Dadansoddi ar gyfer Polisi

YMCHWIL GYMDEITHASOL Y LLYWODRAETH

GSR

GOVERNMENT SOCIAL RESEARCH

Analysis for Policy

Llywodraeth Cymru
Welsh Government

SOCIAL RESEARCH NUMBER:
16/2024
PUBLICATION DATE:
13/03/2024

# Research into the Decarbonisation of Industry and Business

Mae'r ddogfen yma hefyd ar gael yn Gymraeg.
This document is also available in Welsh.

 Digital ISBN 978-1-83577-140-2

# Research into the Decarbonisation of Industry and Business

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Full Research Report: Oliver, D; Solis, E; Miller, N; (2024) *Research into the Decarbonisation of Industry and Business*. Cardiff: Welsh Government, GSR report number 16/2024
Available at: https://www.gov.wales/decarbonisation-industry-and-business



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# Table of contents

## List of tables



## List of figures

## Glossary

| Acronym/Key word | Definition |
|---|---|
| AQPI | Air Quality Pollution Inventory |
| BEES | Building Energy Efficiency Survey |
| BEIS | Department of Business, Energy & Industrial Strategy. The report will refer to BEIS as this was correct at the time of writing. |
| CB | Carbon Budget |
| CCC | Climate Change Committee (Formerly the UK Committee on Climate Change) |
| CCS | Carbon Capture and Storage |
| CEH | UK Centre for Ecology & Hydrology |
| $CO_2e$ | Carbon dioxide equivalent |
| CRF | Common Reporting Format |
| DA | Devolved Administration |
| DA-GHGI | Devolved Administration Greenhouse Gas Inventory |
| DEFRA | Department for Environment, Food and Rural Affairs |
| DSA | Data Supply Agreements |
| DUKES | Digest of UK Energy Statistics |
| EMEP | European Monitoring and Evaluation Programme |
| ETS | Emissions Trading Scheme |
| EU-ETS | European Union Emissions Trading System |
| GHG | Greenhouse Gas |
| GHGI | Greenhouse Gas Inventory |
| GWP | Global Warming Potential |
| IA | Inventory Agency |
| IPCC | Intergovernmental Panel on Climate Change |
| ISSB | Iron and Steel Statistics Bureau |
| KDPs | Key Data Providers |
| LULUCF | Land Use, Land Use Change, and Forestry |
| MPPs | Major Power Producers |
| NACE | Nomenclature of Economic Activities |
| NAEI | National Atmospheric Emissions Inventory |
| NC | National Communication |
| NCFormat | National Communication Format |

| | |
|---|---|
| ND-NEED | Non-Domestic National Energy Efficiency Data |
| NIR | National Inventory Report |
| NIS | National Inventory System |
| NRW | Natural Resources Wales |
| ONS | Office of National Statistics |
| QA | Quality Assurance |
| QC | Quality Control |
| RACHP | Refrigeration, air conditioning and heat pumps |
| SECR | Streamlined Energy Carbon Reporting |
| UK-ETS | United Kingdom Emissions Trading Scheme |
| UNECE | United Nations Economic Commission for Europe |
| UNFCCC | United Nations Framework Convention on Climate Change |
| WG | Welsh Government |

# 1. Introduction

1.1 In March 2021, Welsh Government approved a net zero target by 2050. This was an ambitious new target that, together with the 2019 Climate Emergency declaration, demonstrates that Welsh Government is prioritising action on climate change.

1.2 Wales legislated its first carbon budget (CB) in 2018, and in 2019, Welsh Government published a plan setting out the policies and proposals to meet that budget. In 2021, Welsh Government published 'Net Zero Wales' an outline of plans and policies to meet Carbon Budget 2 (2021-2025), which significantly raised ambitions and introduced a net zero target based on advice from the UK Climate Change Committee (CCC)[1]. To meet the 2050 target, Welsh Government must lay the foundation for change by developing effective policy to drive behavioural, technological, societal, and industrial change throughout the 2020s. In its commitments to undertake action on climate change Welsh Government acknowledges that the 2020s must be a key decade of action[2].

1.3 As per Welsh Government's Carbon Budget 2 (2021-2025), work on decarbonisation is split into the following sectors:

- Industry and Business
- Residential buildings
- Transport
- Waste management
- Land Use, Land Use Change and Forestry
- Agriculture
- Electricity and heat generation
- Public Sector.

1.4 In Net Zero Wales, Carbon Budget 2 (2021-2025), Welsh Government outlines it's ambition statement for Industry and Business:

- 'By 2025 we expect to see a decrease in energy usage in industry of 4% as a result of energy efficiencies whilst building a well-being economy. By 2025 we want to see an increase in electrification in industrial processes by an average of 3%; and grow hydrogen as a fuel by an average of 3%. In addition, over CB2 the primary foundations for further industrial transformation will be laid through our UK ETS (Emissions Trading Scheme) policies and we expect UK Government's net zero Industrial Strategy to enable increased

[1] Welsh Government (2021) Net Zero Wales
[2] Welsh Government (2021) Net Zero Wales Carbon Budget 2 (2021 to 2025)

electrification, fuel switching and Carbon Capture and Storage (CCS) from the 2030s'[3].

1.5 To develop an effective strategy to decarbonise the Industry and Business sector and to meet its net zero 2050 obligations, Welsh Government must develop an evidential baseline from which to measure the efficacy of future policy propositions. Under the Environment Wales Act (2016) statutory progress towards net zero is measured by reference to the Green House Gas Inventory (GHGI) and in relation to established baseline years of 1990 and 1995 depending on the gas[4].

1.6 In December 2021, Welsh Government commissioned Miller Research to undertake research into the decarbonisation of Industry and Business. The research will contribute to setting the foundations for future developments in the decarbonisation of Industry and Business. Industry and Business refers to the categorisation outlined above and defined within 'Net Zero Wales'. The research was undertaken in early 2022 using data from the 2019 GHGI.

1.7 This report is a key output of this research and addresses the following research questions:

- What is the greenhouse gas (GHG) emissions baseline consensus for industry and business in Wales including:
  - What additional existing data sources could be used to improve the analysis already undertaken by Welsh Government using the National Atmospheric Emissions Inventory (NAEI)[5]?
  - How can these additional existing sources be incorporated without additional complexity?
- How might the NAEI be expanded (for example, levels of granularity, categories included, etc.) to improve our understanding of GHG emissions in relation to industry and business in Wales?

1.8 Currently, the Welsh Government uses the NAEI to produce quantitative analysis of GHG emissions of Industry and Business and other sectors. However, this aimed to further explore:

- whether there are additional data sets that could provide a broader and more in-depth picture of GHG emissions
- how the NAEI might be expanded to improve understanding of GHG emissions.

1.9 The remainder of this report is structured as follows:

- Section 2 outlines the methodology used in the collection and analysis of data to inform this report

[3] Welsh Government (2021) Net Zero Wales Carbon Budget 2 (2021 to 2025)
[4] Welsh Government (2016) Environment (Wales) Act 2016
[5] Ricardo Energy & Environment (No Date) National Atmospheric Emissions Inventory

- Section 3 provides the background to the NAEI, outlines the development of the NAEI, its compilation at the UK level, and disaggregation to the Devolved Administration (DA) level
- Section 4 details information of the baseline consensus of Industry and Business. It contains an analysis of the relevant Industry and Business categories within the Inventory
- Section 5 presents a number of key challenges associated with current analysis of GHG emissions and the use and potential expansion of the GHGI
- Section 6 concludes the report with a series of recommendations in relation to the research questions and the key challenges outlined in Section 5.

## 2. Methodology

2.1 The design of the research methodology was built with an emphasis on both qualitative and quantitative data collection. This was done to encourage a more nuanced discussion of the topic and to enable an exploration of the intricacies inherent within the NAEI and its use at the Devolved Administration (DA) level.

2.2 The research contained the following fieldwork:

- qualitative scoping interviews with Welsh Government Economic Policy, Welsh Government Decarbonisation, and Welsh Government Emissions Trading Scheme (ETS) and carbon pricing to understand the challenges they are facing, their current use of the NAEI, and their view on the baseline consensus for Industry and Business in Wales
- a desk-based exploration of the NAEI and other available data sets to understand the categories and scope of emissions included in Industry and Business as well as the processes by which the NAEI is compiled, and the data used within it
- qualitative interviews with key stakeholders involved in the compilation and use of the NAEI. These included stakeholders from Ricardo Energy and Environment (Ricardo henceforth), Aether, The Office of National Statistics (ONS), the Climate Change Committee (CCC), The Department for Business, Energy & Industrial Strategy (BEIS), The Digest of UK Energy Statistics (DUKES) produced by BEIS, and Natural Resources Wales (NRW)
- a workshop with Welsh Government.

# 3. Background

3.1 This section outlines a background to the NAEI, its development, use and the process through which it is compiled at the UK level and disaggregated across the three DAs and England.

### The UK National Atmospheric Emission Inventory

3.2 The UK National Atmospheric Emissions Inventory (NAEI) is a compilation of GHG, atmospheric emissions and pollutant emissions that are produced in the UK[6]. It is comprised of the Greenhouse Gas Inventory (GHGI) and the Air Quality Pollutant Inventory (AQPI).

3.3 The NAEI is used as a reporting tool of GHG emissions to the United Nations Framework Convention on Climate Change (UNFCCC); and of air pollutants to the United Nations Economic Commission for Europe and the European Monitoring and Evaluation Programme (UNECE & EMEP).

3.4 The NAEI is compiled and maintained by Ricardo Energy and Environment (the Inventory Agency, IA) in collaboration with Aether, the UK Centre for Ecology & Hydrology (CEH), Forest Research, Hartley McMaster and Gluckman Consulting. It is commissioned and funded by the Department for Business, Energy & Industrial Strategy (BEIS) with support from the Department for Environment, Food and Rural Affairs (DEFRA), the Welsh Government, the Scottish Government, and the Northern Ireland Department of Agriculture, Environment and Rural Affairs[7].

### UK Greenhouse Gas Inventory

3.5 The UK ratified the United Nations Framework Convention on Climate Change (UNFCCC) in December 1993, and the convention came into force in March 1994[8]. Parties to the Convention are committed to develop, publish, and regularly update national emission inventories of greenhouse gases (GHGs). The UK-GHGI is one of the most comprehensive and detailed inventories in the World, although it does have inherent uncertainties. These will be discussed later in this report.

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[6] Ricardo Energy & Environment (No Date) National Atmospheric Emissions Inventory

[7] Emissions estimates from the energy supply sector, industrial processes sector and waste management sector are produced under the Ricardo Energy and Environment contract. Emissions from the agricultural sector are provided by Rothamsted Research under contract to Defra and emissions and removals in the LULUCF sector are produced on behalf of BEIS by CEH and Forest Research.

[8] United Nations Framework Convention on Climate Change (UNFCCC) (2023) What is the UNFCCC?

3.6 To ensure international comparability and consistency, the GHGI must be produced in alignment with the requirements for National Inventory Systems (NIS) established in the Marrakesh Accords of the Kyoto Protocol (1997)[9]. The NIS system is a requirement of the GHGI only, although in the UK the benefits of the system also apply to the AQPI. The GHGI is compiled and categorised according to guidelines produced by the Intergovernmental Panel on Climate Change (IPCC) (2006)[10]. Within the UK the NAEI is used to track the UK's progress in reducing emissions and inform policy and decision making.

3.7 The inventory covers seven direct GHGs, as per the Kyoto Protocol and the Doha Amendment (2012). These are collectively known as the 'basket' of GHGs and include: Carbon dioxide ($CO_2$); Methane ($CH_4$); Nitrous oxide ($N_2O$); Hydrofluorocarbons (HFCs); Perfluorocarbons (PFCs); Sulphur hexafluoride ($SF_6$); and Nitrogen trifluoride ($NF_3$). HFCs, PFCs, $SF_6$, and $NF_3$ are types of Fluorinated gases (F-gases)[11].

3.8 The variety of direct GHGs have differential implications on the atmosphere and are therefore assigned a global warming potential (GWP). GWP is a means of providing a simple measure of the relative effects of the emissions of various gases when compared with $CO_2$ which has a GWP of one. Once the emissions of GHGs are converted into GWP equivalents, the emissions can be summed and presented as carbon dioxide equivalent emissions, referred to as $CO_2e$. The GHGI presents GHG emissions in GWP, $CO_2e$ or Kilotonnes.

**National System for preparing the UK-GHGI**

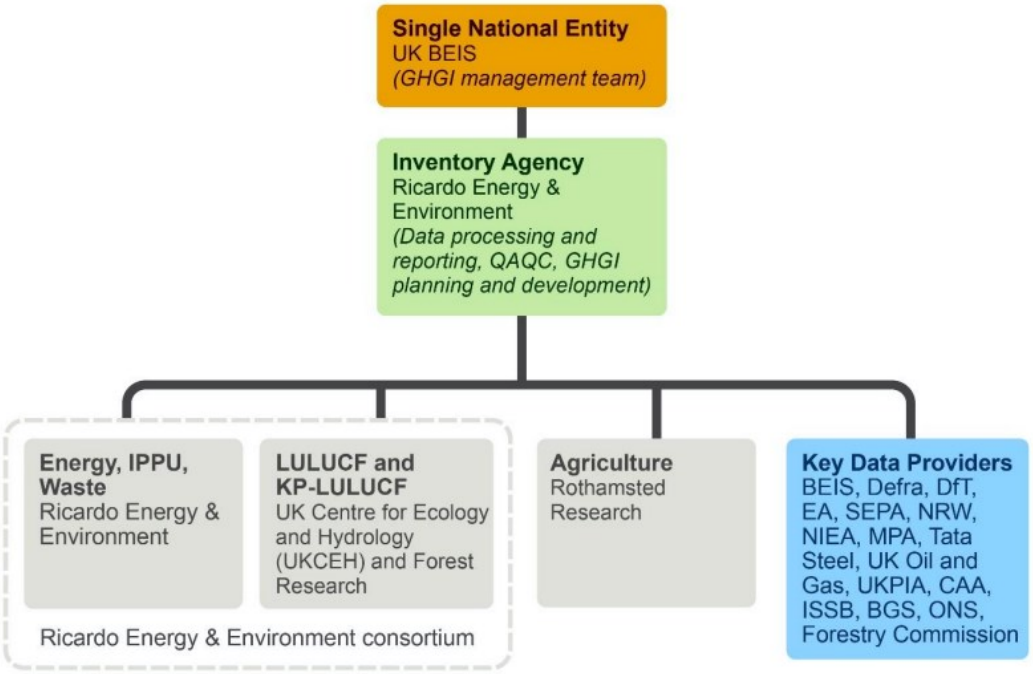
3.9 The UK GHGI is compiled annually according to the IPCC Guidelines and Good Practice Guidance. The Inventory Agency regularly assesses the methodology used to deliver estimates and methodological improvements will be delivered to account for new data sources, updated IPCC guidance, and research sponsored by UK government departments and Devolved Administrations. Improvements to the methodology are backdated to 1990 to ensure a consistent data time series. As a result, methodological changes can lead to alterations to the baseline.

3.10 The UK operates a well-established national system for GHG emissions estimation, reporting and archiving. Within this system activities include: collecting and processing data from a wide range of sources; selecting

[9] United Nations Framework Convention on Climate Change (UNFCCC) (2023) What is the Kyoto Protocol?
[10] Intergovernmental Panel on Climate Change (IPCC) (2006) IPCC Guidelines for National Greenhouse Gas Inventories
[11] United Nations Framework Convention on Climate Change (UNFCCC) (2023) What is the Kyoto Protocol?

appropriate emissions factors and estimation methods according to IPCC guidance; compiling the inventory; managing the inventory Quality Assurance (QA) and Quality Control (QC); prioritisation of methodology; data improvements; and completing uncertainty estimates. The methodologies and data sources used to create the GHGI can be found in Tables 1.5 and 1.6 of the UK National Inventory Report (NIR) submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2021[12]. An outline of the key organisational structure of the UK National Inventory System (NIS) is presented in Figure 1.

**Figure 1 Organisational structure of the UK NIS**

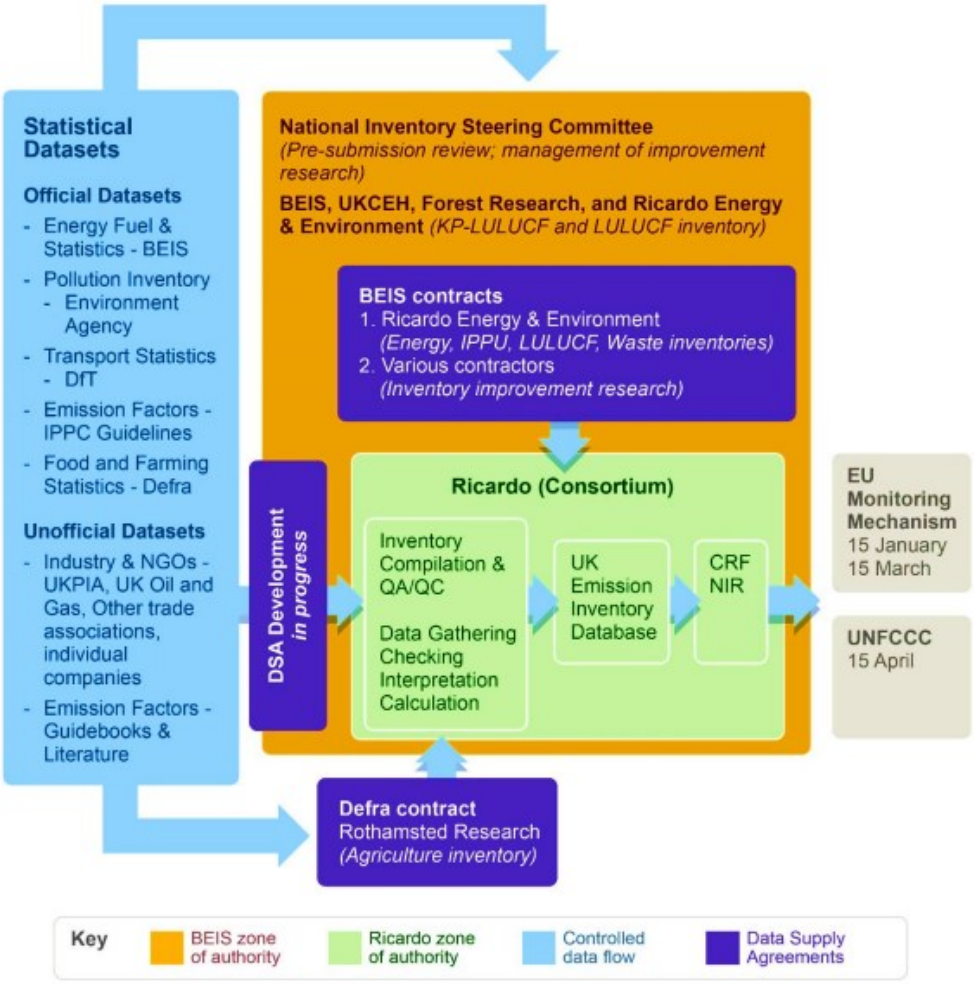



Source: UK NIR, 2021

3.11 The NIR, including Common Reporting Format tables (CRF tables present GHG emissions by IPCC common reporting categories) is reported to the UNFCCC. The national system ensures the UK is engaged with the process of expert review as dictated by Article 8 of the Kyoto Protocol. An outline of the roles and responsibilities within the UK NIS can be found in Figure 2.

[12] Department for Business, Energy & Industrial Strategy (BEIS) (2021) UK Greenhouse Gas Inventory, 1990 to 2019.

**Figure 2 Key elements for preparation of the UK-GHGI**




Source: UK NIR, 2021

3.12 A more detailed description of the national system in the UK can also be found within Section 1.2 of the UK NIR 2021.

### Inventory Compilation

3.13 In reporting to the IPCC, GHGIs must be presented within CRF tables under six IPCC sector categories. These categories are the reporting nomenclature used for annual reports to the UNFCCC and are comprised of:

1- Energy

2- Industrial Processes and Product use

3- Agriculture

4- Land use, land-use change and forestry

5- Waste

6- Other

3.14 Each of these categories is broken down into up to five orders of subcategories to give GHG emissions by source. Within each sector there are a number of first order categories which divide the sector category. These are then broken down up to a further three subcategories. These are indicated in the following format:

1A2gviii_Other_manufacturing_industries_and_construction

3.15 Within this structure, 1 represents Energy, A represents Fuel Combustion Activities, 2 represents Manufacturing Industries and Construction, g represents other industrial combustion, viii represents other manufacturing industries and construction.

3.16 The UK and DA GHGIs are presented by National Communication reporting format (NCFormat), for consistency with National Statistics produced by BEIS. These sectors are also used in National Communication (NC) reports to the UNFCCC. High level NCFormat Sectors include Agriculture, Business, Energy Supply, Industrial Processes, Land use, land use change and forestry, Public, Residential, Transport and Waste Management. These are then broken down into Sub-sectors, categories, fuel groups, fuel and source. The activity name is also recorded in the UK-GHGI.

3.17 Mapping between NCFormat and IPCC sectors can be found in Appendix five of the UKs 2014 NIR[13]. Mapping between Welsh Government Sector titles, NCFormat and IPCC sectors can be found in Appendix four of Net Zero Wales[14].

3.18 Information used in the compilation of the UK-GHGI is drawn from a wide range of emissions sources and UK statistics for activities producing GHG emissions. This includes fuel consumption, industrial production, agriculture, land use, land use change, forestry, and waste. A breakdown of the data used for each category of the GHGI can be found within the UK NIR 2021[15].

3.19 Data within the GHGI is presented by source and by end user. Source emissions are GHG emissions generated at source as a result of an activity or process. End user emissions are emissions from Energy production (e.g power stations), which are re-allocated to users of electricity. Direct emissions and end user emissions are derived from two distinct calculations and must therefore be considered independently. End user sectoral categories are consistent with those used in the National Communications to the UNFCCC. End user calculations allocate emissions from fuel and electricity producers to the end users – this allows emission estimates for a consumer of energy to include the emissions from the production of the fuel

[13] Ricardo Energy and Environment (2014) Devolved Administrations Greenhouse Gas Inventory, 1990 to 2014 Appendices.
[14] Welsh Government (2021) Net Zero Wales.
[15] Department for Business, Energy & Industrial Strategy (BEIS) (2021) UK Greenhouse Gas Inventory, 1990 to 2019.

or electricity they use. End user data is not a requirement from the UNFCCC for inclusion in NIRs. End user data is included to provide BEIS and DAs with information to support policy needs. A fuller description of the process to estimate end user emissions can be found in Annex 9 of the UK NIR 2021[16].

3.20 Generally the data with the lowest uncertainty is that of traded emissions. Traded emissions are emissions reported to and compiled by the UK-ETS (Emission Trading Scheme) formerly the EU-ETS. Emissions covered under the ETS tend to be large emitters and energy intensive industries such as power generators and heavy industry. The UK-ETS is a market solution to reducing emissions, based on a 'cap and trade' approach. A cap is set on the total amount of certain GHG emissions that applicable sectors are allowed to emit. Applicable organisations receive emission trade allowances that can be purchased in order to balance emissions and meet the established cap. Over time the cap on allowable emissions is reduced leading to an overall reduction in emissions across the scheme.

3.21 The EU/UK-ETS applies to regulated sites with a rated thermal input exceeding 20MW. The ETS counts all individual installations in excess of 3MW towards this 20MW total. The UK-ETS is not currently net zero compliant although the UK-ETS Authority has committed to consultation on how to ensure the cap is net zero compliant. The reporting and permitting documentation required as part of the UK-ETS provides high-level detail of site-specific activities and resultant emissions. Emission analysis undertaken at each UK-ETS site incorporates emission sources, emission points, source streams (referring to fuels and materials), and technical details of the regulated activity (e.g. if emissions are generated by combustion). These documents also provide information on the approach to calculation and measurement devices (type of device, measurement range, uncertainty and location). ETS documentation also categorises the nature of the operation into its corresponding Nomenclature of Economic Activities (NACE) codes[17], which facilitates economic mapping of emissions. More detail on how UK-ETS data is used in the UK-GHGI compilation can be found in the Annex to the UK NIR 2021[18].

3.22 While there is granular data on heavy emitting industries collected under the UK-ETS, data for smaller operations that do not meet energetic and emission requirements is harder to collect. The main source of energy consumption data used for data on emissions not directly reported under the UK-ETS come from the Digest of UK Energy Statistics (DUKES) annual reports, produced by BEIS. DUKES provides a detailed account of energy consumption, trade, and production at the UK level. The digest presents

[16] Ricardo Energy & Environment (2021) UK NIR 2021. Annex.
[17] NACE codes are a European statistical classification of enterprises based on their core activity.
[18] Ricardo Energy & Environment (2021) UK NIR 2021. Annex.

energy data as a UK total and by fuel type: solid fuels, oil, gas, electricity, renewables, and combined heat and power. In many cases, these data are used directly in the inventory without modification. However, there are instances where activity data used are not based directly on DUKES, instead utilising alternative data sources which provide supplementary information to the allocation of fuel to individual sectors and sources. To obtain consumption data, DUKES performs a number of energy supply-side surveys. This enables them to allocate different energy uses into the applicable sectors and corresponding subcategories and aggregate energy supply and demand. Once activity data and fuel type are compiled, emissions are calculated applying conversion factors for the fuel type.

3.23 In some instances, surrogate data is utilised to better allocate emissions to certain sectors, such as employment statistics, although it is difficult to estimate whether surrogate statistics are a good proxy indicator to reduce uncertainty around sectoral emissions[19].

**Devolved Administration Inventories**

3.24 Wales, Scotland, Northern Ireland and England each have devolved responsibility to address GHG emissions and the range of country-specific statutory and policy commitments is increasing. To support policy implemented in each DA, the Inventory Agency develops DA-GHGIs which are extended and updated annually. DA-GHGI's are published annually in the first half of June.

3.25 DA-GHGI's aim to provide an effective and accurate reporting tool to reflect the impact upon emissions from the implementation of both devolved and reserved measures. DA-GHGI's are presented in NCFormat, with the intention that emissions align with policy analysis requirements of DAs. However, in Wales the sectors outlined in Net Zero Wales do not align directly with NCFormats. Mapping between IPCC codes, NCFormats and Welsh Sectors can be found in Appendix four of Net Zero Wales[20]. Within the discussion of inventory compilation methodology, source data and trends, IPCC Sector nomenclature is used, in order to present a greater level of detail aligned with specific emission sources.

3.26 With the UK-GHGI based largely on UK statistics, it would theoretically be ideal to obtain a complete set of equivalent statistics for each constituent country to compile each DA-GHGI. However, as such a set of statistics is not available for all sources and for all constituent countries, and would require significant DA resource to produce, it is necessary to disaggregate UK

[19] Department of Food and Rural Affairs (DEFRA) (2014) Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2014, Appendices.
[20] Welsh Government (2021) Net Zero Wales

emissions into the four constituent countries through estimation. This means that there are emission categories that could have larger uncertainties at the DA level, resulting in the misallocation of certain emissions in those categories in which granular and accurate data is missing. Nonetheless, it is worth noting that the UK and DA GHGIs are widely considered among the most reliable emission inventories in the world. In 2019 the Welsh GHGI is estimated to have an overall uncertainty of ± 3 per cent[21]. More information on the data used in the disaggregation of the UK-GHGI into DA-GHGI's can be found in the annex of the UK 2014 NIR[22].

3.27 Energy balances are produced and split by sector at the UK level before being disaggregated into inventories for the three DAs and England. Given the lack of reliable bottom-up data on energy consumption, allocations are done utilising estimations and proxies. For example, following supplier surveys and other sporadic BEIS surveys, information is obtained on total fuel type use and activity source; this is then split into the corresponding proportion per DA and disaggregated into IPCC categories.

3.28 Within the UK-GHGI, GHGs are presented by activity, source, GHG, fuel group, and fuel. However, within the DA-GHGI emissions are presented by source and pollutant. This is because data on activity and fuel is based on disaggregation from the UK-GHGI and is therefore not displayed within the DA-GHGI as this would infer DA Energy Statistics. While estimations are derived per fuel, they are not presented as such within the DA-GHGI's. The data for these estimations by fuel are made available to Welsh Government and other DAs.

**Inventory Improvement**

3.29 The Inventory Agency operates a programme of improvement for DA inventories which includes a periodic review of the available source data and estimation methods. This operates in parallel with the programme of improvement to the UK-GHGI. The inventory is subject to constant scrutiny and review through a yearly QA/QC process led by BEIS and Ricardo which filters down into all other participating organisations[23].

3.30 A key aspect of the inventory is the timeline analysis of emissions, which forms the basis of baselining and setting reduction targets. Inventory improvements are not only carried out for present data collection, but also to reduce uncertainties regarding data collection on years in which there is little accurate evidence. This is particularly pertinent for data collection in years

[21] Welsh Government (2021) Net Zero Wales,
[22] Department of Food and Rural Affairs (DEFRA) (2014) Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2014, Appendices.
[23] Department for Business, Energy & Industrial Stategy (BEIS) (2021) UK Greenhouse Gas Inventory, 1990 to 2019

prior to the introduction of the ETS, in 2006. Reporting and accounting mechanisms have changed, and emission sources have moved from one sector to another.

3.31 As a result, data quality may not be consistent throughout the time series for certain emission sources. For example, for emission source 2A1 “Cement Production”, emissions data for the years 2005 and 2006 are incomplete because some kilns were reporting under a different scheme. For emission source 2A2 “Lime Production”, ETS data for the period 2005-2007 is incomplete because some sites were exempt from reporting in the ETS, which were later included. Data for the period 1994-2004 is reported in the Pollution Inventory (PI) but is not disaggregated between combustion emissions and industrial process emissions (which would allocate the emissions into different sectors); accordingly, emissions are divided following a set of assumptions.

3.32 Whenever a method, dataset or data source is updated, this has an effect on the time-series of emissions, and thus impacts on the baseline and on carbon budgets and targets, as they are based on the baseline emissions. If incorporating new datasets into the calculations of past emissions increases the estimated emissions for a given sector, this means that the reduction over time would have to increase, as the baseline emissions would be bigger than previously assumed. Welsh Government targets are defined as percentage reductions from the baseline which goes some way to mitigating the impacts of baseline changes relative to an absolute $CO_2e$ target, however changes to the baseline can still impact perceived progress towards emission reduction. For example, in 2018, the emissions of $NO_x$ were recalculated following a revision of DUKES for the sources 1A1 (Energy Industries), 1A2 (Manufacturing Industries) and 1A4 (Other sectors), which led to an increase of 9kt of $NO_x$ emissions compared to the previous estimation[24]. Revisions to the UK-GHGI are reported to the UNFCCC in the NIR.

3.33 These assumptions follow a thorough methodological approach, and the annual inventory improvement cycle is an assurance that the evidence utilised is constantly being updated. Nevertheless, there is concern at the UK government level regarding completeness and consistency of the inventory, mostly because accurate and granular point source data is scarce. Recently, as part of the improvement cycle, BEIS has commissioned a piece of work to identify data gaps in the GHGI, since they estimate that one third of emissions could be missing or misallocated.

3.34 The UNFCCC expert review team also undertakes annual reviews of the UK-GHGI to highlight reporting issues of transparency, completeness, consistency, comparability or accuracy and provide recommendations for

[24] Ricardo Energy & Environment (2021) UK Informative Inventory Report (1990-2019)

improvement. The results of the UNFCCC 2019 review and the actions taken by the Inventory Agency to address these can be found in the UK NIR 2021[25].

3.35 BEIS and the Inventory Agency have also developed a Key Category Analysis (KCA) ranking system to aid with prioritisation of improvement work. The Annex to the UK NIR 2021 contains a prioritised list of 42 IPCC categories for this improvement work[26]. The top 10 KCA ranked categories are presented in table 1.

**Table 1 Top ten Key Category Analysis ranked IPCC Categories**

| KCA rank | IPCC Code | IPCC Category | GHG |
|---|---|---|---|
| 1 | 1A3b | Road transportation: liquid fuels | $CO_2$ |
| 2 | 1A4 | Other sectors: gaseous fuels | $CO_2$ |
| 3 | 1A1 | Energy industries: solid fuels | $CO_2$ |
| 4 | 5A | Solid waste disposal | $CH_4$ |
| 5 | 1A1 | Energy industries: gaseous fuels | $CO_2$ |
| 6 | 1A2 | Manufacturing industries and construction: solid fuels | $CO_2$ |
| 7 | 1A1 | Energy industries: liquid fuels | $CO_2$ |
| 8 | 1A2 | Manufacturing industries and construction: solid fuels | $CO_2$ |
| 9 | 4B | Cropland | $CO_2$ |
| 10 | 3A1 | Enteric fermentation from Cattle | $CH_4$ |

Source: UK NIR 2021

3.36 Throughout the fieldwork and literature review, it was highlighted that one of the biggest challenges with the inventory is the lack of accurate bottom-up data and data on smaller sites and operations resulting in a continued reliance on assumptions. To address this, a key aim of the current improvement cycle is how, and which, databases could be included to reduce uncertainties and improve the emission data reliability of smaller emitters. This is of particular importance as the share of total Welsh emissions covered by the ETS has been falling in recent years.

3.37 This work is ongoing alongside work to improve the accuracy of individual IPCC categories by KCA rank. The KCA prioritisation has been developed for improvement to the UK-GHGI and addresses categories identified by the IA. However, it does not identify or address inaccuracies associated with emission disaggregation. Although a more accurate UK inventory will likely result in a more accurate Welsh inventory, action by Welsh Government to increase the availability of bottom-up data in Wales will help to increase the accuracy of the Welsh Inventory. The focus of inventory improvement for the IA is around increasing the accuracy of the UK inventory and the

[25] Ricardo Energy & Environment (2021) UK Informative Inventory Report (1990-2019)
[26] Ricardo Energy & Environment (2021) UK National Inventory Report (NIR) 2021

assumptions underpinning disaggregation, there is no targeted inventory improvement specific to DAs.

## 4. Baseline consensus of Industry and Business

4.1 In Wales, action on climate change has accelerated since the 'Environment (Wales) Act 2016' which requires Welsh Government to reduce emissions of GHGs in Wales by at least 80 per cent by 2050 through a system of interim emissions targets and carbon budgets[27]. In 2021, the Senedd agreed to revise Wales' statutory climate targets in line with the recommendations of the Climate Change Committee (CCC) in their December 2020 advice. The revised targets include a 37 per cent average reduction over Carbon Budget 2 (2021-2025), a 58 per cent average reduction over Carbon Budget 3 (2026-30), and achievement of a 63, 89, and 100 (net zero) per cent reduction in 2030, 2040 and 2050 respectively[28].

4.2 In 2019, Welsh Government published 'Prosperity for All: A Low Carbon Wales' [29] which established how Wales intended to meet its first Carbon Budget (CB1) (2016-2020) and the 2020 interim target through 100 policies and proposals across Ministerial portfolios. Prosperity for All was aligned with CCC sector emission pathways, defined as; Power, Buildings, Transport, Industry, Land Use, Agriculture, Waste and F-gases. CCC sectors now include; Agriculture, Aviation, Electricity Supply, F-gas, Fuel Supply, Land Use, Manufacturing and Construction, Non-residential buildings, Residential buildings, Shipping, Surface Transport and Waste.

4.3 Wales second Carbon Budget and delivery plan, "Net Zero Wales"[30], adopts a revised set of sector definitions aligned with categories within the DA-GHGI, and Welsh Government's work on decarbonisation. These sector definitions include; Electricity and Heat Production, Industry and Business, Transport, Residential Buildings, Waste Management, Agriculture Land Use Land Use Change and Forestry (LULUCF), and Public Sector. Mapping of these sectors to NCFormat sectors and IPCC categorisation can be found within Annex 4 of "Net Zero Wales"[31]. Industry and Business includes all IPCC categories listed under NCFormat, 'Energy Supply' with the exception of the following IPCC Categories:

- 1A1ai_Public_Electricity&Heat_Prouduction
- 1A1aiii_Public_Heat_Production.

4.4 The Welsh Government sector definition of Industry and Business includes emissions from IPCC categories under NCFormats; 'Business', 'Industrial

[27] Welsh Government (2016) Environment Wales Act.
[28] Welsh Government (2021) Net Zero Wales.
[29] Welsh Government (2019) Prosperity for All.
[30] Welsh Government. (2021) Net Zero Wales.
[31] Welsh Government (2021) Net Zero Wales Carbon Budget 2 (2021-25)

Processes', and some of 'Energy Supply'. These NCFormats account for 62, 12, 25 per cent of total Industry and Business emissions respectively in 2019.

4.5 It is worth noting that within CB1, GHG emissions now defined under the sector Industry and Business in Wales were split into Industry (emissions directly generated by industrial processes and reactions), F-gases, and Non-residential buildings (energy utilised to power the specific occupational use of the building)[32]. If emission categorisation was done according to CCC sectors, emissions now reported under Industry and Business, would be split into CCC sectors; 'Manufacturing and construction', 'Fuel supply', 'Non-residential Buildings', and 'F-gases'. Splitting DA emissions into CCC sectors is complicated as some CCC categorisations split IPCC categories into multiple sectors by fuel type. As a breakdown of fuel type is not available at the DA-GHGI level, the categorisation by CCC sectors makes understanding Welsh emissions challenging.

4.6 Finally, previous targets established under the Climate Change Strategy for Wales set a baseline of average relevant emissions between 2006 and 2010 as well as 1990. To align with the Kyoto Protocol, the UK has established a baseline of 1990/1995 and Wales has since adopted a base year of 1990/1995. Emissions of $CO_2$, $CH_4$, and $N_2O$ have an established base year of 1990. HFCs, $NF_3$, PFCs and $SF_6$ have a base year of 1995[33].

4.7 It is worth highlighting that whilst Welsh Government has adopted a 1990/95 as a base year as a requirement under the Environment Act, there is no international obligation to do so. Adopting an alternative base year for measuring policy impact could be beneficial, as the uncertainty of emissions increases as the baseline year becomes more remote. More accurate data is available from 2005-2006, when the EU-ETS was first introduced.

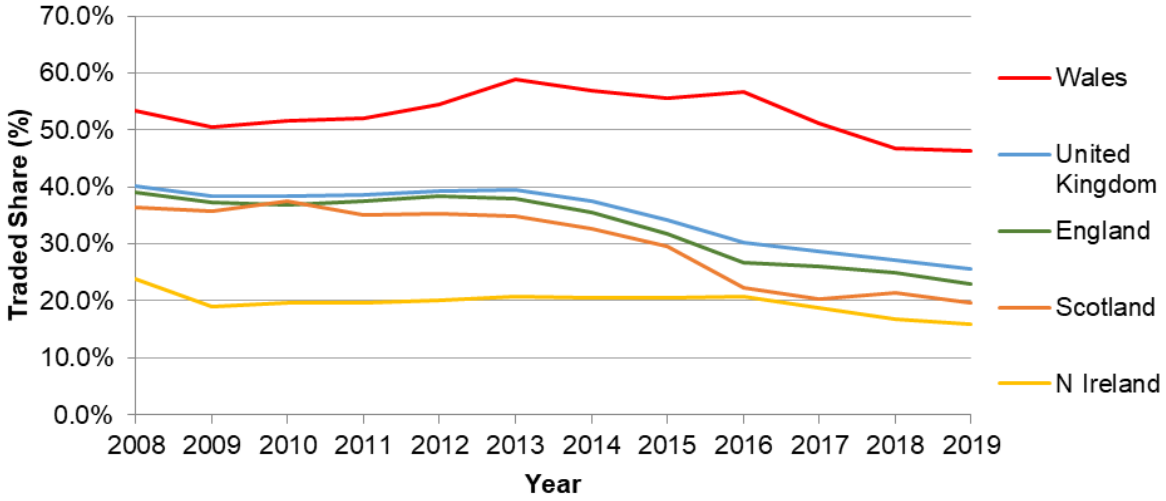
**Source Emissions**

4.8 In Wales the share of total emissions covered by the EU/UK-ETS has been consistently higher than in other DAs and the UK, reflecting the high share of heavy industry in Wales. As a result, in 2019, Wales had the highest proportion of traded emissions at 46.4 per cent while the UK figure was 25.7 per cent. However, it is worth nothing that the traded share of emissions as a proportion of total emissions has been falling across the UK. In Wales, the traded share of emissions peaked in 2013 at 58.9 per cent. Figure 3 outlines

[32] Welsh Government (2022) Final Statement for the First Carbon Budget and 2020 Interim Target
[33] Signatory Parties of the Kyoto Protocol can choose to baseline F-gases against the year 1990 or 1995, as long as all F-gases (HFCs, PFCs and SF6) are baselined against the same year. Wales and the UK chose to use the year 1995 as the baseline year for F-gas emissions.

the traded share of emissions in the UK and within each DA. These figures exclude emissions from international aviation and shipping.

**Figure 3 Traded percentage share of emissions (2008-2019)**

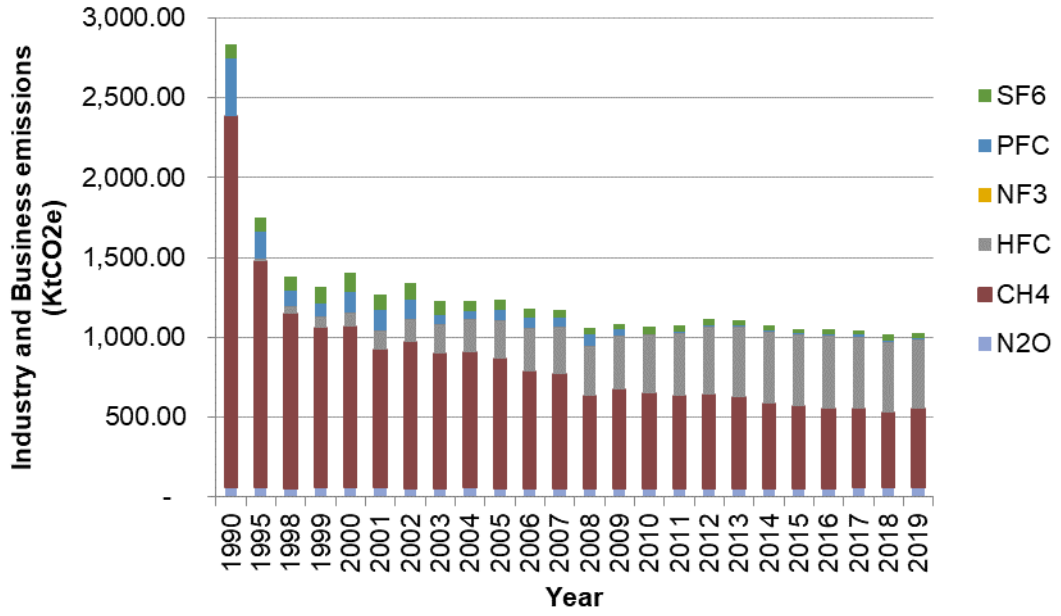



Source: Miller Research analysis of NAEI

4.9 The total emissions for Industry and Business in Wales in 2019 was 14,832.31 kt $CO_2e$. Collectively this represents 38.1per cent of total Welsh emissions. Industrial Processes contributed 4.9 per cent to total emissions, while Business emissions are responsible for 23.7 per cent, and included Energy Supply emissions represent an additional 9.6 per cent.

4.10 Total source emissions from Industry and Business in Wales since 1990 by gas type is presented in Figure 4. In 2019, 93.1 per cent of Industry and Business emissions were from $CO_2$, 3.3 per cent resulted from CH4, and 2.9 per cent arose from HFCs.

**Figure 4 Industry and Business emissions by gas (KtCO2e 1990-2019)**




Source: Miller Research analysis of NAEI

4.11 A breakdown of the composition of Industry and Business emissions by gas as well as the percentage changes in each of the gases between the base year and 2019 is presented below.

4.12 $CO_2$ emissions represent 94 per cent of 'Business' emissions, 99 per cent of 'Industrial Process' emissions, and 87 per cent of included 'Energy Supply' emissions. Collectively, $CO_2$ emissions have fallen 32 per cent since the base year. 97 per cent of $CH_4$ emissions are attributed to 'Energy Supply'. These emissions have fallen 79 per cent since the base year. Emissions from HFCs are responsible for 2.89 per cent of total Industry and Business emissions. HFC emissions are almost exclusively attributed to IPCC categories within 'Business' and have grown 2122 per cent since the base year. $N_2O$ emissions have seen reductions of 10 per cent collectively across NCFormat sectors 'Business' and 'Industrial processes' between 1990 and 2019. However, these reductions have been counteracted by increased $N_2O$ emissions included Energy Supply. $SF_6$ and PFC emissions are responsible for 0.31 per cent of total Industry and Business emissions and have been falling since the base year. $NF_3$ emissions are responsible for a minute proportion of total Industry and Business emissions. These emissions peaked in 2000 before falling to 0.1 kt $CO_2e$ in 2011. 0.3 kt $CO_2e$ of $NF_3$ emissions were produced in Wales in 2019.

**Table 2 Composition and change of Industry and Business emissions by gas (1990-1995)**

| GHG | Base Year | Proportion of Industry and Business emissions in 2019 | Change since base year |
|---|---|---|---|
| CO2 | 1990 | 93.05% | - 32% |
| CH4 | 1990 | 3.31% | - 79% |
| HFC | 1995 | 2.89% | + 2122% |
| N20 | 1990 | 0.44% | 0% |
| SF6 | 1995 | 0.24% | - 58% |
| PFC | 1995 | 0.07% | - 94% |
| NF3 | 1995 | 0.0002% | +28% |

Source: Miller Research analysis of NAEI

4.13 The proportions of traded emissions within Industry and Business are high with 98.1 per cent of Industrial Process emissions, 73.8 per cent of Business emissions, and 85.7 per cent of Energy Supply emissions are reported directly under the EU/UK-ETS. Accordingly, 77.9 per cent of total Business and Industry source emissions are traded and the accuracy of emissions within this is high.

4.14 However, as the Energy Supply category is sub-divided into Welsh Government classifications of 'Industry and Business' and 'Electricity and Heat Production', with only 33.8 per cent of Energy Supply emissions included within Industry and Business, identifying the extent to which included emissions are traded is a challenge. Whilst investigating the use of EU/UK-ETS data within the Energy Supply categorisation can give some indication of the extent to which Energy Supply emissions included in Industry and Business are traded, this is an area that requires further investigation through the Inventory Agency.

4.15 Data on 'Petroleum Refining' and 'Other energy industries' directly uses the UK-ETS as the basis for the DA-GHGI. However, data on the manufacturing of solid fuels utilises a combination of EU/UK-ETS, estimations on regional consumption data (although this limited in Wales), and data obtained by the Iron and Steel Statistics Bureau (ISSB). Based on these uses of EU/UK-ETS data, it is likely that at least 65 per cent of Energy Supply data included within Industry and Business is traded.

4.16 The contribution to total Industry and Business emissions can be broken down by relevant IPCC code. There are 59 such codes related to emissions from Industry and Business within the Welsh GHGI. The ten IPCC codes with the largest contributions to total Industry and Business emissions in 2019 as well as their NCFormat Category are shown below.

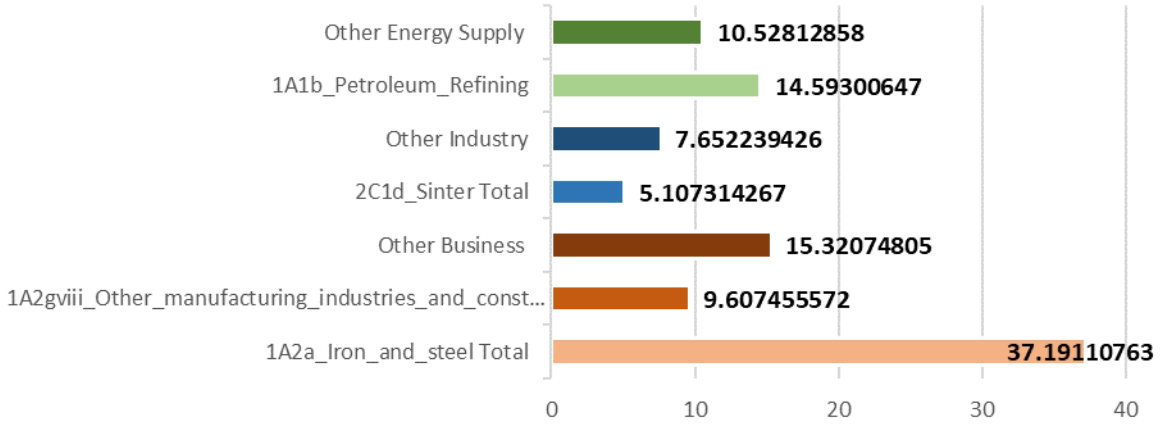
**Table 3 Largest IPCC code contributors by percentage of total Industry and Business emissions in 2019**

| IPCC Code | NCFormat | % of Industry and Business emissions |
|---|---|---|
| 1A2a_Iron_and_steel | Business | 37.19% |
| 1A1b_Petroleum_Refining | Energy Supply | 14.59% |
| 1A2gviii_Other_manufacturing_industries_and_construction | Business | 9.61% |
| 2C1d_Sinter | Industry | 5.11% |
| 2A1_Cement_Production | Industry | 3.82% |
| 2C1b_Pig_iron | Industry | 3.22% |
| 1A4ai_Commercial/Institutional | Business | 3.04% |
| 1A1ci_Manufacture_of_solid_fuels | Energy Supply | 2.98% |
| 1A2c_Chemicals | Business | 2.47% |
| 1A2gvii_Off-road_vehicles_and_other_machinery | Business | 2.44% |
| Total | | 84.46% |

Source: Miller Research analysis of NAEI

4.17 Collectively, these ten IPCC categories represent 84.5 per cent of Industry and Business emissions in Wales in 2019. Figure 5 presents a visual representation of the contribution of the top four IPCC codes to total emissions of Industry and Business. Collectively these top four IPCC codes account for 66.5 per cent of total emissions. The cumulative contribution of the remaining 55 IPCC codes is highlighted within each of the three relevant NCFormats.

**Figure 5 Contributions to total Industry and Business emissions in 2019**




Source: Miller Research analysis of NAEI

1A2a_Iron_and_steel

4.18 Iron and Steel in Wales is responsible for 37.19 per cent of total GHG source emissions from Industry and Business, and 14.16 per cent of total Welsh emissions. There are two key emission sources within *1A2a; blast furnaces and iron and steel – combustion plant*. Emissions from blast furnaces account for 30.0 per cent of *1A2a_Iron_and_steel* emissions and have increased 6.0 per cent since 1990. Combustion plant emissions account for 70.0 per cent of iron and steel emissions and have fallen 30.2 per cent since 1990. Iron is produced in blast furnaces by the reduction of iron-bearing materials with a hot gas. There are a number of combustion processes involved with iron and steel production. Combustion processes include heaters, flares, dryout heaters and several types of furnaces. For example, soaking pits and reheat furnaces are used to raise the temperature of the steel until it is sufficiently hot to be plastic enough for economical reduction by rolling or forging. Annealing furnaces are used to heat the steel to relieve cooling stresses induced by cold or hot working and to soften the steel to improve machinability and formability.

1Agviii_Other_manufacturing_industries_and_construction

4.19 Other manufacturing industries and construction are responsible for 9.6 per cent of total source emissions from Industry and Business. Key emission sources within this category include Autogeneration – exported to grid, Autogenerators (on site) and Other industrial combustion. These account for 4.3, 9.2 and 86.4 per cent of *1Agviii* emissions respectively. Emissions from Autogeneration – exported to grid and Autogenerators have increased by 256 and 378 per cent between 1990 and 2019, and there is no requirement to include autogeneration in the ETS. From a policy planning perspective, this may generate long-term issues, as Major Power Producers (MPPs) decarbonise, and sites may increase their reliance on energy coming from autogeneration (especially as a strategy to address natural variability in renewable energy generation). Emissions from Other industrial combustion have fallen 61.4 per cent over the same period. Other industrial combustion is used as a ‘residual’ source category to balance accounts between GHGI activity and DUKES demand totals. This category englobes all emission sources that do not fall between IPCC categories 1A2a-f (see Annex II). There is limited accurate information as to the composition of activities reported under ‘other industrial combustion’. This is an area requiring further research.

2C1d_Sinter

4.20 Sintering is the process of forming a solid mass by applying to a material heat and pressure without reaching the melting point. This imparts strength and integrity to the material in question. In Wales, sintering is carried out to create a product that can be used in blast furnaces, and the resulting sinter is mainly utilised to convert iron into steel. Sinter is the primary feed material for making iron and steel in a blast furnace because sintering converts fine-sized raw material into agglomerates of a suitable size and chemical composition for charging into the blast furnace oven and ensuring stable operation. Sintering is also a process that recovers the raw material value of many waste iron-bearing materials to the blast furnace to produce iron. Sintering is a continuous process that consumes feed materials of ore fines, coke, reverts (including blast furnace dust, mill scale and other by-products of steelmaking), recycled hot and cold fines from the sintering process, and trim materials (e.g., calcite fines, and other supplemental materials needed to produce a sinter product with prescribed chemistry and tonnage). The materials are proportioned and mixed to prepare a chemically uniform feed to the sinter strand, so that the sinter will have the qualities desired for satisfactory operation of the blast furnace. Sinter emissions are associated entirely with the direct production of Sinter and are responsible for 5.1 per cent of Industry and Business source emissions. Sinter emissions have fallen by 33.0 per cent between 1990 and 2019.

1A1b_Petroleum_Refining

4.21 Petroleum Refining is responsible for 5.6 per cent of total Welsh emissions, and 14.6 per cent of total emissions from Industry and Business. Emissions from Petroleum refining have fallen 39.0 per cent since 1990.

**End user emissions**

4.22 In addition to direct GHG emissions generated in the direct production of energy (at source) Industry and Business is a key contributor to end user emissions. These include emissions from power stations, for example, which are re-allocated to users of electricity. Direct emissions and end user emissions are derived from two distinct calculations and must therefore be considered independently.

4.23 Wales has a lesser share of the UK’s end user emissions compared to the by source estimates and has achieved higher emission reductions since 1990 than the by source inventory indicates.

4.24 Industry and Business were responsible for 2268 kt$CO_2$e of emissions from electricity use in 2019. This represents 59.0 per cent of emissions from electricity in Wales. This is important to consider when discussing emissions from Industry and Business, particularly in light of increasing electrification.

4.25 Overall 'Business' and 'Industrial Processes' are responsible for 42 per cent of total end user emissions in Wales. Iron and Steel emissions account for 17 per cent of the national total end user emissions.

**Baseline changes over time**

4.26 Changes to the inventory methodology are applied across the time series. This ensures time series consistency which ensures trends and mitigations compared to the base year are accurate. This can cause the baseline to change as emissions reporting or estimation increases in accuracy. While a large proportion of Industry and Business emissions in Wales are recorded through the EU/UK-ETS and therefore have a high degree of accuracy, there is greater uncertainty around non-traded emissions. This is particularly because disaggregation from UK statistics may fail to accurately account for contextual differences across the regions.

4.27 In the 2019 Welsh GHGI, methodological revisions from the previous year resulted in base year emissions for Industry and Business falling by 38 kt$CO_2$e, and increasing by 88 kt$CO_2$e in 2019.

# 5. Challenges

5.1 This section identifies a number of key challenges arising in expanding the NAEI, and its use in Welsh Government analysis.

### Emission estimation

5.2 The UK-GHGI is widely considered as one of the most accurate inventories in the World. The methodological basis of the inventory is constantly being revised and updated through yearly improvement cycles ensuring that reporting and estimating mechanisms are updated regularly to reflect the latest available data and methodological innovations.

5.3 However, given the inventory does not record a direct measurement of all emissions released at source but rather provides emission estimates based on statistics or other activities proxies, there remain inherent uncertainties within the inventory. It would be virtually impossible to obtain accurate point-source data of all emission sources, meaning estimations and assumptions based on proxy data are essential to address these gaps.

5.4 This is an issue at the DA level as DA emission data is disaggregated from UK totals, but each DA has different energetic needs and uses. While disaggregation methodologies attempt to allow for these differences, where DA level statistics do not exist, UK-wide statistics are used. For example, Wales is more rural than England with more off-grid areas, and these emissions can only be estimated using energy consumption models. As a result, reliance on modelling is not sensitive to local action, which makes it difficult to implement and monitor effective, targeted policies and measures. As a result of these limitations additional monitoring, reporting and verification processes will likely be necessary, such as Welsh Government performance indicators, although these are still in their infancy and currently rely on NAEI data. Expanding the availability of accurate source emission data in Wales for emissions not covered under the ETS would increase the reliability of the GHGI and provide valuable data for monitoring and evaluation of local policy action.

### Limited granularity

5.5 Within the DA-GHGI the limited granularity of emissions makes understanding the exact source of emissions a challenge. For example, within Industry and Business, the limited granularity is apparent in the IPCC emission category “1A2gviii_Other Manufacturing Industries and Construction”. As outlined in Section 4, 1A2gviii is used as a ‘residual’ source category to reconcile GHGI activity and DUKES demand totals.

There is no additional data to disseminate this category in a more granular manner despite the category accounting for 9.61 per cent of total Industry and Business source emissions.

5.6 This limited granularity is an impediment for policy design and implementation and can be a source of uncertainty within the sector, since the lack of further detail could imply an inherent misallocation of emissions within the category. Increasing the granularity of the DA-GHGI would likely require methodological approval from BEIS and sufficient data to enact such changes across all DA-GHGI's. However, if potential changes would be beneficial for DAs, the research indicated that BEIS would be open to studying the implementation of suggested improvements. For example, DA-GHGIs do not include a breakdown of emissions by fuel, as this would infer a Welsh energy balance which does not exist. Yet estimates for DA-GHGIs are derived per fuel and could technically be incorporated into the inventory.

**F-gases**

5.7 Fluorinated gases (F-gases) comprise four of the seven reported gases in the GHGI: Hydrofluorocarbons (HFCs); Perfluorinated Compounds (PFCs); Sulfur Hexafluoride ($SF_6$); and Nitrogen Trifluoride ($NF_3$). In 2019, 90.1 per cent of F-gas emissions within Industry and Business came from HFCs, which are mostly used in refrigeration, air conditioning appliances, aerosols and foams, metered-dose inhalers and fire equipment, and are emitted during the manufacturing, use and end-of-life of any products containing HFCs.

5.8 F-gas emissions account for 1.42 per cent of total Welsh GHG emissions with a GWP of up to 23,000 times greater than that of carbon dioxide[34]. It is important to have a detailed understanding of these gas emissions to accurately abate their release. Industry and Business are responsible for 91.5 per cent of total F-gas emissions in Wales.

5.9 In Wales, F-gas emission from industrial processes have fallen by 95 per cent since the base year, primarily as a result of EU regulation introduced in the early 2000s which limited the use of F-gases in industrial processes. However, despite process-related F-gas emissions being almost entirely erased, HFC emissions from refrigeration, air conditioning and heat pumps (RACHP) have increased considerably, mitigating the impact of reductions achieved in industrial processes. Overall, total emissions from F-gases across Industry and Business in Wales have increased by 85 per cent, with emissions from refrigeration applications responsible for the majority of this increase.

[34] Welsh Government (2019) Prosperity for All.

5.10 Understanding the use of F-gases within RACHP has become a crucial requirement to reduce emissions from F-gas use across Wales. There are a number of challenges embedded within the decarbonisation of RACHP systems. The RACHP market is complex, with a number of sub-sectors and systems designed for highly specialised applications. As a result it is difficult to generate accurate estimations or design cross-sectoral and widely applicable solutions. In addition to this, there is no data on what type of F-gases is used in each DA, for example, if the HFCs utilised in HPs are the same across the UK, or how they might differ. This affects the estimation of the GWP and resulting CO2e of RACHP operations and increases the uncertainty relating to the emissions associated with these gases. It is worth noting that, according to the CCC, despite F-gas emissions from RACHP systems having a high GWP, there are environmental benefits of using HFCs in RACHP to reduce the use of fuel combustion in this sector.

5.11 Although there is currently little evidence to help disseminate F-gas emissions, upcoming work commissioned by UK government aims to address these data gaps. Given the high impact of these gases, and increases in their emissions over time, a unified approach to reducing their use will be essential. The Welsh Government should further investigate how to reduce uncertainties within these emissions, ideally in close communication with BEIS and the IA.

**Categorisation**

5.12 Another challenge identified in the research is the slight lack of consistency regarding the categorisation and sector composition of the GHGI. Although methodological updates are an essential step in increasing inventory robustness, and this will inevitably entail certain changes, consistency is a key factor for long-term policy making and forward-looking solutions. This is important in the GHGI because any major changes to the baseline or sectoral totals can have a ripple effect over the planification of carbon budgets and reduction targets. At the Welsh Government level, consistency over the baseline for Industry and Business will aid effective policy making.

5.13 There are multiple examples of this within discussion around GHG emissions categorisation. One example is the different sectoral splits between GHGI NCFormats and the CCC. This adds a degree of complexity when it comes to modelling scenarios and onboarding advice, since both bodies produce research, reports, and consultation to the Welsh Government. The use of CCC sectors within CB1 resulted in non-residential buildings being excluded from Industry and Business, although these are now included. This has resultant impacts on decarbonisation planning, and the way in which sectoral

targets and measures are designed. The challenges associated with transferring the DA-GHGI into CCC sectors have been outlined in Section 4.

5.14 There are still ongoing debates at the UK level regarding sectoral definitions, boundaries and taxonomy within the GHGI, and future changes to categorisations may occur.

### Emissions from on-site energy production fed back to the grid

5.15 Currently, the DA-GHGI can be filtered to obtain emissions from autogeneration on site and autogeneration fed back into the grid. Nonetheless, the fieldwork outlined some concerns with the accuracy and validity of this data. Data from the ETS is not sufficiently transparent or detailed to accurately allocate these emissions. There is also no requirement to include on-site generation within ETS reporting, and meter point data does not capture on-site generated energy.

5.16 This means that there is no information on where this energy is going to, or where it's coming from, which leads to a misallocation of energy use estimates. It also means that the values given are most likely all estimated based on inaccurate data, which likely has a high rate of uncertainty.

5.17 Currently, BEIS circulate a quarterly survey to help calculate the electricity generated on-site. An example of the survey can be found in Figure 6. Values referring to electricity supplied back to the grid are made available through the survey. However, the survey could be improved to collect more accurate data. There is no evidence being collated regarding the destination of the electricity being supplied back to the grid (item 1.4 in Figure 6) or to other customers directly (item 1.5 in Figure 6). This information could be crucial to improving the energy balances at the DA level. As a first step, BEIS have decided to bring back in-house the autogenerators Survey in order to improve data quality and coverage.

**Figure 6 BEIS Autogeneration Survey**

**I. Electricity generated on site from your own generating plant**

| | | | MWh |
|---|---|---|---|
| 1.1 | Total generated ..... | 10 | |
| | Used as follows: | | |
| 1.2 | Consumed in power station complex..... | 110 | |
| 1.3 | Used on site for power and processing..... | 120 | |
| 1.4 | Sold to electricity generation/supply companies..... Electricity generation and supply companies include all companies licensed to sell electricity to consumers. | 14 | |
| 1.5 | Sold to other customers off site..... | 15 | |

1.6 Is any of the electricity that you sell or use, and have included within the answers above, bought in rather than generated by your generating plant? ☐ Yes ☐ No

If the answer to item 1.6 is 'No' then the sum of items 1.2 to 1.5 should agree with the amount given at 1.1. Please check that you have quoted the values at items 1.1 to 1.5 in **MWh**.

Source: BEIS[35]

5.18 Moreover, there is limited knowledge regarding the extent of this emission source amongst traded or non-traded emissions, and thus no information as to how it affects the total energy use of the sites using on-site generated energy.

### Commercial sensitivity

5.19 In Wales, a relatively small number of large emitters creates issues with commercial sensitivity if the granularity of data within the GHGI were to be increased. There are currently approximately 65 sites in Wales that report under the UK-ETS. Publication of process data for large industries in Wales that are responsible for a high proportion of emissions would be commercially sensitive.

5.20 Ensuring such processes are reported on and sufficient detail provided to Welsh Government, without disclosing commercially sensitive information, is a key challenge in the implementation of effective and targeted policy action.

### GHGI vs Environmental Account

5.21 At the UK level, the UK-GHGI provides data on the greenhouse gas emissions from sources within the UK. The UK-GHGI is then adjusted by Ricardo and the Office of National Statistics to produce UK Environmental

[35] Department for Business, Energy & Industrial Stategy (BEIS) (2022) Electricity Statistics Methodology Note

accounts. Environmental accounts show how the environment contributes to the economy, the impacts the economy has on the environment, and how society responds to environmental issues.

5.22 The UK environmental account adjusts the GHGI to account for residency-based emissions, shipping, and international air travel (although at the Wales level bunker fuel sales for international aviation and shipping are already reported in the GHGI). The total of these emissions is then mapped by industry section and grouped under Standard Industrial Classification (SIC) codes.

5.23 Environmental accounts enable emissions to be compared to economic statistics such as GVA and employment. Welsh Government has commissioned a SIC mapping of its DA-GHGI. SIC mapping will provide invaluable data for Welsh Government on the nature of emissions within sectors of the economy, and specific industries. It is worth highlighting that the total of Industry and Business emissions under the GHGI will likely be lower than the total emissions contained within the SIC mapping as SIC mapping will cover the whole economy and account for emissions within the supply chain of specific industries. ONS has investigated producing DA Accounts previously and identified limited appetite among DA policy makers. The research suggests this appetite has changed in recent years, given the rise of environmental and decarbonisation policies and agendas at the UK and DA level. Welsh Government should engage with the ONS and Ricardo to understand how a Welsh Account could be provided to Welsh Government regularly.

# 6. Conclusions and Recommendations

6.1 This section outlines a number of recommendations and conclusions in relation to the challenges presented above. It identifies a number of additional existing data sources which could be used to improve the analysis already undertaken by Welsh Government, how such data sources could be incorporated into current analysis without additional complexity, and how the NAEI may be expanded to improve understanding of GHG emissions related to Industry and Business in Wales.

**Data electronification**

6.2 As outlined in Section 3, the UK-ETS reporting and permitting documents contain a high level of detail regarding emissions from a specific operation at a particular site. In Wales, the UK-ETS is managed and regulated by Natural Resources Wales (NRW). Emissions data are fed directly from the UK-ETS (or, pre-2021, from the EU-ETS) into the NAEI, and this is split into IPCC source categories within the GHGI.

6.3 However, despite the EU/UK-ETS capturing a high level of accuracy and precision from participants in the scheme, these data are only included broadly within the GHGI. Much of the detail and data compiled within the EU/UK-ETS permitting documents is not currently utilised by the NAEI or any policy team. EU-ETS Registry documents do get used for analysis, and these contain information directly obtained from the permitting documents, but detail found in reporting and permitting documents is not made available to governments, and hence not fully utilised. This information could prove invaluable in better understanding GHG emissions and the processes responsible for emissions from large emitters. It could help identify opportunities to design process-based policies and interventions better targeted at abating certain emission types.

6.4 Currently only summary data for sites within the EU/UK-ETS is available to the IA. There are a number of potential reasons for this. Firstly, despite containing significant detail, permitting and reporting documents are not produced in a way that facilitates easy dissemination or application and results are not collected in a database. Accordingly, inter-site comparison would be labour intensive and some form of data electronification would be required. Secondly, process data is highly commercially sensitive, especially given the relatively low number of EU/UK-ETS permits granted in Wales. Such data may disclose manufacturing and process details that private companies would not want to share.

6.5 Whilst this information could enhance the knowledge of GHG emissions from industrial processes, it is unlikely that private entities would agree to sharing such detailed information. To address this, we recommend Welsh

Government engagement with NRW to electrify EU/UK-ETS data, and make it available to government decision making teams, but not publicly available, as is the GHGI. Anonymisation of data and privacy assurance would be key steps in this engagement. Additional emissions detail contained within ETS permitting documentation and Installation AEM Reports could help Welsh Government in designing strategies and interventions to support large industrial corporations to decarbonise. This additional documentation would not increase the accuracy of emission data within the GHGI as total emission for each site are entirely accounted for in the GHGI and would rather serve to enhance the knowledge about industry-related emissions and processes.

**Increasing data collection**

6.6 A notable challenge of the NAEI is to obtain accurate and reliable data for small operations. The emissions (both for process and energy consumption) of these sites are usually based on estimation produced by DUKES, and generally the uncertainty around these emissions is directly proportional to how small the operation is. Increasing the accuracy of the GHGI can be done through either increasing the availability of bottom-up data or increasing the reliability of proxy data. Reducing the use of estimations is a key objective of the NAEI. However, given the logistical difficulties and the potential burden on businesses and industries associated with increasing bottom-up data collection, reducing the use of estimations is a considerable challenge.

6.7 With EU/UK-ETS data providing the most accurate and robust available emissions data, there is a question as to what the potential extent of its scope could be. It is highly unrealistic to include all sites within the ETS; it would be an expensive and time-consuming process with limited gains in emissions covered given the extent of Industry and Business emissions covered under the current UK-ETS. It is worth noting that investigation of scope enlargement of the UK-ETS could take the form of either a reduction in the threshold required to report under the UK-ETS (20MW) or a reduction in the size of installations included within each site. However, the viability of potential scope enlargement would depend on the value that Welsh Government places on more accurate emissions data, and the extent to which this would provide greater detail on emissions than that currently being estimated. As larger industries and emitters decarbonise, driven by participation in the ETS, smaller non-ETS sites will become more important and the uncertainty around emissions from these sites, more significant. Increasing the reporting requirements to include smaller emitters either through expansion of the ETS or through an alternative reporting mechanism would help to address inaccuracies in reporting these emissions. Welsh

Government should continue to explore how to drive decarbonisation in smaller emitters without impacting market competitiveness.

6.8 Other sources of data collection are also being developed which are not currently used within the GHGI. For example, Streamlined Energy and Carbon Reporting (SECR)[36]. SECR requires large companies to include energy and carbon information within directors reports from the 1 April 2019. As per sections 465 and 466 of the Companies Act 2006, Large companies are defined as companies meeting two or more of the following criteria: an annual turnover of £36 million or more; balance sheet assets of £18 million or more; or 250 or more employees[37]. Data reported under the SECR may provide useful information for Welsh Government in assessing emissions and developing policies for Industry and Business. SECR data is not currently being investigated for inventory improvement.

**Survey reviews**

6.9 To improve and update evidence on energy usage in non-domestic premises, governments carry out surveys of a sample of selected sites. Surveys provide insights into how energy is used in a particular moment in time, and this evidence can then be used to produce mitigation and abatement plans.

6.10 Although some of these surveys are done at the UK level, there are others that target specific DAs. This is the case for the Building Energy Efficiency Survey (BEES), which addressed non-residential buildings in England and Wales in 2014-2015[38]. The research collected data through 3,690 telephone surveys and 214 site surveys and provided records on energy usage, information on the profile of the building (age, size, etc) and the nature of the organisation.

6.11 Although the BEES is not undertaken periodically, these channels and data collection mechanisms exist already. Considering that one of the key challenges of the NAEI is collecting robust granular data outside of large emitters, there is potential to building on existing survey channels to update evidence and fill in data gaps within the GHGI for business and non-domestic emissions.

6.12 Welsh Government could improve knowledge on buildings' emissions and emissions from smaller operations through existing or dedicated surveys within Wales. Exploring the possibility of a Welsh energy consumption survey would reduce the assumption-based approach to building emission

[36] UK Government (2019) Environmental Reporting Guidelines: Including Streamlined Energy and Carbon Reporting Guidance
[37] UK Government (2006) Companies Act 2006
[38] UK Government (2023) Building Energy Efficiency Survey

calculations. Where possible emissions data should be integrated into existing surveys undertaken by Welsh Government. This can be done by ensuring that most, if not all, non-ETS operations have gas and electricity meters installed in the key energetic inputs. This would enable reliable total energetic use data to be accurately measured at source. Data on fuel use for off-road mobile machinery, which has a relatively high level of uncertainty (see Annex I), would also help narrow down the reliance on assumptions and is a data point that could be incorporated into surveys.

6.13 In the 2019 inventory the impact of increasing coverage of point-source data collection is visible. A revision to the 2019 inventory adopted an updated dataset covering a wider array of both large and small industrial sites and resulted in an increase in emissions from 'Energy Supply' by 167 $ktCO_2e$ in the UK (25 $ktCO_2e$ in Wales).

### Additional data sources

6.14 There were a number of existing data sources identified in the process of this research which could be used to improve and complement analysis already undertaken by Welsh Government using the NAEI. Data sources that have not already been mentioned are expanded upon below.

**Table 4 Additional data sources**

| Data set | Explanation |
|---|---|
| BEES | Building Energy Efficiency Survey |
| ND-NEED | Non-Domestic National Energy Efficiency Data |
| SECR | Streamlined Energy Carbon Reporting |
| IA estimations of fuel use for Das | Estimations of fuel use within each IPCC category conducted by the IA in production of the DA-GHGI. |
| UK-ETS documentation | Permitting and reporting document provided to NRW in Wales can provide increased detail on processes within traded emissions |
| 2005-2019 UK local authority and regional $CO_2$ emissions | National Statistics produced by BEIS, approximating $CO_2$ emissions within local authorities in Wales. |

Source: Miller Research

ND-NEED

6.15 The Non-Domestic National Energy Efficiency Data Framework 2021 (ND-NEED) is a data compilation of non-residential building stock and energy consumption in England and Wales[39]. It provides coverage of electricity and gas consumption intensity measured at meter point level. The database covers energy use obtained via the public distribution system and splits it into sector, building size and business size.

6.16 Since the framework is founded on meter-point data, it presents an accurate representation of consumption figures for grid energy in non-domestic buildings. The ND-NEED does not cover off-grid energy consumption, such as on-site autogeneration. However, DUKES estimates 89 per cent of non-domestic building electricity consumption was from the grid in 2019. The ND-NEED therefore has the potential to provide a reliable complement to DUKES' present approach of analysing energy consumption from the supply side.

6.17 The ND-NEED is currently being explored by the DUKES team as a potential new source of data to improve estimations of Business and Non-domestic emissions. The Welsh Government should engage with BEIS to design and align future editions of this framework to suit their needs, since the report is produced exclusively for Wales and England. There is scope for improvement of the results the ND-NEED, for example regarding the uncertainty of business sizes in both countries.

UK local authority and regional $CO_2$ emissions

6.18 The UK local authority and regional CO2 emissions data base is a framework produced by BEIS that provides emissions data split by Welsh Local Authority (LA) from the year 2005-2006 onwards.

6.19 This is done by analysing meter-point data using a Meter Point Administration Number (MPAN). Each meter has a profile class, which splits consumption into domestic consumers and industrial and commercial consumers. This enables the mapping of consumed energy per profile of consumer within the LA.

6.20 This database provides a valuable insight into emissions split by LA at the Welsh level, which can be a very good starting point for effective local policymaking. The Welsh Government should consider exploring how to incorporate these results into their analysis (as well as the Technical Report produced by BEIS to accompany the framework[40]). There are, however,

[39] UK Government (2014) Non-domestic National Energy Efficiency Data-Framework (ND-NEED)
[40] Department for Business, Energy & Industrial Strategy (BEIS) (2019) Local Authority $CO_2$ emissions technical report.

some issues with this database which mirror the issues identified for other emission frameworks and datasets. There is uncertainty for a small number of sites regarding the emission sources, particularly where emissions could result from numerous different sources. The main sectors within this uncertainty analysis would be the chemical, food and paper industry.

6.21 Another issue is correctly identifying the fuel composition on sites where it is assumed that fuel combustion is taking place. In the absence of accurate fuel data, it is usually assumed that gas is the most likely used fuel. However, some sectors utilise a wide range of fuels, over which estimations are hard to make and uncertainties arise.

6.22 A detailed account of the issues with this Local Authority Database, as well as the methods used to make estimations for smaller and larger emitter, can be found in the technical report.

**Potential expansions to the NAEI**

6.23 Expanding the NAEI to include more granular data would require the incorporation of additional data sets or the further disaggregation of existing proxies.

6.24 While there is potential for existing data sets such as UK-ETS data to be incorporated, this first requires formatting and electronification to enable analysis by the IA and raises issues around commercial sensitivities, given the relatively limited number of sites reporting under the ETS in Wales and the highly specialised nature of some of these sites.

6.25 Where additional data can be made available, i.e. through regional or sector specific surveys, or increased carbon reporting requirements, the NAEI will assess and review their use, likely incorporating them if they provide more accurate data. For example, better Wales-specific energy use data per sector would reduce the requirement for the IA to deploy proxies to estimate Wales share of UK statistics. There is currently little existing data on Wales specific energy use, and the research did not identify any additional data sets that could be immediately incorporated into the NAEI that the IA and BEIS are not already investigating. The IA acknowledges that the disaggregation of UK data into the DA inventories relies on assumptions and estimates rather than bottom-up data, which would be more reliable. As a result, it is likely that the IA would welcome any Welsh Government activity to increase the availability of Welsh-specific data, particularly if changes can be easily rolled-out in other DAs. Engagement with the IA to understand the quality requirements for any survey data would ensure data collected can be accommodated by the IA. Methodological improvements that can be developed at the DA level and rolled out across the UK would be most welcomed by BEIS and the IA.

6.26 Where additional data is not available, further disaggregation may provide increased granularity of data within the GHGI. However, increasing granularity within the GHGI based of disaggregation of proxies increases the uncertainty of emissions within the GHGI, especially for smaller sites.

6.27 The GHGI could be expanded to include a traded vs non-traded breakdown for each IPCC code. This would enable Welsh Government to understand the exact emission sources where there remains a higher degree of uncertainty. A breakdown of traded vs non-traded emissions would also provide Welsh Government with insight into how traded emissions are impacted relative to non-traded emissions, whether the share in traded emissions is falling as a result of disproportionate emission reductions within the UK-ETS compared to non-traded emissions, or if processes are migrating out of the ETS. Such data would allow projections of emissions for each IPCC category to be translated to emissions that would fall under the ETS cap within the Welsh Government 2050 pathways tool.

6.28 Another potential expansion to the GHGI could be to include the estimations of fuel use that are undertaken by the IA. However, this data would likely be commercially sensitive and is currently made available to Welsh Government on request. Welsh Government should ensure this data is obtained by the IA and used in policy development and analysis.

# 7. References


Department for Business, Energy & Industrial Strategy (BEIS) (2019) Local Authority $CO_2$ emissions technical report.

Department for Business, Energy & Industrial Strategy (BEIS) (2021) UK Greenhouse Gas Inventory, 1990 to 2019

Department for Business, Energy & Industrial Strategy (BEIS) (2022) Electricity Statistics Methodology Note

Department of Food and Rural Affairs (DEFRA) (2014) Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2014, Appendices.

Intergovernmental Panel on Climate Change (IPCC) (2006) IPCC Guidelines for National Greenhouse Gas Inventories

Intergovernmental Panel on Climate Change (IPCC) (2018) Annex ii, AR5.

Ricardo Energy & Environment (No Date) National Atmospheric Emissions Inventory

Ricardo Energy and Environment (2014) Devolved Administrations Greenhouse Gas Inventory, 1990 to 2014 Appendices

Ricardo Energy & Environment (2021) UK National Inventory Report (NIR) 2021

Ricardo Energy & Environment (2021) UK Informative Inventory Report (1990-2019)

UK Government (2006) Companies Act 2006

UK Government (2014) Non-domestic National Energy Efficiency Data-Framework (ND-NEED)

UK Government (2019) Environmental Reporting Guidelines: Including Streamlined Energy and Carbon Reporting Guidance

UK Government (2023) Building Energy Efficiency Survey

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United Nations Framework Convention on Climate Change (UNFCCC) (2023) What is the Kyoto Protocol?

Welsh Government (2016) Environment (Wales) Act 2016

Welsh Government (2019) Prosperity for All.

Welsh Government (2021) Net Zero Wales

Welsh Government (2021) Net Zero Wales Carbon Budget 2 (2021 to 2025)

Welsh Government (2022) Final Statement for the First Carbon Budget and 2020 Interim Target

# 8. Annex.

## Annex I

In order to identify the highest emitting fuel sources with the highest uncertainty factors, a cross-reference analysis between the DA-GHGI and the GHGI Annex II (uncertainty estimations per fuel) was carried out. Consistent with the high proportion of traded emissions in Industry, there are no high emitting sources with high activity or emission factor uncertainty in this sector. This was not the case in Business, where there are certain sources with high uncertainties, as can be seen below. It is worth noting that the uncertainty calculations are carried out for fuel at the UK level. This means that some of the fuels outlined may not be applicable to Wales, even though the IPCC categories analysed are those presented in the Welsh GHGI.

**Table 5 Uncertainty within UK-GHGI fuel sources relevant to Industry and Business in Wales**

| NCF orma t | Highest emitters Wales | Highest uncertainty fuels | Activity Uncertainty (%) | Emission Uncertainty (%) | Explanation |
|---|---|---|---|---|---|
| Busi ness | 1A2_Iron and Steel | 1A2_Gas/Di esel Oil | 20 | | The AD for stationary combustion in industrial sectors is quite uncertain. DUKES does not distinguish between mobile and stationary sources, and other AD data sources (e.g. EU ETS) have limited coverage of gas oil use across all of 1A2. |
| Busi ness | 1A2c_Chemical s | 1A2_non-fuel combustion | 50 | 100 | Minor fuel in the sector however, so maybe not even applicable to Wales |
| Busi ness | 1A2gvii_Off-road vehicles and other machinery | 1A2_Petrole um coke | 20 | 15 | EF uncertainty reflects range of petroleum coke (petcoke) composition that may be used for fuel in 1A2. AD uncertainty is quite high as we have limited data from DUKES and not much AD from EU ETS on petcoke use. Petcoke is sometimes used in Steel production, hence potentially applicable to Wales. |
| | | 1A2_Motor Gasoline | 20 | | Motor gasoline allocations are very uncertain. Applicable under off-road transportation |
| Busi ness | 1A4ai_Commer cial/Institutional | 1A4_Gas/Di esel Oil | 30 | | High AD uncertainty as scarce data on use of this fuel, e.g. in mobile machinery, in 1A4. |
| | | 1A4_Motor Gasoline | 50 | | Motor gasoline allocation are very uncertain. Possibly applicable for mobile machinery |
| | | 1A4_Peat | 30 | | Mainly used in boilers, so potentially applicable in non-res buildings. Minor fuel in this category, however. |

| | | | | | |
|---|---|---|---|---|---|
| | | 1A4_Petroleum coke | 20 | 15 | EF uncertainty reflects range of petcoke composition that may be used for fuel in 1A2. AD uncertainty is quite high as we have limited data from DUKES and not much AD from EU ETS on petcoke use. Petcoke is sometimes used in Steel production, hence potentially applicable to Wales. |
| Energy | 1A1b_Petroleum refining<br>1A1ci_Manufacture of solid fuels | 1A1_Refinery Gas | 25 | 15 | Within the 1A1 Category, the fuel with the highest uncertainty that may be applicable to petroleum refining and manufacture of solid fuels is Refinery Gas, although there is no further specification if this fuel is used in Petroleum Refining and Manufacture of solid fuels. Comparisons between EU ETS and DUKES are variable over time. Risk that in earlier years the "own use" may have been mis-reported to energy stats. High uncertainty on AD. Also a variable quality fuel, so the EF is also uncertain. |
| | 1B1ai_Underground mines: mining Activities<br>1B1b_Solid fuel transformation | 1B1_Petroleum Coke | 20 | 10 | Minor fuel in the sector however, so maybe not even applicable to Wales |

Source: Miller Research analysis of the NAEI

## Annex II

Activities included in categories 1A2a-f[41].

**Figure 7 Activities included in categories 1A2a-f**

| | | | | | |
|---|---|---|---|---|---|
| 3 | Iron and steel | 1A2a | Iron and steel | Iron and steel | 1A2a |
| 4 | Non-ferrous metals | 1A2b | Non-ferrous metals | Non-ferrous metals | 1A2b |
| 5 | Chemicals | 1A2c | Chemicals | Chemical and petrochemical | 1A2c |
| 6 | Pulp and paper | 1A2d | Pulp and paper | Paper, pulp and printing | 1A2d |
| 7 | Food and tobacco | 1A2e | Food and tobacco | Food and tobacco | 1A2e |
| 8 | Other Industries w/o NMM | 1A2f | Other industries (incl. offroad) (fos.) | Transport equipment | 1A2f2 |
| | | | | Machinery | 1A2f3 |
| | | | | Mining and quarrying | 1A2f4 |
| | | | | Wood and wood products | 1A2f5 |
| | | | | Construction | 1A2f6 |
| | | | | Textile and leather | 1A2f7 |
| | | | | Non-specified industry | 1A2f8 |

Source: IPCC

[41] Intergovernmental Panel on Climate Change (IPCC) (2018) Annex ii, AR5.