Greenhouse Gas Inventories for SWEEG: Methodology Paper

CENTRE FOR ENERGY AND THE ENVIRONMENT

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MANAGEMENT SUMMARY
The Centre for Energy and the Environment has produced baseline greenhouse gas inventories for
district and unitary authorities within the south-west peninsula. The inventories inform the
development of trajectories to net zero carbon. This report documents the methodology adopted
to prepare the inventories.
1. Introduction
The Centre for Energy and the Environment has produced baseline greenhouse gas inventories for district and unitary authorities within the south-west peninsula. The inventories inform the development of trajectories to net zero carbon. This report documents the methodology adopted to prepare the inventories.

1.1 Scope – Greenhouse Gases
The inventories include the six greenhouse gases covered by the Kyoto Protocol, namely carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF₆). The global warming potential (GWP) of each gas has been used to combine the values for the six pollutants into a single carbon dioxide equivalent (CO₂e) value. The GWP values used were taken from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report 2013¹, as shown in Table 1.1. The values are based on a 100-year time horizon and exclude climate-carbon feedbacks.

<table>
<thead>
<tr>
<th>Gas</th>
<th>Global warming potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide (CO₂)</td>
<td>1</td>
</tr>
<tr>
<td>Methane (CH₄)</td>
<td>28</td>
</tr>
<tr>
<td>Nitrous oxide (N₂O)</td>
<td>265</td>
</tr>
<tr>
<td>Hydrofluorocarbons (HFCs)</td>
<td>Varies with species (4 – 12,400)</td>
</tr>
<tr>
<td>Perfluorocarbons (PFCs)</td>
<td>Varies with species (6,630 – 17,400)</td>
</tr>
<tr>
<td>Sulphur hexafluoride (SF₆)</td>
<td>23,500</td>
</tr>
</tbody>
</table>

1.2 Scope – Geographic Boundaries
The geographic boundaries for the assessment were those of the unitary and district authorities within the former county of Devon, Cornwall and the Council of the Isles of Scilly. Separate inventories have been produced for each authority area.

1.3 Scope – Emission Sources
Emissions have generally been considered from sources within the geographic boundary. Sources have been categorised into the sectors and sub-sectors listed in Table 1.2. Emissions have been reported within these subsectors as far as possible given data availability; in some cases emissions are aggregated at a higher level. Aviation and marine emissions have been excluded from the analysis.

¹ IPCC, Fifth Assessment Report, 2013.
Table 1.2. Sectors and sub-sectors used to report greenhouse gas emissions.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Sub-sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stationary energy</td>
<td>Residential buildings</td>
</tr>
<tr>
<td></td>
<td>Commercial and institutional buildings and facilities</td>
</tr>
<tr>
<td></td>
<td>Manufacturing industries and construction</td>
</tr>
<tr>
<td></td>
<td>Energy industries</td>
</tr>
<tr>
<td></td>
<td>Agriculture, forestry and fishing industries</td>
</tr>
<tr>
<td>Transportation</td>
<td>Road vehicles</td>
</tr>
<tr>
<td></td>
<td>Railways</td>
</tr>
<tr>
<td></td>
<td>Off-road vehicles</td>
</tr>
<tr>
<td>Waste</td>
<td>Solid waste disposal</td>
</tr>
<tr>
<td></td>
<td>Biological treatment of waste</td>
</tr>
<tr>
<td></td>
<td>Incineration and open burning</td>
</tr>
<tr>
<td></td>
<td>Wastewater treatment and discharge</td>
</tr>
<tr>
<td>Industrial processes and product use (IPPU)</td>
<td>Industrial processes</td>
</tr>
<tr>
<td></td>
<td>Product use</td>
</tr>
<tr>
<td>Agriculture, forestry and land use (AFOLU)</td>
<td>Livestock</td>
</tr>
<tr>
<td></td>
<td>Land</td>
</tr>
<tr>
<td></td>
<td>Aggregate source and non-CO₂ emissions</td>
</tr>
<tr>
<td>Other indirect emissions</td>
<td>Other scope 3 emissions from all sources</td>
</tr>
</tbody>
</table>

Emissions are reported by *scope*, depending on where the emissions occur. Scope 1 emissions arise from sources located within the inventory’s physical boundary, for example direct combustion of fuel in a heating boiler. Scope 2 emissions occur as a direct consequence of the use of grid-supplied electricity, steam and cooling within the inventory’s physical boundary, i.e. from fuel combusted to produce the electricity or heat. Scope 3 emissions occur as a result of activity other than that covered by Scope 2 outside of the inventory’s physical boundary as a result of activity within the boundary. In this study, Scope 3 emissions were limited to losses associated with electricity transmission and distribution.

2. **Methodology by sub-sector**

Sources of data including activity and consumption data and greenhouse gas emission factors are documented in this section for each sub-sector. In some cases alternative sources of information were available and may be used to verify the magnitude of uncertainty in calculated emissions.

It should be noted that there are some differences in the methodology adopted and that used to produce similar baseline inventories for Cornwall and the Isles of Scilly. These latest inventories were not subject to client-driven specifications of the inventories prepared previously, allowing simpler methodologies to be adopted that generally result in very similar output. The spreadsheet constructed allows output to be produced for Cornwall and the Isles of Scilly that can be directly compared to that for the Devon district and unitary authorities.

2.1 **Fuel consumption (Stationary Sources)**

Emissions arising from fuel consumption in the domestic, non-domestic and transportation sectors were taken from greenhouse gas emissions data compiled by national government at local authority level. Only CO₂ emissions are reported by that source; emissions of CH₄ and N₂O were estimated by comparing the fuel-specific emissions factor for each pollutant. The emission factors were sourced from those compiled by the UK government for company reporting. For electricity, the values used were taken from the methodology paper for the *data year*, as against the *reporting year*. Factors for the *reporting year* lag behind the *data year* values derived from underlying national greenhouse gas emissions inventory data by two years. Significant differences
arise between the two sets of values in the case of electricity where the emission factors have changed rapidly over the past few years as a consequence of the change in electricity generation technology mix. For other fuels and activity, this problem was addressed by taking values from the annual emission factor spreadsheets, with a two-year offset applied (e.g. for 2016, the value in the 2018 version of the spreadsheet was applied).

Fuel consumption is generally reported by suppliers on a gross calorific value basis. Emission factors calculated on this basis have therefore been used in the calculations described above. Petroleum product and manufactured solid fuel consumption data are not disaggregated further by fuel type. Consumption was mapped to the most ubiquitous type of fuel for each subsector, taken to be burning oil for the domestic consumption of petroleum products and coking coal for domestic MSF.

Emissions from electricity usage were disaggregated into scope 2 emissions from electricity production implicit in the consumption and scope 3 emissions from transmission and distribution losses on the basis of the emission factors.

Industrial and commercial emissions are reported as a single aggregate figure for each fuel (electricity, gas and other). These have been reported under commercial/institutional. An additional emissions figure is provided for large industry; this has been reported under manufacturing and construction.

2.2 ENERGY INDUSTRIES
Emissions from electricity generation plant has been taken from the National Atmospheric Emissions Inventory (NAEI) list of point sources. Energy from waste plants have been excluded at their emissions have been considered under waste. Given the lack of data on emissions from other auxiliary operations or small generators the magnitude of their emissions has not been estimated.

2.3 AGRICULTURE, FORESTRY AND FISHING
Data on agricultural emissions published at local authority level include the consumption of petroleum, solid fuels, urea application and liming. The majority of emissions are assumed to arise from petroleum combustion, and CH₄ and N₂O emissions have been estimated on this basis.

Agriculture emissions from livestock and cultivation have been reported separately, and include enteric fermentation in livestock, the management of manure produced by livestock, and nitrogen, phosphate, potash and magnesium application on cultivated land. Emissions have been estimated from agricultural activity data taken from government statistics. Detailed data at local and district authority level are only published for selected years, coinciding with the EU Farm Structure Survey. The latest available data year is 2016. Data have been interpolated between years as necessary. Exeter and East Devon’s emissions are reported as an aggregate figure, as are those for Plymouth, Torbay and South Hams. In these cases, agricultural emissions for Exeter, Torbay and Plymouth were assumed to be negligible.

Greenhouse gas emission factors for each type of livestock, fertiliser application rates and emission factors for fertilisers were taken from Cornwall Council’s 2008 inventory. The latter only provide a CO₂e emission value. The figures have been checked against the latest versions of the source documents and have been found to remain representative.
As an alternative, NAEI area 12 source emission data for CO₂, CH₄ and N₂O are available for the agricultural sector. These have been summed for each district or unitary authority; they represent total emissions from agricultural fuel consumption, livestock and arable farming.

2.4 On-road Transportation
Road transport emissions are reported at local authority level 3, by road type. Emissions of CH₄ and N₂O have been estimated by comparison of fuel emission factors; the petrol / diesel split of fuel consumption was taken from local authority level transport fuel data 11. CO₂ emissions from “transport–other” have been included in the road transport figure; this includes emissions from LPG-powered road vehicles, the combustion of lubricants in road vehicles, aircraft support vehicles, coal-fired railways and inland waterways. Given the diverse mix of sources, no attempt has been made to estimate emissions of CH₄ and N₂O.

No data have been identified for electric and other alternative-fuelled vehicles. Electricity consumed to recharge vehicles will be reported under the domestic and commercial, institutional and industrial sectors.

2.5 Railways
Emissions from diesel-powered trains are reported at local authority level 3. Emissions of CH₄ and N₂O have been estimated by comparison of fuel emission factors.

Electricity consumption by railway vehicles is reported under industrial and commercial electricity in the local authority emission dataset 3. None of the national rail network in Devon or Cornwall is electrified; electric railways are limited to cliff lifts and heritage operations such as the Seaton Tramway and battery-electric on-rail maintenance vehicles and are therefore considered negligible.

2.6 Off-road Transportation
Off road vehicles are defined as transportation within facilities such as airports. These were assumed to be negligible within the study area and were not estimated.

2.7 Solid Waste Disposal, Including Incineration
NAEI point 6 and area 12 source emission data for CO₂, CH₄ and N₂O were summed within each area. Point sources included emissions from landfill sites, biological waste treatment plants (composting and biogas plants) and waste incinerators (including energy-from-waste plants). All area source emissions were allocated to disposal by landfill, as any large incineration plants would be present in the point source data. Wastewater treatment plants were excluded as emissions from wastewater treatment were considered separately.

2.8 Wastewater Treatment and Discharge
Data for wastewater treated by South West Water were sourced from a Freedom of Information request for Devon, Cornwall, Torbay and Plymouth and closely matched data in the company’s annual performance and regulatory reports 13. The data are based on measurements for sewage treatment works with a dry weather flow in excess of 50 m³/day. The final figures had been uplifted by 1.3% to account for the proportion of the population served by smaller sewage treatment works for which measurement data are not available. Wastewater from Saltash is pumped under the River Tamar and treated at Ernsettle sewage treatment works in Plymouth. The population of Saltash is approximately 15,000 or 3% of Cornwall as a whole. The figures provided by South West Water for Cornwall and Plymouth have been adjusted to account for wastewater generated within Saltash but treated within Plymouth.
Wastewater generated within each district within Devon was estimated based on the number of households within the area compared to the total number of households in Devon.

On the Isles of Scilly, the council acts as the water authority; no data have been forthcoming on wastewater arisings or emissions.

2.9 INDUSTRIAL PROCESSES AND PRODUCT USES
This category includes greenhouse gas emissions from industrial processes (the production and use of mineral products, chemicals and metals), and emissions from product use (non-energy use of lubricants and paraffin waxes, and emissions of fluorinated gases).

The National Atmospheric Emissions Inventory includes data on large point sources of greenhouse gas emissions. Some of these are clearly already considered within other categories, e.g. power generation, waste treatment and disposal. Other entries include mineral operations and food processing plants. The vast majority of emissions from these facilities are expected to arise from fuel combustion and electricity consumption, and will therefore have been included under industrial and commercial stationary source emissions.

Data on the use of fluorinated gases were taken from the National Atmospheric Emissions Inventory and apportioned to each area on the basis of emissions from non-domestic electricity consumption. Fluorinated gases are used in, and emitted from, refrigeration and fire-fighting systems, use as blowing agents and propellants, as an insulant in electrical switchgear and in metal production. Local usage will therefore vary and the apportioned value is subject to significant uncertainty.

2.10 LAND USE CHANGE
CO₂ emissions from land use change have been taken directly compiled by national government at local authority level. CH₄ and N₂O emission are highly dependent upon the type of land use change occurring and therefore were not estimated. Examination of emissions from land use and land use change as reported to the IPCC indicate that CO₂ emissions dominate.

3. CONCLUSIONS
Baseline greenhouse gas inventories have been produced for district and unitary authorities within the south-west peninsula. The inventories inform the development of trajectories to net zero carbon. This report documents the methodology adopted to prepare the inventories.

REFERENCES


8 2008 greenhouse gas inventory for Cornwall and the Isles of Scilly. (Undated), Cornwall Development Company.


