the ground and from animal deposits when grazing. In addition, nitrogen is present in artificial fertiliser and in crop residues which are reincorporated into the soil. A small amount of carbon is produced from the application of lime to resist soil acidity.

Figure 11 -IPCC Land Use Classifications Highland 2018



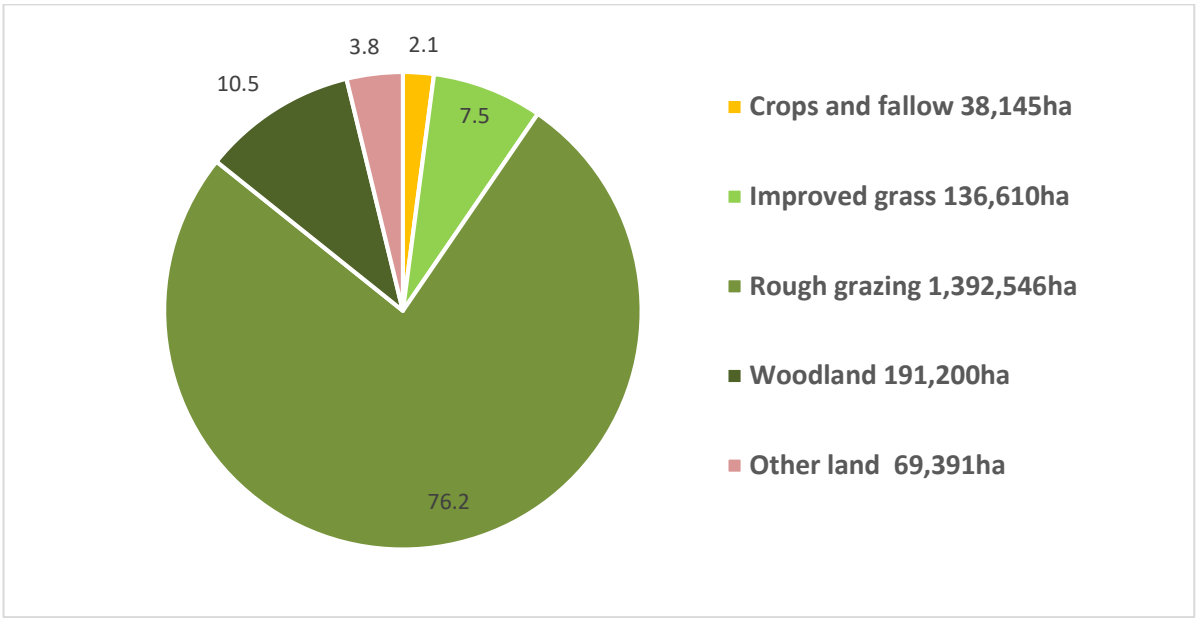
4.78 The HC area covers 2,648,400 hectares. Across such a vast area there are significant differences in agricultural activity and associated greenhouse gas emissions. In very broad terms most of the Highland area is designated as having Less Favoured Area status within the European Union and is regarded by the assessment Land Capability for Agriculture (James Hutton Institute) as being unfit for anything more than extensive grazing for animals. There are, however, significant contrasts within the area, and land around the Moray Firth and in Caithness is some of the most productive in Scotland. Work towards carbon reduction in Highland needs to recognise these contrasts and range.

4.79 To calculate greenhouse gas emissions for agriculture involved assessing numbers of stock and areas of crops recorded in the 2018 June Agricultural Census issued by the Scottish Government. We have allocated data into the six ECO districts currently operated by the Council. The main calculations, however, have been carried out at the lower level of ten districts in order to incorporate assumptions about animal and crop management that vary between the east and west coast (Caithness, Sutherland, Easter Ross, Black Isle, Inverness, Nairn, Badenoch& Strathspey, Lochaber, Skye and Wester Ross). The census data is aggregated up from agricultural parish level to districts. Experts from the Highland Council Planning and Development service assisted with assigning parish geography to that of the six ECO districts.

4.80 In 2018 the total agricultural land reported in the June Annual Census stood at 1,828,875ha, dominated by rough grazing at 76%. At the other end of the scale, crops occupy only 2% of the land. This varies dramatically between districts with rough grazing making up 85% of the agricultural land in Wester Ross, falling to only 7% in the Black Isle.

4.81 In terms of crops the main cereals in Highland in 2018 are spring barley, 21,667ha, spring oats, 2,594ha, and wheat 2,833ha. Over half of the barley is grown in Easter Ross and the Black Isle. Over two thirds of the wheat being grown in the area is produced in the Black Isle and Easter Ross with approximately 15% each in Inverness and Nairn.

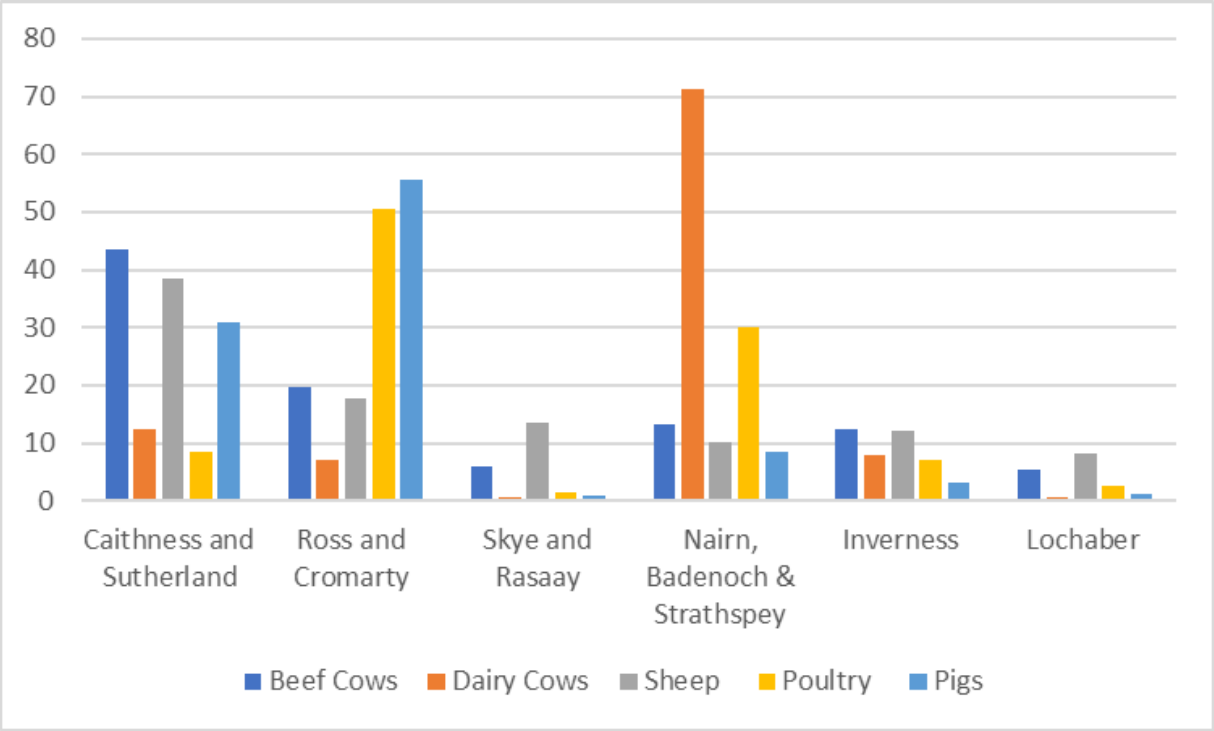
Figure 12 - Agricultural Land in The Highland Council Area 2018



4.82 Across the Highland area, cattle are predominately beef with small dairy herds; 64,250 beef cattle and 2,668 dairy cows respectively. Approximately a third of the beef herd is in Caithness

followed by Inverness district and then Badenoch and Strathspey. The majority of the dairy cows are in Nairn with the largest sheep flock in Caithness. Just over three quarters, 77% of pigs are in Easter Ross and Sutherland with a further 9% in Nairn. Nearly half the poultry flock are in Easter Ross with a further 30% in Nairn. There is a range of smaller numbers of animals and stock reared across the area including ducks and geese, horses, deer, goats and even just over 200 camelids (predominately alpacas)

Figure 13 - Percentage Distribution of Livestock by Highland Council ECO area 2018



4.83 Our analysis indicates total agriculture emissions for 2018 at 493,546 tonnes CO_2e. There are some subtle differences when assessing these emissions compared with Scotland as a whole. Enteric emissions are higher in Highland though manure methane is lower, reflecting the relatively low level of housing of stock. Nitrogen from fertiliser is lower in Highland but nitrogen from manure spread to land and from grazing deposits is higher. This reflects the predominance of cattle and sheep over crops and the extensive nature of stock management in the Highlands where animals will spend more time outdoors. Methane constitutes 65% of the total emissions, most of this from enteric processes arising from the digestive system of ruminant animals. Nitrogen emissions are spread quite evenly between artificial fertiliser, organic manure and grazing deposits which refers to the manure left on pasture and hill ground by grazing animals.

Table 19 - GHG Emissions from Agriculture in the Highland Council Area in 2018

	CO2e t	%
Animals		
Enteric methane	287,190	58.2
Manure methane	31,085	6.3
Manure nitrogen	29,149	5.9
Soils Nitrogen		
Artificial Fertiliser	39,480	8.0
Animal manure	37,119	7.5
Crop residues	17,943	3.6
Sewage	2,061	0.4
Grazing deposits	32,578	6.6
Soils Carbon		
Liming	16,941	3.4
Total	493,546	100.0

Forestry and Other Land Use

4.84 The IPCC categorises land use very broadly into forestland, cropland, grassland, wetland and settlement land. Forestland gives rise to emissions and sequestration of carbon in the biomass of growing trees, in soils and for example drainage. An indication of overall land use has been derived from the Land Cover of Scotland survey carried out in 1988. Emissions for 2018 have been based on more recent data but the LCS88 map remains one of the best for overall coverage and is given here as an illustration. Digital mapping identifies Highland is heavily dominated by grassland consisting of rough grazing, semi natural land, heather moorland and montane areas, representing 80% of the land area. Most of the cropland is around Inverness, Easter Ross and the Black Isle though with notable areas of improved grassland in Caithness.

Table 20 - Land Use (Hectares) in Highland Council ECO Areas 1988

	Caithness and Sutherland		Ross and Cromarty		Skye and Rasaay		Nairn, Badenoch & Strathspey		Inverness		Lochaber	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Forestland	30,243	4	30,689	5	4,832	3	25,403	8	29,848	9	44,751	9
Cropland	89,535	11	55,265	9	16,748	10	34,498	11	44,064	14	12,648	2
Grassland	628,525	79	510,890	82	146,838	86	251,498	78	232,131	72	379,428	80
Wetland	40,471	5	24,477	4	1,862	1	6,539	2	14,146	4	24,667	5
Settlement	2,625	0	2,500	0	266	0	1,595	0	2,642	1	1,217	0
Other	5,588	1	1,035	0	111	0	1,814	1	1,096	0	7,168	1
Total	**796,987**		**624,856**		**170,657**		**321,347**		**323,927**		**469,879**	

*****This table, while now 32 years old, provides an excellent breakdown of land use by ECO areas. While there will be changes in the absolute numbers, it is unlikely there have been significant changes in this area breakdown of land use.

4.85 In 2018 the National Forest Inventory records a total area of 380,728 ha of forested land in the THC area. Of this, 75% are conifers and 25% broadleaf. In terms of ownership, 41% are managed by Forestry & Land Scotland and 59% in other ownership. The species and age of trees are derived from NFI provisional estimates for woodlands in the Highlands and Islands Conservancy and show the predominance of Sitka Spruce, Scots Pine and Lodgepole Pine amongst the firs and birch and oak amongst the broadleaves.

Table 21 - Principal Woodland Species in the Highland Council Area in 2018

	Ha FC	%	Ha Other	%	Ha Total	%
Conifers						
Sitka Spruce	36,004	35%	68,993	38%	104,997	37%
Scots Pine	24,652	24%	56,818	31%	81,469	29%
Norway	2,054	2%	3,111	2%	5,166	2%
Larches	6,379	6%	8,252	5%	14,631	5%
Douglas	2,162	2%	2,976	2%	5,139	2%
Lodgepole	30,274	30%	39,502	22%	69,776	25%
Other	865	1%	1,759	1%	2,624	1%
Total	**102,391**		**181,411**		**283,802**	
Broadleaf						
Oak	1155	4%	4667	7%	5822	6%
Beech	289	1%	1420	2%	1709	2%
Sycamore	0	0%	1522	2%	1522	2%
Ash	289	1%	1319	2%	1608	2%
Birch	15011	55%	46977	68%	61988	66%
Hazel	289	1%	812	1%	1100	1%
Hawthorn	0	0%	101	0%	101	0%
Alder	577	2%	4363	6%	4940	6%
Willow	0	0%	1928	3%	1928	2%
Other	9815	36%	6392	9%	16207	12%
Total	**27,425**		**69,501**		**96,926**	

4.86 Age profiles enable an assessment to be made of the annual average increment in cubic metres per hectare for individual species. We have also included a calculation to identify the biomass in the crown, branches and roots to give a figure for the annual sequestration from the growing trees. Part of this sequestration is lost due to harvest and this has been assessed for Highland at a rate of $5m^3$ per hectare, though a portion of the biomass is left behind in the form of roots and branches. Forest soils are subject to emissions due to drainage and this is marked in Highland where the UN National Inventory assumes that drainage has taken place on all organo-mineral, peat and 24% of mineral soils. An estimate is also made for the impact of fertiliser. While this is no longer used by Forestry Scotland, it is assumed to be applied in the private sector for young trees at a rate of 150kg N per hectare applied twice during the first 10 years, giving an average of 30kgN/ha/yr for these trees. While these emissions are not negligible, they are small and have a very small impact in eroding the significant sequestration supported by woodland and trees.

Table 22 – Highland Council Area Greenhouse Gas Emissions from Forestry 2018

	Tonnes N_2O	Tonnes Carbon	Tonnes CO_2e
Forestry Activity			
Biomass growth		-830,734	-3,046,026
Harvest		528,980	1,939,595
Harvest residue		-217,032	-795,784
Litter and deadwood		-24,458	-89,709
Total			**-1,991,924**
Forest Soils			
Forest soils drainage	40.59	90,202	342,839
Fertiliser	6.79		2,025
Total			**344,864**
Forest Impact			**-1,647,060**

Other Land Use

4.87 The national inventory for other land use emissions is based on a land use matrix that is challenging to reproduce at a local level. Our analysis has used agricultural data to provide a reliable but partial account of land use change over the last twenty years. This is an incomplete account but provides an illustration of issues that are important in THC area. A full account would require the development of a long-term land use matrix and this would be a useful ambition for Highland climate change work.

4.88 For other land use, the main source of emissions is changes in soil carbon concentrations, either from a change of land use, which provokes a transition from one soil carbon stock to another, or from the management of land. Our analysis uses a figure of soil carbon for cropland of 150tC/ha, improved grassland of 230tC/ha and rough grassland and forestland of 330tC/ha. We have created a matrix to illustrate the emission changes between 1998 and 2018.

Table 23 - Agricultural Land Use Matrix for 1998 and 2018 (Hectares)

From/To	Crops ha	Improved Grass ha	Rough Grass ha	2018 total ha
Crops	38,053	0	0	38,053
Improved Grass	4,363	117,134	15,123	136,620
Rough Grass	0	0	1,393,429	1,393,429
Other		152	145,825	148,359
1998 total	44,798	117,286	1,554,377	1,716,461

4.89 For cropland, 38,053 ha has remained in the same use, as has 117,134 ha improved grassland and 1,3933,429 ha rough grassland. For the cropland, it is assumed that carbon stocks are reduced due to cropping though this is balanced by the input of fertiliser and manure. For improved grassland there is a gradual accumulation due to inputs of fertiliser and manure. In addition, it is estimated that cropland on organic soils is subject to drainage which it is estimated results in the loss of 5tC/ha per year. This results in significantly high emissions, particularly in the case of Ross and Cromarty where Easter Ross and the Black Isle hold the most intensively cultivated land in Highland.

4.90. Land use change results in a transition from one soil carbon stock to another and these movements are judged to take place over very long periods with an average of 75 years for loss and 525 years for carbon gain. The largest change is the reduction in rough grazing from 1,555,377ha to 1,393,429ha, some of it to improved grassland and the balance very likely to woodland. Because of the restricted data used for this calculation we are not able to identify this change precisely. As other research gives the same soil carbon stock for rough grassland and forestry, it would not have implications for emissions. Analysis of the 4,363ha lost from cropland to improved grassland and for the rough grassland changed to improved grassland, identifies the former resulting in a sequestration and the latter in emissions. None of the results from other land use make substantial inroads on the huge sequestration offered by the trees and this is the dominant feature of land use in Highland.

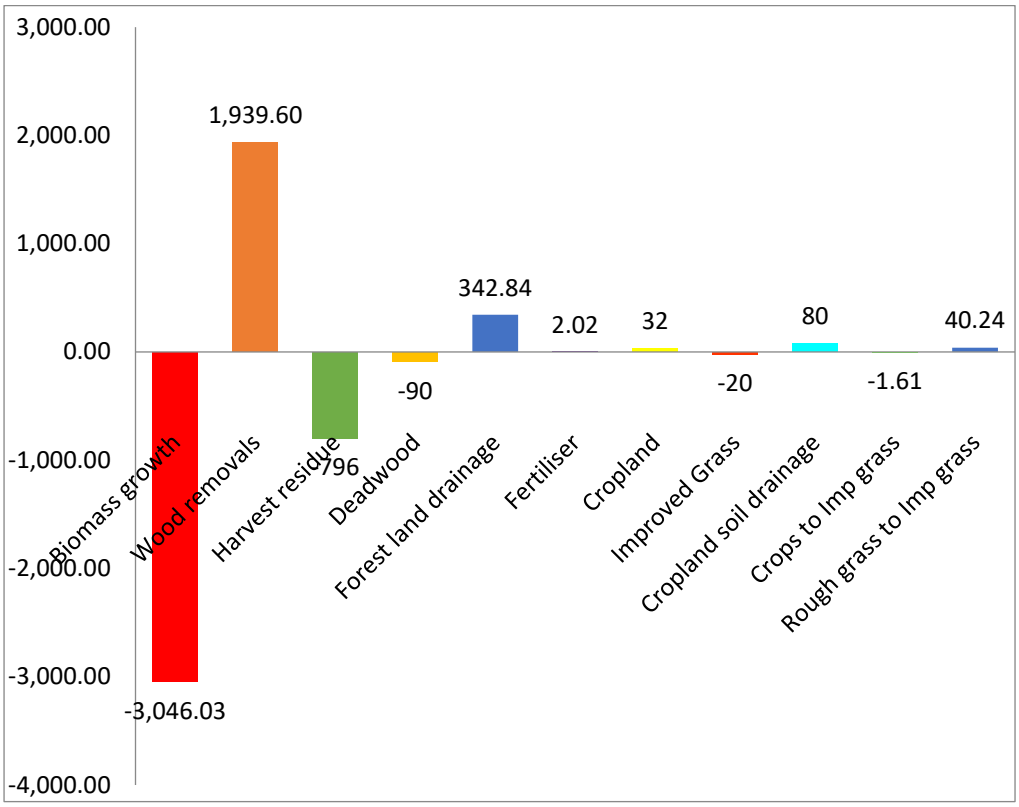
Table 24 - Highland Council Area Greenhouse Gas Emissions from Other Land Use 2018

	Tonnes N_2O	Tonnes Carbon	Tonnes CO_2e
Land use change			
Cropland to improved grass		-439	-1,610
Rough grass to improved grass		10,975	40,244
Land remaining in the same use			
Cropland		8,827	32,366
Improved grassland		-5,425	-19,894
Cropland soils drainage		1,089	3,992
	0.87		259
Total			**55,357**

Inventory Results for Forestry and Other Land Use

4.91 The results from the previous paragraphs and sections have been consolidated in this section to provide overall sector figures for 2018. Emissions arising from biomass growth and for changes in soil carbon total 1,591,703t CO_2e. The most significant of these is forestland where the removal of carbon into the biomass of growing trees dominates the statistics for the entire inventory.

Figure 14 - Highland Council Area Land Use GHG Emissions (kT CO_2e) 2018



Comparison between Highland ECO districts

4.92 To provide a local context to this analysis and help to inform possible local interventions and projects, the following table summarises the main land use emissions for each of the ECO areas.

Table 25 - GHG Emissions (TCO_2e) from Land Use in Highland Council ECO Areas

	Caithness & Sutherland	Ross & Cromarty	Skye & Rasaay	Nairn, Badenoch & Strathspey	Inverness	Lochaber	Total
Forestry							
Biomass growth	-733,429	-585,294	-177,838	-477,233	-486,200	-586,032	-3,046,026
Wood removals	501,940	360,756	113,889	311,377	301,778	349,855	1,939,595
Harvest residue	-205,938	-148,012	-46,727	-127,753	-123,814	-143,540	-795,784
Deadwood	-21,517	-17,340	-5,279	-13,983	-14,303	-17,288	-89,710
Drainage from forestland	92,840	60,801	18,018	57,964	56,263	58,124	344,010
Fertiliser	523	387	125	317	310	362	2,024
Land remaining in same use							0
Cropland	6,155	17,773	104	4,447	3,795	93	32,367
Improved Grass	-8,422	-3,742	-1,336	-2,472	-2,981	-941	-19,894
Drainage from cropland	6,768	15,877	113	4,191	3,928	5	30,882

	Caithness & Sutherland	Ross & Cromarty	Skye & Rasaay	Nairn, Badenoch & Strathspey	Inverness	Lochaber	Total
Land use change							0
Crops to Imp grass	-844	-508	-65	-180	0	-14	-1,611
Rough grass to Imp grass	21,252	0	663	6,349	0	11,980	40,244
TOTAL	**-340,672**	**-299,302**	**-98,333**	**-236,976**	**-261,225**	**-327,395**	**-1,563,903**

4.93 The table illustrates the domination of forestry carbon sequestration. The degree of forest cover differs between ECO areas. For example, Lochaber has high forest sequestration despite being smaller in area than Ross and Cromarty. This carbon removal is offset to an extent in areas with more intensive agriculture. Cropland drainage for instance is significant in Ross and Cromarty where Easter Ross and the Black Isle are exceptionally productive for the area.

Soil Carbon stocks

4.94 While an emissions account is concerned with annual impacts, it is important to be aware of the significance of the carbon store in Highland soils. According to a recent report from ClimateXChange (Rees et al, 2018) Scotland's soils contain 3,056 million tonnes of carbon. A calculation has been made for Highland using values for carbon stocks in Scottish soils from a study in 2005 (Bradley et al). This gives a figure of 860,025t C. As shown in Table 26 the vast majority of the carbon stock is in the semi natural land which consists of rough grazing, bog and mountain areas.

Table 26 – Carbon Stocks in Highland Council ECO Area Soils TCO_2e 2018

	Caithness and Sutherland		Ross and Cromarty		Skye and Rasaay		Nairn, Badenoch & Strathspey		Inverness		Lochaber	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Arable	3,963	2	5,400	3	917	2	3,043	3	4,637	4	849	1
Pasture	14,516	6	4432	2	2446	5	3,268	3	3026	3	1607	1
Semi natural	212,614	85	169,535	86	46,182	88	86,818	80	79,621	77	126,388	84
Woodland	17,616	7	17,505	9	2,774	5	14,898	14	16,420	16	21,260	14
Settlement	101	0	53	0	2	0	62	0	45	0	27	0
Total	**248,810**		**196,925**		**52,321**		**108,089**		**103,749**		**150,131**	

Peatland

4.95 In addition to the land carbon emissions identified in previous sections, there is growing awareness of the levels of carbon stored in the area's peatlands. The Intergovernmental Panel on Climate Change issued guidance in 2013 on estimating emissions from wetlands and a group of UK scientists produced the first estimate for UK peatlands in 2017. Their data has been used to develop an estimate for Highland for this report which gives a total of 897,916t CO_2e per year. This research and methodology is under review and will be incorporated into the UK National Inventory in some form in the near future. This is an important area for Highland Council to monitor as Peatland and associated emissions have such an impact on the appearance of the area and also the area's GHG Inventory figures. Due to the emerging nature of this analysis, we have excluded results from the 2018 inventory.

Table 27 - Highland Council ECO Area Peatland Emissions TCO2e 2018

	Caithness & Sutherland	Ross & Cromarty	Skye and Rasaay	Nairn, Badenoch & Strathspey	Inverness	Lochaber	Total
Forest	100,085	17,120	5,558	10,486	5,210	11,870	150,329
Cropland	348,460	40,993	38,469	10,871	15,956	286	455,035
Heather dominated modified bog	18,377	6,045	162	12,085	5,908	2,687	45,264
(drained/undrained)	29,639	9,749	261	19,491	9,529	4,333	73,002
Grass dominated modified bog	504	389	171	1,574	1,611	1,736	5,985
(drained/undrained)	814	627	275	2,539	2,598	2,800	9,653
Extensive grassland	49,822	1,590	5,313	5,785	1,474	3,698	67,682
Intensive grassland	72,937	3,761	5,499	3,724	0	2,617	88,538
Near Natural Bog	1,477	207	92	263	322	67	2,428
Total	622,115	80,480	55,801	66,818	66,818	30,094	897,916

Discussion

4.96 Agriculture and land use plays an essential role in the highlands to sustain rural employment and help maintain the area's landscape and appearance that is essential for the tourism and recreation sectors. This is an essential element of the rural highlands which now has an international reputation for tourism. In light of this importance, it will be essential to undertake projects and programme activity that help to maintain the characteristics of the area. This will have to happen in a manner that increasingly seeks to minimise greenhouse gas emissions.

4.97 Emissions from agriculture continue to be some of the most difficult to reduce. Considerable work has been undertaken at a UK level on minimising the use of fertilisers and ensuring that their application is appropriate to the weather and soil conditions. Good advice is available from SAC Consulting, Quality Meat Scotland[13], the Farm Advisory Service[14] and the Technical Notes from Scotland's Rural College[15] (SRUC). Mitigation measures have been researched extensively, most notably in the Marginal Abatement Cost Curves for Agriculture (MACC) prepared for the Committee on Climate Change[16]). Measures to reduce emissions from livestock have focussed on increasing the efficiency of production through diet, animal health and technical measures such as nitrification inhibitors. As far as stock is concerned there have been some advances with minimising methane output by adjusting feed but these are largely for intensive herds where there is a higher reliance on processed feed, and are thus of less relevance to the extensive agriculture that characterises the Highland Council area. The cost of such measures may not be affordable in Highland agriculture.

[13] Better Soil and Grassland Management for Scottish Beef and Lamb Producers, Quality Meat Scotland, 2013
[14] https://www.fas.scot/crops-soils/soils/making-best-use-of-organic-fertilisers-and-manures/
[15] https://www.sruc.ac.uk/downloads/120713/fertiliser_and_lime_technical_notes
[16] https://www.theccc.org.uk/publication/scotlands-rural-collage-sruc-ricardo-energy-and-environment-2015-review-and-update-of-the-uk-agriculture-macc-to-assess-abatement-potential-for-the-fifth-carbon-budget-period-and-to-2050/

4.98 The work undertaken on the MACC has shown that the carbon benefits from afforestation dwarfs all other measures. Forest and Land Scotland have carried out trials of low-density cattle grazing in woodlands[17] with evidence of benefits for biodiversity. One of the main recommendations for stock is to maintain high health standards to ensure that meat is produced as effectively as possible. Consideration is often given to the emissions per kilo of meat produced and this leads to intensification of agriculture. However, in the context of Highland, it has been argued that intensification would lead to loss of other benefits such as biodiversity**.**

4.99 In addition to considering specific measures to reduce emissions, there is value to assess the type of farming activity that should be sustained in rural areas. Current emissions calculations have followed the IPCC guidance and review emissions arising as a result of actions taken in a particular area. This is known as production based or territorial emissions. There is an emerging argument for also considering the emissions embedded in producing the food we purchase and consume. The Scottish Government has acknowledged the importance of this issue and has commissioned studies of consumption-based emissions. The latest of these reports[18] identified emissions for 2016 at 73Mt CO_2e compared to 41.6Mt CO_2e as the 2018. A report on Bristol showed that consumption-based emissions stood at three times higher than territorial emissions. In the case of Highlands, we import substantial amounts of food into the area and there is a strong lobby as well as a statutory requirement under the Community Empowerment (Scotland) Act 2015 for the production of more food locally. Nourish Scotland is a national organisation that argues strongly for this principle. It would be entirely feasible to produce basic vegetables in Highland to feed the local population. Additionally, if we were to maintain a certain level of meat consumption, we might want to increase the herds in Highland rather than reduce them. This might lead to an increase in stock related emissions which need to be weighed against the economic and social and environmental benefits that might be gained.

[17] https://www.forestresearch.gov.uk/research/impacts-of-large-herbivores-on-woodlands/impacts-of-large-herbivores-on-woodlands-survey-of-cattle-grazed-woodlands-in-britain/

[18] https://www.gov.scot/publications/scotlands-carbon-footprint-1998-2016/pages/10/

Chapter 5 – Findings and Recommendations

5.1 Commissioned at the start of 2020, this report provides a GHG emissions inventory for the Highland Council area for 2018. Where analysis was able to provide robust data, we have also provided area GHG profiles for the Council's 6 Executive Council Officer (ECO) areas. To help inform processes and provide a structure to analysis and reporting, we have been guided by the international Global Protocol for Community-Scale Greenhouse Gas Emission Inventories and by guidance from the Intergovernmental Panel on Climate Change.

5.2 Shortly after this work was commissioned, the COVID – 19 pandemic effected the whole of the UK economy. In response, businesses closed or worked with significantly less staffing. This impacted our ability to complete primary research especially in the transport sector where we were collecting data regards fuel, ferry trips etc.

5.3 Our core analysis utilised official energy consumption and emissions data produced by the UK Government Department for Business, Enterprise and Industrial Strategy. We have used data that has been accessed for different spatial levels. When accessing data at smaller statistical areas, for example Middle Layer Super Output Area (MSOA), we have encountered data confidentiality issues. Accessing data, especially for commercial consumption, at too small a geographical area, runs the risk of identifying larger consumers. This has created a challenge when comparing a single Highland Council area emissions figure with one grossed up from combining emissions from smaller areas. The two figures are different. This is a significant challenge when trying to undertake analysis for the smaller Eco areas.

5.4 Waiting for the most recent data release allowed 2018 to be the base year for this comprehensive Highland Council GHG Inventory. Analysis identified a GHG emissions total for the Highland Council area in 2018 of 2,652,316 tCO_2e, and the counterbalancing sequestration of carbon in forestry plantations at 1,647,060 tCO_2e. This would reduce the net emissions to 1,005,256 tCO_2e, the equivalent of 4.3 tCO_2e per resident.

	Scope 1	Scope 2	Scope 3	Total tCO2e
Stationary Residential	198,546	63,291	5,367	267,205
Stationary Commercial*	699,094	260,643	22,104	981,841
Road Transport Petrol	142,532	0	0	142,532
Road Transport Diesel	414,736	0	0	414,736
Rail	10,095	0	0	10,095
Water transport	60,308			60,308
Industrial Processes and Product Use (IPPU)	189,141		9,930	199,071
Waste	20,331	0	7,294	27,625
Agriculture & Other Land Use	493,546	0	0	493,546
Other Land Use – Net of Improvements	55,357			55,357
Total, excluding Forestry Sequestration	**2,283,686**	**323,934**	**44,695**	**2,652,316**
Per Capita, excl Forestry Sequestration				11.3
Forestry Sequestration				-1,647,060
Total, incl Forestry Sequestration				**1,005,256**
Per Capita, incl Forestry Sequestration				4.3

*We have used the official commercial energy consumption figures, electricity and gas for 2018 rather than the modelled energy use per sector which overestimated gas consumption and underestimated electricity consumption.

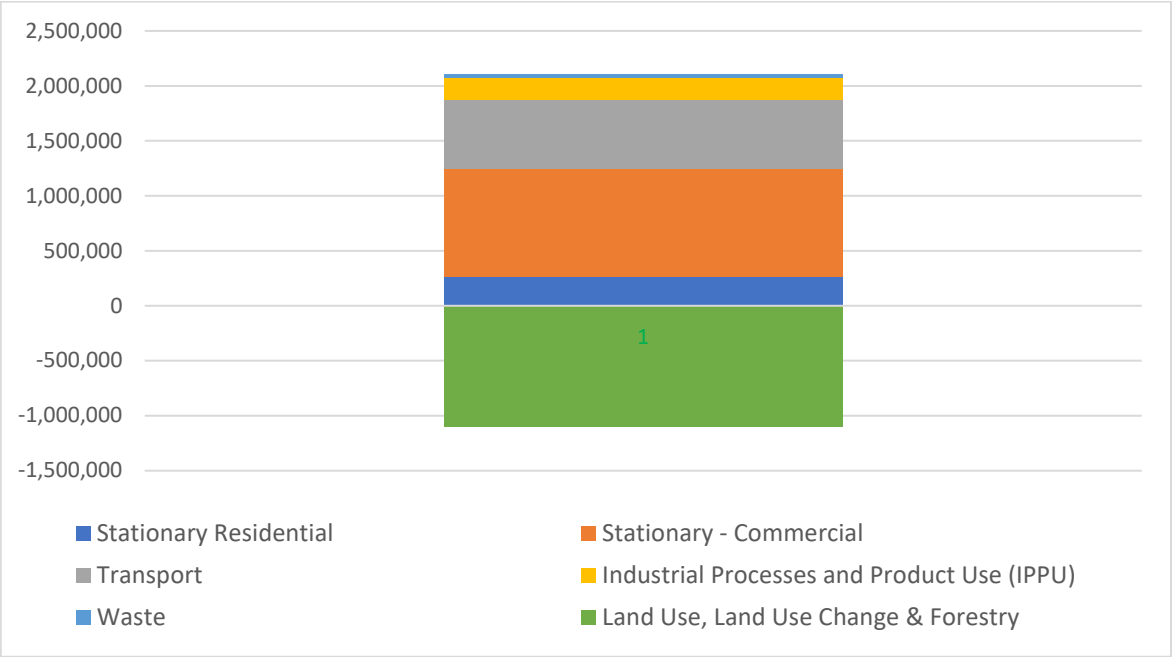
5.5 Stationary commercial energy use is the largest contributor to the Council area's overall GHG emissions. Emissions are arising from the consumption of gas, heating oil, electricity and liquid fuels. Agriculture and other land use are the next largest source of emissions in the area. There is growing recognition of the global contribution of agriculture and food production related emissions. Consumption of diesel for road transport and the subsequent and emissions are the next largest proportion of the area's emissions.

5.6 The area's land resource is also a source of carbon storage. Each year there is carbon sequestration and absorption to the soils as well as releases. This complements the significant stocks already stored in the area's soils. Overall, there was a net absorption of carbon to the area's soils in 2018. An emerging area of emissions analysis considers the release of carbon from peatland. We have calculated the possible distribution of peat released carbon emissions for the whole Council area as well as the individual ECO areas. However as this is very much a developing area of emissions analysis, we have not included it in the Highland Council area figures.

5.7 While the area is home to a significant level of renewable energy production, we have not included that as an element of the GHG inventory. The Scottish Government have agreed an accelerated trajectory of GHG emission reductions, allowing the country to reach net zero at an earlier date than the rest of the UK. Renewable energy will play an increasingly important role in achieving this target and also helping to reduce the carbon intensity of grid supplied mains electricity. Current accepted practice is for highland area renewable energy to supply the national grid. This helps to reduce the carbon intensity of electricity, across the UK. However, it also dilutes the prospective emissions reduction if this energy was produced in the highlands and all used locally.

5.8 The following chart provides a useful snapshot of the Highland Council areas position regards net zero. Sequestration of emissions in the area's forests, helps to cancel out nearly half the area's emissions. The chart combines emissions producing activity with the emissions sequestration, below the line.

Figure 15 - Balance of Highland Council Area GHG Emissions in 2018



5.9 The report has been completed alongside a separate piece of work to address how the Highland Council can establish an improved focus on emissions reduction in the organisation's own estate as well as work with partners to maximise the emission reduction potential in the Highlands. The following recommendations combine commentary from both reports.

5.10 Across the Highland Council area, there remains a broad mix of housing stock, which has different energy requirements, and subsequent GHG emission profiles. While newer housing is more energy efficient and has a lower emissions profile, older properties are less energy efficient. A key challenge for residents in these properties is the cost of interventions that will make the properties more energy efficient. This can be a concern for low income households where there is a greater prominence of fuel poverty. But for a significant proportion of residents in the area, fuel spend is likely to be less of a concern. This potentially undermines the potential to reduce residential emissions. However, it does suggest the focus of public interventions to reduce stationary energy should be targeted at older, higher emissions properties occupied by lower income residents.

5.11 The COVID 19 pandemic in 2020 has had a significant impact on levels of homeworking. While this may have more of an impact in urban areas, increased homeworking will displace a proportion of emissions from commercial to domestic premises. Even with a treatment for COVID 19, there is unlikely to be a complete return to historical working environments in commercial premises. A key opportunity for THC and stakeholders, for example Home Energy Scotland, will be to maintain oversight of existing and emerging sources of public funding that will be made available to help improve residential properties, especially where there is an increased level of homeworking.

5.12 The commercial sector, during 2020, is being considerably exposed to the impacts of COVID 19. Cost reduction and minimisation has been a key focus. Reducing energy consumption, with the subsequent benefit in emissions reduction, is a key opportunity for organisations to reduce costs. However, there is likely to be a challenge in justifying more expensive energy efficiency interventions that may have a longer payback.

5.13 There is existing support available from Zero Waste Scotland, to help reduce commercial energy consumption and associated GHG emissions. While THC may have limited scope to engage with occupiers of commercial premises, where they do, there is scope to help promote the likes of Zero Waste Scotland and the Business Energy Efficiency Service.

5.14 The report highlights the significant level of emissions being produced by transport, especially vehicles consuming diesel. Emissions arising from diesel car use increased by 35% between 2011 – 18. For a comparison, petrol consumption in cars and resulting emissions declined by 28% over the same period. There has also been significant growth over the same period, in the fuel consumed and emissions arising from diesel powered light goods vehicles. There is a small but growing number of electric vehicles in the area and this is being supported by a growing number of charging points. There is now a requirement that new houses being built to have a specific connection that will facilitate electric vehicle charging equipment.

5.15 An interesting transport consideration that emerged during the preparation of this report is the COVID 19 generated move towards more active travel. This also coincided with a significant switch from community to working from home. Transport counts will be able to identify how these developments during 2020 helped to reduce vehicle journeys and their associated emissions. Bus fuel consumption and emissions increased 8.5% over the period 2011-18. It will be interesting in future updates of this inventory, to assess the impact of the COVID 19 outbreak, on public transport.

5.16 There is increasing knowledge of how the production and release of GHG emissions can be minimised when processing waste. There has been a steady decline in the amount of biodegradable waste sent to landfill. This will help to reduce the future production of GHG emissions. There is also increasing knowledge of how to address the production of emissions by existing landfill materials.

5.17 The extensive size of the Council area results in a range of land use emission interest and challenges. Agriculture will continue to evolve with an ebb and flow of emissions arising from different land management practices, animal husbandry etc. The role of woodland for carbon sequestration has been well documented and this provides a significant resource in the highlands. There is a need to at least maintain woodland cover in the area, while ideally increasing planting to create an expanding resource to help support future carbon sequestration.

5.18 Peatland is increasingly recognised as playing a significant role in carbon storage in the highlands and also Scotland. Due to the emerging nature of the analysis, we have not included the figures for carbon arising from different uses of peat soils. This will become a more accepted process in the near future, and this will raise some interesting debate about peatland and why and how we manage and exploit this resource,

5.19 While the following is a repeat of a recommendation in a previous Highland Council commissioned report on emissions for Inverness district, the rationale for this suggestion still remains and is perhaps even greater now. The Scottish Government is required to deliver a net zero Scotland by 2045. This will involve reducing emissions while increasing levels of sequestration and storage in soils etc. Covering a third of Scotland, the highlands will be well placed to become a major player in helping the Scottish Government meet its targets. There may be scope to establish a working group/initiative to help collaboration amongst key local stakeholders and build a programme of concerted action to maximise carbon sequestration and storage in the Highlands.

Appendix 1 – Employment By Industry 2018 for Highland Council and Eco Area

	Caithness and Sutherland		Ross and Cromarty		Skye and Rasaay		Nairn, Badenoch & Strathspey		Inverness		Lochaber	
	Employee	**%**	Employee	%	Employee	%	Employee	%	Employee	%	Employee	%
Agriculture, forestry & fishing	600	3.9%	600	2.7%	160	3.4%	180	1.8%	300	0.6%	450	4.5%
Mining, quarrying & utilities	**1,500**	**9.7%**	425	1.9%	25	0.5%	20	0.2%	1,250	2.4%	170	1.7%
Manufacturing	750	4.8%	**2,375**	**10.8**	200	4.2%	475	4.8%	2,125	4.0%	850	8.5%
Construction	1,000	6.5%	1,875	8.5%	275	5.8%	850	8.5%	3,000	5.7%	750	7.5%
Motor trades	190	1.2%	275	1.2%	50	1.1%	90	0.9%	1,625	3.1%	110	1.1%
Wholesale	450	2.9%	700	3.2%	100	2.1%	375	3.8%	1,375	2.6%	200	2.0%
Retail	1,375	8.9%	2,000	9.1%	325	6.8%	1,000	10.0	**5,500**	**10.5**	**1,125**	**11.2**
Transport & storage (inc postal)	650	4.2%	950	4.3%	220	4.6%	220	2.2%	2,750	5.2%	650	6.5%
Accommodation & food services	**1,750**	**11.3**	**2,125**	**9.7%**	**1,125**	**23.7**	**2,000**	**20.0**	**4,500**	**8.6%**	**2,000**	**20.0**
Information & communication	325	2.1%	375	1.7%	90	1.9%	275	2.8%	1,125	2.1%	80	0.8%
Financial & insurance	130	0.8%	160	0.7%	140	2.9%	50	0.5%	550	1.0%	45	0.4%
Property	220	1.4%	275	1.2%	120	2.5%	210	2.1%	550	1.0%	180	1.8%
Professional, scientific & technical	1,125	7.3%	1,250	5.7%	250	5.3%	500	5.0%	3,000	5.7%	240	2.4%
Business administration & support services	450	2.9%	1,375	6.2%	110	2.3%	550	5.5%	3,500	6.7%	375	3.8%
Public administration & defence	800	5.2%	2,000	9.1%	180	3.8%	240	2.4%	3,000	5.7%	475	4.8%
Education	1,125	7.3%	1,500	6.8%	**425**	**8.9%**	650	6.5%	3,000	5.7%	800	8.0%
Health	**2,250**	**14.5**	**2,500**	**11.4**	**800**	**16.8**	**1,125**	**11.2**	**12,500**	**23.8**	**1,250**	**12.5**
Arts, entertainment, recreation & other	800	5.2%	1,125	5.1%	160	3.4%	**1,125**	**11.2**	2,125	4.0%	600	6.0%
Total	15,500	100%	22,000	100%	4,750	100%	10,000	100%	52,500	100%	10,000	100%

Source: Business Register and Employment Survey 2018

Appendix 2 – Central Heating Type – Highland Council and ECO Areas

	Caithness and Sutherland		Ross and Cromarty		Skye and Rasaay		Nairn, Badenoch &		Inverness		Lochaber		Highland Council Area	
	Number	% of households	Number	% of households	Number	% of households	Number	% of households	Number	% of households	Number	% of households	Number	% of households
All households	18,512		24,432		4,534		11,287		34,713		8,613		102,093	
No central heating	586	3	728	3	297	7	372	3	901	3	331	4	3,215	3.1
Gas central heating	4,371	24	6,172	25	340	7	3,971	35	20,037	58	356	4	35,247	34.5%
Electric central heating	4,085	22	6,271	26	1,2777	28	3,062	27	7,259	21	3,215	37	25,170	24.7%
Oil central heating	5,960	32	7,782	32	1,522	34	2,702	24	4,164	12	3,063	36	25,194	24.7%
Solid fuel central heating (wood & coal)	2,143	12	1,389	6	490	11	336	3	595	2	793	9	5,746	5.6
Other central heating	361	2	361	1	175	4	168	1	327	1	154	2	1,546	1.5
Two or more types of central heating	1,006	5	1,729	7	433	10	676	6	1,430	4	701	8	5,975	5.9

Source: 2011 Census of Population. Other central heating includes solar, liquefied petroleum gas (LPG) or other bottled gas.