BASELINE EMISSIONS INVENTORY

GALWAY COUNTY COUNCIL

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Contents

Glossary of Terms

AR6	Sixth Assessment Report
BEI	Baseline Emissions Inventory
BER	Building Energy Rating
CAP23	Climate Action Plan 2023
CRF	Common Reporting Format
CO_2	Carbon Dioxide
CoR	Certificates of Registration
CSO	Central Statistics Office
EPA	Environmental Protection Agency
GHG	Greenhouse Gas
GVA	Gross Value Added
GWP	Global Warming Potential
$ktCO_2e$	Kilotonne Carbon Dioxide Equivalent
LA	Local Authority
LPG	Liquefied petroleum gas
LULUCF	Land Use, Land Use Change, and Forestry
M&R	Monitoring and Reporting
NAEI	National Atmospheric Emissions Inventory
NFR	Nomenclature for Reporting
NIR	National Inventory Report
NTA	National Transport Authority
SEAI	Sustainable Energy Authority Ireland
SECAP	Sustainable Energy and Climate Action Plan
UNFCCC	United Nations Framework Convention on Climate Change
WFP	Waste Facility Permits

1. Executive Summary

Local Authorities (LA) are taking a leadership role in acting on climate and as part of the National Climate Action Plan are developing comprehensive Local Authority Climate Action Plans to address greenhouse gas (GHG) emissions in their administrative areas. These plans will be based on evidence, with the impacts measured over time. Enabling these Baseline Emissions Inventories (BEI), a key instrument to enable LAs to design their climate plans and measure the impact of its associated actions related to emission reductions across the LA's own operations as well as varying sectors of society. This report presents the results of a BEI for Galway County Council, breaking down the county's emissions by sector and providing Galway-specific context towards the sectors. In addition, the emissions that the Local Authority is directly responsible for are presented.

The calculations for this inventory were made primarily using a dataset for 2019 from the Environmental Protection Agency (EPA) called MapEIre, which is the result of the National Mapping of GHG and non-GHG Emissions Sources project. The project spatially mapped GHG emissions on a square kilometre scale for the entire Irish Exclusive Economic Zone, assigning the emissions to where they were produced. This dataset was the basis for measuring emissions in County Galway for the sectors Industrial Processes; Waste; Agriculture; Land Use, Land Use Change and Forestry (LULUCF), as well as the direct combustion emissions for the Residential, Commercial Services, and Manufacturing sectors. The latter three sectors (referring to the sectors mentioned earlier) also include electricity consumption emissions, which, in MapEIre, are categorized separately from other emissions due to the spatial methodology used, where all emissions from electricity are assigned to the power plant of generation, and not allocated to specific sectors.

Therefore, it is necessary for a separate analysis to distribute electricity emissions to the Residential, Commercial Services and Manufacturing categories. The Central Statistics Office (CSO) has metered electricity consumption available at the county level, split between residential and non-residential usage. This consumption data was then converted to carbon dioxide equivalent (CO_2e), the standard measure for measuring the global warming potential of GHGs and assigned to the sectors. Commercial and Manufacturing electricity were split based on an indicator of economic output.

Transport emissions were calculated using the National Transport Authority's (NTA) model and emissions from the local authority's own activities from the Sustainable Energy Authority Ireland's (SEAI) Monitoring and Reporting (M&R) programme. An inventory of Fluorinated gases, or F-gases, for the county, was also extracted from the MapEIre dataset.

The GHG emissions for County Galway in 2019 totalled 3,009 $ktCO_2e$, about 5% of the national total.

Emissions Category	County Galway Emissions ($ktCO_2e$)	National Emissions[1] ($ktCO_2e$)
Residential	450 (15%)	9,552 (15%)
Commercial Services	117 (4%)	4,618 (7%)
Manufacturing Combustion	99 (3%)	6,737 (10%)
Industrial Processes	23 (1%)	2,267 (3%)
Transport	478 (16%)	12,196 (19%)
Waste	21 (1%)	991 (1%)
Agriculture	1,343 (44%)	22,134 (34%)
LULUCF	478 (16%)	6,657 (10%)
Total	**3,009 (100%)**	**65,152 (100%)**

2. Introduction

Climate Action at the Local Authority level is a crucial component of Ireland's policy agenda, as evidenced by documents such as the National Climate Action Plan 2023 (CAP23) and the Climate Action Charter 2019. [1]Efforts to act against climate change and its negative impacts require urgent action and Local Authorities (LA) are taking a leadership role within their jurisdictions. As part of CAP23, local authorities are to develop Local Authority Climate Action Plans, which will consist of targeted actions informed by evidence. It is, therefore, necessary to have a comprehensive understanding of current emissions and to identify which emission sources the Action Plan should target and how.

The European Union aims to be climate-neutral by 2050 as part of its commitment to combating climate change.[3] The 2020 Climate and Energy package and the 2030 Climate and Energy Framework[4], intend to set the EU on the path to achieving the transformation towards a low-carbon economy as detailed in the 2050 low-carbon roadmap and set the key climate and energy targets for Europe.

As part of Ireland's climate action planning framework, Galway County Council is taking the necessary steps towards contributing to the state's climate goals and to take action to adapt and mitigate the effects of climate change by working as an implementing body with local communities, businesses, and the national government. [5]To inform these actions, Galway County Council has developed a Baseline Emissions Inventory (BEI) report. The BEI report measures the amount of greenhouse gases emitted in the baseline year and provides a sectoral breakdown of the results. The BEI report is based on local data from GHG emitting activities, such as energy production and consumption statistics as well as other information that reflects local GHG emission conditions.

The purpose of this BEI report is to calculate the emissions in the Local Authority area and analyse the sources. This will provide an evidence base for the LA to further calibrate mitigation objectives and targets. A thorough understanding of local energy use and greenhouse gas emission circumstances will serve as the foundation for developing the Local Authority's climate action plan. The BEI report is based on local and national data from 2019, on energy production and consumption and other GHG emissions in County Galway and contains insights into Galway County Council's emissions. The GHG emission figures are based primarily on MapEIre, metered electricity data provided by the CSO, and NTA data for Transport. The national emission reduction target of 51% by the end of 2030 is based on the greenhouse gas emissions reported for the end of 2018, in the national greenhouse gas emissions inventory. Accordingly, the collation of data to inform the local authority BEI should be relative to the baseline year of 2018, or as close to 2018 as possible. The closest year to 2018 for the primary dataset for this BEI, MapEIre, is 2019, thus all calculations were made for 2019.

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[1] https://www.gov.ie/en/publication/7bd8c-climate-action-plan-2023/

[2] National data are drawn from https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/EPA-Ireland's-Provisional-GHG-Emissions-1990-2021_July-2022v3.pdf; but with the category "Energy Industries" distributed to Residential, Commercial and Manufacturing categories using the same methodology as for the Local Authority Inventory

[3] https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2050-long-term-strategy_en

[4] https://climate.ec.europa.eu/eu-action/climate-strategies-targets_en

[5]https://consult.galwaycity.ie/en/consultation/draft-galway-city-development-plan-2023-2029/chapter/chapter-2-climate-action

3. Methodology

3.1 National Emissions Inventory

The EPA has overall responsibility for the national greenhouse gas inventory in Ireland's national system and compiles Ireland's national greenhouse gas emission inventory on an annual basis. Ireland's legal reporting obligations require that we submit data for the period 1990-2021 in January, March, and April 2023 to the European Commission and the United Nations Framework Convention on Climate Change (UNFCCC).

In response to climate governance and legislative advancements in 2021, the EPA published the provisional inventory data in July 2022 for the period 1990-2021. The provisional estimates of Ireland's greenhouse gas figures for the years 1990-2021 are based on interim energy balances provided by the SEAI in June 2022. The latest available data from other data providers such as the Central Statistics Office and the Department of Agriculture, Food, and the Marine (DAFM). [6]These are compiled using methodologies by UNFCCC reporting guidelines. Verified emissions data from installations within the EU's Emissions Trading Scheme (ETS) are included. As the baseline year for this report is 2019, the 2019 national values are shown below. However, the most recent year is 2021 and this provisional data can be found here. Additionally, it should be noted that the EPA recalculates inventories from previous years as inventory capacity is increased and better data become available.

In 2019, total emissions in Ireland were 64,220 ktCO_2 equivalent.[7] It is important to note that this figure differs from the national total mentioned at the bottom of the table on page 4 of this report, with an approximate difference of 100 kt. The disparity is attributed to various factors, such as emissions in the EPA energy industries category that are not solely related to electricity. Another factor to consider is the potential use of different Global Warming Potentials (GWPs) between the AR4 and AR6 assessment reports, which contributes to the discrepancy. These emissions are then broken down into the following categories: Energy Industries, Residential, Manufacturing Combustion, Commercial Services, Transport, Industrial Processes, F-Gases, Agriculture, Waste, and Land Use/Land Use

[6]https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/EPA-Ireland's-Provisional-GHG-Emissions-1990-2021_July-2022v3.pdf

[7]https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/Ireland_NIR-2021_cover.pdf

Change/Forestry (LULUCF). Note that the 'Energy Industries' category is not represented as its category in the final Local Authority inventory and thus the individual categories are not directly comparable.

Category	Description
Energy Industries	Includes emissions from fuel combustion in power plants as well as from the extraction, production and distribution of fossil fuels
Residential	Includes emissions from space and water heating in households.
Manufacturing Combustion	Includes emissions from the combustion of fuels used in manufacturing processes, such as food processing.
Commercial Services	Includes emissions from space and water heating in commercial buildings.
Transport	Includes emissions from domestic road, rail, air and maritime transport.
Industrial Processes	Includes emissions from various industrial processes such as in cement production
F-Gases	Includes emissions of fluorinated gases, potent GHGs used in refrigeration, air conditioning and other industrial processes.
Agriculture	Includes emissions from livestock, fertilizer use and agricultural soils.
Waste	Includes emissions from the disposal and treatment of waste.
LULUCF	Includes both emissions and removals of GHGs associated with land use, land-use change, and forestry activities, such as the loss, gain and management of forests, peatlands and grasslands.

Table 1 National Inventory Categories and Totals

Agriculture is the largest contributor to the overall emissions in 2019 at 33% of the total. Transport and Energy Industries are the second and third largest contributors at 18% and 14% respectively. Residential and LULUCF emissions account for 10% each. These five sectors accounted for 85% of national total emissions in 2019. The remainder is made up of the Manufacturing Combustion at 7%, Industrial Processes sector at 3%, Waste at 2%, F-Gases at 1% and Commercial Services at 1%. To accurately depict the National Irish Baseline Emissions data, it is crucial to emphasize that the energy industry is a standalone category and does not correspond with the figures mentioned in the executive summary table. All emissions coming from electricity are assigned under the Energy Industries.

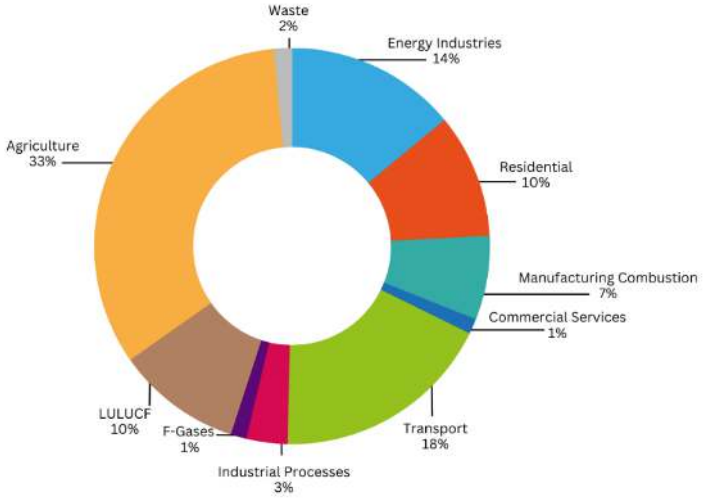


Figure 1 National Emissions Inventory (2019)

3.1.1 Reported Greenhouse Gases

Emissions data for the following gases are reported on an annual basis: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

Ireland has higher than average emissions of methane and nitrous oxide because we have the highest relative agriculture emissions contribution from any of the EU member states.[8]

For the inventory, these gas emission quantities are converted to CO_2 equivalent using Sixth Assessment Report (AR6) GWP values for a 100-year time horizon[9] by multiplying the mass of the emissions by the gas' corresponding GWP. GWPs compare the global warming impacts by measuring how much energy the emissions of 1 tonne of gas will absorb over some time. It should be noted that the 2019 EPA Inventory used IPCC Fourth Assessment Report values for Global Warming Potential, which will result in minor differences between this BEI and the EPAs 2019 data.

Greenhouse Gas	Global Warming Potential
Carbon Dioxide (CO_2)	1
Methane (CH_4)	29.8
Nitrous Oxide (N_2O)	273
Sulphur Hexafluoride (SF_6)	25,200
Hydrofluorocarbons (HFCs)	4 - 14,600
Perfluorinated Compounds (PFCs)	6,630 - 11,100
Nitrogen Trifluoride (NF_3)	17,400

Table 2 Greenhouse Gases Global Warming Potential (AR6[10])

3.1.1.1 Carbon Dioxide

CO_2 is the main greenhouse gas emitted through anthropological activities, causing global warming. It is present in all sectors and easily outweighs the other GHGs in terms of the raw mass of emissions. As the reference gas, the GWP will be 1 regardless of the period used. A 100-year horizon was used for this report. CO_2 stays in the atmosphere for hundreds of years[11].

3.1.1.2 Methane

CH_4 one of the most impactful gases emitted by activities in County Galway[12]. It is primarily emitted from agricultural activities and waste. Methane has a GWP of 29.8. It absorbs much more energy than CO_2 but stays in the atmosphere for only about 10 years.[13]

[8] https://www.epa.ie/our-services/monitoring--assessment/climate-change/ghg/latest-emissions-data/

[9] https://report.ipcc.ch/ar6/wg1/IPCC_AR6_WGI_FullReport.pdf

[10] Note: The 2019 EPA Inventory used IPCC Fourth Assessment Report values for Global Warming Potential, which will result in minor differences between this BEI and the EPAs 2019 data.

[11] https://www.epa.gov/ghgemissions/overview-greenhouse-gases

[12] https://www.epa.ie/our-services/monitoring--assessment/climate-change/ghg/agriculture/

[13] https://www.iea.org/reports/methane-tracker-2021/methane-and-climate-change

3.1.1.3 Nitrous Oxide

N_2O has a GWP of 273. Agriculture is the main sector emitting N_2O. It stays in the atmosphere for over 100 years.[14]

3.1.1.4 F-gases

Fluorinated gases trap substantially more heat than CO_2 does per tonne. Sulphur Hexafluoride (SF_6), has a GWP of 25,200, Hydrofluorocarbons (HFCs) have a GWP ranging from 4 to 14,600, Perfluorinated compounds (PFCs) range from 6,630 to 11,100 and Nitrogen trifluorides (NF3) has a GWP of 17,400. SF_6 is present in Industrial Processes. In the national inventory, F-gases are grouped as their sector accounting for about 2% of national emissions.

3.2 National Grid Fuel Breakdown

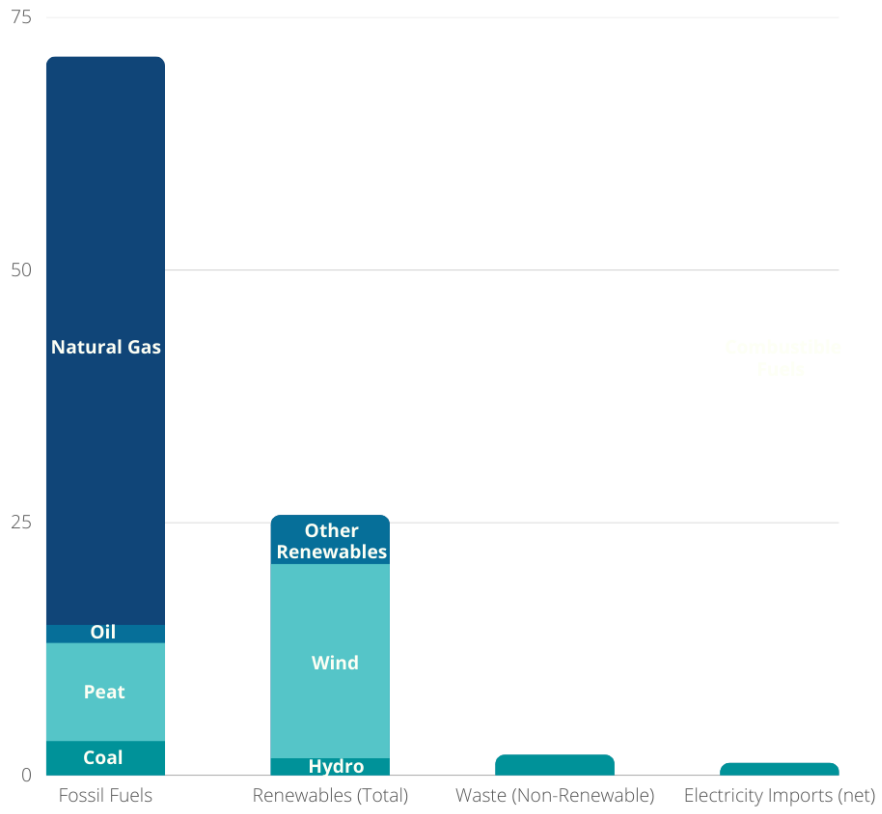


Figure 2 National Grid Fuel Breakdown (%)

In 2019, natural gas constituted the largest share of Ireland's electricity supply, accounting for 56% of the energy input. Wind energy followed closely, contributing 19% of the input. When combined, all renewable sources accounted for 26% of the energy inputs used in electricity generation. However, it is important to note that 46% of the energy inputs are lost before reaching the end consumer, resulting in an overall grid efficiency of 54%. Notably, Ireland's grid has shown a positive trend in terms of

[14]https://www.nitricacidaction.org/transforming-the-sector/nitrous-oxide-emissions-from-nitric-acid-production/

reducing carbon dioxide (CO2) emissions, with the CO2 intensity declining from 636 gCO2/kWh in 2005 to 324 gCO2/kWh in 2019. [15]

3.3 The MapEIre Project

Beginning in 2016, the EPA, in cooperation with Aarhus University in Denmark, carried out the National Mapping of GHG and non-GHG Emissions Sources (MapEIre) project.[16] The purpose of this project was to assign a spatial distribution to the national emissions inventory. Greenhouse gas emissions in Ireland are distributed based on a square kilometer grid covering the entire Irish Exclusive Economic Zone. The allocation is done by gas type and subsectors following the common reporting format (CRF) and Nomenclature for Reporting from the UNFCCC. This dataset can then be used to calculate emissions inventories for a smaller area as well, in this case, a Local Authority area. It should be noted that the methodology used by the MapEIre project varied among the subsectors and some may have been mapped more robustly than others.

This methodology accounts for emissions in the square kilometre where they are created, and not necessarily where the outputs of the emissions are consumed. For example, transportation emissions reflect the locations of rail lines, road networks, and airports. Power plants will heavily influence the spatial emissions of where they are located but would be difficult to see on the map as they would only be reflected in a single grid cell. Below is a sample result from MapEIre's CO_2 inventory. The image on the left depicts CO_2 emissions on a 1km x 1km for all of Ireland.

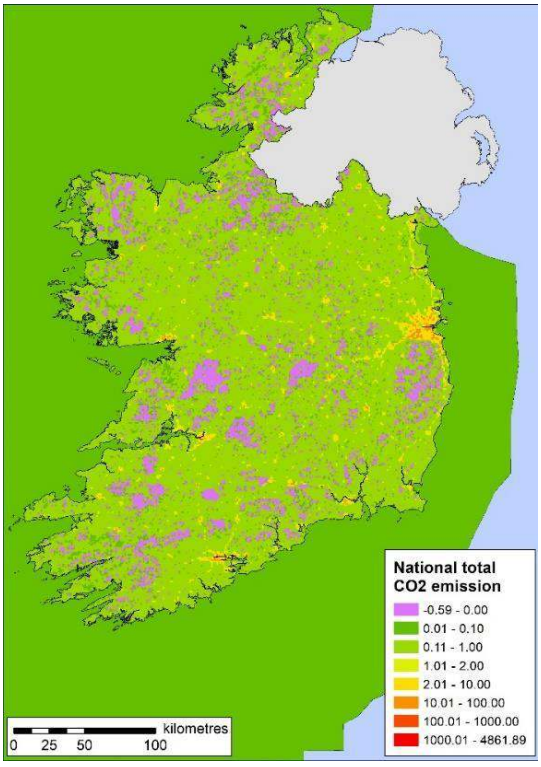


Figure 3 Sample representations of the MapEIre dataset

3.4 Local Authority Emissions Inventory Approach

The primary approach towards calculating the emissions inventory for the Local Authority's jurisdiction was through using the MapEIre dataset of Spatial GHG emissions by local authorities for 2019. This

[15] https://www.seai.ie/publications/Energy-in-Ireland-2020.pdf
[16] https://projects.au.dk/mapeire/

dataset contains the emissions for each Local Authority in Ireland broken down on a 1 x 1 km scale, with further classifications including the CRF Classification, the NFR codes and the pollutant names. The GHGs included in the local authority MapEIre dataset are CH_4, CO_2, N_2O and SF_6.

For this inventory, the data was filtered to only include emissions within County Galway. Then all emissions were converted to CO_2 equivalent using Sixth Assessment Report (AR6) GWP values for a 100-year time horizon[17] by multiplying the mass of the emissions by the gas' corresponding GWP. GWPs compare the global warming impacts by measuring how much energy the emissions of 1 tonne of gas will absorb over a period. The EPA's NIR used Fourth Assessment Report GWP values for the national inventory, which would result in small differences and should be kept in mind when comparing this inventory with the NIR.

All gases in the MapEIre dataset for County Galway were converted to CO_2 equivalent. The sum of these values broken down by sectors, subsectors and gas type is the basis of County Galway's BEI. However, alternative sources were used for the Transport and Energy Industries categories. Transport emissions were calculated with data provided by the National Transport Authority and Energy Industries using data provided by the Central Statistics Office.

In MapEire and the associated BEI report, public sector emissions, including those from local authorities (LA), are allocated across several sectors. Transport-related emissions from the public sector, such as those from public transport services, are assigned to the transport sector. Building-related emissions from public sector buildings, such as schools, hospitals, and government offices, are assigned to the commercial sector. This includes emissions from heating, cooling, and lighting these buildings. However, emissions from public lighting, such as street lighting, are typically allocated to the non-residential electricity sector. It is important to note that the allocation of public sector emissions may vary depending on the specific activity and location, and the BEI report is updated regularly to reflect the latest data and methodological approaches.

According to the latest MapEire and the associated BEI report, energy-related agricultural emissions are assigned to the agriculture sector. The MapEire report provides a detailed breakdown of the emissions from various sectors, including agriculture, transport, commercial, and residential. While transport-related emissions are assigned to the transport sector and buildings-related emissions are assigned to the commercial sector, energy-related agricultural emissions are allocated to the agriculture sector. This includes emissions from the use of energy-intensive machinery and equipment in farming, as well as energy consumed in the production of fertilizers and other agricultural inputs [18].

Emissions are reported by mass using the International System of Units (SI). The Kilogramme (kg) is the base unit. Also used are Tonnes (equal to 1,000 kilogrammes), Kilotonnes (equal to 1,000 tonnes) and Megatonnes (equal to 1 million tonnes). All values have been rounded for display purposes.

3.4.1 Electricity Consumption

There are limitations to the MapEIre data regarding providing actionable information for a Local Authority planning climate action to reach emissions reduction targets. The greatest of these is that emissions from electricity are assigned to the power plants where the electricity is generated, not the homes, businesses, etc., where it is consumed. The inventory derived directly from MapEIre will result in an inventory of emissions broken down into the following sectors: Agriculture, Commercial Services, Energy Industries, Industrial Processes, LULUCF, Manufacturing Combustion, Residential, Transport,

[17] https://report.ipcc.ch/ar6/wg1/IPCC_AR6_WGI_FullReport.pdf
[18] https://www.epa.ie/publications/research/air/Research_Report_317.pdf

and Waste. Under this version of the inventory, all emissions would be Scope 1 emissions, or direct GHG emissions that occur from fuel combustion. This results in all emissions from electricity being assigned to Energy Industries, rather than where the electricity is consumed. However, it is of more value for local authorities to understand where electricity is being consumed than generated to develop appropriate and specific mitigation actions. Therefore, the electricity emissions in this BEI are Scope 2 emissions, which are indirect GHG emissions associated with the purchase of electricity for own use.[19]

Therefore, for this inventory, the Energy Industries category has been removed and replaced with electricity consumption data that have been assigned to the Residential, Manufacturing, and Commercial sectors. The national total of emissions from Public Electricity and Heat Production under the Energy Industries category in 2019, according to the NIR, was 8,985 kt CO_2 (about 14% of the total).

Metered electricity consumption statistics for 2019 are available from the CSO on a county level and divided into categories of 'Residential' and 'Non-Residential.'[20] The emissions factor from Ireland's 2019 grid (0.3245 kg CO_2/kWh), as provided by the SEAI, was then used to convert electricity consumption into CO_2 equivalent as depicted below.[21] Multiplying the kWh of electricity by this factor results in a measure of the CO_2 equivalent emitted by the generation of the electricity. The emissions from residential electricity are calculated directly this way, as that is one of the sectors in question for this report. However, the Non-Residential emissions were split further into Manufacturing and Commercial sectors using Gross Value Added as a proxy measure for electricity consumption.[22] Gross Value Added is an economic indicator provided by the CSO on a sub-regional basis. The emissions from electricity for Manufacturing and Commercial sectors were therefore estimated by applying the ratio of Gross Value Added by sector to the total Non-Residential electricity emissions for the Local Authority area. In terms of the national level, this methodology yields emissions that are only 4% different from the electricity emissions reported in the National Inventory Report (NIR).

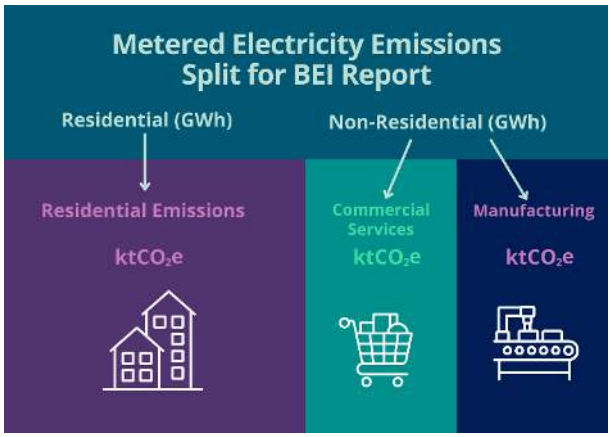


Figure 4 Metered Electricity Emissions Split for BEI Report

[19] The third classification of GHG emissions, Scope 3, goes deeper into the supply chain of emissions and would include emissions from production processes for goods produced outside of County Galway that are consumed within the county. On a national scale, consumption-based emissions for Ireland are 69% higher than production-based emissions, primarily due to the import of goods for household consumption, according to the Economic and Social Research Institute (Link: https://www.esri.ie/publications/the-global-emissions-impact-of-irish-consumption).

[20] https://www.cso.ie/en/releasesandpublications/er/mec/meteredelectricityconsumption2020/

[21] https://www.seai.ie/publications/Low-Carbon-Heating-and-Cooling-Technologies.pdf

[22] [22] https://www.cso.ie/en/releasesandpublications/er/cirgdp/countyincomesandregionalgdp2019/

There is a significant portion (24%) of national non-residential electricity consumption that is not coded by the CSO for confidentiality reasons, meaning it was not assigned to any county. This consumption is from very large energy users, such as data centres. However, none of this consumption is within the Local Authority area and is therefore not included in this inventory.

Electricity Calculations Summary for the BEI:

- Gwh res (Gigawatt-hours residential) from CSO: obtained the residential electricity consumption data from the Central Statistics Office (CSO).
- Gwh non res (Gigawatt-hours non-residential) from CSO: Similarly, sourced the non-residential electricity consumption data from the CSO.
- Conversions to CO_2e (Carbon dioxide equivalent) for each: To estimate the carbon emissions associated with electricity consumption, the appropriate CO_2e conversion factors were applied. These factors were derived from region-specific emission data and represent the amount of carbon dioxide equivalent emissions associated with each unit of electricity consumed.
- Split of non-residential electricity between Commercial and Manufacturing using GVA (Gross Value Added): The allocation of non-residential electricity consumption between the commercial and manufacturing sectors was determined using the Gross Value Added (GVA) methodology. By analyzing GVA data, which quantifies the value of goods and services produced by each sector, the estimated proportion of non-residential electricity consumed by commercial and manufacturing activities were estimated.

3.4.2 Transport

3.4.2.1 Background and Introduction of MapEIre

MapEIre is a comprehensive dataset that provides a breakdown of transport emissions at the local authority level[23]. The dataset covers a range of transport types, including national navigation (shipping), railways, and Road Transport (heavy-duty vehicles and buses, light-duty vehicles, mopeds & motorcycles, and passenger cars).

The methodology used for estimating road transport emissions in MapEIre is based on traffic count data, which is obtained from the National Road Authority's traffic counters. This methodology uses available mileage data for national roads and estimates the mileage for other roads by subtracting the national road mileage from the total mileage. The method creates a map of all the roads, excluding national roads, by using road width as a measure of mileage. To calculate the number of vehicles on the road, the method uses traffic count data and groups together certain vehicle categories. The residual of the national total mileage is allocated to the remaining roads. In MapEIre, the road network area is used as a proxy for mileage and makes use of population density to approximate emissions accumulation in urban and rural areas.

3.4.2.2 Background and Introduction of National Transport Authority (NTA) Regional Modelling System

The National Transport Authority (NTA) is a statutory non-commercial entity in the Republic of Ireland that operates under the Department of Transport, Tourism and Sport.

NTA follows a complex model that requires numerous precise, reliable, and comprehensive datasets to calculate carbon emissions. The organization's carbon emission impact is informed by regional models with full geographic coverage, detailed representations of travel demand, a comprehensive

[23] https://www.iea.org/reports/transport

road network, and a public transport network that includes Park & Ride, along with active modes like walking and cycling.

The NTA Model uses various factors such as emission rate calculation coefficients, the National Atmospheric Emissions Inventory 2013, fuel scaling parameters, the fleet split data, degradation factors, and tire break and abrasion emissions rates. The NTA Model then calculates emissions based on fleet makeup and vehicle speed for each link in the model. [24]Calculations are carried out by ENEVAL using COPERT 5 emission rates.[25]

The NTA Model outputs emissions data by link, zone, sector, or grid, which allows results to be mapped in GIS. [26]By doing so, the results are presented in a visual format, making it easier for NTA to analyse and interpret the data. This comprehensive methodology enables NTA to accurately assess the carbon emissions produced by various sectors.

The NTA model process estimates greenhouse gases (GHG) such as nitrous oxides, particulate matter, hydrocarbons, methane, carbon monoxide, and carbon dioxide[27]. However, for this BEI, the GHG emissions used by the NTA include only carbon dioxide and methane. To facilitate comparison, the AR6 GWP values were used to convert the current emissions into CO_2 equivalents. It should be noted that nitrous oxide (N_2O) is not measured in the NTA methodology.

3.4.2.3 Transport Baseline Emission Inventory Methodology

Although the National Transport Agency and MapEIre employ distinct methodologies, the total national CO_2 equivalent calculated using both methods in 2019 is roughly similar.[28] According to the EPA National Inventory, the total GHG emissions for 2019, which include Road Transport, Railways System, and Shipping, were 12,219 $ktCO_2$, with Road Transport accounting for 11,371 $ktCO_2$. Meanwhile, the National Transport Agency reported that the Road Transport sector produced 9,503 $ktCO_2$ in the same year. For establishing an accurate Baseline Emission Inventory for the Transport Sector, two methodologies, MapEIre and NTA, are combined to provide a comprehensive picture of transport emissions:

- The MapEIre dataset is used to determine GHG emissions for national navigation (shipping) and railway subsectors. The NTA methodology does not measure the national navigation (shipping) and railway subsector.
- The NTA dataset is used to determine GHG emissions for all vehicles in the road network. This methodology is more robust due to more recent datasets and accuracy with the inclusion of additional factors. Specifically, the NTA methodology includes Degradation Factors NAEI 2013 and Catalytic Converter Failure rates, as well as fleet, split data based on work done in 2012 by SYSTRA and pivoted off 2016 observed fleet data. These additional factors make the NTA methodology more accurate compared to the MapEIre methodology.

[24] https://blanchardstownscheme.ie/wp-content/uploads/sites/6/2022/06/Chapter-07-Air-Quality.pdf
[25]https://www.nationaltransport.ie/planning-and-investment/transport-modelling/regional-modelling-system/appraisal-tools-rtm/
[26]https://www.nationaltransport.ie/planning-and-investment/transport-modelling/regional-modelling-system/appraisal-tools-rtm/
[27]https://www.nationaltransport.ie/planning-and-investment/transport-modelling/regional-modelling-system/appraisal-tools-rtm/
[28] https://www.epa.ie/publications/research/air/Research_Report_317.pdf

By combining these two datasets, a comprehensive and accurate picture of transport emissions can be obtained, which is essential for developing effective strategies to reduce GHG emissions in the transport sector.[29]

3.4.3 Local Authority

Another category of emissions that is included in this report for the Local Authority Baseline Emissions Inventory is the emissions from the Local Authority's activities. [30]Data is required to be reported annually to the SEAI's Monitoring and Reporting system[31]. There are no additional calculations required, but the emissions are presented in this report as an additional category for the Local Authority to consider when planning mitigation activities. It should be noted that these emissions are included in the MapEIre inventory distributed among the various sectors. For example, the Local Authority's fleet emissions would be included in the MapEire and NTA transport emissions data. They are therefore not added to the broader GHG inventory but rather presented in an additional section as a closer look into Local Authority emissions in County Galway.

3.4.4 Galway County Bottom-up Inventory

Galway County Council has commissioned parallel inventories with different methodologies and baseline years.

How do the emissions inventories relate to each other?

- Arup's top-down inventory according to the CoM methodology was used to set a precedence for the bottom-up Baseline Emissions Inventory for County Galway. This Baseline Inventory is indicative, to provide an initial starting point of the emissions proportions in the county.[32]
- Following this, Arup's bottom-up inventory is comprised of more granular data (generally based on Codema/SEAI methodology, adjusted as necessary) and data collected directly from stakeholders, providing a greater level of detail than the top-down inventory. This inventory was prepared for the baseline year (2018) per national targets. This inventory is considered to have the greatest level of detail, thus providing a better representation of the County's emissions, and is used to inform the subsequent plans.
- Bable's top-down assessment is used to verify Arup's bottom-up inventory, though acknowledging differences in the baseline year, demonstrating similar emissions proportions, and confirming the applicability of the bottom-up baseline. This inventory was prepared for consistency with other local authorities for comparability of results.

The three methodologies differ in their approach and assumptions, with varying levels of uncertainty. As acknowledged in the CARO Mitigation Guidance for Local Authorities all methodologies for local-level emissions baselines will require assumptions, as it is not possible to create a completely accurate picture of emissions (even national-level inventories must include assumptions). Each methodology has pros and cons utilising the best available information, but are deemed fit for their purpose, in providing a means of identifying areas for improvement and inspiring action.

3.4.4.1 Arup – Top-Down Emissions Inventory

The Covenant of Mayors (CoM) provides a common reporting framework for cities to assess GHG emissions by applying a standardised approach, which has been developed by multi-disciplinary

[29] https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-12

[30] https://www.local.gov.uk/climate-change-reporting-guidance-local-authorities

[31] https://www.seai.ie/business-and-public-sector/public-sector/monitoring-and-reporting/

[32] https://consult.galway.ie/en/system/files/materials/6596/SEA%20Environmental%20Report_0.pdf

experts and in consultation with a variety of stakeholders. [33]This inventory was prepared before the development of the CARO Local Authority Guidance and was deemed the preferable approach for the Irish context at the time of preparation. The CoM approach enables comparison across international cities.

3.4.4.2 Arup – Bottom-Up Emissions Inventory:

The Codema/SEAI bottom-up inventory is based on the Codema Guidance (2017) "Developing CO_2 Baselines: A Step-by-step Guide for your Local Authority" developed in partnership with the Sustainable Energy Authority of Ireland (SEAI). [34]This inventory was prepared before the development of the CARO Local Authority Guidance and was deemed the preferable approach for the Irish context at the time of preparation. However, the Codema approach has been modified where necessary, given the data's availability, to provide a thorough analysis once possible gaps were identified. The variations are detailed in Arup's baseline report. Crucially this approach has been supported by stakeholder engagement whereby 'direct data' was obtained by high-energy users and fed into the bottom-up baseline.

[33]https://www.globalcovenantofmayors.org/wp-content/uploads/2019/04/FINAL_Data-TWG_Reporting-Framework_website_FINAL-13-Sept-2018_for-translation.pdf

[34] https://www.antaisce.org/blog/green-communities-low-carbon-community-plans-2022-update

4. GHG Emissions Inventory for County Galway

4.1 Local Authority Profile

This report measures the GHG emissions for County Galway in 2019. The county is located on the west coast of Ireland, being the southernmost part of the province of Connacht. County Galway has the Atlantic Ocean to its west, whilst sharing borders with the counties of Mayo, Roscommon, Offaly, Tipperary, and Clare. Galway, with an area of 6,149 km^2, is the second-largest county in Ireland by area and the largest county in Connacht, in terms of size and population. [35]County Galway had a population of 258,058 in 2016. Other notably large settlements in Galway are Tuam, Ballinasloe, Loughrea, Oranmore, Athenry, and Gort. The County comprises an area of 1,510,592 acres, although 77,922 acres are covered by water, and another 476,957 acres are mountain or bogland. [36] Approximately 77.8% of people in County Galway live in rural areas.[37] Although, including Galway City drops this percentage down significantly to 54%.

4.2 County Galway Scope 1 Emissions

As set out in Section 3.2, the MapEIre dataset contains the emissions for each county in Ireland broken down on a 1 x 1 km scale, with further classifications including the CRF Classification, the NFR codes, and the pollutant names.

All emissions were converted to CO_2 equivalent using Sixth Assessment Report (AR6) GWP values for a 100-year time horizon by multiplying the mass of the emissions by the gas' corresponding GWP for this inventory. The data was filtered to only include emissions within County Galway. The inventory derived directly from MapEIre is broken down into the following sectors: Agriculture, Commercial Services, Energy Industries, Industrial Processes, LULUCF, Manufacturing Combustion, Residential, Transport, and Waste.

Under this version of the inventory, all emissions would be Scope 1 emissions, or direct GHG emissions that occur from fuel combustion. Emissions from electricity are assigned to the power plants where the electricity is generated, rather than where the electricity is consumed (homes, businesses, etc.)

[35] https://circabc.europa.eu/webdav/CircaBC/ESTAT/regportraits/Information/ie01_geo.htm
[36] https://www.libraryireland.com/topog/G/Galway.php
[37] https://data.cso.ie/

The results of the MapEIre inventory for County Galway are provided in Figure 5 below.

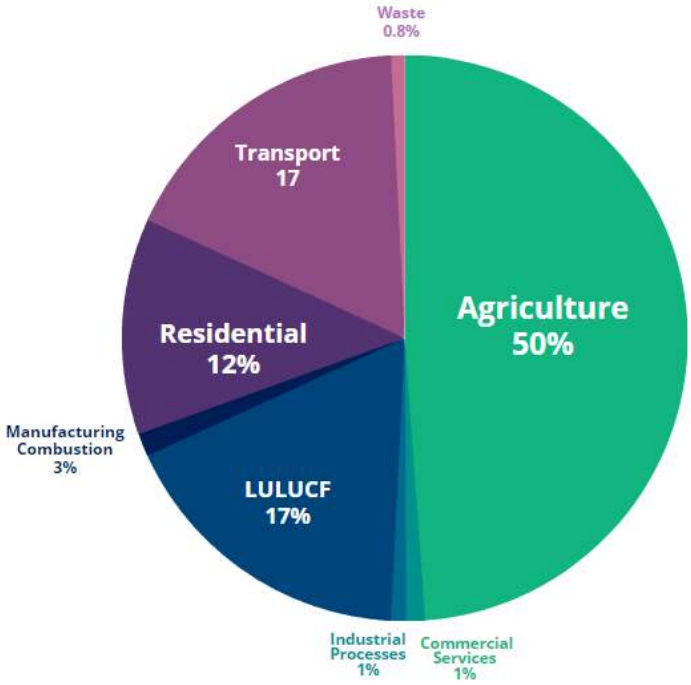


Figure 4 County Galway Sectoral Breakdown of Scope 1 Emissions

4.3 County Galway Emissions Breakdown by Gas Type

The following chart breaks down County Galway GHG emissions by type of GHG emitted, rather than by the global warming potential of the sector. However, because Energy Industries is removed, this breakdown does not include any emissions from electricity, thus having a smaller overall total than the main inventory.

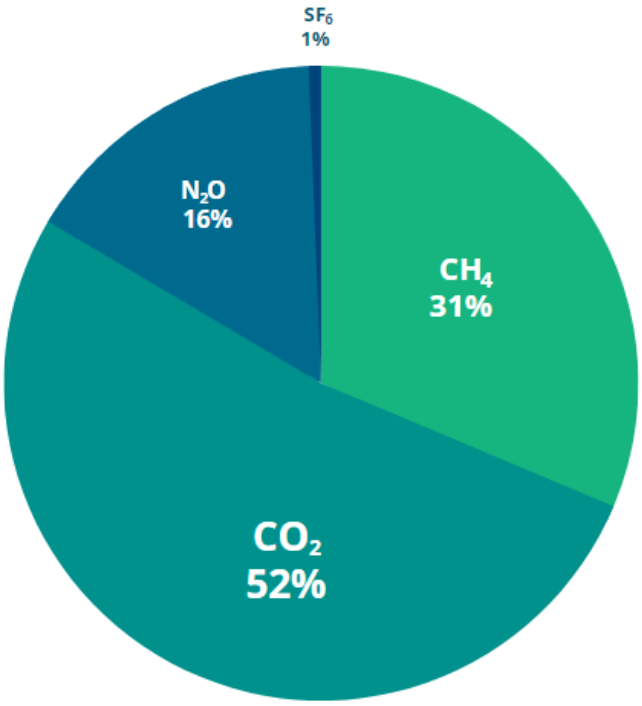


Figure 5 County Galway Emissions by Gas Type

4.3 County Galway Emissions: Sectoral Breakdown

The inventory derived directly from MapEIre provides an inventory of Scope 1 emissions broken down into the following sectors: Agriculture, Commercial Services, Energy Industries, Industrial Processes, LULUCF, Manufacturing Combustion, Residential, Transport, and Waste. All emissions from electricity are assigned to Energy Industries, rather than where the electricity is consumed[38].

It is of more value for Local Authority Climate Action Plans to understand where electricity is being consumed than generated to develop appropriate and specific local mitigation actions. Therefore, as detailed in Section 3.3.1, the Energy Industries category has been removed from this inventory and replaced with electricity consumption data that have been assigned to the Residential, Manufacturing, and Commercial sectors. Also, as detailed in Section 3.3.2, the transport emissions are based on NTA modelling rather than the methodology used in MapEIre.

The resulting output is the Baseline Emission Inventory for County Galway which will be used to inform the development of the Local Authority Climate Action Plan for County Galway. A full-page summary can be found on the next page.

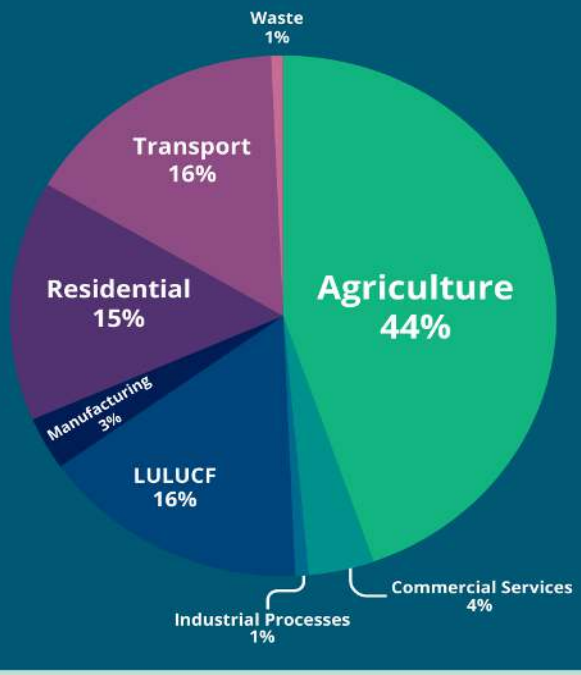
[38]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1051408/2020-final-greenhouse-gas-emissions-statistical-release.pdf

County Galway

Baseline Emissions Inventory Results 2019

Total Emissions: 3,009 $ktCO_2$ equivalent (5% of national total)

National Emissions 65,152 $ktCO_2$ equivalent



1,343 $ktCO_2e$ **Agriculture**	**478** $ktCO_2e$ **LULUCF**	**99** $ktCO_2e$ **Manufacturing**	**450** $ktCO_2e$ **Residential**
478 $ktCO_2e$ **Transport**	**21** $ktCO_2e$ **Waste**	**117** $ktCO_2e$ **Commercial Services**	**23** $ktCO_2e$ **Industrial Processes**

Note: Energy industry emissions have been allocated to the categories where they are consumed.

4.4 Residential

Baseline Emissions Inventory Results

Galway county: **450 $ktCO_2e$ (15%)**

National: **9,552 $ktCO_2e$ (15%)**

Residential

4.4.1 Category Description

The Residential sector accounts for emissions from activities in people's homes. On a national level, the Residential sector accounts for about 15% of total energy-related emissions, with the average dwelling emitting 5 tCO_2 per annum[39]. This includes emissions from space and water heating, as well as from electricity consumption. In addition to energy-related emissions, there are also non-energy emissions associated with the Residential sector. Energy emissions primarily come from activities related to space and water heating, as well as electricity consumption[40]. Non-energy emissions, on the other hand, stem from sources such as cooking, waste management, and other household-related factors. While energy-related emissions make up a significant portion of the Residential sector's emissions, it's important to consider and account for both energy and non-energy emissions to accurately assess the sector's overall environmental impact.[41]

4.4.2 Baseline Data

In County Galway, heating accounted for 76% of emissions in the Residential sector, while electricity consumption accounted for 24%. The national split is also about 76% direct fuels and 24% electricity.[42]

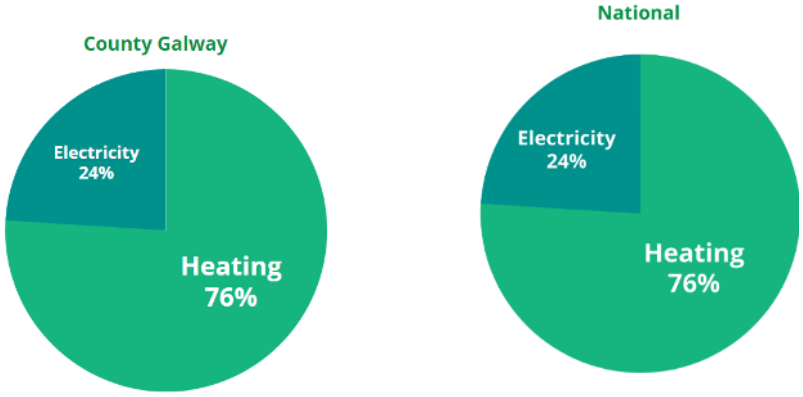


Figure 6 County Galway and National split of household energy usage

[39] https://www.seai.ie/publications/Energy-in-Ireland-2020.pdf

[40] https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-energy

[41] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1051408/2020-final-greenhouse-gas-emissions-statistical-release.pdf

[42] https://www.seai.ie/publications/Heating-and-Cooling-in-Ireland-Today.pdf

The table below shows the GHG breakdown of Residential emissions from direct fuels only. Direct fuels refer to Scope 1 fuels (e.g. oil, gas, solid fuel) burned on-site, such as for heating purposes. However, Figure 2 shows the breakdown in primary energy supply for electricity generation broken out by fuel type and energy source at the national level.

GAS	$ktCO_2e$
CH_4	12
CO_2	328
N_2O	1
Total	**341**

Table 3: Gas Breakdown of Residential Sector Emissions for County Galway

4.4.3 Supporting Information

4.4.3.1 Local Authority Area Housing Stock

According to Census 2016 data, there were 78,696 units in County Galway.[43] Over half of these were 1 and 2-person households and 17.7% of the total units were vacant in 2016.[16] Nationally, 12.3% of homes were vacant during this census period. The main central heating fuel is oil (36,322 homes) followed by peat (14,360)[44].

Oil	Natural gas	Electricity	Coal	Peat	LPG	Wood	Other
36,322	2,512	3,365	1,527	14,360	634	1,320	726
60%	4%	5%	3%	24%	1%	2%	1%

Table 4 Central Heating Fuel Sources in County Galway (number of homes)

Housing stock and household size statistics are important factors that influence the amount of energy used for heating, cooling, and electricity in homes.[45] This information can provide insights into the residential emissions in the Local Authority area and the context as to why they occur.

[43] https://consult.galway.ie/system/files/materials/17/Appendix%202%20Housing%20Strategy%20%26%20HNDA.pdf

[44] https://www.cso.ie/en/releasesandpublications/ep/p-copep/thecensusofpopulationfromanenvironmentperspective2011and2016/mainresults/

[45] https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-energy

Existing Housing Stock

County	Housing Stock	Holiday Homes	% Vacancy
Galway	78,696	10,279	19.4%

Table 5 Existing Housing Stock for County Galway in 2020

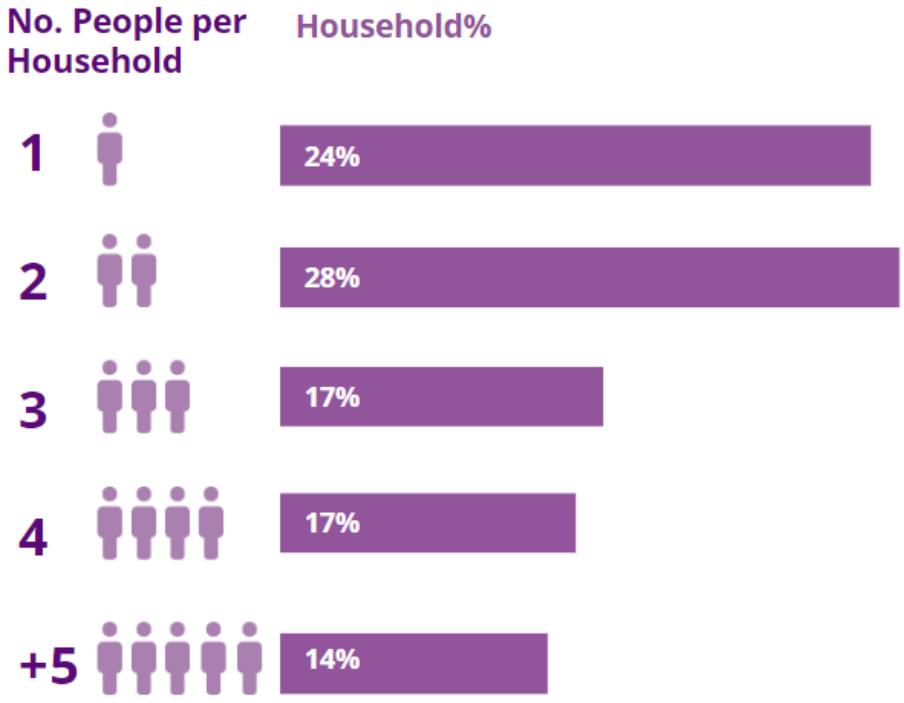


Table 6 Household Size Cohorts in County Galway

Housing tenure and occupancy type also give valuable insights into residential emissions. [46]For example, rented houses carry a split incentive regarding energy efficiency improvements where the landlord may be responsible for upgrades and renovations, but the tenant would be the one benefitting from the resulting energy savings. It should be noted that the CSO uses different source data for different tables- hence the inconsistent totals. For instance, some tables include total housing stock, others include only occupied housing stock.

[46] https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-energy

Housing Tenure

	Households	Household %
Social Housing	1,381	6%
Rented (Privately)	8,641	15%
Owner Occupied (All)	48,358	75%
Other Rental	3,128	5%
Not Stated	1,532	2,4%

Table 7 Housing Tenure in County Galway

Household Occupancy

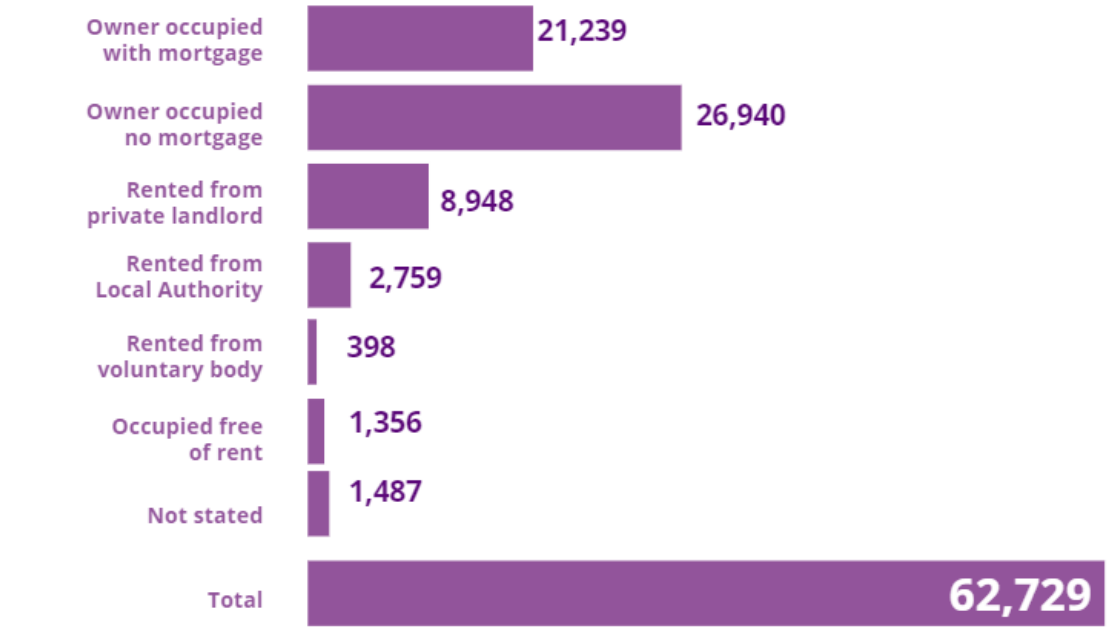


Figure 7 Household Occupancy [16]

4.4.3.2 Building Energy Ratings

A BER measures the energy performance of a home. They range from A1 (most efficient) to G (least efficient). [47] They are calculated based on the energy required by the building for heating, cooling, ventilation, and lighting by SEAI-registered BER assessors. The National Climate Action Plan aims to

[47] https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_6686

retrofit 500,000 homes to a B2 BER or better. [48]Below is the current distribution for County Galway. It should be noted that not all homes have undergone a BER assessment, and the distribution may not be representative of the entire housing stock.

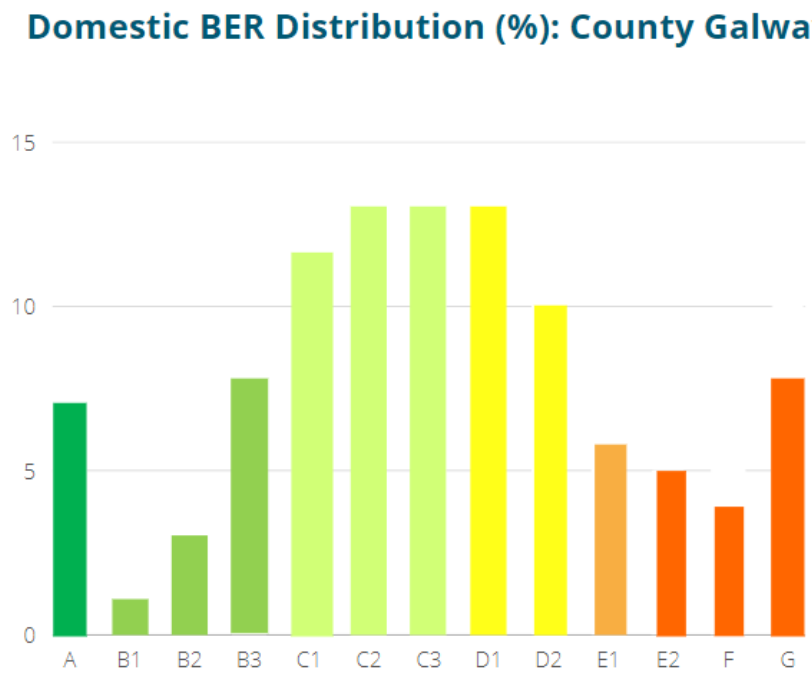


Figure 8: Domestic BER Distribution (%): County Galway in 2020

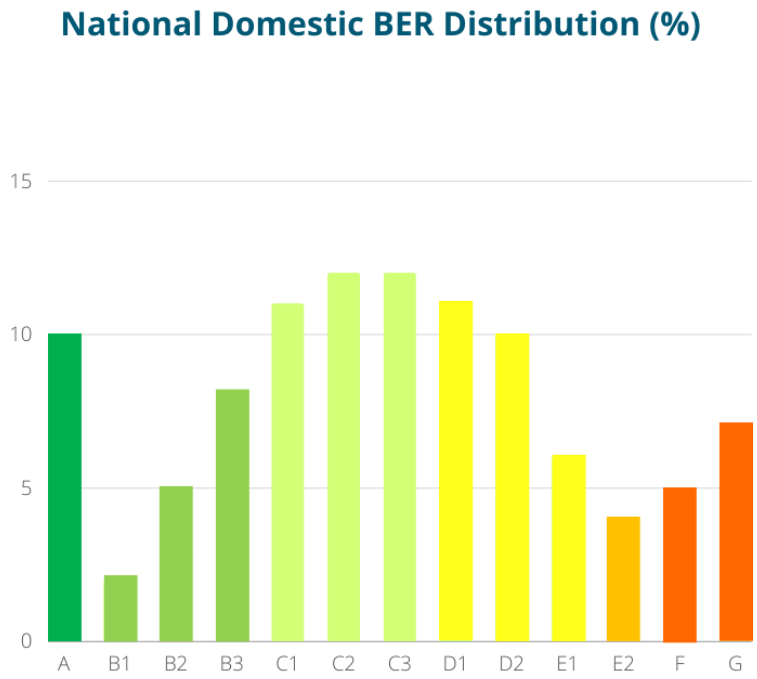


Figure 9: BER National Breakdown in 2020

[48]https://www.gov.ie/en/publication/5052a-national-retrofit-plan/

In 2016, 98% of dwellings nationally that were constructed in the BER database achieved an 'A' rating, indicating high energy efficiency. The following map depicts the spatial distribution for County Galway of median BER rating by small area.[49]

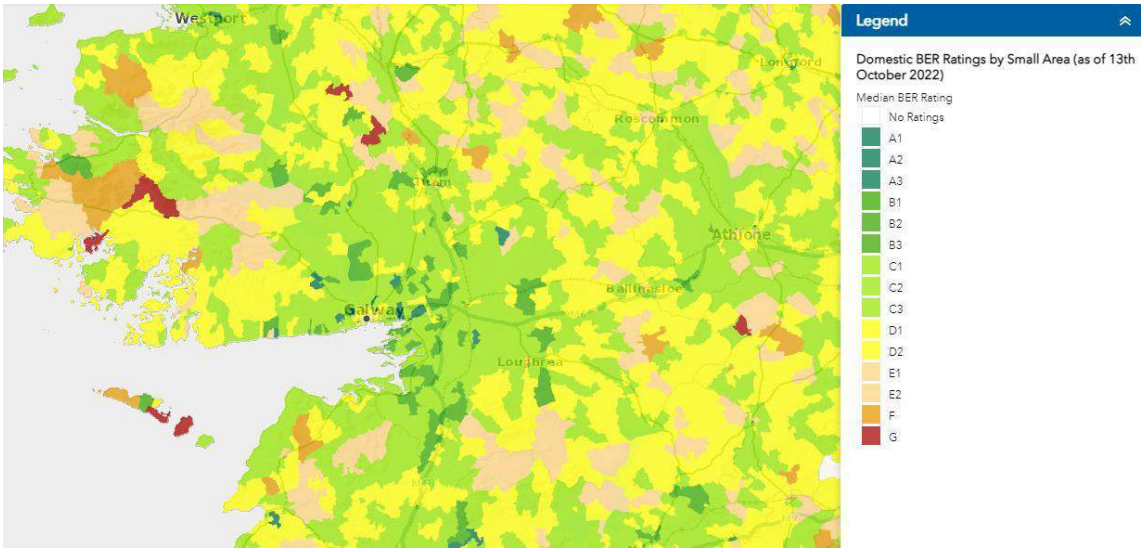


Figure 10 Domestic BER Ratings by Small Area- October 2022

4.4.3.3 Social Housing

The Energy Efficiency Scheme launched in 2013 made capital funding available to improve the standard and overall quality of local authority social housing stock. Phase 1 of the programme provided funding targeted at the less intrusive cavity wall/attic insulation works while Phase 2 focused on fabric upgrade works to dwellings.

The new 10-year programme reflects a significant upscaling from 'shallow' to 'deeper retrofit' and calls for the 'retrofit' of 500,000 homes to a B2/Cost Optimal Equivalent (BER) standard by 2030, of which, approximately 36,500 are expected to be local authority owned homes. [50] Works eligible under the EERP include attic/cavity wall insulation or external wall insulation where required, windows and doors replacement, heat pump installation, and ancillary and associated works.

The Cost Optimal Equivalent level typically requires attic insulation, wall insulation, and the installation of a heat pump to replace inefficient boilers. Local authorities are urged to choose a mix of properties across a range of BERs to allow for homes that need significant expenditure to be balanced out by those needing lesser spending to achieve the overall average cost per dwelling.

Local authorities are also required to invite energy suppliers (from SEAI's list of Obligated Parties) to participate in and assist with the execution of the EERP.

When selecting dwellings to undergo the EERP, several factors are to be considered and include:

- Dwellings built after 2008 are generally not suitable for EERP as they are constructed to TGD Part L 2008 or TGD Part L 2011 advanced performance requirements.
- Initially concentrating on dwellings within housing developments to maximise the number of dwellings in any one locality.

[49] https://gis.seai.ie/ber/

[50] https://www.seai.ie/news-and-media/home-energy-upgrades-2022/

- Geographical area of the selected housing developments – need to rotate EERP works between MCC Municipal Districts to achieve a fair and even distribution of the works.
- Extent of the scope of works required for the dwellings, and the costs associated with same, considering the grant funding limitations.
- Number of dwellings at the construction stage at any one time, and the supervision of same, must be controlled and at an acceptable level.

There are 2,525 social housing units in County Galway[51]. Their BER distribution can be found below.

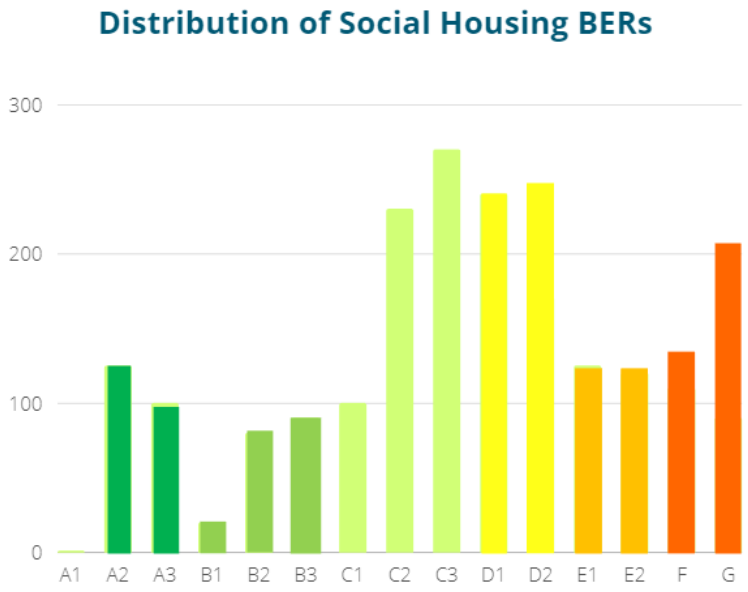


Figure 11: Distribution of Social Housing BERs in County Galway (for those properties with a BER assessment)

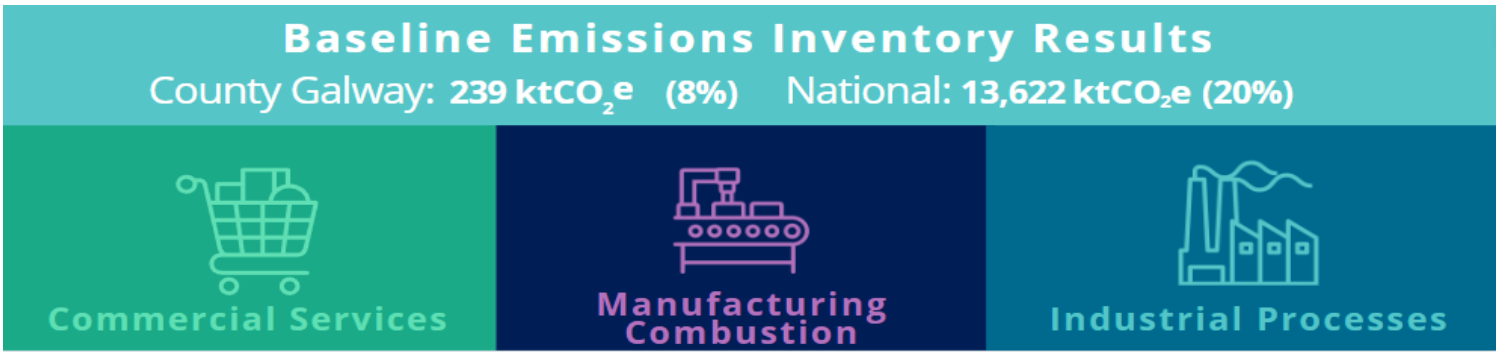
4.4.3.4 National Context

A comprehensive retrofit programme is a key measure in the CAP23 to reduce Residential emissions. The National Residential Retrofit Plan aims to achieve the equivalent of 500,000 homes retrofitted to a Building Energy Rating of B2/cost optimal or carbon equivalent. [52] Also, there are plans to install 400,000 heat pumps in existing buildings by 2030 as a means to replace outdated and inefficient heating systems.[53] A total of 18,400 home retrofits were completed in 2020. However, just 4,000 were to a B2 standard and 1,600 installed a heat pump. Reaching BER B2 or an equivalent level was required for the Social Housing National Retrofitting Programme to roll out in 2021 with retrofitted homes.[54] The SEAI estimates 17.7 MW of installed solar PV capacity in the Residential sector in Ireland in 2018 and that 44kt oil equivalent of renewable ambient energy from heat pumps was used. [55]

The national emissions ceiling for 2030 for residential buildings is 4MtCO_2 equivalent. In 2019, residential consumption made up 31% of the electricity used.[56], the ceiling is 3 MtCO_2 equivalent.

[51] https://noac.ie/noac_publications/report-50-noac-performance-indicator-report-2021/
[52] https://assets.kpmg.com/content/dam/kpmg/ie/pdf/2023/02/ie-irelands-climate-action-plan-2023.pdf
[53] https://www.seai.ie/news-and-media/home-energy-upgrades-2022/
[54] https://www.seai.ie/publications/SEAI-Retrofit-Annual-Report-2022.pdf
[55] https://www.seai.ie/publications/2020-Renewable-Energy-in-Ireland-Report.pdf
[56] https://www.cso.ie/en/releasesandpublications/ep/p-mec/meteredelectricityconsumption2021/

4.5 Non-residential Emissions: Commercial, Manufacturing Combustion, Industrial Processes



4.5.1 Background

Commercial, Manufacturing, and Industrial Processes are the three primary subcategories of Non-residential Emissions. Each category includes a unique set of processes and activities that go into producing greenhouse gas emissions.

Commercial emissions are a significant contributor to greenhouse gas emissions and are often a major focus of efforts to reduce carbon footprints. Commercial entities such as businesses, offices, and industrial complexes require a lot of energy to operate, which often comes from fossil fuels[57]. The burning of these fossil fuels releases greenhouse gases such as carbon dioxide, methane, and nitrous oxide, which trap heat in the atmosphere and contribute to climate change. In the commercial sector, energy consumption is largely driven by activities such as heating, cooling, ventilation, lighting, cooking, and refrigeration. **Manufacturing Combustion** processes involve a range of activities, such as heating, cooling, and processing materials, and often require the use of large machinery and equipment. These processes can consume significant amounts of energy and produce large quantities of emissions, particularly in industries such as iron and steel, non-ferrous metals, and chemicals[58].

The Industrial Processes sector estimates GHG emissions occurring from industrial processes, from the use of GHG in products, and non-energy uses of fossil fuel carbon. [59]These processes include, but are not limited to, cement production, lime production, ceramics, solvent use, as well as the food and beverage industry. The emissions in this category are from Industrial Processes rather than combustion. It is important to note that the GHG emissions estimated in the Industrial Processes sector are not related to space or water heating.

In the Irish national inventory, commercial emissions, manufacturing processes, and industrial processes are three separate categories that are accounted for individually. These categories represent different sources of greenhouse gas emissions and are reported separately to provide a detailed understanding of the country's emissions profile. However, in this case, these categories are being combined into a broad non-residential category. Emissions from commercial, manufacturing combustion, and industrial sources that are not related to residential activities are being reported together under this category.

Activity emissions and electricity emissions are added and calculated together in the non-residential sector. This is because non-residential activities often require a significant amount of electricity to

[57] https://www.iea.org/reports/buildings
[58] https://www.iea.org/articles/the-challenge-of-reaching-zero-emissions-in-heavy-industry
[59] https://www.iea.org/reports/co2-emissions-in-2022

operate, and the emissions associated with that electricity consumption must be included in the overall emissions from those activities.

The electricity emissions are based on metered consumption. This means that the amount of greenhouse gas emissions associated with electricity consumption is calculated based on the amount of electricity used as measured by a meter. The emissions associated with generating that electricity are allocated to the end-use sector based on this consumption data.

By splitting the measured non-residential electricity consumption in County Galway based on an economic indicator (see section 3.4.1), it has been estimated that the combined commercial and manufacturing sectors produce approximately 88 $ktCO_2$ and 64 ktCO2 of electricity emissions, respectively. This amounts to a total of approximately 152 $ktCO_2$ of non-residential electricity emissions for both sectors combined which accounts for 63% of the total GHG emissions of this sector.

4.5.2 County Galway: Baseline Inventory for Non-residential Emissions

The Non-residential sector in County Galway is a significant source of greenhouse gas (GHG) emissions. To better understand the sector's emissions profile, Figure 13 displays both activity and electricity emissions, providing a comprehensive overview of the total GHG emissions for the sector. The data shows that the Commercial Services subsector is responsible for the largest proportion of emissions at 49%, followed by Manufacturing Combustion and Industrial Processes. The Industrial Processes category contains no electricity element.

Breaking down the data further, Figure 14 shows emissions exclusively from the activity of the Non-residential sector, excluding electricity emissions. This information can be useful in identifying specific sources of emissions within the sector and guiding targeted reduction strategies.

Similarly, Figure 15 displays the emissions attributed solely to electricity consumption within the Non-residential sector, excluding activity emissions. Understanding the proportion of emissions from electricity consumption can help develop effective energy management and efficiency strategies.

Total Non-Residential Emissions (Activity emissions + Electricity emissions)

Sectors	$ktCO_2e$
Commercial Services	117
Manufacturing Combustion	99
Industrial Processes	23
Total	239

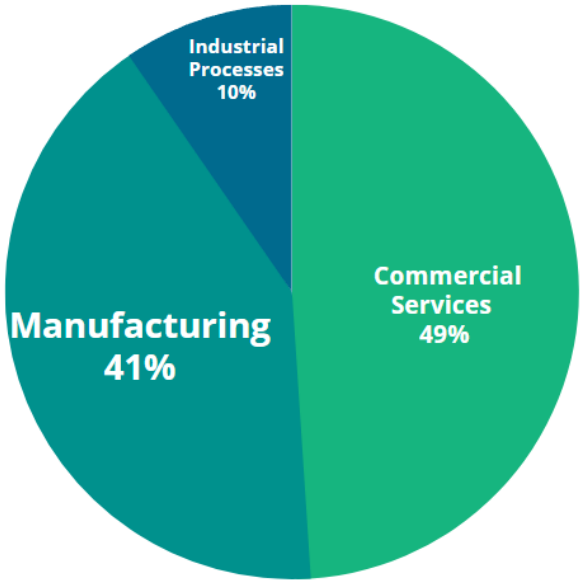


Figure 12 Total Non-Residential Emissions in County Galway (Activity emissions + Electricity emissions)

Activity emissions

Sectors	ktCO$_2$e
Commercial Services	29
Manufacturing Combustion	36
Industrial Processes	23
Total	88

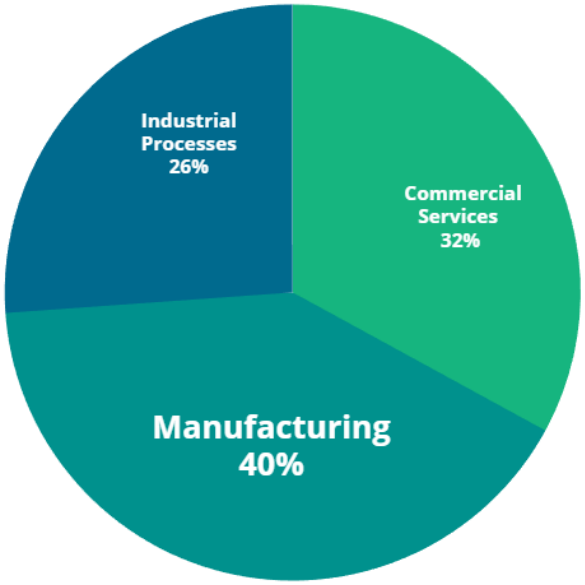


Figure 13 Activity- only emissions in County Galway (no electricity)

Electricity Emissions

Sectors	ktCO$_2$e
Commercial Services	88
Manufacturing Combustion	64
Total	152

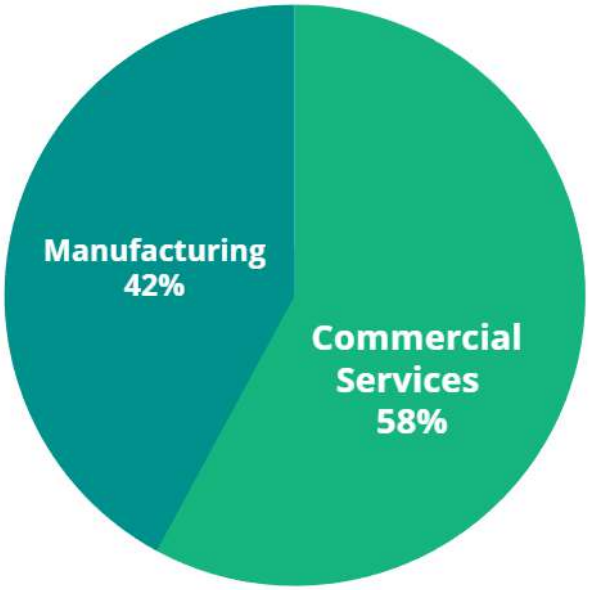


Figure 14 Non-residential Electricity Emissions in County Galway

Subcategories from MapEire for Commercial, Manufacturing, and Industrial Processes

The subsectors of each of the non-residential emission sectors - commercial, manufacturing combustion, and industrial processes - are shown below. This information has been acquired through MapEIre and provides a more detailed breakdown of the sources of G HG emissions within the county. Analysing these subsectors can help identify areas for improvement and develop targeted strategies to reduce emissions. These are Scope 1 emissions only and therefore do not include emissions from electricity consumption.

Manufacturing

Subsector	$ktCO_2e$
Chemicals	8
Food processing, beverages and tobacco	3
Iron and steel	0.05
Non-ferrous metals	3
Other	12
Pulp, Paper and Print	0.3
Non-metallic minerals	9
Total	36

Table 8 Manufacturing Subsector Emissions in County Galway

Industrial Processes

Subsector	$ktCO_2e$
Ceramics	0.025
Domestic solvent use including fungicides	1.5
Food and beverages industry	0.2
Lubricant use	1
Other product use	1.5
Other solvent use	0.5
Paraffin wax use	1
Not assigned	19
Total	23

Table 9 Industrial Processes Subsector Emissions in County Galway

4.5.3 Supporting Information

Non-residential emissions largely align with economic trends. National emissions have remained relatively stable in recent years. Fuel switching from more carbon-intensive oil and coal to lower-carbon natural gas has been one of the drivers for the reduction in this area. [60]

As discussed before, the electricity emissions coming from the Commercial Services were measured using Building Energy Ratings. A BER measures the energy performance of a building. They range from A1 (most efficient) to G (least efficient). They are calculated based on the energy required by the building for heating, cooling, ventilation, and lighting by SEAI-registered BER assessors. 10% of non-domestic buildings in County Galway have a B2 BER or better, in line with the national average of 8%. There are 16,167 solely commercial buildings within the Local Authority area, a total of 89,426 residential, and a further 2,918 labelled as unclassified.

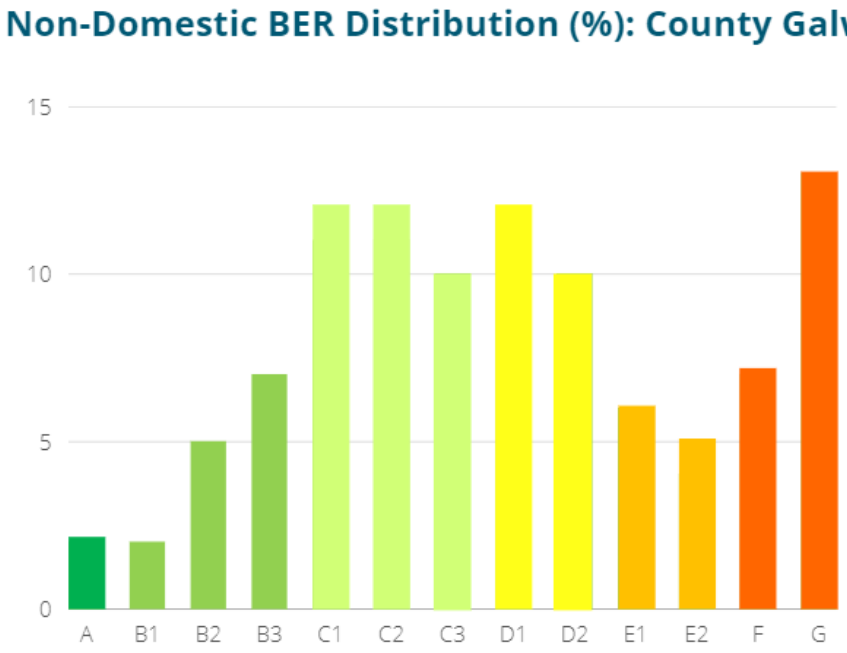


Figure 16: Regional Non-domestic Buildings BER Distribution (%)

[60] https://www.iea.org/reports/co2-emissions-in-2022

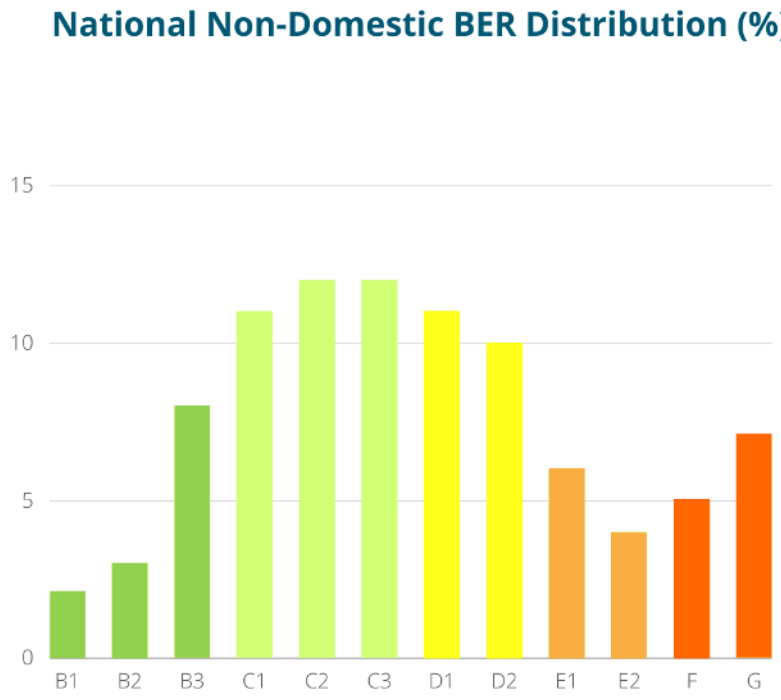


Figure 17: National Non-Domestic BER Distribution (%)

Commercial services:

The following table shows the GHG breakdown of Commercial emissions from direct fuels only. Direct fuels refer to Scope 1 fuels burned on-site, such as for heating purposes. As the electricity emissions were calculated with a different dataset to include them as Scope 2, the GHG breakdown is not available.

Gas	$ktCO_2e$
CH_4	0.17
CO_2	29
N_2O	0.04
Total	29

Table 10 Commercial Sector Emissions from Direct Fuels by Gas Type in County Galway

Manufacturing Combustion:

The following table shows the gas breakdown of Manufacturing emissions from direct fuels only, CO_2 gas dominates the emissions of the manufacturing sector:

Gas	$ktCO_2e$
CH_4	0.1
CO_2	35
N_2O	0.1
Total	36

Table 11 Manufacturing Sector Emission from Direct Fuels by Gas Type in County Galway

Industrial Processes

The industrial output and processes in County Galway and generally of West Ireland are relatively low compared to the counties located in East Ireland.[61] As of 2017, the Industrial and Construction sector in County Galway employed 22,975 workers, which make up 20.9% of employed workers in County Galway.[62] Due to the small scale of Industries and Industrial Processes in the County, this sector accounts for only 1% of the total GHG emissions emitted with 23 kt of CO_2 (see Table 10). The most dominant greenhouse gas emitted in the Industrial Process sector is Sulphur Hexafluoride (SF_6).

Gas	$ktCO_2e$
CH_4	4
CO_2	1
N_2O	18
Total	23

Table 12 Industrial Processes Sector Total Emissions by Gas Type in County Galway

[61] https://www.cso.ie/en/releasesandpublications/er/ciprcd/censusofindustrialproduction-localunitsregionalandcountydata2017/

[62] https://westerndevelopment.ie/policy/our-region/galway-county-analysis/

4.6 Transport

4.6.1 Background

Transport in 2019 accounted for approximately 19% of Ireland's greenhouse gas (GHG) emissions which is equivalent to 11 $MtCO_2e$, with road transport responsible for 94% of those GHG emissions.[63] The emissions coming from the transport sector are primarily sourced by the burning of diesel and petrol in combustion engines (passenger cars, light-duty vehicles, heavy-duty vehicles, and buses) and are also directly responsible for a range of air pollutants that negatively impact both human health and the environment.

Between 1990 and 2019, Transport shows the greatest overall increase in GHG emissions at 112%, from 5,143 $ktCO_2e$ in 1990 to 10,915 $ktCO_2e$ in 2019, with road transport increasing by 115%.[64] The increase in emissions up to 2007 can be attributed to general economic prosperity and increasing population with a high reliance on private car travel, as well as rapidly increasing road freight transport.

This sector accounts for emissions from the combustion of fuel for all transport activity, including domestic aviation, road, railway, water-borne navigation, and other transportation (which includes gas pipeline transportation). Emissions from road transport were relatively stable for the period 2015-2019, at an average of 11.6 Mt CO_2eq but reduced to 9.7 Mt CO_2eq in 2020 due to the COVID-19 implications.[65] Domestic aviation emissions are included in the national inventory but make up less than 1% of transport emissions. International aviation and maritime navigation are reported as "memo items" in the national emission inventory. This means they are not counted as part of Ireland's national total emissions but are reported by Ireland to the UNFCCC and EU for information purposes.

Transport has been the sector most responsive to changes in economic growth in Ireland. Transport energy use and CO_2 emissions peaked in 2007, before falling sharply during the recession[66]. It returned to growth in 2013, but by 2019 total Transport energy use was still 8.5% below the 2007 peak, mostly due to heavy goods vehicles remaining 31% below 2007 levels (see Figure 18 below).

[63] https://www.epa.ie/our-services/monitoring--assessment/climate-change/ghg/transport/
[64] https://www.seai.ie/data-and-insights/seai-statistics/key-statistics/transport/
[65] https://www.seai.ie/data-and-insights/seai-statistics/key-statistics/transport/
[66] https://www.seai.ie/publications/Energy-in-Ireland-2021_Final.pdf

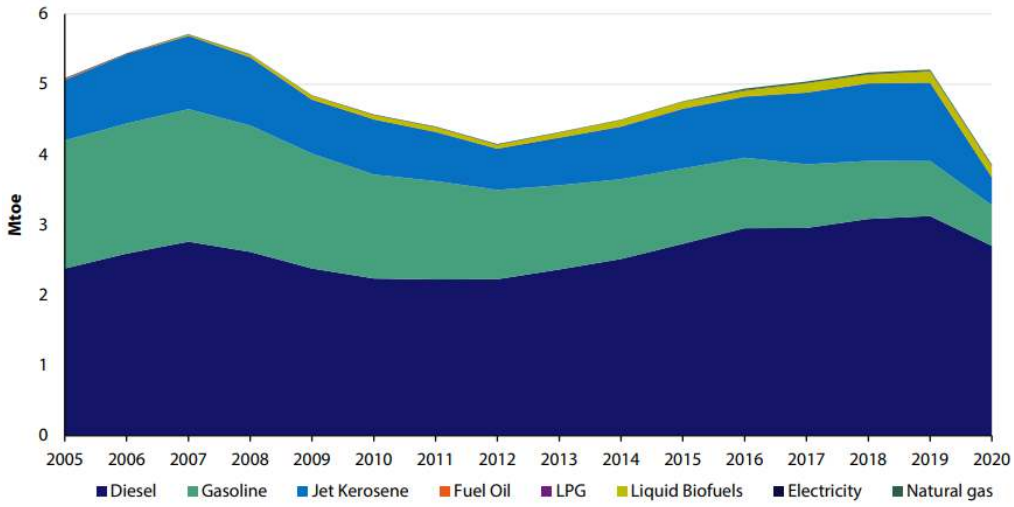


Figure 18 Transport Fuel Usage over Time in Ireland

Fuel consumption in Transport is often closely aligned to the mode used: jet kerosene is used for air transport, fuel oil for shipping, with petrol and LPG are almost exclusively used for road transport. Diesel consumption is used for road transport, navigation, and rail. The most important point to note is that Transport remains almost completely dependent on fossil fuels, particularly oil products. This lack of fuel diversity is unique among the energy-using sectors. Renewables made up just 4% in 2019, which scores very low in comparison with other European Countries.[67]

This has meant that there has been very little decarbonisation of the Transport fuel mix to date, with Transport CO_2 emissions remaining tightly coupled to energy use. In 2019, Transport CO_2 emissions were the same as they had been in 2005.

[67] https://www.seai.ie/publications/Energy-in-Ireland-2021_Final.pdf

	2020		2005		2019-2020		2015-2020		2005-2020	
	Quantity (ktoe)	Share (%)	Quantity (ktoe)	Share (%)	Absolute change (ktoe)	Overall change (%)	Overall change (%)	Average annual change (%)	Overall change (%)	Average annual change (%)
Private car	1,637	42%	1,891	37%	-443	-21.3%	-24.1%	-5.4%	-13.5%	-1.0%
HGV	725	19%	1,112	22%	-65	-8.2%	15.7%	3.0%	-34.8%	-2.8%
LGV	301	8%	0	0%	-33	-9.8%	-20.3%	-4.4%	-	-
Domestic aviation	2	0%	27	1%	-4	-59.7%	-53.3%	-14.1%	-90.9%	-14.8%
International aviation	396	10%	832	16%	-714	-64.3%	-53.0%	-14.0%	-52.4%	-4.8%
Public passenger	117	3%	157	3%	-21	-15.3%	-11.9%	-2.5%	-25.4%	-1.9%
Rail	36	1%	45	1%	-8	-19.0%	-8.8%	-1.8%	-20.1%	-1.5%
Navigation	104	3%	50	1%	15	16.4%	45.5%	7.8%	109.2%	5.0%
Gas pipeline	15	0%	2	0%	15	-	-	-	588.7%	13.7%
Fuel tourism	80	2%	387	8%	80	-	-	-	-79.2%	-9.9%
Unspecified	461	12%	581	11%	461	-	-	-	-20.6%	-1.5%
Total	**3,875**	**100%**	**5,084**	**100%**	**-1,359**	**-26.0%**	**-19.0%**	**-4.1%**	**-23.8%**	**-1.8%**

Source: SEAI

Figure 19 National Transport Data Through the Years

A core objective of the National Planning Framework is the need for more sustainable forms of Transport to reduce energy demand and greenhouse gas emissions, such as active modes of travel, and electric vehicles, and increase the usage of public transportation. The National Planning Framework for Transport also places a strong emphasis on enhanced regional accessibility in Local Authorities.[68] The national emissions ceiling for Transport for 2030 is 6 $MtCO_2e$.

The levels of noise, accidents, and congestion associated with road transport reduce the quality of life, deter active travel, and costs society hundreds of millions of euros per annum in wasted time.

Behavioural change and promoting cleaner, safer, and more sustainable mobility is critical for climate policy, and it also represents an opportunity to improve our health, boost the quality of our lives, meet the needs of our growing urban centres, and connect our rural, urban, and suburban communities.

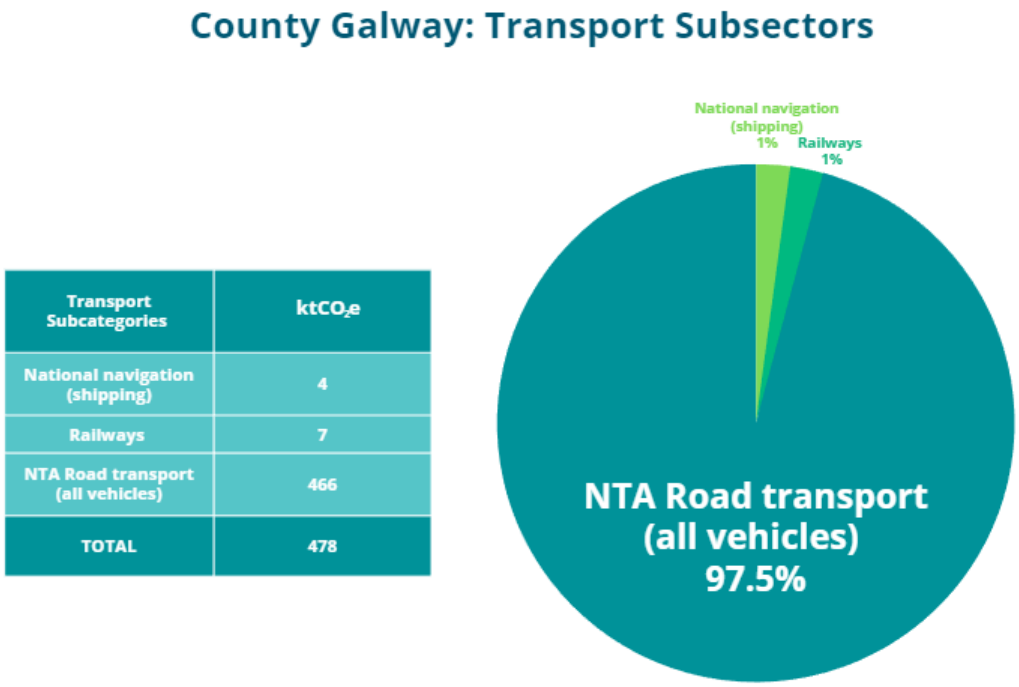
The recently revised CAP23 sets out the required level of decarbonisation for transport in quantitative terms as summarised in Table 15 below:

2018 Emission $MtCO_2e$	Indicative Target for 2025 Emission $MtCO_2e$	Indicative Target % Reduction for 2025 $MtCO_2e$	2021 Emissions $MtCO_2e$	% Increase (+)/ Reduction (-) to date $MtCO_2e$
12	10	20%	11	-11

Table 13 Required Level of Decarbonisation for Transport [69]

[69] (https://www.gov.ie/en/publication/7bd8c-climate-action-plan-2023/)

4.6.2 County Galway: Baseline Inventory for Transport



Transport Subcategories	$ktCO_2e$
National navigation (shipping)	4
Railways	7
NTA Road transport (all vehicles)	466
TOTAL	478

Figure 20 CO_2 Emissions from Transport Subsectors in County Galway

The Transport sector in County Galway accounted for 478 $ktCO_2eq$, which makes 15% of the total County's emissions, and is the second largest emitting sector after Agriculture (see Fig.2). As seen in the graph, the Road transport is the highest emitting subcategory in the transport sector. The graph below shows the breakdown of road transport for County Galway between different types of vehicles (private cars; heavy-duty vehicles and buses; light-duty vehicles).

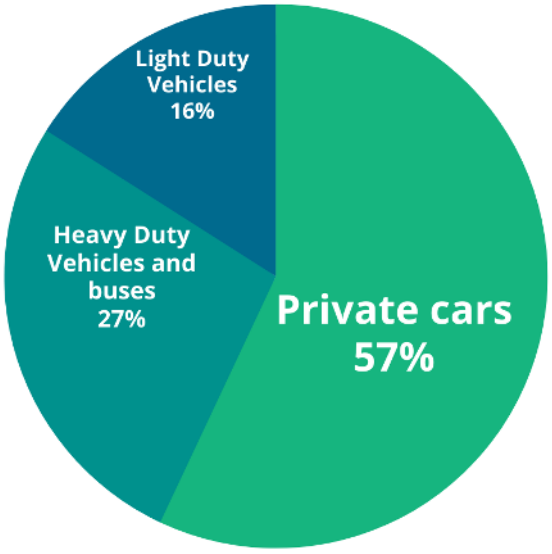


Figure 21: Breakdown of Road Transport per type of vehicle in County Galway

4.6.3 Supporting Information

In line with the objectives outlined in the National Planning Framework, County Galway faces the immediate challenge of sustainable mobility. Private car usage in the county is particularly high, with 67% of residents relying on personal vehicles compared to the national average of 65.6%. [70]This preference for cars is primarily attributed to the county's predominantly rural nature, as explained earlier. With dispersed settlements and a relatively low population density of 42 people per square kilometre, County Galway lacks viable and sustainable alternative modes of transportation, further perpetuating reliance on private cars.

County Galway Transport emissions reflect the County's Transport characteristics. The yearly travel average for passenger cars is 17,643 km travelled/ year. The emissions coming from passenger cars account for 56% of the total Transport emissions, with 267.6 $ktCO_2e$ emitted in 2019. The second highest number of CO_2 emissions in the Transport sector for 2019 comes from the Heavy-Duty vehicles and buses which account for 124.24 $ktCO_2e$ and 27% of the total Road Transport share (see Table 19). The table derived from CSO (see Table 18) presents the road traffic volumes of the national fleet by county and vehicle type for 2019, the exact number of vehicles, kilometres driven in total per type of vehicle and the average kilometres travelled per vehicle. The County's route length in 2019 was 449 km of one-way road.[71] Despite this, about 40% of the population of County Galway lives over 5km from this national road network.[72]

Private cars	km (million)	Average km
117,293	2,069	17,408
Heavy Duty vehicles and buses	**km (million)**	**Average km**
20,462	435	21,282
Mopeds & Motorcycles	**km (million)**	**Average km**
1,538	4	2,695
Tractors & Machinery	**km (million)**	**Average km**
5,433	93	17,066
Small PSVs	**km (million)**	**Average km**
974	39	40,504

Table 14 Road Traffic Volumes of National Fleet by County Galway of Owner and Vehicle Type, 2019 CSO

[70]https://www.pleanala.ie/publicaccess/ABP-302848-18%20-%20FI%20Response/ABP-302848-18%20-%20Volume%204%20-%20RFI%20Documentation/Volume%201%20-%20Report/ABP-302848-18%20-%20RFI%20Design%20Report%20-%20Volume%201%20-%20Main%20Report.pdf

[71]https://www.cso.ie/en/releasesandpublications/ep/p-tranom/transportomnibus2019/roadsafetyandroadlengths/

[72]https://www.cso.ie/en/releasesandpublications/ep/p-mdsi/measuringdistancetoeverydayservicesinireland/publictransportservices/

County Galway, being a car-centric rural area reflects the low levels of public transport usage in comparison with private car travel. In 2019 the County had 132 licensed bus operators, which is above the average bus operator numbers in Ireland.[73]

Emissions are categorised per type of fuel in vehicles and type of vehicle

To add value and bring County Galway's representatives a step closer to taking effective climate action plans, the emissions per type of fuel in County Galway's registered vehicles and type of vehicles were assessed by using local and international data, to make certain assumptions which are explained in detail in the Methodology sector. Private cars and goods vehicles, as the highest emitting categories, are examined. It is important to note that these calculations include all cars registered in Galway County (including Galway City).

Based on the methodology followed, it was found that a diesel private car in County Galway emits 3 tonnes of CO_2 per year, while an electric car emits only 1.2 tonnes of CO_2 per year

Type of fuel	Average Consumption per 100km	Average km driver per year	CO_2 emitted per private car per km	CO_2 emitted per private car in a year
Diesel	7 litres	17,400 km	180g CO_2 per km	3t CO_2
Petrol	8 litres	17,400 km	185g CO_2 per km	3t CO_2
Electricity	15 kWh	17,400 km	66g CO_2 per km	1.1t CO_2

Table 15 CO_2 Emissions per Type of Fuel for Private Cars in County Galway

Based on the same methodology it was found that a diesel goods vehicle emits on average 15 tonnes of CO_2 in a year, while a petrol goods vehicle emits on average 16 tonnes, as displayed below:

Type of Fuel	Average consumption per 100km	Average km driver per year	CO_2 emitted per goods vehicle per km	CO_2 emitted per Heavy duty vehicles and buses in a year
Diesel	28 litres	21,200 km	729g CO_2 per km	15t CO_2
Petrol	32 litres	21,200 km	761g CO_2 per km	16t CO_2

Table 16 CO_2Emissions per Type of Fuel for Goods Vehicles

[73] https://www.cso.ie/en/releasesandpublications/ep/p-tranom/transportomnibus2019/publictransport/

4.7 Waste

4.7.1 Background

The Waste sector includes emission estimates from solid waste disposal, composting, waste incineration (excluding waste to energy), open burning of waste, and wastewater treatment and discharge. The largest of these sources is solid waste disposal on land (landfills) where methane (CH_4) is the gas concerned. In contrast with the other sectors, the greenhouse emissions coming from Waste have been decreasing rapidly throughout the years due to the improved management of landfill activities, including increased recovery of landfill gas utilised for electricity generation and flaring is a core driver in decreased emissions from the Waste sector. This can be seen in the figure below:

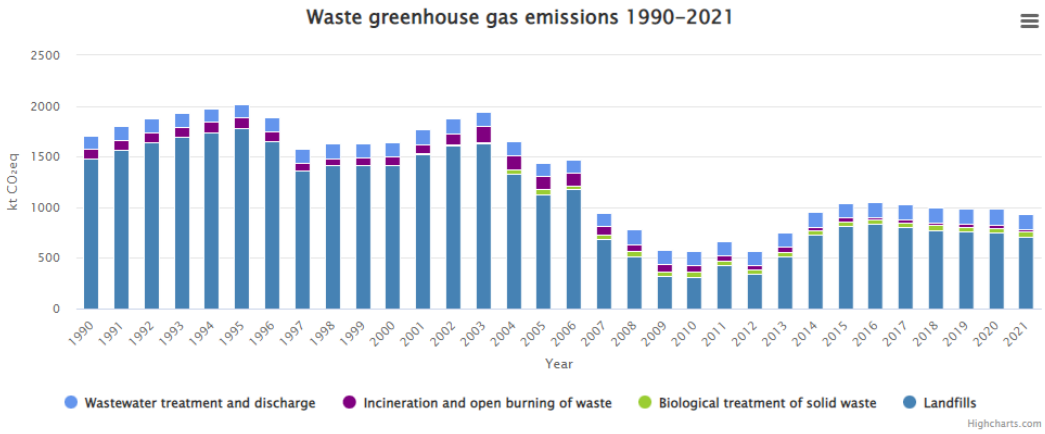


Figure 22: National Waste greenhouse gas emissions from EPA [74]

Waste emissions per head are lower in Ireland compared to the EU average and emissions have fallen since 2005. Ireland has made significant progress in managing waste streams, particularly in improving recycling rates and diversion from landfill[75].

4.7.2 County Galway: Baseline Inventory for Waste

As seen below, most of the Waste Emissions come from the *Biological Treatment of Waste- Solid waste disposal on Land,* which account for 70% of the total Waste Emissions. This is followed by the emissions caused by domestic wastewater handling, which accounts for roughly 26% of the total Waste Emissions sector.

[74] https://www.epa.ie/our-services/monitoring--assessment/climate-change/ghg/waste/
[75] https://www.europarl.europa.eu/RegData/etudes/STUD/2017/581913/EPRS_STU(2017)581913_EN.pdf

Sector	$ktCO_2e$
Composting	0.4
Solid Waste	17
Domestic Wastewater Handling	6
Open Burning	0.4
Total	25

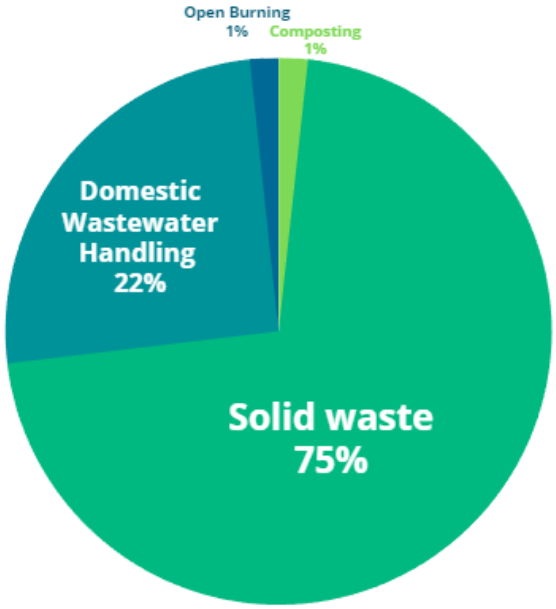


Figure 23: Waste Subsector Emissions in County Galway

4.7.3 Supporting information

Currently, County Galway has 3 recycling centres (Clifden, Tuam, and Ballinasloe) where waste is collected and processed. [76]The most dominant greenhouse gas emitted in the Waste sector is Methane which emanates primarily from landfills (CH_4), followed by Nitrous Oxide (N_2O), as shown below:

GAS	$ktCO_2e$
CH_4	23
CO_2	0.4
N_2O	1.4
Total	23

Table 17 Waste Sector Emissions by Gas Type in County Galway

[76] https://www.galway.ie/en/services/environment/wasteandlitter/civicamenitysites/

4.8 Agriculture

4.8.1 Background

Agriculture emissions are greenhouse gases (GHG) released into the atmosphere during farming activities, including livestock rearing, crop production, and land use change. These emissions are primarily composed of methane (CH_4) and nitrous oxide (N_2O), which have significantly higher global warming potentials than carbon dioxide (CO_2). [77]Agriculture emissions are responsible for a considerable portion of global GHG emissions, and the sector has a crucial role to play in addressing climate change.

In Ireland, agriculture is the highest emitting sector, contributing to 34% of the country's total GHG emissions in 2019. The primary source of emissions is methane from livestock, which accounts for about 63% of the total agriculture emissions. [78]Livestock such as cows, sheep, and pigs produce methane through enteric fermentation, a digestive process that breaks down feed in their stomachs, leading to the production of methane gas. [79]The use of nitrogen fertilizers and manure management is another significant source of agriculture emissions in Ireland[80]. The application of nitrogen fertilizers and the handling of animal manure can lead to the release of nitrous oxide, a potent greenhouse gas that is over 300 times more powerful than CO_2.[81]

Reducing agriculture emissions is a critical challenge for Ireland, given the sector's importance to the country's economy. [82]Agriculture is a vital part of Ireland's economy, generating 8% of the country's gross value added and providing over 8.5% of national employment in 2019[83]. Ambitious targets have been set for Irish agriculture to reduce GHG emissions by 25% by 2030. The national emissions ceiling for 2030 is 17.25 $MtCO_2$ equivalent to agriculture.

4.8.2 County Galway: Baseline Inventory for Agriculture

This sector's emissions range from enteric fermentation, manure management, agricultural soils, liming, and the use of fertilisers and urea. MapEIre data provides a breakdown of emissions within this sector, covering a wide range of sub-categories. [84]According to the latest MapEIre and the associated BEI report, energy-related agricultural emissions are assigned to the agriculture sector. The MapEIre report provides a detailed breakdown of the emissions from various sectors, including agriculture, transport, commercial, and residential. Energy-related agricultural emissions are allocated to the

[77] https://www.fao.org/3/cb3808en/cb3808en.pdf
[78] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8420985/pdf/vfab037.pdf
[79] https://www.europarl.europa.eu/RegData/etudes/STUD/2021/695482/IPOL_STU(2021)695482_EN.pdf
[80] https://www.teagasc.ie/rural-economy/rural-economy/agri-food-business/agriculture-in-ireland/
[81] https://www.teagasc.ie/media/website/publications/2014/Rural_Economic_Development_in_Ireland.pdf
[82] https://assets.kpmg.com/content/dam/kpmg/ie/pdf/2021/11/ie-ireland-2030-carbon-emissions-targets.pdf
[83]https://www.gov.ie/en/publication/6223e-climate-action-plan-2021/f
[84] https://www.eea.europa.eu/publications/Progress-and-prospects-for-decarbonisation

agriculture sector, whereas transportation-related emissions are assigned to the transportation sector and building-related emissions are allocated to the commercial sector. This includes emissions from the use of energy-intensive machinery and equipment in farming, as well as energy consumed in the production of fertilizers and other agricultural inputs such as off-road Agriculture Transport.

The MapEIre dataset breaks down the agriculture sector into several sub-sectors, which have been grouped further for ease of understanding. A visual depiction of this is provided below:

Subsector	ktCO2e
Livestock Enteric Fermentation	904
Soil Applications	68
Inorganic fertilizer	95
Soil processes	93
Cultivation of organic soils	117
Manure management	107
Machinery and Vehicles	62

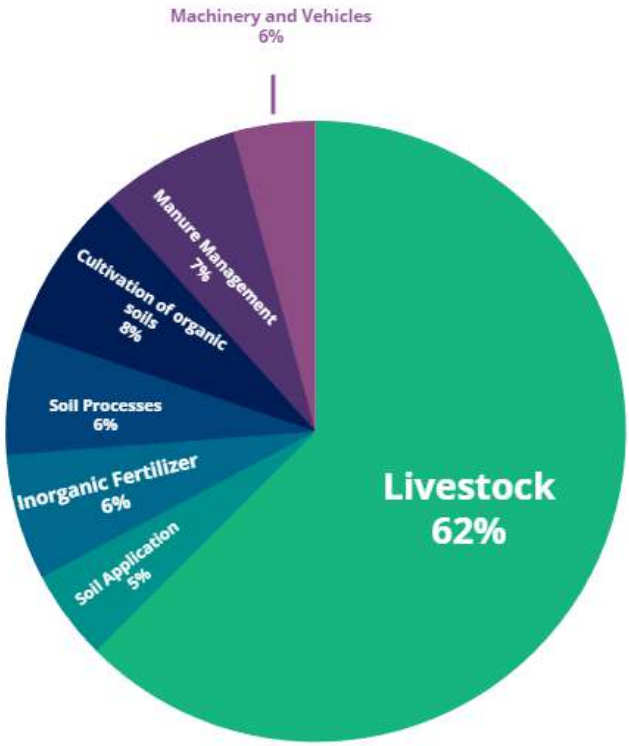


Figure 24 Breakdown of Agriculture Emissions by Subsector in County Galway

Raw Subcategories

SUBCATEGORY	$ktCO_2e$
Livestock	
Dairy cattle	124
Goats	0.1
Horses	5
Sheep	94
Swine	0
Mules and asses	0.3
Non-dairy cattle	605
Urine and dung deposited by grazing animals	75
Manure Management	
Manure management - Dairy cattle	12
Manure management - Goats	0.07
Manure management - Horses	1
Manure management - Mules and asses	0.06
Manure management - Non-dairy cattle	82
Manure management - Other poultry	1
Manure management - Sheep	9.8
Manure management - Swine	0
Cultivation of organic soils	
Cultivation of organic soils	117

SUBCATEGORY	$ktCO_2e$
Machinery and vehicles	
National fishing	0.2
Off-road vehicles and other machinery	39
Stationary	4
Agriculture	18
Inorganic fertilizer	
Inorganic N-fertilizers (includes also urea application)	95
Soil Processes	
Liming	28
Mineralization	0.02
Nitrogen leaching and run-off	44
SOIL APPLICATIONS	
Urea application	1
Sewage sludge applied to soils	0.1
Animal manure applied to soils	64
Atmospheric deposition	20
Crop residues applied to soils	3
TOTAL	**1449**

Table 18 Emissions by Subcategory

4.8.3 Supporting Information

Galway is a rural county where Agriculture plays a vital role in underpinning the rural economy[85]. The Galway Region is a diverse geographic region. In the lowland areas dry stock mixed farming and dairy farming dominate, whilst in the mountainous parts suckling, sheep, and mixed farming are widely found.

The Census of Agriculture 2019 indicates that since the previous census of 2010, the number of farms in the Region has fallen from 13,445 to 12,717, a decrease of 5.5%. 71.5% of these farms in 2019, were 30 hectares or less in size per farm.[86] Nevertheless, due to the value of Agriculture in County Galway, it is not a surprise that the sector emits 44% (1448.87 kt of CO_2) of the total carbon emissions in the county (see Sectoral Breakdown Emissions figure). The most dominant greenhouse gas emitted in the agriculture sector is Methane, followed by Nitrous Oxide.

Additional data collection from CSO Agriculture Census[87] and Teagasc[88] provide further insight into the sector's emissions, helping to further information on the development of suitable actions. Farm animals in County Galway are directly responsible for almost 57% of the carbon emitted in the

[85] https://www.teagasc.ie/media/website/publications/2014/Rural_Economic_Development_in_Ireland.pdf
[86] https://data.cso.ie/
[87] https://www.cso.ie/en/statistics/agriculture/censusofagriculture/
[88] https://www.teagasc.ie/about/farm-advisory/advisory-regions/galway--clare/

agriculture sector. The highest emitting subsector within the county is the Non-dairy Cattle which is responsible for 41.8% of the total carbon emissions. [89]

Type of Cattle	Value
Cows	138,800
Dairy cows	38,000
Other cows	100,800
Bulls	700
Total cattle: male	147,600
Total cattle: female	297,800

Table 19 Livestock figures for the county per 2019

Galway has over 336,401 hectares of agricultural fields. Consequently, it comes as no surprise that this county is a leader in Irish agriculture and agribusiness[90].. However, this entails a considerable number of GHG emissions emitted. The cultivation of organic soils was responsible for 8% of the total GHG emissions produced by activities in the agricultural sector.[91] In addition, current farming technology used for the agriculture sector in County Galway seems to have a significant impact on carbon emissions. The MapElre dataset shows that inorganic nitrogen fertilisers are responsible for 95.28 $ktCO_2$ emitted, which makes for 6.58% of the total emissions in the sector. Methane (CH_4) and nitrous oxide(N_2O) are the two most prevalent greenhouse gases released in the agriculture sector, respectively, as illustrated below:

GAS	$ktCO_2e$
CH_4	915
CO_2	70
N_2O	464
Total	**1148**

Table 20: Agricultural Sector Emissions by Gas Type in Galway County

[89] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8420985/pdf/vfab037.pdf

[90] https://assets.kpmg.com/content/dam/kpmg/ie/pdf/2021/11/ie-ireland-2030-carbon-emissions-targets.pdf

[91] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8420985/pdf/vfab037.pdf

4.9 Land Use, Land Use Change and Forestry (LULUCF)

4.9.1 Background

Land Use, Land Use Change and Forestry (LULUCF) is responsible for emissions as well as carbon sinks, related to land use change and forestry. It involves the emissions and removals from land use, land use change and forestry, including forest land, cropland, grassland, wetlands, settlements and other land types, as well as through the harvesting of wood products. Land management has a key role in the response to climate change. Ireland has significant and healthy biosystems, including grassland, hedgerows and forests, which sequester or absorb carbon dioxide (CO_2). This is a separate category from Agriculture because while LULUCF primarily deals with land use and forestry practices to enhance carbon sequestration and mitigate emissions, Agriculture involves the production and management of crops and livestock, and includes emissions and removals associated with agricultural activities such as enteric fermentation, manure management, and soil management.

Since 1990, Ireland's forest area has expanded by approximately 300,000 ha[92]. As these forests grow and mature, they represent an important CO_2 sink and long-term carbon store in biomass and soil. However, low forest planting rates in recent years are a future risk in terms of national forest estate continuing to act as a significant carbon sink. In 2019 the LULUCF sector accounted for 3,210 $ktCO_2$ equivalent removed and 9,867 $ktCO_2$ equivalent emitted [93]. In 2019, the national net emissions for LULUCF accounted at 6,657kt CO_2.

Land use and land-use change contribute significantly to global greenhouse gas emissions. Deforestation, conversion of natural ecosystems to agriculture, and other land use changes result in the release of carbon dioxide (CO2) into the atmosphere, which contributes to the greenhouse effect and climate change.

On the other hand, land use and management practices can also offer significant potential for reducing emissions. Land-based activities can contribute to the sequestration of carbon, or the removal of CO2 from the atmosphere and its storage in soil, vegetation, and other organic matter. For example, reforestation and afforestation efforts can help sequester carbon from the atmosphere, acting as a natural sink for greenhouse gases. In addition, sustainable agriculture practices such as conservation tillage, agroforestry, and cover cropping can improve soil health, increase soil carbon sequestration, and reduce greenhouse gas emissions.

4.9.2 County Galway: Baseline Inventory for LULUCF

As a result of such land composition, LULUCF is responsible for 16% of the total GHG emissions in County Galway, with 483 $ktCO_2$ equivalents emitted. As seen in Table 24, County Galway's Cropland,

[92] https://www.epa.ie/our-services/monitoring--assessment/climate-change/ghg/lulucf/
[93] https://www.epa.ie/our-services/monitoring--assessment/climate-change/ghg/lulucf/

Forestland, and Harvested Wood Product were responsible for the removal of 420 $ktCO_2$ equivalents of emissions, whilst the areas of Grassland, Settlements, Wetlands, and Other Land were responsible for emitting 900 $ktCO_2$ equivalents of emissions.

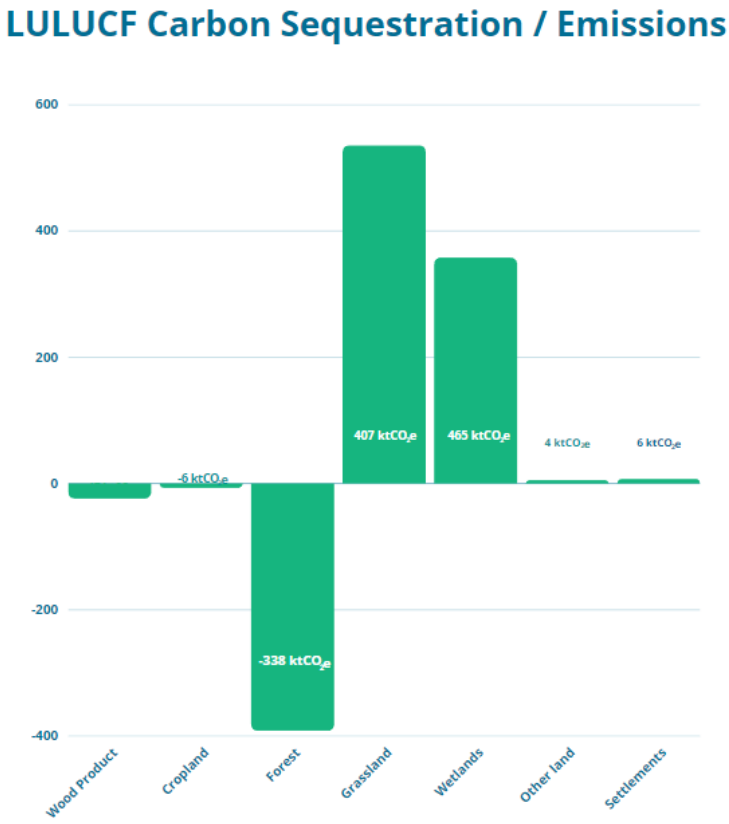


Figure 25 Carbon Sequestration and Emissions from LULUCF

4.9.3 Supporting Information

County Galway is known to contain a wide variety of wetlands, grasslands, and forestry, which support many flora and fauna species of high conservation concern. [94]The County is geographically divided by Lough Corrib, with the two dividing parts of Galway being considerably different from each other. The Eastern part is for the most part flat and fertile land, whereas the western part is relatively barren and mountainous.[95]

There are around 150 lakes of various sizes, with Lough Corrib being the largest, covering a surface of 30,000 acres.[96]

There is a large variation in soil types in the region. There are significant areas of peat, rock (grey), brown earth, gleys, and others. When peatlands and wetlands are drained and damaged, carbon is released into the atmosphere. In addition, there is geographical diversity in the region, from lowlands

[94]http://galwaybiodiversity.com/wp-content/uploads/2015/02/G-City-Co-Biodiversity-Plan-2014-full.pdf
[95]https://www.libraryireland.com/topog/G/Galway-Topography.php#:~:text=Lough%20Corrib%20divides%20the%20county,rugged%2C%20mountainous%2C%20and%20barren.
[96]https://www.libraryireland.com/topog/G/Galway-Topography.php#:~:text=Lough%20Corrib%20divides%20the%20county,rugged%2C%20mountainous%2C%20and%20barren.

to mountains and large areas of commonage and rough grazing. This variation has resulted in vastly different farming practices in the region.

The Agricultural land category includes pastures, natural grasslands, and non-irrigated arable. Below is information about the different types of land in County Galway and the corresponding area covered in hectares. The table below outlines the area for agricultural land.

Subcategory	Area (ha)
Pastures	289,283
Natural Grasslands	4,280
Non-irrigated arable land	1,042
Total Agricultural Land	**294,605**

Table 21 Agricultural Land Use Distribution[97] in County Galway

The Forest land category includes coniferous forest, broad-leaved forest, and mixed forest. The Forest Land in County Galway is responsible for sequestering 338 $ktCO_2e$ and emitting none. Below is information about the different types of Forest land in County Galway and the corresponding area covered in hectares. The table below outlines the area for forest land.

Subcategory	Area (ha)
Coniferous	28,613
Broad-leaved forest	3,253
Mixed forest	5,156
Transitional Woodland	17,437
Total Forest Land	**54,459**

Table 22 Forest Land Use Distribution[41] in County Galway

The Wetland category includes peat bogs, inland marshes, salt marshes, estuaries, and coastal lagoons. The Wetland areas in County Galway are responsible for sequestering 0 $ktCO_2$ and emitting 465 $ktCO_2e$.

[97] https://gis.epa.ie/GetData/Download

Below is information about the different types of wetlands in County Galway and the corresponding area covered in hectares. The table below outlines the area for wetlands.

Subcategory	Area (ha)
Peat Bogs	153,818
Inland marshes	3,568
Salt Marshes	51
Coastal Lagoons	7
Total Wetland	**157,444**

Table 23 Wetland Land Use Distribution[98] in County Galway

The Other Land Uses category includes the rest of the land use in County Galway. Below is information about the different types of Other Land Uses in County Galway and the corresponding area covered in hectares.

Subcategory	Area (ha)
Discontinuous urban fabric	3,337
Industrial units	170
Sport and leisure facilities	708
Road and rail networks	149
Airports	78
Burnt areas	4,187
Bare rocks	2,102
Sparsely vegetated areas	10,903
Intertidal flats	183
Beaches, dunes, sands	611
Complex cultivation patterns	1,060
Total Wetland	**221,339**

Table 24 Other Land Use [42 in] County Galway

The most dominant greenhouse gas emitted in the LULUCF sector is carbon dioxide (CO_2), followed by methane (CH_4), shown in the table below:

[98] https://gis.epa.ie/GetData/Download

GAS	$ktCO_2e$
CH_4	48
CO_2	406
N_2O	28
Total	**483**

Table 25 Land Use, Land Use Change, and Forestry Emissions by Gas Type in County Galway

5.Other Inventories

5.1 Fluorinated Gases

Fluorinated gases are artificially produced gases used in a range of industrial applications.[99] They are often used to substitute gases that deplete the ozone, as they do not damage the atmospheric ozone layer. However, they are greenhouse gases with high GWPs, thus contributing to climate change. They were not included as their sector in the Chapter 3 Inventory (present in Industrial Processes) but are added here.

Hydrofluorocarbons are typically found in applications such as refrigeration, air-conditioning, aerosols, and foams.[100] SF_6, however, is used primarily in the electricity and electronics supply industries, e.g., the semiconductor industry, where it is used as an electronic insulator due to its inertness[101].

F-gases in Ireland are controlled by European Regulation (EC) No. 517/2014. [102]This Regulation aims to cut EU emissions of F-gases by two-thirds of 2014 levels by 2030. It is a legal requirement in Ireland that all businesses that install, maintain, or service stationary refrigeration, stationary fire protection systems and extinguishers, air conditioning, and heat pump equipment containing or designed to contain F-Gas refrigerants, obtain an F-Gas Company Certificate.[103]

5.1.1 County Galway: Baseline Inventory for F-gases

Using MapEIre's CRF Geospatial Dataset, two types of F-gases were identified in County Galway: hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6). The CO_2 equivalent of the SF_6 is included in the 3.1.1 results section as part of the overall GHG emissions, thus the SF_6 presented in the table below is double counted and is only presented to show the extent of SF_6 gases in the County. However, the CO_2 equivalent of the HFCs is not included in the overall GHG emissions, thus counted for the total GHG emissions. The NRF MapEIre GIS files were used to inform the data for the Fluorinated gases. The total mass of both is listed below:

F-gas	CO_2e
HFCs	35
SF_6	0
Total	35

Table 26 Measured Emissions from F-gases in County Galway

[99] https://climate.ec.europa.eu/eu-action/fluorinated-greenhouse-gases_en
[100] https://www.ccacoalition.org/fr/slcps/hydrofluorocarbons-hfcs
[101] https://library.wmo.int/index.php?lvl=categ_see&id=10223#.Y3-3eXaZOUk
[102] https://www.epa.ie/our-services/compliance--enforcement/air/fluorinated-greenhouse-gases-f-gases/
[103] https://www.legislation.gov.uk/nisr/2009/184/made/data.xht?wrap=true

5.2 Local Authority own Emissions

All public bodies in Ireland must achieve a 51% reduction in energy related GHG emissions and a 50% improvement in energy efficiency by 2030[104]. This is tracked through the SEAI's Monitoring and Reporting (M&R) system, in which each public sector organisation reports the following:

- Annual energy consumption for all energy types.
- The annual value quantifies the level of activity undertaken by the organisation each year. This is referred to as the activity metric.
- Details of energy-saving projects implemented and planned.
- Summary of the approach adopted for reviewing the organisation's energy management programme.

In 2020, public bodies saved €1.8 billion and 6 million tonnes of CO_2 emissions through avoided energy use between 2009 and 2020.[105] The public sector was 34% more energy efficient than in 2009 and exceeded its 33% energy efficiency target for 2020[106]. In 2019 approximately two-thirds of LA's electricity consumption was for Public Lighting. The remaining third was primarily used in LA buildings. The total emissions from the public sector in County Galway are 5.3 ktCO_2 equivalent. This represents less than 1% of the total emissions for the County. These emissions are not separated from the broader MapEIre inventory but rather provide a closer look at the emissions the LA is directly responsible for. Electricity consumption represents the bulk of the LA's emissions reported to the SEAI M&R system, followed by Transport and Heating emissions.

Electricity emissions come entirely from purchased electricity in 2019, the largest fuel source for Heating is gas, and the largest fuel source for the Transport fleet is road diesel.

[104] https://www.seai.ie/business-and-public-sector/public-sector/public-sector-energy-programme/obligations-and-targets/

[105] https://www.seai.ie/news-and-media/public-sector-saved-1.8-b/

[106] https://www.seai.ie/business-and-public-sector/public-sector/monitoring-and-reporting/introduction-to-mr/

County Galway own Emissions

Energy	Energy Category	Energy Type	$kgCO_2$
Electricity			2,581,139
	Electricity		2,581,139
		Net Electricity Imports (MPRN data)	2,581,139
		Onsite Generation by Non-Fuel Renewables or Landfill Gas	0
Thermal			874,119
	Heating Oils		122,393
		Kerosene	88,881
		Gasoil	33,511
	Gas		751,727
		Natural Gas (GPRN data	677,426
		LPG (purchased by volume)	67,988
		LPG (purchased by weight)	6,313
Transport			1,862,505
	Transport Fuels (Mineral Oil Fuels)		1,862,505
		Petrol (excl. blended bioethanol)	27,461
		Road Diesel (DERV) (excl. blended biodiesel)	1,575,998
		Marked Diesel (non-thermal)	259,046
	Transport Biofuels		0
		Biodiesel (incl. all blended biodiesel)	0
		Bioethanol(incl.all blended bioethanol)	0
Total CO2 Emissions			5,317,763

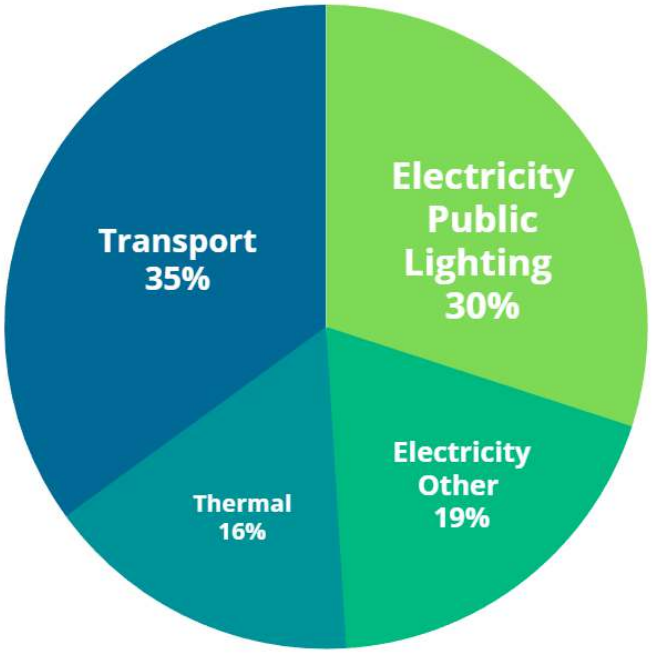


Figure 26 CO_2 Emissions from Electricity, Thermal, and Transport

BASELINE EMISSIONS INVENTORY
GALWAY COUNTY COUNCIL

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