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ENVIRONMENTAL SCIENCE &
PLANNING

BASELINE EMISSIONS INVENTORY REPORT

Baseline Emissions Inventory Report for County Leitrim



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Prepared for:
Leitrim County Council

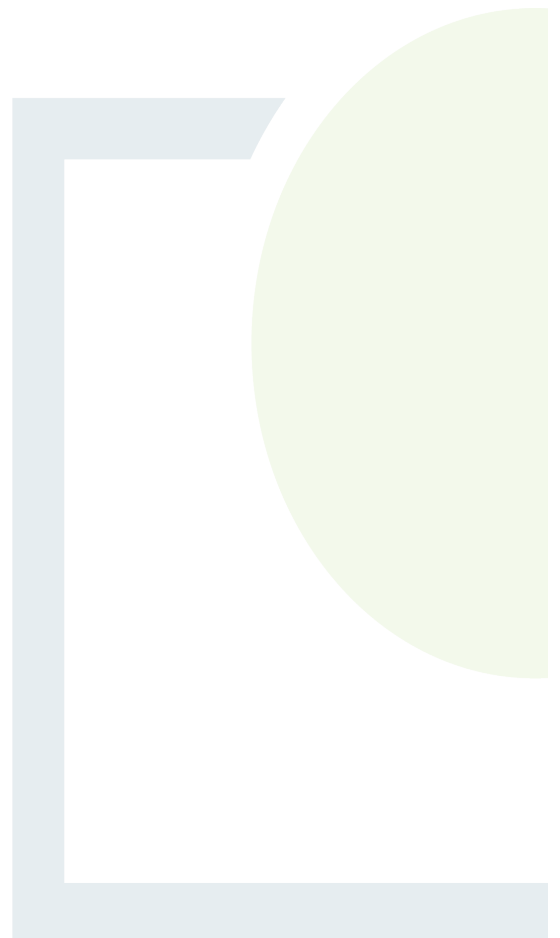
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Baseline Emissions Inventory Report for County Leitrim

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Abstract: This report presents the findings of a baseline emissions inventory study carried by Fehily Timoney and Company (FT) on behalf of Leitrim County Council. The report presents the baseline greenhouse gas emissions from various sectors in a year. This baseline report aims to raise awareness of climate change and the impact that different sectors in the north-east region have on Ireland's overall carbon emissions. It provides Leitrim County Council with the necessary information to make informed decisions on climate change actions to lower the county's carbon emissions. The sectors that have been included in this analysis are residential, commercial and industrial, agriculture, transport, waste and wastewater and land use, and land use change and forestry (LULUCF).

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EXECUTIVE SUMMARY

This report presents the findings of a 'Tier 2' Baseline Emission Inventory (BEI) study carried out by Fehily Timoney and Company (FT) for the county of Leitrim. The report evaluates and determines the baseline greenhouse gas (GHG) emissions from various societal sectors in the county and for the local authority organization in 2018 and allows LCC to measure the emission reductions required to achieve the emission reduction target of reducing GHG emissions by 51% by 2030.

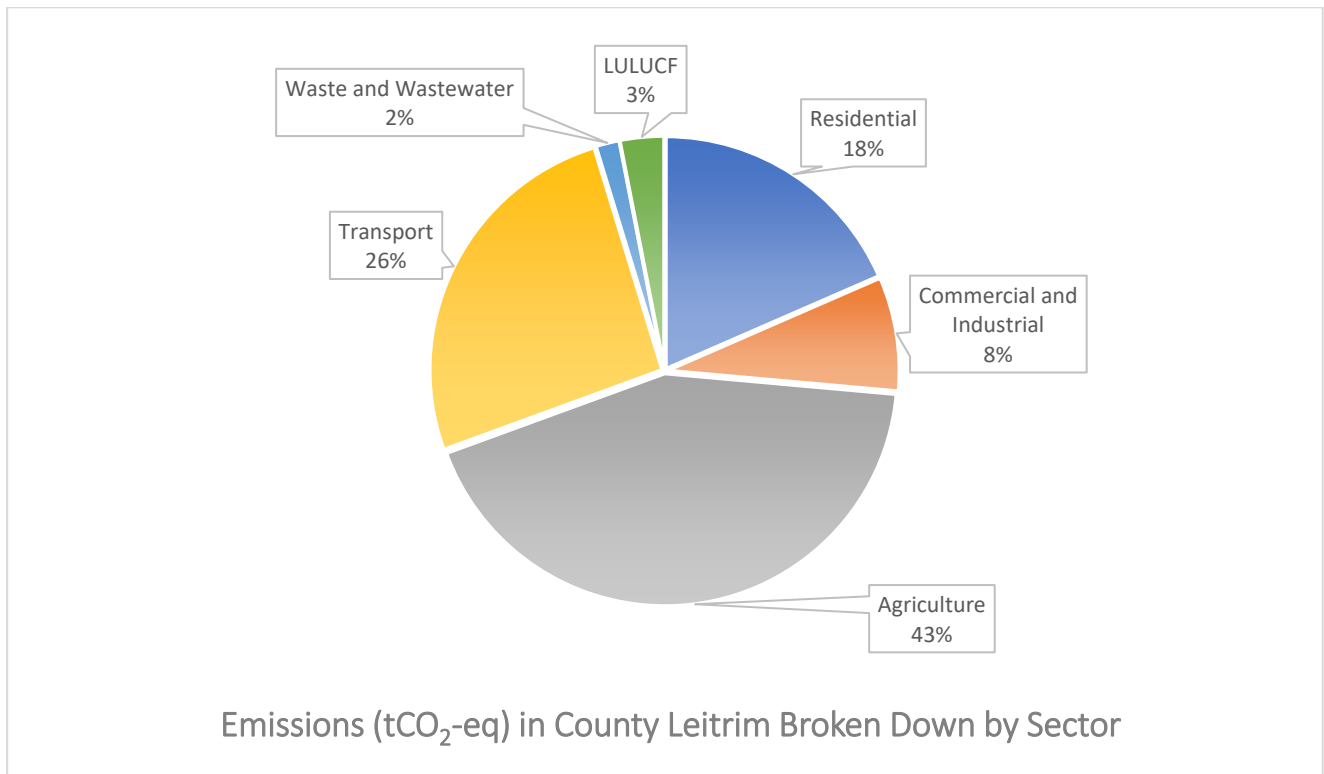
The sectors that have been included in the county wide analysis are residential, commercial and industrial, agriculture, transport, waste and wastewater, and land use, and land use change and forestry (LULUCF). GHG emissions associated with the local authority's own operations have been accounted for separately.

The methodology is based on the Tier 2 'Bottom-Up' Approach defined in Annex C to the Draft Local Authority Climate Action Plan Guidelines.

Overall, the emissions generated from all analysed sectors in the county equate to 618,972 tCO₂-eq in the baseline year. An overall emission reduction of 315,676 tCO₂-eq to 303,296 tCO₂-eq is required for the county across all sectors to achieve the target to reduce GHG emissions by 51% by 2030.

The top three sectors in the county in terms of GHG emission levels were Agriculture, Transport and Residential producing 43%, 26% and 19% of tCO₂-eq respectively, of the total emissions in the county. The analysis shows that these sectors should be the main targets of climate action initiatives.

A percentage breakdown of sectoral GHG emissions in County Leitrim in the baseline year is provided in the figure below:





1. INTRODUCTION

1.1 Background and Purpose

This report presents the findings of a 'Tier 2' Baseline Emission Inventory (BEI) study carried out by Fehily Timoney and Company (FT) for the county of Leitrim on behalf of Leitrim County Council.

The methodology is based on the Tier 2 'Bottom-Up' Approach defined in Annex C to the Draft Local Authority Climate Action Plan Guidelines. While a Tier 1 approach requires the most basic and straightforward BEI calculation, the Tier 2 approach requires a greater degree of literature review, data collation, manipulation and data generation and subsequently more detailed outputs than the Tier 1 method. The Tier 2 method provides a greater degree of emissions breakdown and sub-categorisation of emission sources and human activities within each sector.

The report evaluates and determines the baseline greenhouse gas (GHG) emissions from various societal sectors in the county in 2018 and allows Leitrim County Council to measure the emission reductions required to achieve the emission reduction target of reducing GHG emissions by 51% by 2030. This baseline report aims to raise awareness of climate change and the impact that different sectors in the north-east region have on Ireland's overall carbon emissions. It provides Leitrim County Council with the necessary information to make informed decisions on climate change actions to lower the county's carbon emissions.

1.2 Overview

The sectors that have been included in the county-wide analysis are residential, commercial and industrial, agriculture, transport, waste and wastewater, and land use, land use change and forestry (LULUCF).

The methodology is based on the Tier 2 'Bottom Up' Approach defined in Annex C to the Draft Local Authority Climate Action Guidelines.

The national emission reduction target of 51% by the end of 2030 is based on the GHG emissions reported for the end of 2018, in the national GHG emissions inventory. Accordingly, the data collated and analysed to inform this BEI is relative to the baseline year of 2018, or the nearest year possible to 2018.

GHG emissions are reported as Carbon dioxide (CO₂) or Carbon dioxide equivalent (CO₂-eq) in this report. The Global Warming Potential (GWP) of other GHGs (e.g., Methane, CH₄) has been factored to allow for reporting in CO₂-eq. Where the term 'emissions' in and of itself is used in this report, this refers solely to GHG emissions, and not non-GHG emissions (such as Sulphur oxides, SO_x, or Nitrogen oxides, NO_x).

1.3 Baseline Year Recalculation Policy

Making meaningful comparisons of emissions data over time is an integral part of any GHG accounting assessment that aims to be credible, transparent and useful. A prerequisite for such meaningful comparisons is a consistent data set over time, or in other words, comparisons of 'like' with 'like' over time. A baseline year (2018 in this case) is a reference point in the past with which current emissions can be compared. In order to maintain the consistency between data sets, baseline year emissions need to be recalculated when new data or methodological approaches become available. As such, baseline year emissions, as calculated in this report, shall be retroactively recalculated when updating the BEI to reflect any future changes in either data set availability or emission accounting methodologies that would otherwise compromise the consistency of emission measurement over time and the integrity of the BEI.



1.4 Structure of the Report

This report is structured as follows from this point forward:

- **Section 2 - Context:** This section provides background detail on the climate change challenge; policy and statute underpinning climate action in Ireland; Ireland's GHG emission targets and the background to and purpose of BEIs in a local context.
- **Section 3 - Baseline Emission Inventory:** This section reports on GHG emissions associated with each societal sector in the county. Detail on methodologies for calculating sectoral emissions, results and analysis, and data assumptions and limitations is provided in this section. GHG emissions associated with the local authority's own operations have been accounted for separately.
- **Section 4 - Overview and Main Conclusions:** This section quantifies the total amount of GHG emissions in the county (broken down by sector in percentage terms) and identifies the amount of GHG emission reductions required overall for the county. It also reports on the local authority's GHG emissions and emission reductions required for the local authority as an organization.

1.5 The Sectors Examined

A list of the sectors examined and a description of the scope of each sector is provided in Table 1-1.

Table 1-1: The Sectors Examined

Sector	Scope of the Sector
Residential	This sector covers all GHG emissions associated with dwellings. It covers GHG emissions from electricity use and combustion sources. It covers both private owned dwelling and social house units.
Commercial and Industrial	This sector covers Manufacturing Combustion as well as space heating, water heating, cooking and laundry involved in Commercial Services. Generally, it covers GHG emissions from electricity use and combustion sources. It also covers GHG emissions from Industrial Processes. The Commercial Services sub-category covers the provision of services for the purpose of generating profit or revenue generally. These can include: 1) selling goods and services, 2) advertising and marketing, and 3) banking and finance. This sector also covers GHG emissions from the Institutional sector (i.e., emissions associated with local and central government, schools, hospitals etc.), which is defined as a sub-sector of the commercial sector in the EPA National Emission inventory 2021.
Agriculture	This sector covers agricultural related GHG emissions from enteric fermentation, manure management, agricultural soils, liming, and use of fertilisers and urea application. Livestock farming results in the generation of GHG emissions from enteric fermentation and manure management. The management and use of soils in agriculture (e.g., through the application of fertilizer or lime) also results in the generation of GHG emissions (e.g., through N ₂ O volatilization from fertilizer, urine, dung; CO ₂ volatilization from liming or urea application).
Transport	The primary source of this sector's emissions come from the burning of diesel and petrol in combustion engines. This sector covers GHG emissions from private vehicle use as well as public transport.



Sector	Scope of the Sector
Waste and Wastewater	This sector is responsible for the emissions from the handling of waste, incineration of waste (without energy utilization), composting, and wastewater handling.
Land Use, Land Use Change and Forestry (LULUCF)	This sector is responsible for emissions as well as removals, related to land use, land use change and forestry. Forest land (and harvested wood production), grassland, cropland, wetlands, and settlement areas all result in GHG emissions and removals. The CO ₂ mass balance for each type of land use is dependent on the above-ground biomass, below-ground biomass, dead organic matter (litter and dead wood) and soils associated with each land use type. Land use change results in a change in CO ₂ emission / removal mass balances associated with a geographic area based on these factors.

Further detail on particularly complex sectors and sub-sectors is provided in Appendix 1.



2. CONTEXT

2.1 Climate Change Challenges

Climate change refers to the long-term changes in the earth's weather patterns or average temperatures. In Ireland this is demonstrated by rising sea levels, extreme weather events and changes in the eco-system. Extensive research and a significant body of evidence has shown a correlation between the increasing global average temperature and the increasing quantity of GHG released into the atmosphere, particularly from anthropogenic sources.

Changes in weather patterns and climate can have significant adverse impacts on the environment and human beings. The Intergovernmental Panel on Climate Change (IPCC) published the *Climate Change 2022: Impacts, Adaptation and Vulnerability in 2022*. Included in this report is an outline of observed impacts of climate change on the environment and human beings. These include impacts from inland flooding, damages to infrastructure, impacts from infectious disease, displacement, animal and livestock health and productivity, mental health and water scarcity derived from climate change.

The seriousness of the potential impacts and risks associated with climate change is reflected in the vast quantity of legislation that has been introduced to mitigate those impacts and risks, beginning with the establishment of the United Nations Framework Convention on Climate Change (UNFCCC) treaty in 1992. Subsequent significant, international treaties, agreements have been made and international gathering taken place since, including, the Kyoto Protocol, the Paris Agreement, 2030 Climate and Energy Policy Framework and the twenty-seven UNFCCC, Convention of the Parties (COP) conferences that have taken place since its formation.

The Paris Agreement was the first-ever universal, legally binding global climate change agreement, adopted at the Paris climate conference (COP21) in December 2015.

There are many significant additional benefits to reducing GHG emission levels and increasing the share of renewable energies. These include a decrease in dependency on fossil fuels, which in turn results in a higher security of energy supply, better health, lower energy costs, an increase in the county's competitiveness, and a more sustainable economy.

2.2 Greenhouse Gas Emission Targets

The Climate Action and Low Carbon Development Act (as amended) provides a statutory underpinning to climate action in Ireland. It specifies the requirement to develop a national Climate Action Plan (CAP) (and update it every year), a National Adaptation Framework (NAF), a National Long Term Climate Action Strategy and Sectoral Adaptation Plans (SAPs). It also specifies a series of carbon budgets and the associated sectoral emission ceilings.

It sets out actions that must be taken to ensure delivery of commitments and a target to reduce GHG by 51% by 2030 and to achieve net zero GHG emissions by 2050. The successful delivery of climate action and the achievement of these targets will require significant, unanimous effort across all sectors of society.



There are currently three carbon budgets, indicating the limit of GHG emissions over three consecutive five-year periods beginning with the period 2021-2025. The 51% target applies to GHGs that come from all sectors of society including industrial, agricultural, energy, land use and other anthropogenic (i.e., human-based) activities in the State. The 51% target for 2030 is the primary constraint on carbon budgets for the periods 2021-2025 and 2026-2030. Ireland's total GHG emissions in 2018 were 68.3 Mt CO₂eq. Therefore, the first two carbon budgets must lead to our total emissions being reduced to 33.5 Mt CO₂eq by 2030.

In the latest National Climate Action Plan developed (CAP23), which was published in late December 2022, Sectoral Emission Ceilings (SECs) have been defined. Sectoral Emissions Ceilings (SECs) refer to the total amount of permitted greenhouse gas emissions that each sector of the economy can produce during a specific time period. Specific GHG emission reduction targets have been prescribed for each sector of society to reflect the SECs. More detail on Sectoral Emission Ceilings for Ireland can be found via the following Government of Ireland web link - [gov.ie](http://www.gov.ie) - [Sectoral Emissions Ceilings \(www.gov.ie\)](http://www.gov.ie)

The Environmental Protection Agency (EPA) has confirmed that Ireland has exceeded its 2020 target for GHG emissions by 6.73 Mt CO₂-eq. Projections indicate that Ireland can meet its climate action targets over the 2023 – 2030 period but only with the full implementation of CAP23. CAP23 is an update of the Climate Action Plan 2021 and is the first Action Plan delivered under the amended Act of 2021. It reflects the Government-approved carbon budgets and sectoral emissions ceilings, which seeks to provide a pathway and framework to achieving a 51% reduction in greenhouse gas emissions by the end of this decade. CAP23 was published on December the 21st 2022.

2.3 Baseline Emissions Inventories - *Setting Local Targets*

A key element of the Climate Action and Low Carbon Development Act (as amended) relevant to local authorities is the requirement for local authorities to prepare individual Local Authority Climate Action Plans (LACAPs) for their functional area. The purpose of LACAPs will be to deliver effective climate action and mitigation at local authority and community levels. Local Authority Development Plans must also be aligned with their LACAP.

The primary goal of the national CAP is to ensure a just transition to a climate neutral Ireland using *'an integrated, structured and evidence-based approach.'* The CAP also states, *'our capacity to anticipate and plan for a just transition requires the development of a robust evidence base to support policy development and effective ongoing monitoring'*. Furthermore *'data will play a critical role in assisting local authorities in forecasting where changes will occur (or are already underway), and who will be most impacted'*.

In line with this overarching policy, the primary objective of this report is the generation of a BEI for the local authority functional area of County Laois. This BEI will be a contemporary snapshot in time of GHG emissions in County Laois and will act as a reference point on which specific county wide and/or sectoral targets can be established to manage and reduce GHG emissions.

Specifically, the BEI will serve to inform the development of the LACAP for the county. LACAPs should have an inward and outward focus. Climate action in the plan should be defined by local authorities for their own organization which they have full control over (i.e., the inward focus), and for communities in their functional area, which they exert a strong influence over in partnership with relevant stakeholders (i.e., the outward focus). As such, a BEI will be prepared for all societal sectors broadly (which would facilitate outward climate action), whilst a separate BEI will be prepared for the local authority organization itself (which would facilitate inward climate action).

The BEIs will allow the monitoring and tracking of progress towards meeting targets and the efficacy of any climate action mitigation measures adopted and implemented by a local authority.



Assessing sectoral contributions will define where reductions in GHG emissions are most needed to achieve GHG emissions targets. By assessing sectoral contributions to climate change and the risks they pose with respect to climate change, local authorities can rank sectors and sub-sectors with respect to their counties contribution to climate change and make informed, practical decisions on how they can contribute to and influence mitigating these risks within each sector in partnership with relevant stakeholders.

Assessing local authority organizational GHG emissions will facilitate a local authority in understanding aspects of its organization that contribute the most in terms of GHG emissions and the optimum areas to target to successfully reduce their organizational GHG emissions in line climate action planning requirements.

LACAPs will be established for a duration of five years. It is expected that, at a minimum, and to maintain an up-to-date and accurate evidence base to inform decision making, local authority BEIs would be revised at least every five years in line with each revision of the local authority CAPs. However, it is also advised that BEIs should be updated when new, significant evidence, data etc. is available.



3. BASELINE EMISSIONS INVENTORY

3.1 Residential

3.1.1 Methodology

The following methodology was used to determine emissions from the Residential sector.

- Central Statistics Office’s (CSO) household census data for the county was reviewed to determine the number and type of dwellings within the county.
- The National BER Research Tool provides data on dwelling type, dwelling floor area and estimated emission per floor area for dwellings. This allows for an estimation of emissions from space heating, hot water, lighting and ventilation from each dwelling type in the county. The database also provides information on year of construction for each building.
- CSO data on mean metered electricity consumption for each dwelling type in the nation in 2018 is used to estimate electricity from electrical appliance use in dwellings. SEAI Conversion factors for 2018 are used to determine CO₂-eq emissions associated with this use.
- This data allows for a determination of the following:
 - Average GHG emissions per year per dwelling type for the county.
 - Total GHG emissions per year per dwelling type for the county.
 - Total GHG emissions from the Residential sector for the county
 - An estimated percentage breakdown of emissions from each dwelling type based on year of construction.
- An estimate for main source of heating fuel per dwelling type for the county can then be made using data from the CSO. This data can be used to determine the number of dwellings in the county that rely on the following fuel types as their main source of space heating: Mains Gas, LPG, Heating Oil, Electricity, Solid Fuel. This aids the characterization of Residential sector emissions, providing an additional layer of insight. This estimate is based on dwellings which have been subject to a BER.

3.1.2 Results

In total, there were 12,263 dwellings recorded in the county. A breakdown of the number and type of dwellings in the county is provided in Table 3-1 and in Figure 3-1:

Table 3-1: Number and Type of Dwelling for the County

Dwelling Type	Number of Dwelling Type in the County
Detached	9,060
Semi-detached	1,983
Terraced	731
Apartments	489

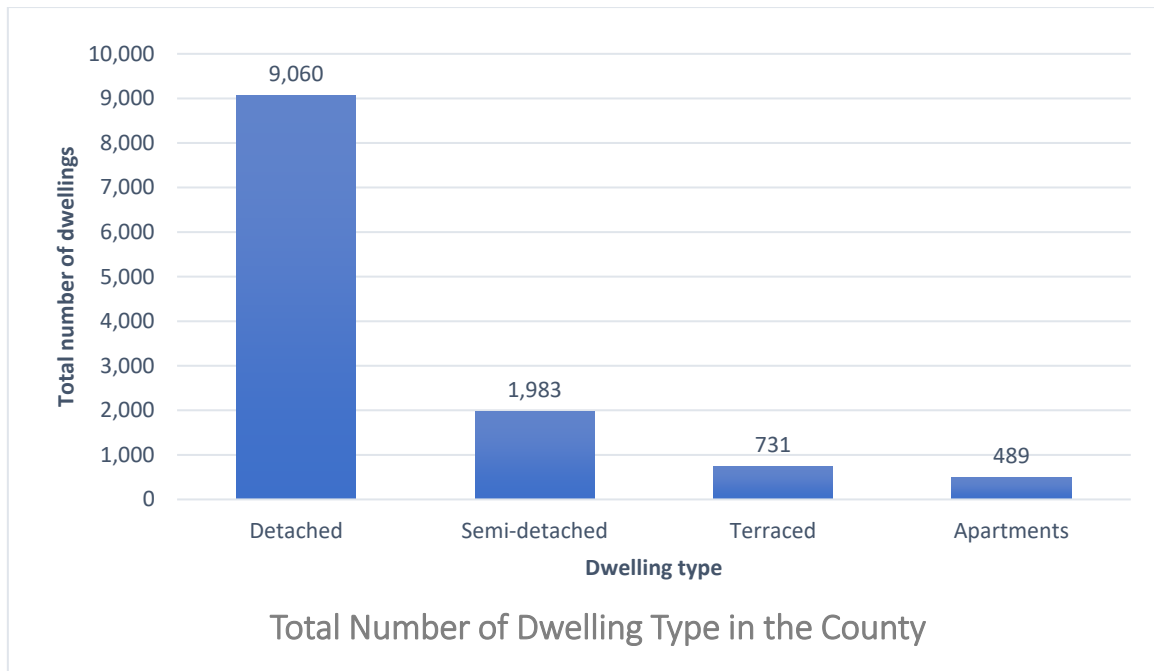


Figure 3-1: Total Number of Dwelling Type in the County

The predominant type of dwelling is detached housing, which is reflective of the rural nature of the county and the level of one-off housing. This is followed by semi-detached housing. There are relatively low levels of terraced housing and apartments.

Information on CO₂ emissions from dwellings in the county for the baseline year is presented in Table 3-2 and Figure 3-2, Figure 3-3, and Figure 3-4.

Table 3-2: GHG Emissions from Dwellings in the County

Dwelling Type	Average CO ₂ -eq Emissions from this Dwelling Type (kgCO ₂)	Number of Dwelling Type in the County	Total CO ₂ -eq Emissions from Dwelling Type in the County (tCO ₂)	CO ₂ -eq Emissions per Dwelling Type unit in the County (tCO ₂)
Detached	10,700.76	9,060	96,949	10.70
Semi-detached	5,491.23	1,983	10,889	5.49
Terraced	5,940.44	731	4,342	5.94
Apartments	4,314.04	489	2,110	4.31
Total Residential Sector Emissions (tCO₂-eq)			114,290	

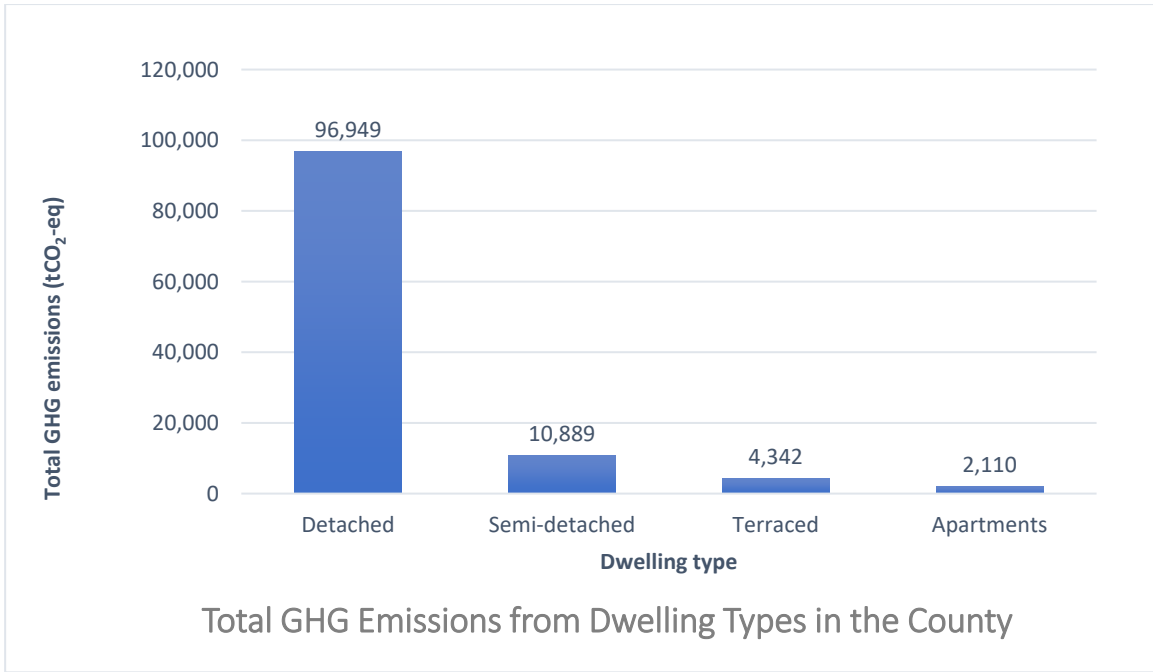


Figure 3-2: Total GHG Emissions from Dwelling Types in the County

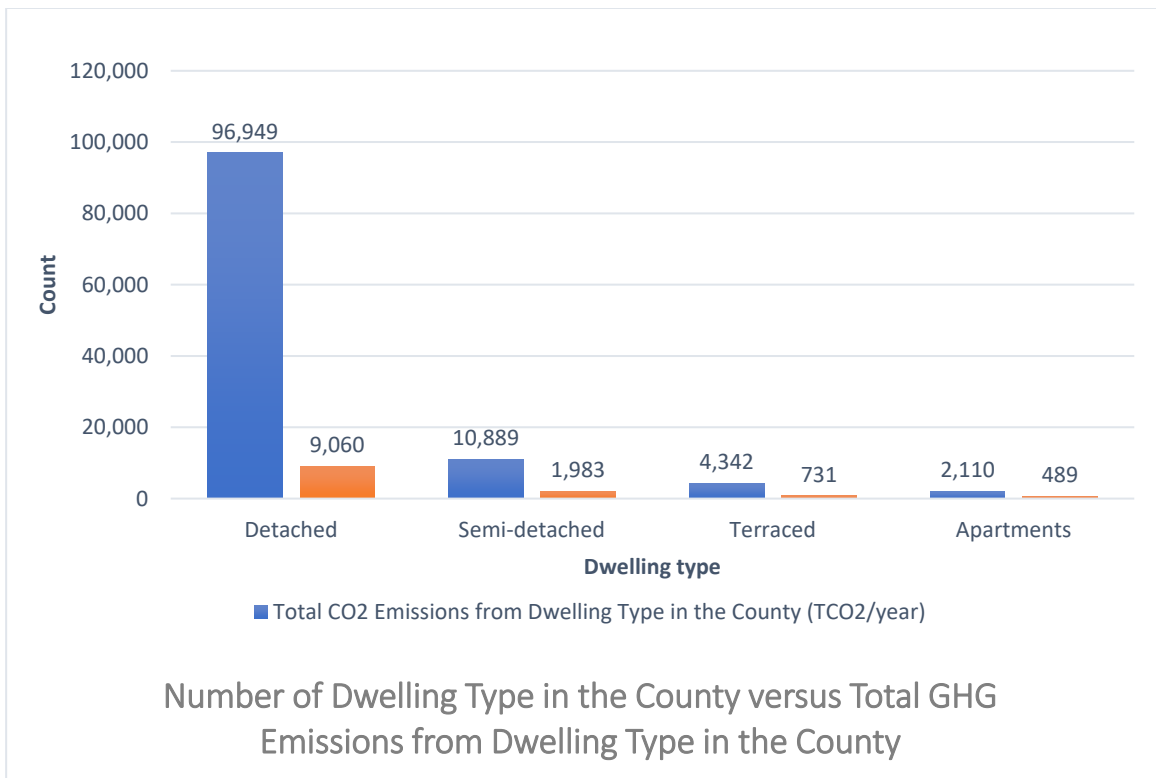


Figure 3-3: Number of Dwelling Type in the County versus Total GHG Emissions from Dwelling Type in the County

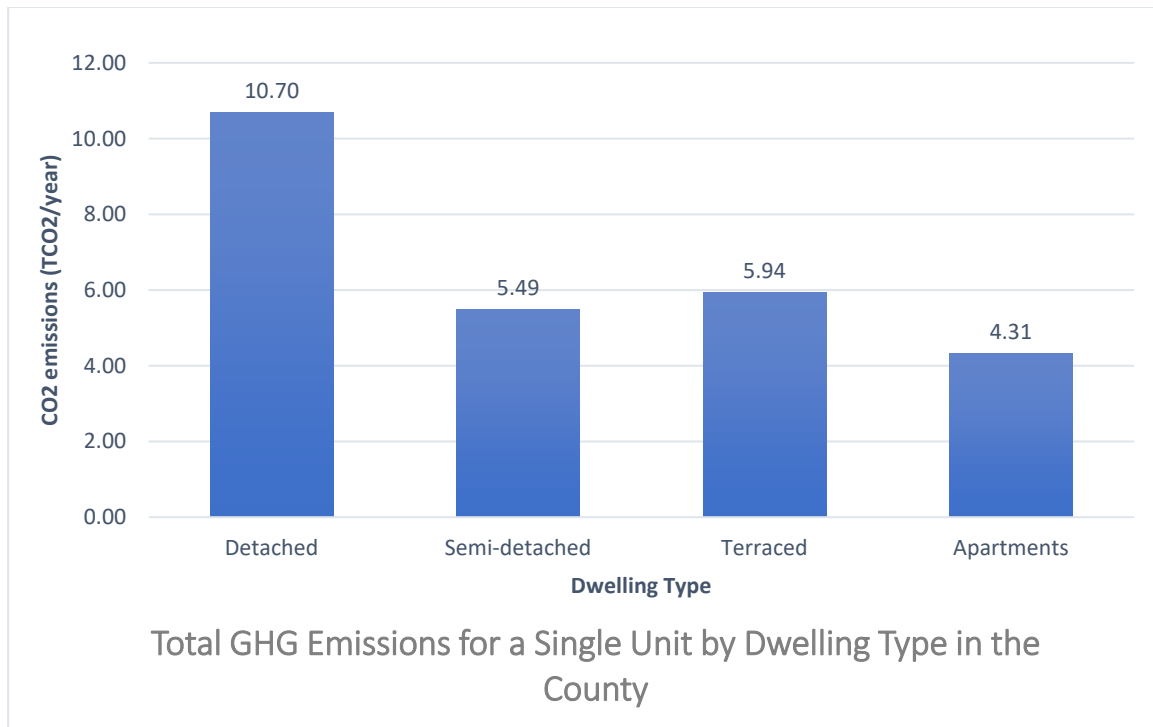


Figure 3-4: Total GHG Emissions for a Single Unit by Dwelling Type in the County.

Detached dwelling contribute the most emissions by far. This reflects the relatively high numbers of detached dwellings in the county, and the higher level of space heating requirements and heat loss associated with these dwellings, which are generally larger than other dwelling types and which have four sides in which heat may be lost from the dwelling. Semi-detached dwellings contribute the second most emissions, followed by terraced housing then apartments.

Detached housing contributes the most in terms of emissions per single unit. Semi-detached housing ranks second highest, ahead of terraced housing, then apartments.

A percentage breakdown of GHG emissions per dwelling type based on year of construction (from BER datasets) is provided in Table 3-3 and illustrated in Figure 3-5.

Table 3-3: Percentage Breakdown of GHG emissions per dwelling type based on year of construction (from BER datasets)

Dwelling Type	Built before 1920	Built between 1920 and 1970	Built between 1971 and 1990	Built between 1991 and 2000	Built between 2001 and 2022
Detached	12.04%	13.92%	37.26%	12.31%	24.48%
Semi-detached	3.31%	12.16%	20.09%	19.88%	44.56%
Terraced	11.20%	24.80%	32.33%	4.30%	27.37%
Apartments	0.00%	6.91%	8.47%	14.81%	69.82%

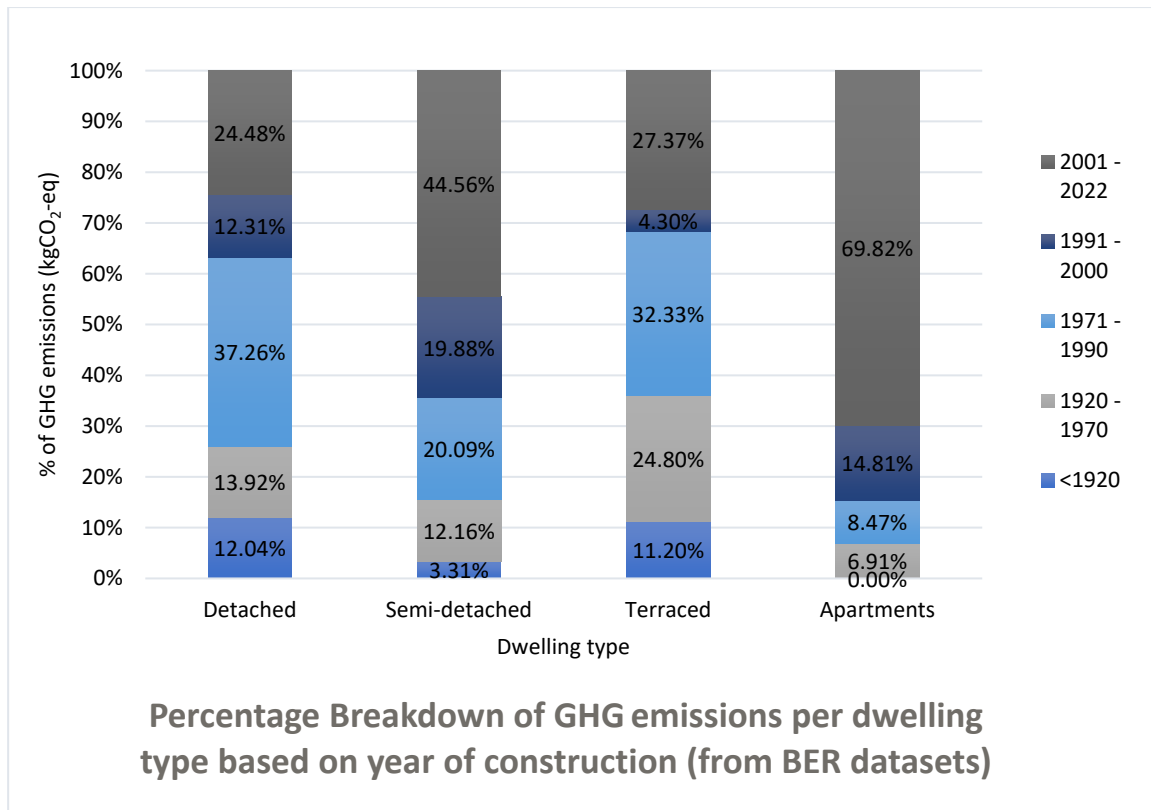


Figure 3-5: Percentage Breakdown of GHG emissions per dwelling type based on year of construction (from BER datasets)

The following is observed from the above:

- Emissions from detached dwellings built between 1971 and 1990 are relatively high.
- A large percentage of emissions from semi-detached housing is from housing built after 2001, which likely reflects the large number of semi-detached houses built in newer planned estates after 2001.
- Emissions from terraced housing built before 1990 are relatively high, which reflects the likelihood that this older housing stock is less energy efficient compared to other types of housing. Terraced housing built after 2001 contributes significantly in terms of emissions.
- Most emissions from apartments originate from apartments built after 1991, which likely reflects the relatively large number of apartments built in this period compared to previous periods.

For further insight, a percentage breakdown of main space heating fuels for dwellings in the county (which have been subject to a BER) is provided in Figure 3-6, Figure 3-7, Figure 3-8, Figure 3-9 and Figure 3-10, in both number and percentage terms.

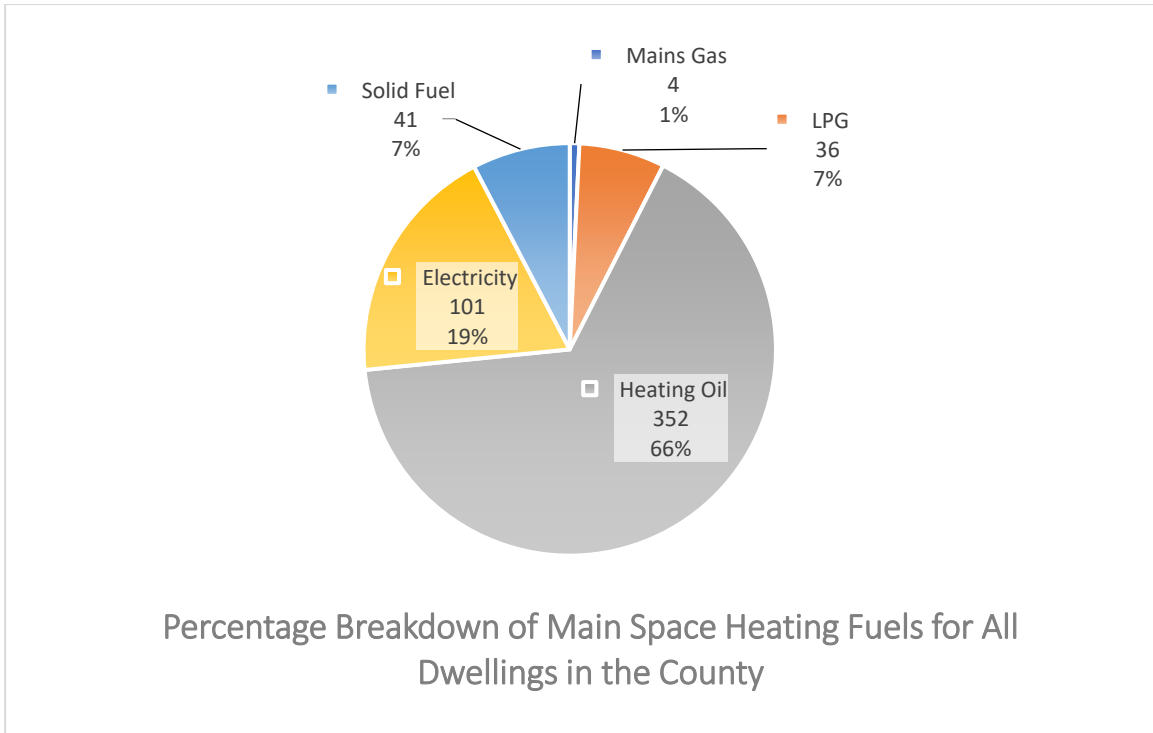


Figure 3-6: Percentage Breakdown of Main Space Heating Fuels for All Dwellings in the County (534 dwellings)

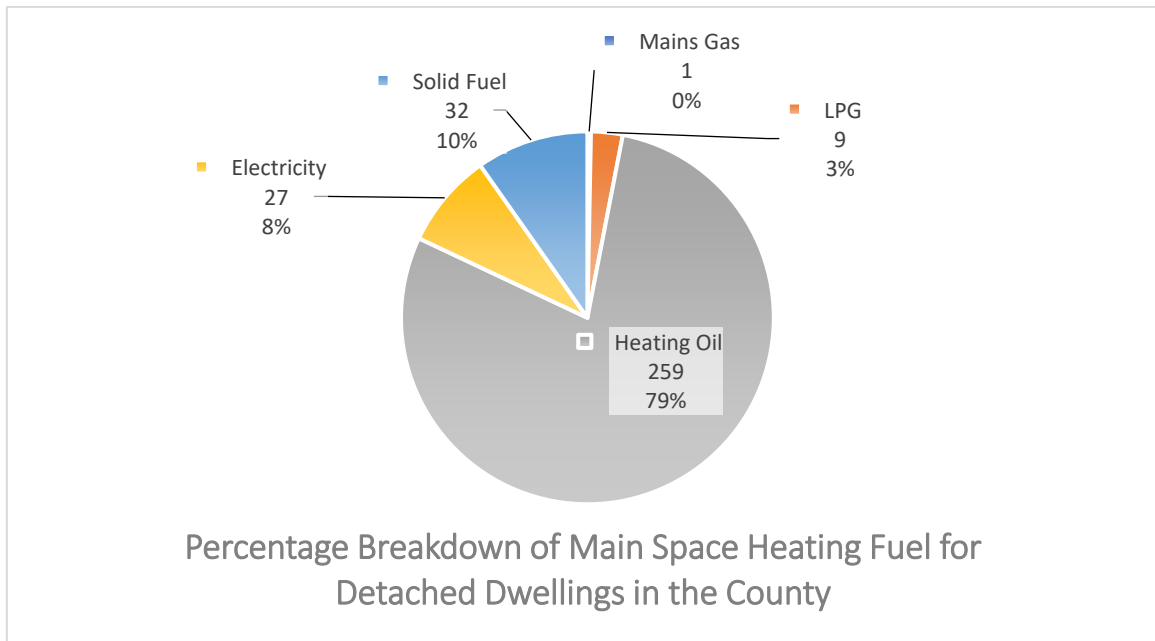


Figure 3-7: Percentage Breakdown of Main Space Heating Fuels for Detached Dwellings in the County (328 in total)

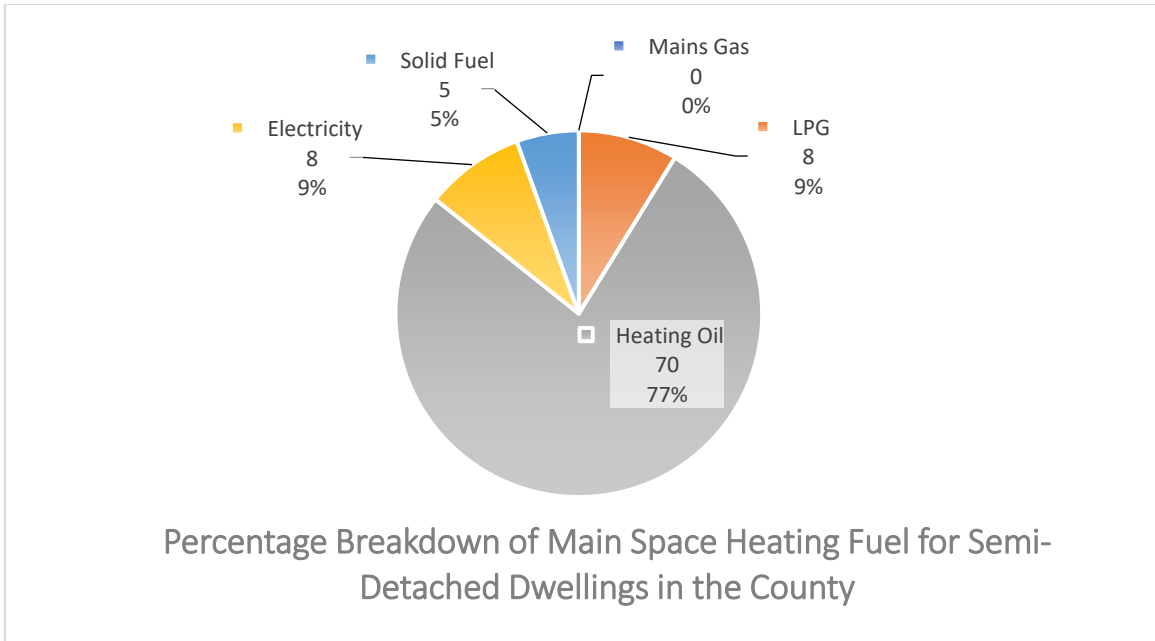


Figure 3-8: Percentage Breakdown of Main Space Heating Fuels for Semi-detached Dwellings in the County (91 in total)

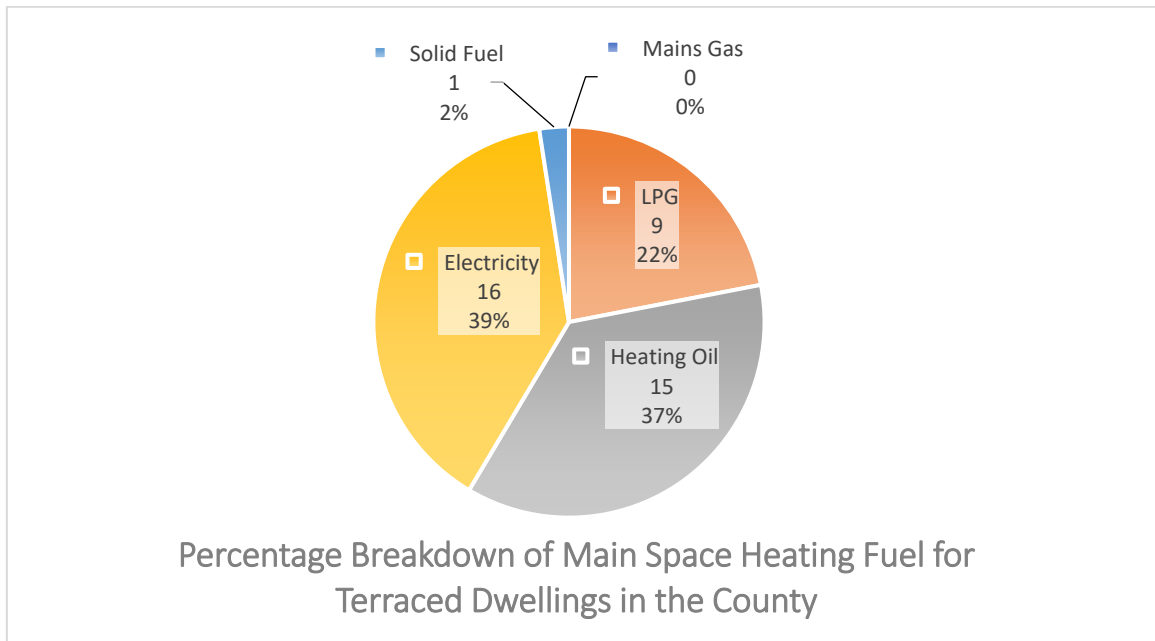


Figure 3-9: Percentage Breakdown of Main Space Heating Fuels for Terraced Dwellings in the County (41 in total)

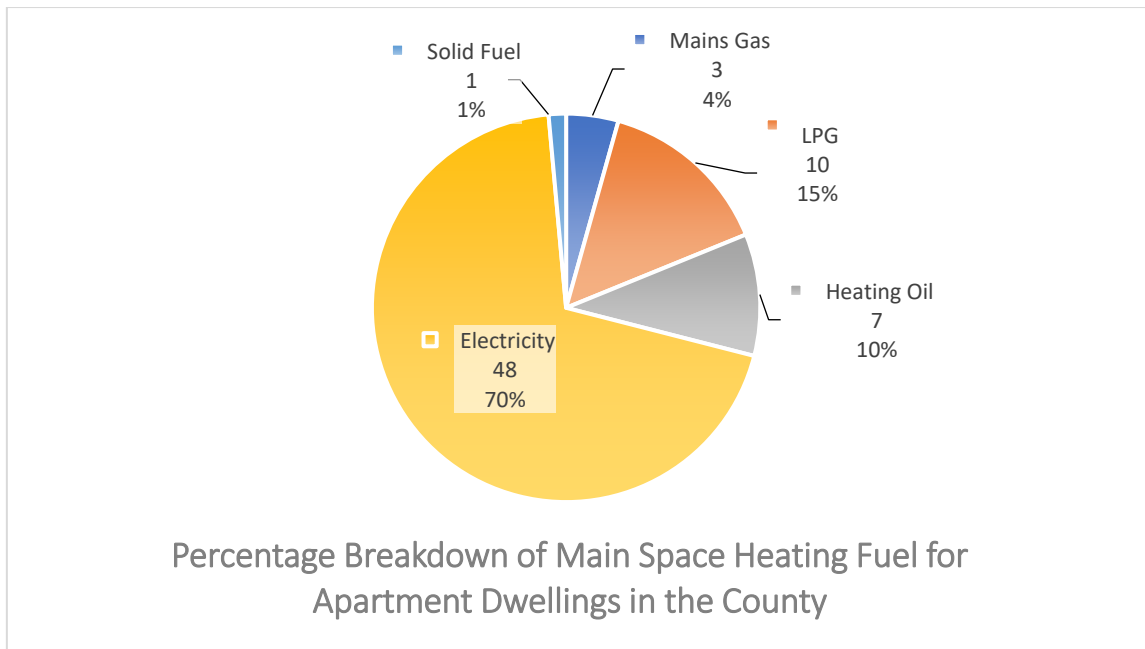


Figure 3-10: Percentage Breakdown of Main Space Heating Fuels for Apartments in the County (69 in total)

The following is observed from the above:

- Heating oil is the primary source of main space heating fuel in the county and is particularly prominent in detached and semi-detached dwellings. The combustion of heating oil generates a higher level of emissions per unit of energy compared to the combustion of many other heating fuels such as gas or LPG. The predominant use of heating oil in detached dwellings is the primary reason for relatively higher emissions from this dwelling type.
- A greater level of LPG and electricity is used to heat terraced housing and apartments in the county.
- Electricity is the primary source of main space heating fuel in the county for apartments, followed by LPG. Heating oil is used less in apartments.
- Very low levels of solid fuels are used for main space heating in the county.

3.1.3 Assumptions and Limitations

The following assumptions and limitations exist in relation to the Residential sector data:

- 'Apartments' include the sum of apartments in purpose-built block, flats in converted house and bed sits.
- BER dwelling types are broken down differently to CSO data. For this macro-level emission inventory development exercise, the following was assumed:
 - A 'Detached' house under the census is the same as a 'Detached' house in the BER database.
 - A 'Semi-detached' house under the census is the same as a 'Semi-detached' house in the BER database.
 - A 'Terraced' house under the census is the same as an 'End-of-terrace' house and 'Mid-terrace' house in the BER database.
 - An 'Apartment' under the census is the same as an 'Apartment,' a 'Ground-floor apartment,' a 'Mid-floor apartment,' and a 'Top-floor Apartment' in the BER database.



- The dwelling types 'House' and 'Maisonette' in the BER database are to be disregarded, as they are not directly comparable to any dwelling type under the census.
- The use of BER data is limited in that it only provides data for dwellings that have had BERs carried out on them, which only represents a proportion of the general housing stock. BER data does however provide a good representation of the housing stock generally given the level of BERs carried out on housing in the county.
- The CSO database for heating fuel type only considers dwellings in the county that have had BER Ratings completed from them. BER data does however provide a good representation of the housing stock generally given the level of BERs carried out on housing in the county.
- There is a marginal degree of overlap or double counting between the BER data and metered electricity consumption data used to inform sectoral emission data. This is because the National BER Research Tool dataset covers emissions from electric space heating and fixed lighting. There are low levels of electric space heating as a main heating fuel in the county, however, and fixed lighting generally accounts for a low proportion of household electricity usage overall. The metered consumption data is therefore reasonable representative of other electrical appliance use. The emission figures presented are therefore a slightly conservative estimate.

3.1.4 Data Sources

- Central Statistics Office, Household Census, 2016.
- SEAI, National BER Research Tool, 2022.
- Central Statistics Office, Metered Electricity Consumption, 2018.
- Central Statistics Office, Main Space Heating Fuel Per County, 2018.

3.2 Commercial and Industrial

3.2.1 Methodology

The following methodology was used to determine emissions from the Commercial and Industrial sector.

- Raw data on commercial and industrial property was downloaded from the Valuation Office's REST Web Services API website for the county. This provides information on commercial and industrial property category and area (m²) in the county.
- The total area (m²) associated with each commercial and industrial property category was calculated.
- Chartered Institute of Building Services Engineer's (CIBSE) TM46 guidance document emission benchmarks (in kgCO₂/m²) for building types were used to estimate CO₂-eq emissions associated with commercial and industrial property categories in the county.
- The total emissions for each of the commercial and industrial properties categories were calculated in tCO₂-eq/year.



3.2.2 Results

In total, there were 2,418 commercial and industrial properties in the county, divided into 10 categories, as per Table 3-4.

The category with the highest area coverage is 'Minerals,' followed by 'Industrial Uses,' 412,463 m² and 230,124 m², respectively. The category with the highest number of individual properties is 'Retail (Shops),' 1,288, which represents 53.3% of the total properties in the county, followed by 'Industrial Uses' 2,196, which represents 24.6% of the total, as per Table 3-4 and Figure 3-11.

Table 3-4: Total Area and Number of Properties per Category in the County

Category	Area (m ²)	Properties per Category
Minerals	412,463	23
Industrial Uses	230,124	596
Retail (Shops)	58,999	1,288
Office	36,727	259
Leisure	18,436	52
Retail (Warehouse)	10,973	20
Health	3,268	5
Miscellaneous	3,396	28
Utility	12	12
Hospitality	39	135
Total	774,436	2,418

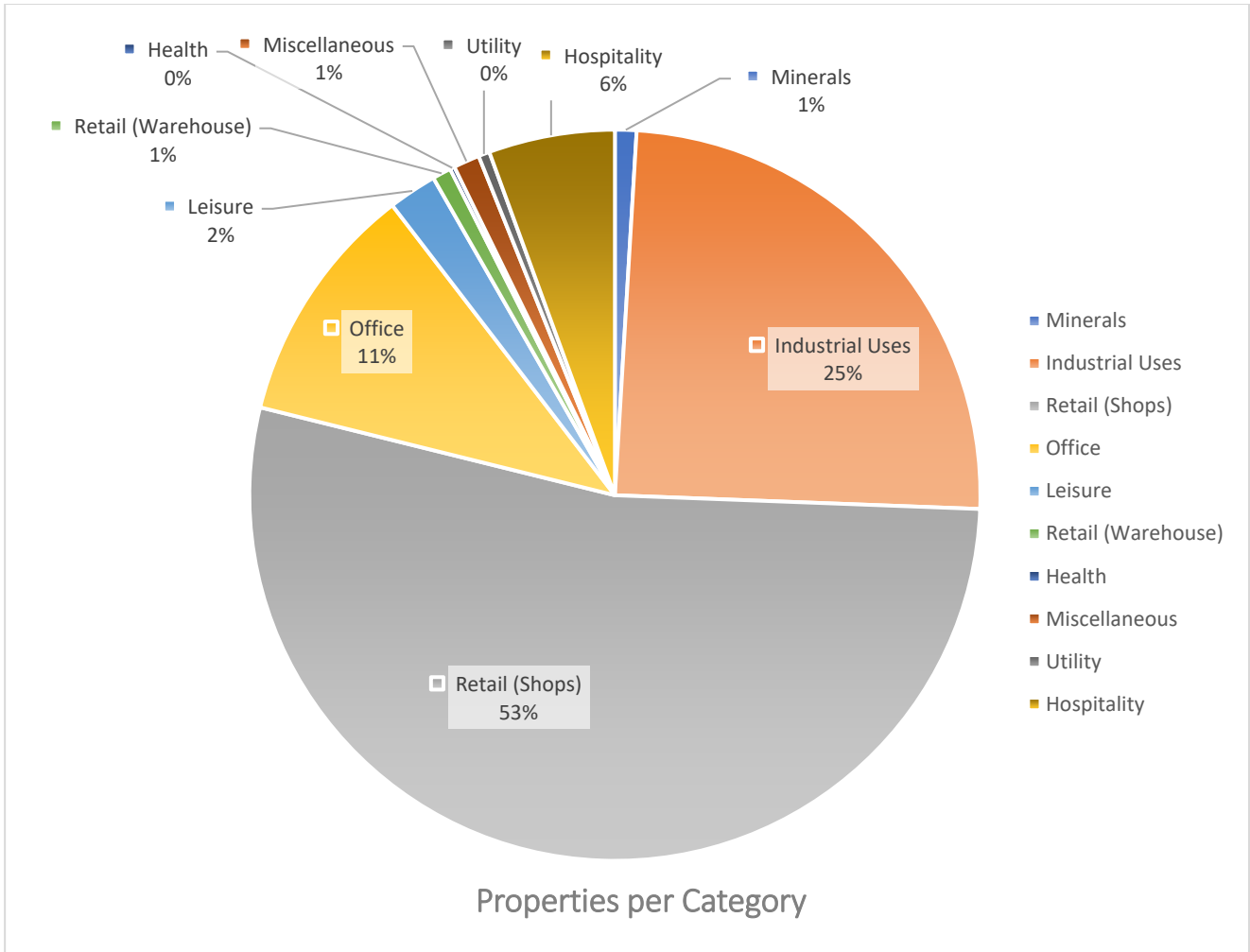


Figure 3-11: Percentage of Properties per Category

Information on CO₂-eq emissions for each category in the baseline year is presented in Table 3-5 and Figure 3-12, Figure 3-13 and Figure 3-14.

The emission values for each category in Table 3-5 were calculated using commercial property area data available from the Valuation Office. The emission benchmarks (in kgCO₂/m²) from Chartered Institute of Building Services Engineer's (CIBSE) TM46 guidance document for each category were then pro-rated against the total area of each category within the county to give an estimation of GHG emissions associated with each category. These estimations are provided in Table 3-5:

Table 3-5: Total Emissions by Category

Category	Total Emissions (tCO ₂ -eq)
Minerals	21,984
Industrial Uses	14,302
Retail (Shops)	7,048
Office	2,856
Leisure	1,719



Category	Total Emissions (tCO ₂ -eq)
Retail (Warehouse)	772
Health	294
Miscellaneous	269
Utility	1
Hospitality	0
Total	
	49,246

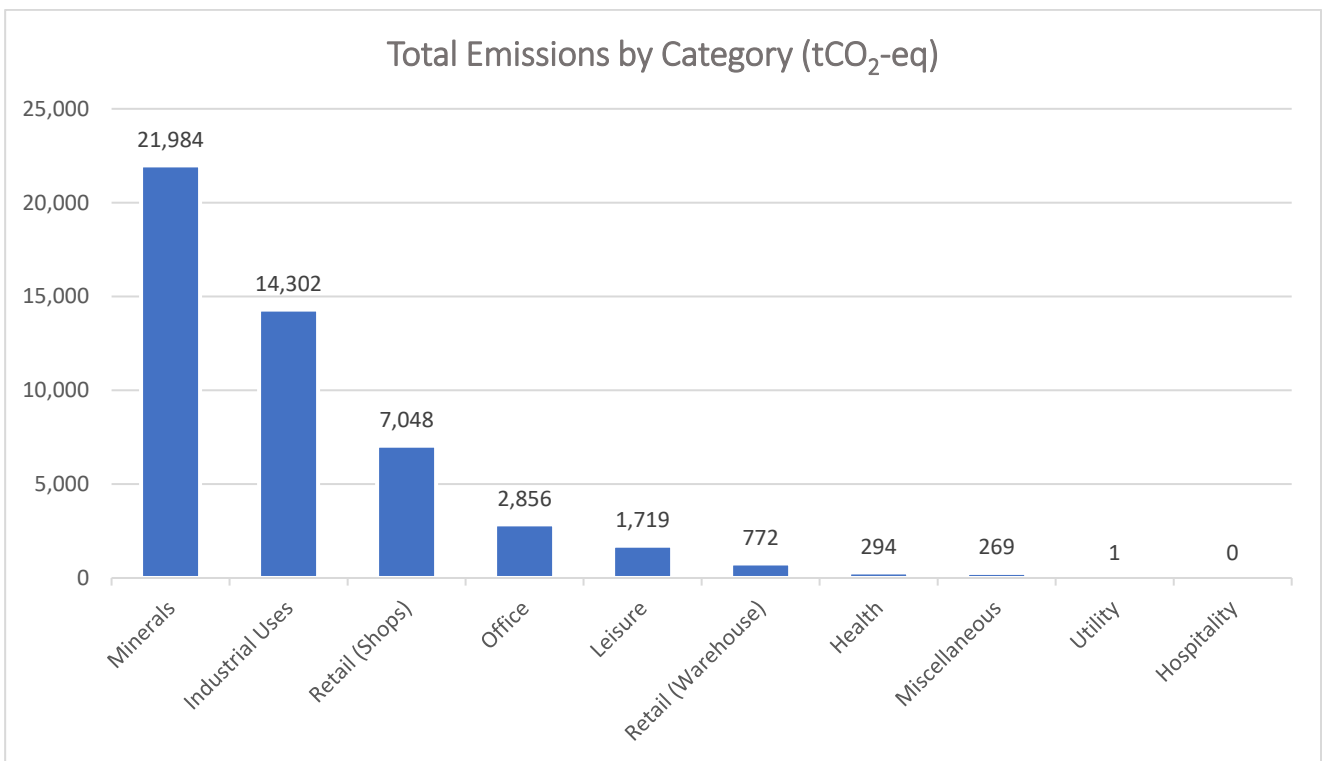


Figure 3-12: Total Emissions by Category (tCO₂-eq)

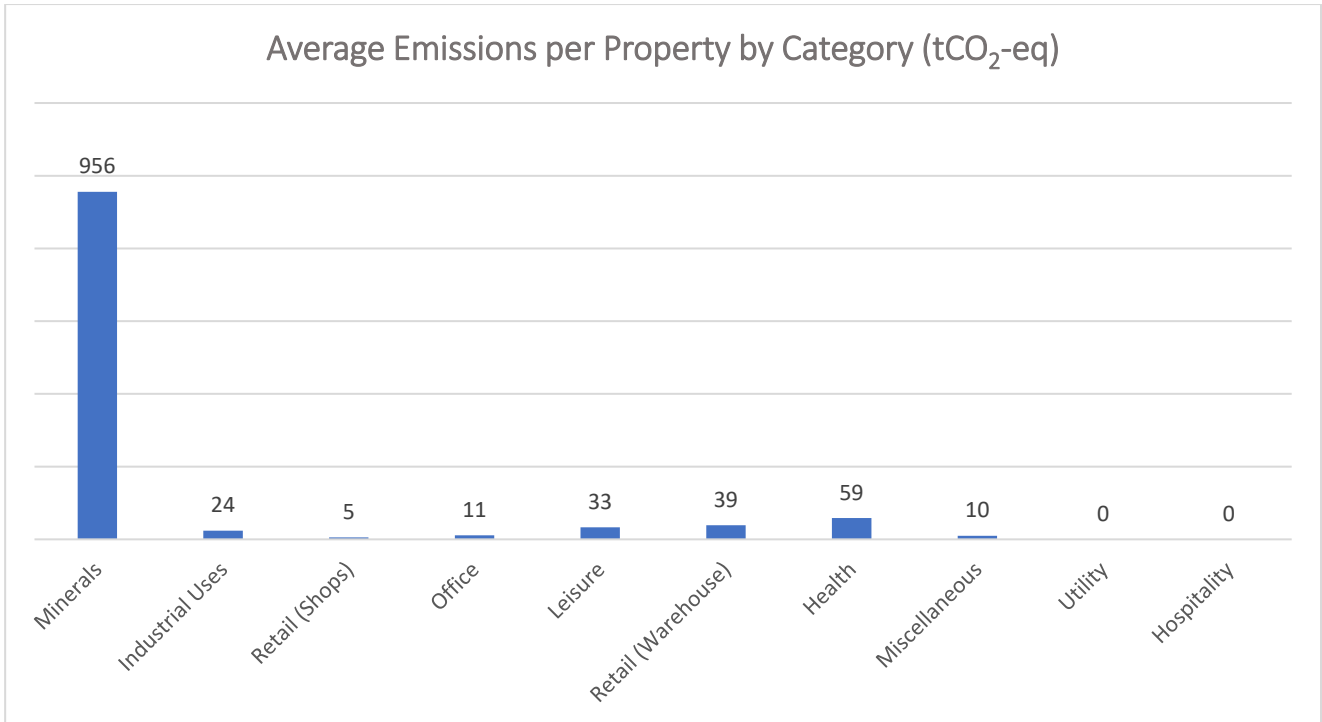


Figure 3-13: Average Emissions per Property by Category (tCO₂-eq)

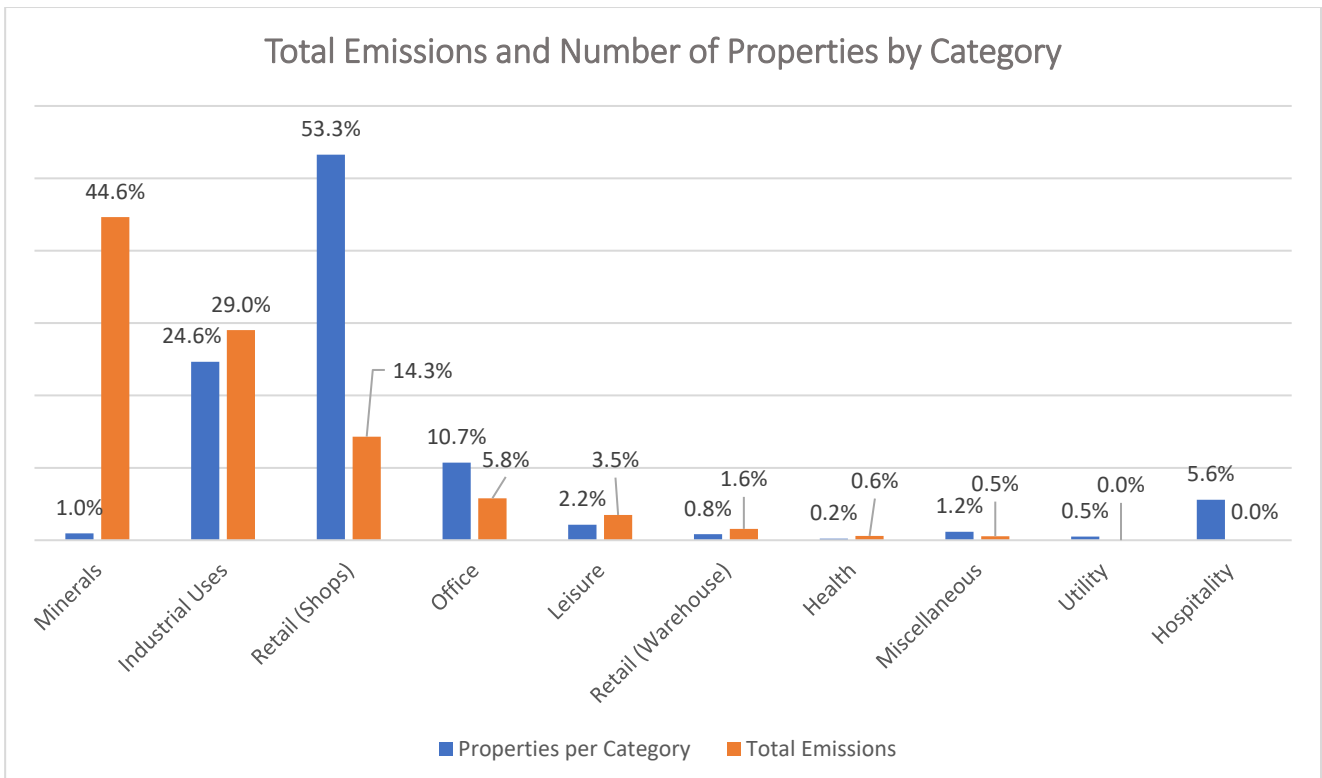


Figure 3-14: Total Emissions and Number of Properties by Category

'Minerals' is the category that generated most CO₂ with 21,984 tCO₂-eq, followed by the 'Industrial Uses' category which generated 14,302 tCO₂-eq. Combined, both these categories represent almost 75% of the Commercial and Industrial emissions in the county, 49,246 tCO₂-eq.



Within the 'Minerals' category, 'Quarry' is the sole 'Use' which generated 21,984 tCO₂-eq (45% of GHG emission in the county). The vast majority of emissions from this sector are likely to originate from a small number of sizeable quarries in the county that are also involved in aggregate and concrete production.

Within the 'Industrial Uses' category and the use 'Factory' generated the highest level of CO₂-eq emissions, 2,462 tCO₂-eq (5%).

When the average emissions are calculated for the number of properties in each category the results show that 'Minerals' properties represent only 1% of the total properties in the county and emit almost 50% of the total CO₂-eq in the county for the sector, 956 tCO₂-eq per property. The second highest in terms of emissions are 'Industrial Uses' which represent 24.6% of the total properties in the county and emit 29% of emissions, 24 tCO₂ per property.

'Retail (Shops)' is the category with the highest percentage of properties (53.3%); however, emissions from this category are 30% less than emission from the 'Industrial Use' category, as an example.

The level of commercial and industrial emissions is relatively low in comparison to other counties in the region.

3.2.3 Assumptions and Limitations

The following assumptions and limitations exist in relation to the Commercial and Industrial sector data:

- The property categories defined in the REST Web Services API differ from the categories defined in the CIBSE TM46 guidance document to an extent. Several assumptions were made to allow for alignment between property/building types therefore (e.g., a 'bakery' was assumed to be a 'small foot outlet,' a 'factory' was assumed to be a 'workshop' etc.).
- The methodology employs emission benchmarks from CIBSE's TM46 guidance document. This document was produced in 2008. The benchmarks do not therefore consider improvements in the energy efficiency of buildings or renewable energy supply provisions since this time to date. This is likely to result in a noteworthy overestimation of emissions from this sector.

3.2.4 Data Sources

- REST Web Services API. Irish Valuation Office. <<https://www.valoff.ie/en/open-data/api/>>. Accessed on the 10th of November 2022.
- Field, J. (2008) Energy Benchmarks: TM46: 2008. London: CIBSE.



3.3 Agriculture

3.3.1 Methodology

County level agricultural data was obtained from the CSO Census of Agriculture.

Once all data was obtained, a breakdown of agricultural sector related emissions was developed. These emissions were broken into four categories, as follows:

- Livestock
- Cereals
- Other Crop, Fruit and Horticulture.
- Managed Soils (sum of direct and indirect N²O emissions, limestone emissions and urea application emissions).

Livestock emissions at county level was determined with reference to national emissions statistics, the national herd, and the herd in the county. This is the most representative and accurate method for determining emissions for livestock.

Guidance on crop farming levels and pig farming in county Leitrim was provided by Teagasc, due to an absence of county level data for Leitrim under the most recent Census of Agriculture.

Managed soils emissions are estimated with reference to national emission statistics for these direct and indirect N²O emissions (e.g., from fertilizer application, urine and dung deposited by grazing, atmospheric deposition), limestone emissions and urea application emissions (during fertilization), the area of managed soils nationally and the area of managed soils in the county.

3.3.2 Results

A breakdown agriculture land use and livestock numbers in the county is presented in Table 3-6 and Table 3-7.

As per Teagasc advice, no crops are grown at scale in county Leitrim due to the presence of unsuitable soil in the county.

Table 3-6: Breakdown of Agricultural Land Use in the County

Breakdown of Agricultural Land Use in the County	
Land Use Type	Hectares
Cereals (including wheat, barley and oats)	0
Other crops, fruit, and horticulture:	0
*Oilseed Rape	0
*Beans and Peas	0
*Maize	0



Breakdown of Agricultural Land Use in the County	
Land Use Type	Hectares
*Potato	0
*Turnip	0
*Beet	0
*Vegetables	0
*Fruit	0

Table 3-7: Breakdown of Livestock Numbers in the County

Breakdown of Livestock Numbers in the County	
Livestock Type	Livestock Numbers
Dairy Cows	1,844
Other Cattle and Cows	63,467
Sheep	154,326
Pigs	4,000
Poultry	3,300

Sheep farming is the main type of livestock farming in the county. Suckler cattle farming is also carried out at a significant scale in the county. Low levels of dairy cattle, pig and poultry farming take place in the county.

A breakdown of agricultural related emissions in the baseline year is presented in Table 3-8:

Table 3-8: Breakdown of Livestock Emissions

Type	CO ₂ -eq Emissions (tCO ₂ -eq)
Livestock	
Cattle	117,858.23
Sheep	22,292.56
Pigs	835.11
Poultry	31.28
Cereals	
Cereals (including wheat, barley, and oats)	0
Other Crops, Fruit and Horticulture	
Other crops, fruit, and horticulture:	0
Oilseed Rape	0
Beans and Peas	0



Type	CO ₂ -eq Emissions (tCO ₂ -eq)
Maize	0
Potato	0
Turnip	0
Beet	0
Fruit	0
Managed Soils	
Managed Soils	125,204.34
Totals	
Total Livestock	141,017.17
Total Cereals	0
Total Other Crops, Fruit and Horticulture	0
Total Managed Soils	125,204.34
Overall Total	266,221.51

Figure 3-15 provides a breakdown of livestock related GHG emissions.

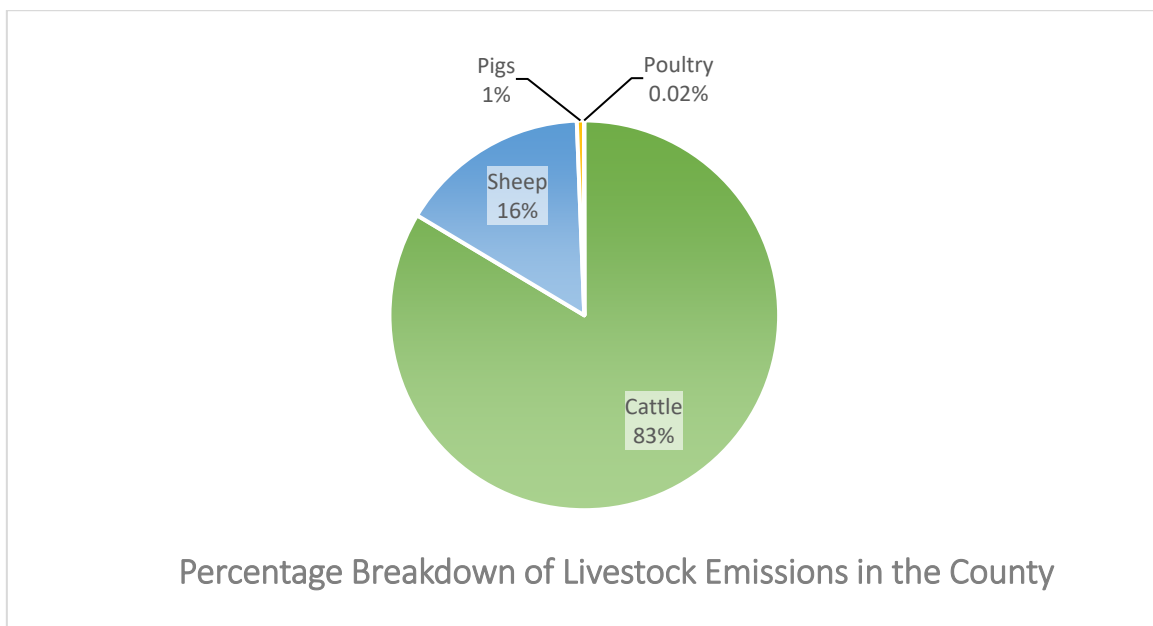


Figure 3-15: Percentage Breakdown of Livestock Emissions



Emissions from cattle (beef and dairy cows) combined contribute the most in terms of livestock related emissions by far, accounting for 83% of CO₂-eq emissions from agriculture in the county. Cattle produce much more methane emissions than other forms of livestock farming, and due to the higher global warming potential of methane, their impact in terms of GHG emissions is of a greater magnitude. Emissions associated with sheep farming in the county are relatively low yet still significant due to the substantial level of sheep farming in the county relatively. GHG emissions from pig and poultry farming are very low relatively.

There is no scalable crop farming present in the county, therefore no GHG emissions have been attributed to this activity.

GHG emissions from managed soils amount to 130,154.22 tCO₂-eq.

Figure 3-16 provides a breakdown of agricultural emissions for each relevant sub-sector in county Leitrim for comparison and clarity.

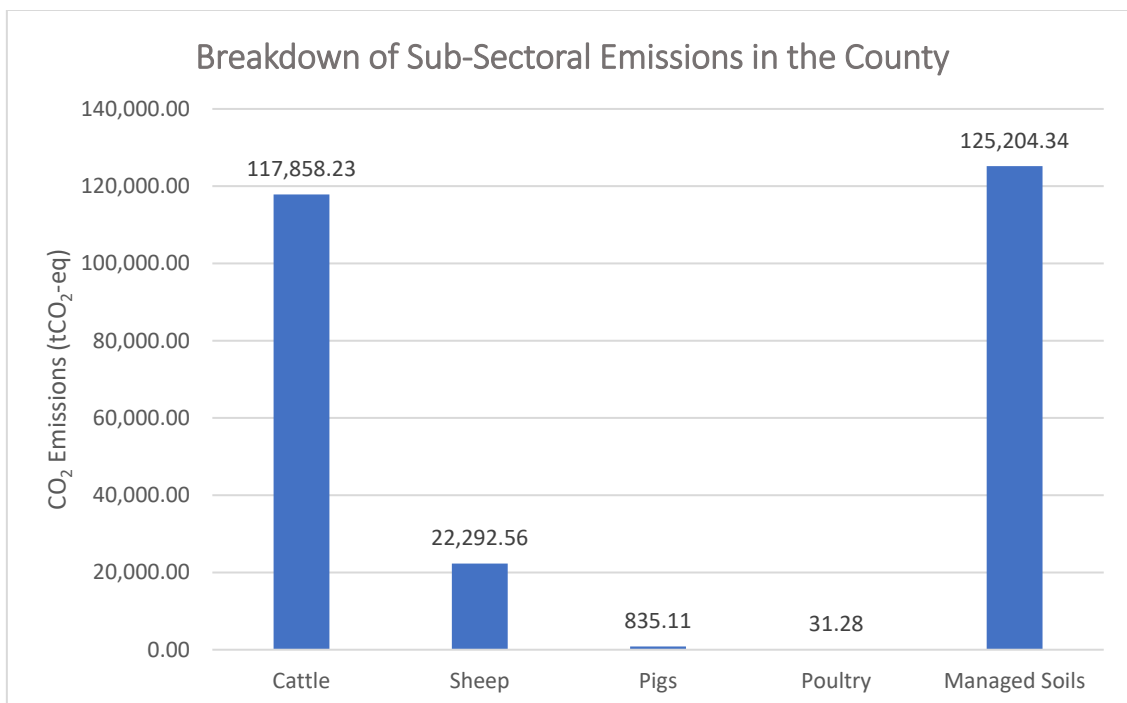


Figure 3-16: Breakdown of Agricultural Emissions for Each Sub-Sector in the County

Agricultural emissions for the county broken down by the four overarching categories, total livestock, total cereals, total other crops, fruit and horticulture and manages soils combined are presented in Figure 3-17.

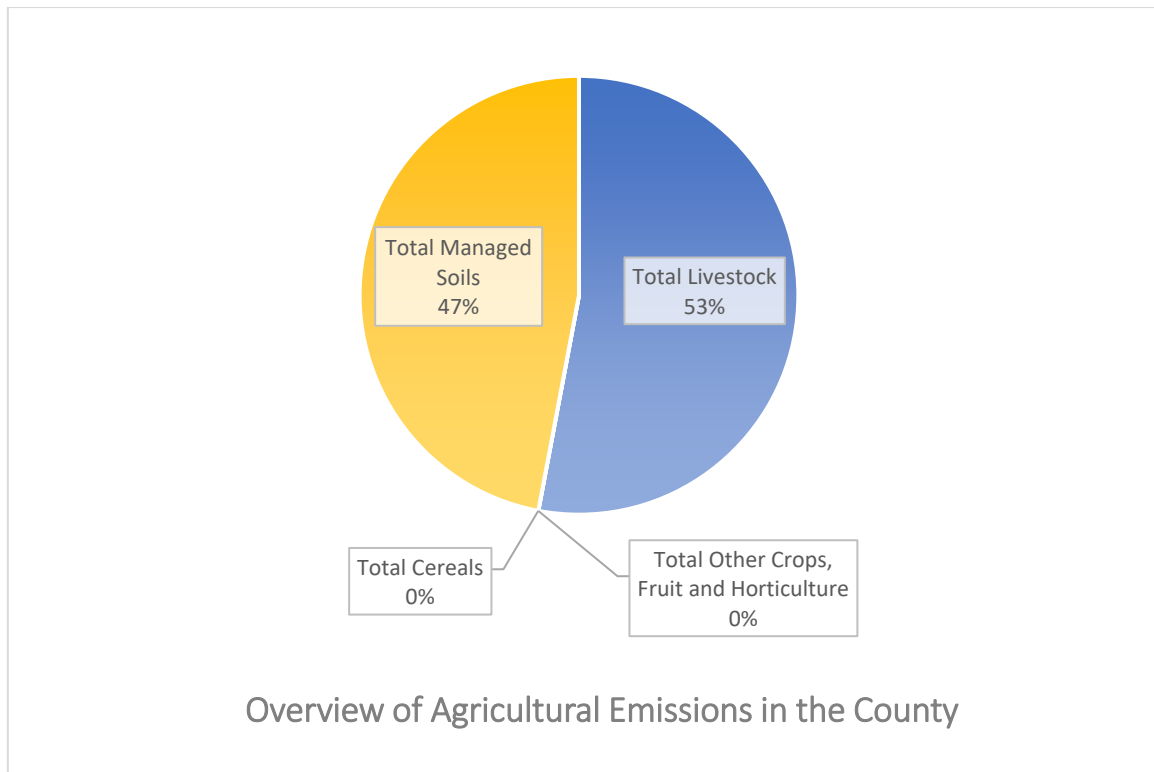


Figure 3-17: Agricultural Emission for the County Overall

As can be seen, livestock emissions account for 53% of agricultural GHG emissions in the county (with cattle farming accounting for the majority of livestock emissions.) Emissions from managed soils account for 47% of agricultural GHG emissions in the county.

3.3.3 Assumptions and Limitations

The following assumptions and limitations exist in relation to the Agricultural sector data:

- It is assumed that all managed agricultural soils in the county release the same level of emissions. In reality, emissions levels will vary depending on the type and level of fertilizer, lime or urea application on those soils based on their specific use (i.e., pasture, wheat, barley, potatoes).

3.3.4 Data Sources

- Central Statistics Office, Census of Agriculture, 2020.
- Environmental Protection Agency, EPA National Emission Inventory 2021.
- Central Statistics Office, Area Farmed in June, 2018.
- Central Statistics Office, Census, Population Statistics, 2016.
- Teagasc, National Farm Survey Sustainability Report, 2018.



3.4 Transport

3.4.1 Methodology

The following methodology was applied to determine transport related emissions in the county:

- The CSO's Transport Omnibus from 2018 was reviewed to ascertain mileage associated with vehicle types in the county in 2018. This was broken down into 'diesel,' 'petrol' and 'other fuel' related mileage.
- UK Department of Environment, Rural Affairs and Food (DEFRA) vehicle emission benchmarks were used to estimate emissions associated with each vehicle type.
- Public transport related emissions data for the nation was sourced from the CIÉ Group. The only public transport bodies in operation in rural counties are Bus Éireann and Iarnród Éireann. The CIÉ Group do not have emissions data broken down by region or by county. Railway related emissions were therefore estimated using railway station numbers nationally and, in the county, assuming that the number of railway stations in a county corresponds to the level of railway services provided in that county. Bus related emissions were estimated using population statistics, assuming that the level of bus service in a county corresponds with population density.

3.4.2 Results

3.4.2.1 Private and Commercial Vehicles

Detail on kilometres travelled in the county broken down by vehicle and fuel type is presented in Table 3-9 and illustrated in Figure 3-18.

Table 3-9: Kilometres Travelled in the County broken down by Vehicle and Fuel Type

Type of Vehicle	Kilometres Travelled			
	Diesel	Petrol	Other Fuels	Total
Private cars	211,000,000	72,000,000	2,000,000	285,000,000
Motorcycles	0	0	0	0
Goods Vehicles	70,000,000	0	0	70,000,000
Tractors and machinery	18,000,000	0	0	18,000,000
Small PSVs	3,000,000	0	0	3,000,000
Large PSVs	2,000,000	0	0	2,000,000
Exempt vehicles	3,000,000	1,000,000	0	4,000,000
Other vehicles	3,000,000	1,000,000	0	4,000,000

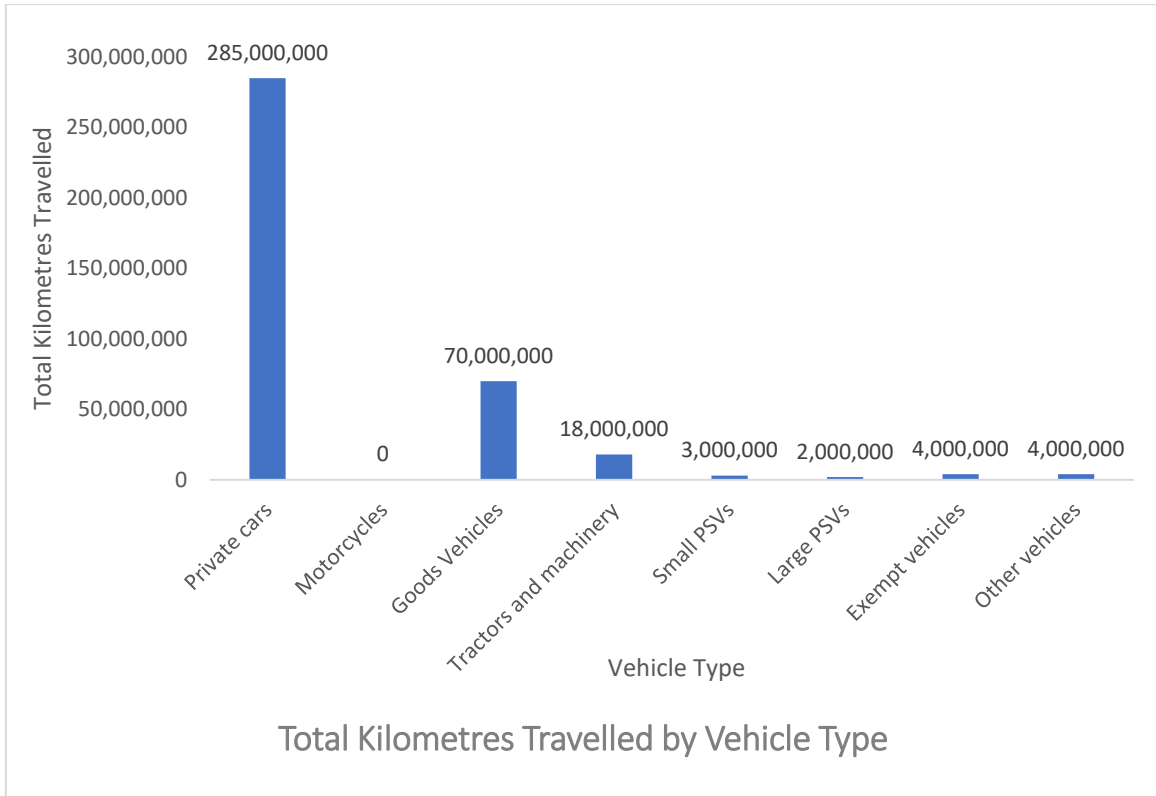


Figure 3-18: Kilometres Travelled in the County broken down by Vehicle and Fuel Type

Private cars account for most of the mileage travelled in the county, followed by goods vehicles and tractors and machinery. This reflects the rural nature of the county, the lack of public transportation and the size of the haulage industry in the county.

A breakdown of vehicle transport emissions for the county by vehicle type is illustrated in Figure 3-19.

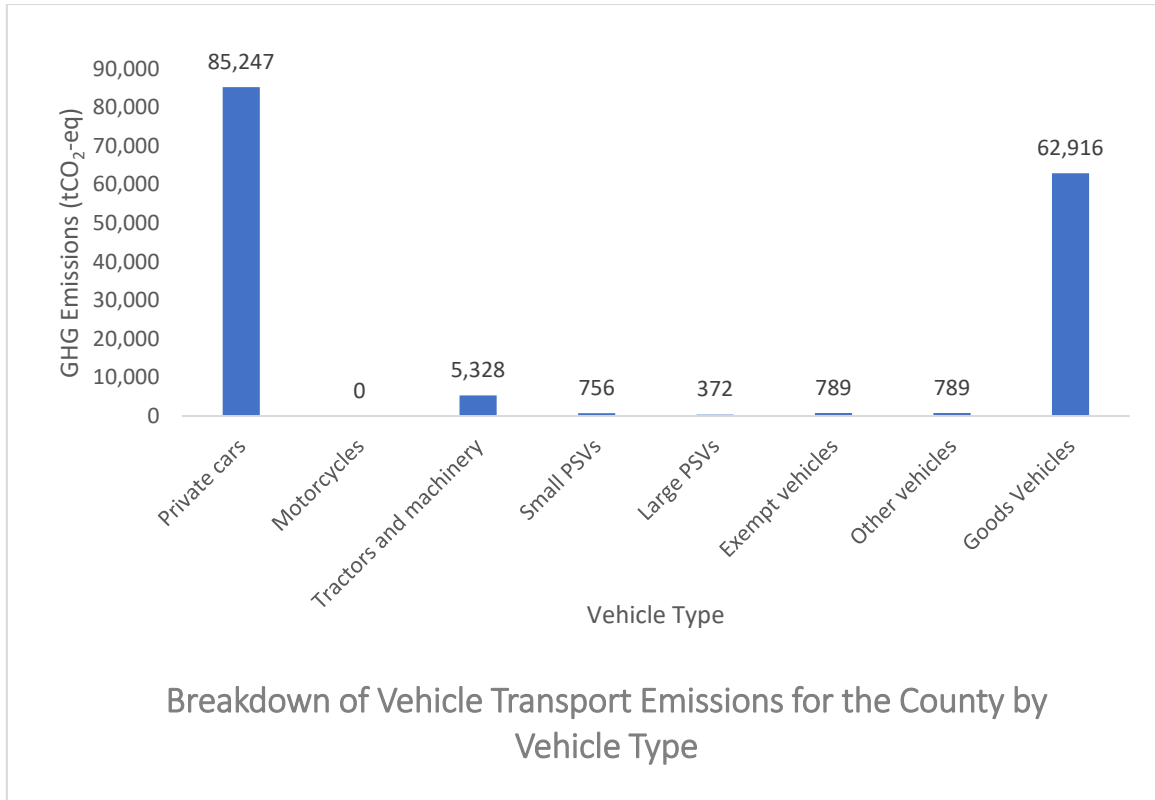


Figure 3-19: Breakdown of Vehicle Transport Emissions for the County by Vehicle Type

Private cars contribute most in terms of emissions, followed by goods vehicles then tractors and machinery. This reflects the relatively high level of carbon emissions associated with weight laden goods vehicles, the relatively high numbers of private cars in the county, and the rural nature of the county.

Total GHG emissions associated with all vehicle types for the baseline year were estimated to be 156,197 tCO₂-eq.

A breakdown of vehicle related emissions by fuel type is illustrated in Figure 3-20.

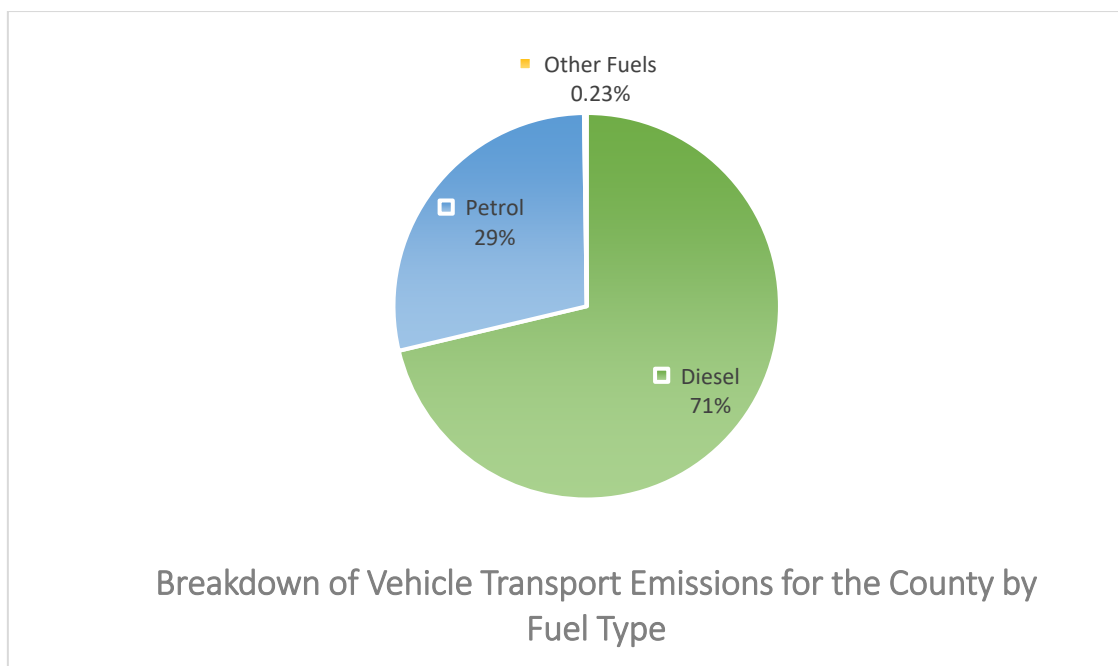


Figure 3-20: Breakdown of Vehicle Related Emissions by Fuel Type

Diesel is the most common vehicle fuel used in the county, followed by petrol, then other fuels (e.g., biofuel, electricity).

3.4.2.2 Public Transport

There is a relatively small bus transport sector in the county. This is due to the county being rural in nature and having a sparse, dispersed population compared to counties that have a great population density and more urban settlement.

Public 'intercity' and local bus services generated an estimated 504.56 tCO₂-eq in the baseline year. This represents a minor quantity of emissions relative to private and commercial transport in the county.

The county is served by the Dublin to Sligo Railway line. There are two railway stations on this line situated in the county, Dromod and Carrick on Shannon railway stations. In a county context, this public transport service is significant and accounts for 3,208.89 tCO₂-eq in the baseline year.

3.4.3 Assumptions and Limitations

The following assumptions and limitations exist in relation to the Transport sector data:

- There is currently a lack of county level data on public transport emissions. This data / data from which this can be estimated (e.g., rail length per county) is currently being sought from the relevant bodies. Railway related emissions are estimated using railway station number nationally and in the county. It is assumed that the number of railway stations in the county corresponds to the level of railway services provided in that county. Bus related emissions are estimated using population statistics. It is assumed that the level of bus service in the county corresponds with population density.



3.4.4 Data Sources

- Transport Omnibus 2018, Central Statistics Office, 2018.
- 2011 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting: Methodology Paper for Emission Factors, DEFRA, August 2011.
- CIÉ Group Annual Report Year Ended 31 December 2021, CIE, 2022.
- Census of Population 2016, Central Statistics Office.



3.5 Waste and Wastewater

3.5.1 Methodology

3.5.1.1 Waste

Qualitative analysis of the waste sector in the county was carried out to determine the level of GHG emissions associated with the sector. The following waste categories defined in the EPA's National Emission Inventory 2021 were examined.

- Managed Waste Disposal,
- Composting,
- Anaerobic Digestion (AD),
- Incineration, and
- Open Burning of Waste.

Using the EPA's licencing and permitting database, all waste facilities in the county that fall under the above categories were identified.

Table 3-10 lists the three managed waste disposal sites identified in the County. Two EPA licenced closed landfill exists in the County, namely Carrick on Shannon Landfill and Mohill Landfill. Although these landfills are no longer operational, they still emit carbon dioxide and methane due to the decomposition of organic matter that occurs within the waste bodies of the landfills.

Table 3-10: Managed Waste Disposal Facilities in the County

EPA Authorisation Reference	Name of Facility
W0064-01	Carrick On Shannon Landfill
W0065-01	Mohill Landfill

Emissions associated with managed waste disposal were calculated using the EPA's Pollution Release and Transfer (PRTR) database, which contains information on emissions to air from landfills. Total Methane (CH₄) and CO₂ emissions for each landfill were determined. CH₄ emissions were converted to CO₂-eq using having regard to its GWP. Some landfill facilities did not have data on emissions to air registered on the PRTR database. In these cases, the study resorted to reviewing a combination of emission monitoring reports, Annual Environmental Reports (AERs) and Tier 1, Tier 2 and Tier 3 Environmental Risk Assessments (ERAs) for the landfills (preferably from 2018) to determine emissions associated with these facilities. In some cases, historic AERs which would have typically contained mass emissions data were referenced.

The accumulated emissions data for managed waste disposal facilities in the county were combined to determine emissions in tCO₂-eq for the baseline year.

There are no composting, anaerobic digestion, or incineration facilities in the county. Thus, there are no emissions in the county from these categories of waste facility.



GHG emission from the open burning of waste were calculated on a pro-rata basis using national emissions data for this category and considering national and county population levels. There is no local data on GHG emissions from this unregularised and uncontrolled activity.

3.5.1.2 Wastewater

Using national emissions data for the wastewater sector defined in the EPA's National Emission Inventory 2021, emissions associated with this sector for the county were estimated for the county on a population pro-rata basis. This was determined to be the most accurate method of estimating domestic wastewater related emissions as there is no 'bottom up' emissions data for municipal wastewater facilities that have an operating capacity less than 100,000 Population Equivalent (PE) (which is the case for all municipal wastewater treatment facilities in the county), on-site wastewater treatment systems, or septic tanks.

3.5.2 Results

3.5.2.1 Waste

A breakdown of the total known emissions from managed waste disposal facilities in the county for the baseline year is presented in Table 3-11 and illustrated in Figure 3-21 and Figure 3-22.

Table 3-11: Emissions from Managed Waste Disposal Facilities in the County

Authorisation Reference	Name of Facility	Emissions kgCH ₄	Emissions kgCO ₂ -eq	Total tCO ₂ -eq
W0064-01	Carrick on Shannon Landfill	221,800	608,400	6,153
W0065-01	Mohill Landfill	108,200	296,900	3,002

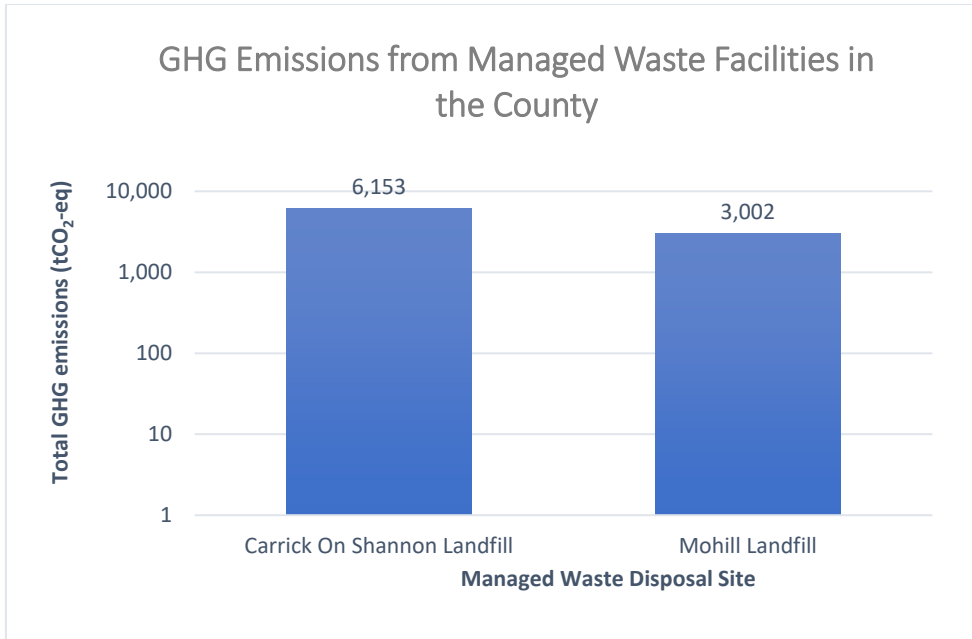


Figure 3-21: Managed Waste Disposal Emissions

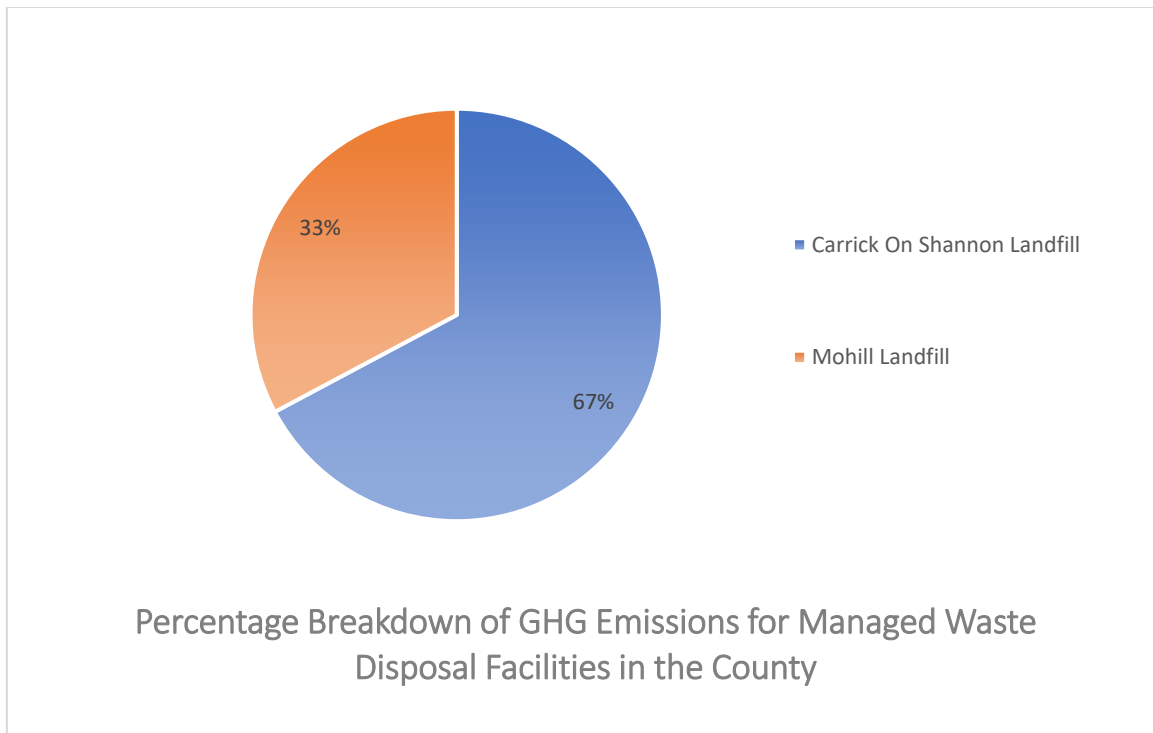


Figure 3-22: Landfill tCO₂-eq Equivalent Breakdown

As can be seen, most emissions are being generated by Carrick on Shannon landfill followed by Mohill landfill. Overall size and spatial extents of the waste landfilled at these sites is the primary factor determining CO₂ emissions.

An estimate for GHG emissions from the open burning of waste in the county for the baseline year is illustrated in Figure 3-23. An estimated 26.75 tonnes of tCO₂-eq emissions are released by open waste burning activities in the County, 0.7% of the national emissions for this category.

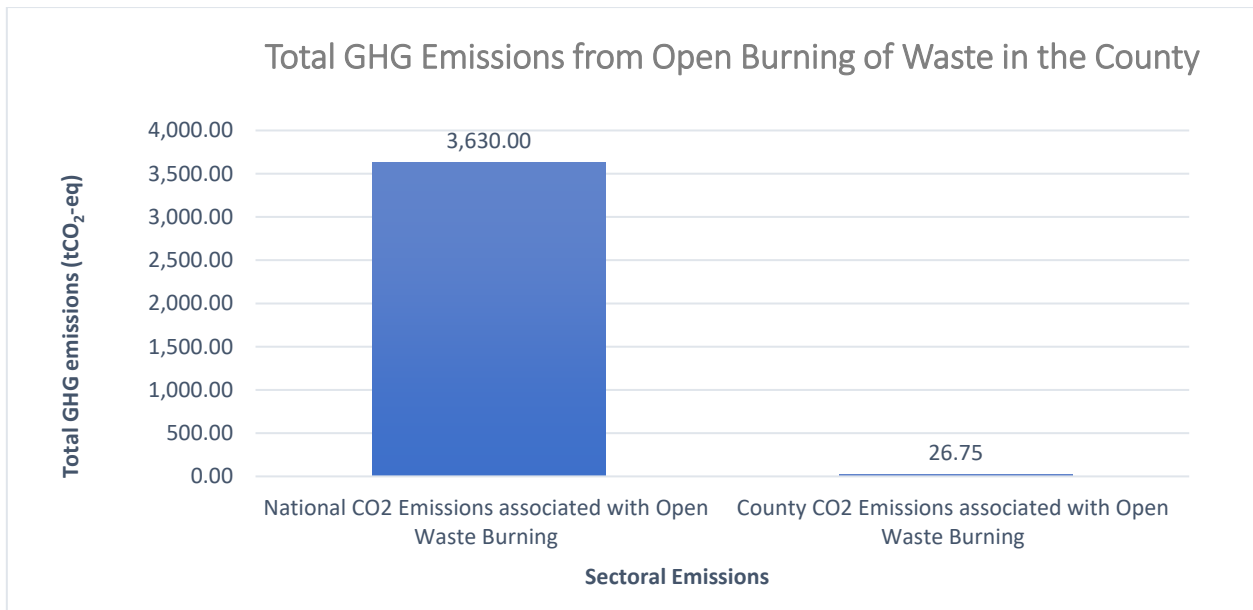


Figure 3-23: CO₂ Emissions from the Open Burning of Waste

3.5.2.2 Wastewater

Estimates for GHG emissions from the wastewater sector in the county for the baseline year are presented in Table 3-12:

Table 3-12: Wastewater Emissions

Sector Category	National CO ₂ Emissions (tCO ₂ -eq)	Population Ireland 2018	Population in the County	Total GHG Emissions (tCO ₂ -eq)
Domestic Wastewater	147,900.00	4,761,865.00	35,087	1,090

A comparison between wastewater sector emission in the county and in the nation overall is illustrated in Figure 3-24.

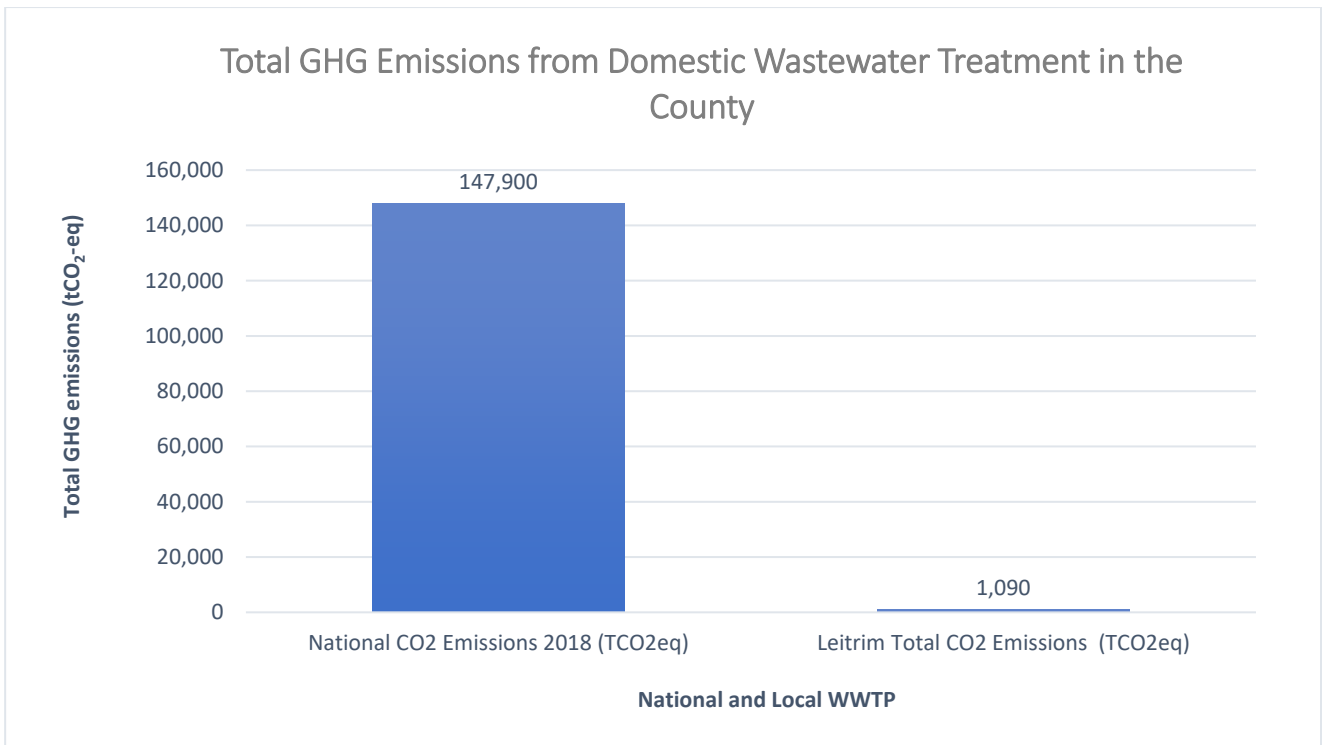


Figure 3-24: County and National Wastewater Emissions

3.5.2.3 Summary

A summary of the key findings for the waste and wastewater sectors is presented below:

- Total emissions from the waste sector in the county were estimated to be 9,181.75 tCO₂-eq (inclusive of managed waste disposal and the open burning of waste)
- The majority of waste sector emissions in the county are generated by Carrick on Shannon landfill.
- Methane made up 90% of the CO₂-eq emissions from landfills overall.
- Carbon dioxide made up 10% of the CO₂-eq emissions from landfills.
- Total emissions from the wastewater sector in the County were estimated to be 1,090 tCO₂-eq, which represents a small fraction of domestic wastewater emissions nationally.
- Total GHG emissions from the waste and wastewater sector combined were estimated to be 10,272 tCO₂-eq (including emissions from managed waste disposal, the open burning of waste and domestic wastewater treatment). These figures are broken down by sub-sector and illustrated in Figure 3-25.

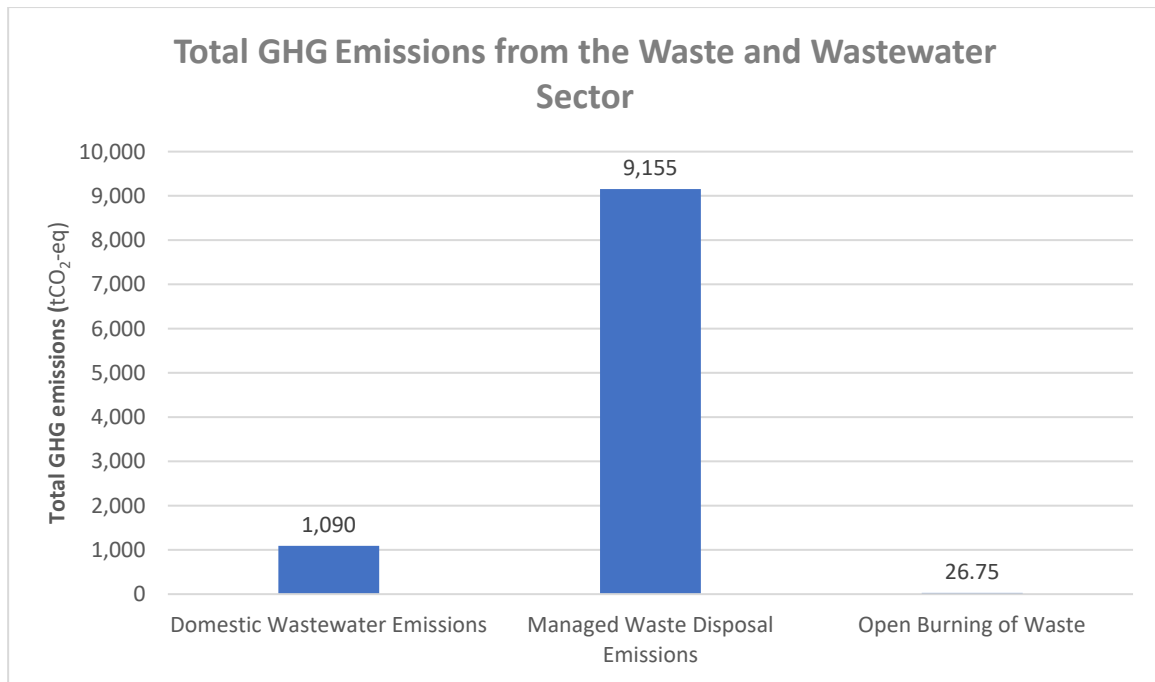


Figure 3-25: GHG Emissions from the Waste and Wastewater Sector

3.5.3 Assumptions and Limitations

The following assumptions and limitations exist in relation to the Waste and Wastewater sector data:

- Managed waste disposal related to all regularized landfills.
- There is no 'bottom up' emissions data for municipal wastewater facilities that have an operating capacity less than 100,000 Population Equivalent (PE) (which is the case for all municipal wastewater treatment facilities in the county), on-site wastewater treatment systems, or septic tanks.

3.5.4 Data Sources

- Central Statistics Office, Census of Population, 2016
- National Emission Inventory, EPA, 2021.
- EPA IE licence, IPC licence, waste licence and WFP search databases and licence files for landfills contained within them - accessed 15/11/2022.



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

3.6.1 Methodology

The following methodology was used to determine emissions from the LULUCF sector.

- The EPA's National Emissions Inventory 2021 was reviewed to determine emissions associated with land use types defined under this category - Forestland, Cropland, Grassland, Wetland.
- The CORINE Land Cover Inventory for Ireland was reviewed to ascertain the area in km² of each land use type in the county and in the nation overall.
- National GHG emissions for each land use type were then pro-rated for the county based on land use type cover nationally versus land use type cover in the county. An estimation of emission release and CO₂ absorption levels for the county for each land use type can then be made.

3.6.2 Results

A breakdown of land use type cover in the county is presented in Table 3-13.

Table 3-13: Breakdown of Land Use Type Cover in the County

Land Use Type Cover for the County	
Land Use Type	km ²
Forestland	127.3
Cropland	686.24
Grassland	455.11
Wetland	310.82
Settlement	19.4

Cropland is the most dominant land use type cover spanning across 686.24 km² across the county. This is followed by Grassland covering 455.11 km², Wetland at 310.82 km², Forestland at 127.3 km² and Settlement at 19.4 km². There are relatively high levels of wetland in the county. This reflects the amount of surface water bodies present in the county and the low-lying nature of many parts of the county. There are relatively high levels of forestland in the county.

Information on tCO₂-eq emissions related to land use, land use change and forestry for the various land uses in the county for the baseline year is presented in Table 3-14 and Figure 3-26.



Table 3-14: Breakdown of LULUCF Emissions by Land Use Type for the County

LULUCF Emissions Broken Down by Land Use Type	
Land Use Type	tCO ₂ -eq
Forestland	-110,069
Cropland	-10,205
Grassland	74,077
Wetland	63,526
Settlement	1,703
Total	19,033

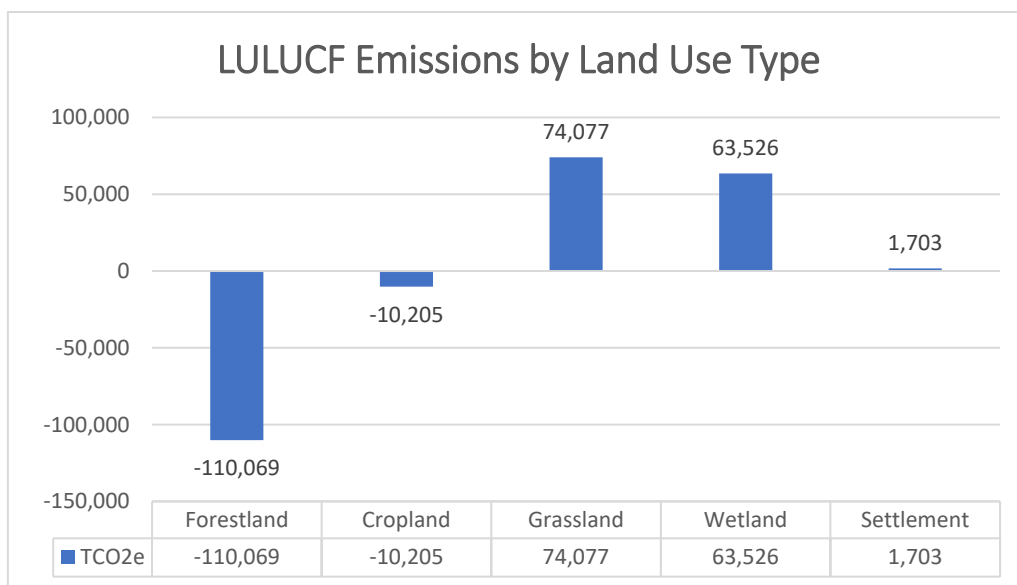


Figure 3-26: Breakdown of LULUCF Emissions by Land Use Type for the County

Grassland in the county is the land use type that contributes most in terms of emissions, followed by Wetland. Forestland and Cropland serve to absorb CO₂ considering both CO₂ gains and losses overall. These land use types generally absorb more carbon (e.g., through vegetative photosynthesis) than they release (e.g. through deforestation or harvesting).

Forestland is the most significant carbon sink within the county. Most forestland within County Leitrim exists on peatlands.

3.6.3 Assumptions and Limitations

It is assumed that each land use type has a universal rate of GHG generation / absorption. In reality, emission / absorption levels would differ between specific land use types (e.g., an area of conifer forest versus an area of broadleaved forest).



3.6.4 Data Sources

- CORINE Land Cover Inventory for Ireland - Accessed 14/11/2022.
- Environmental Protection Agency, EPA National Emissions Inventory, 2021.



4. OVERVIEW AND MAIN CONCLUSIONS

The analysed sectors in the county generated 618,972 tCO₂-eq in the baseline year, overall. A breakdown of these emissions and targeted emission levels for 2030 by sector is presented in Table 4-1:

Table 4-1: Breakdown of Emissions Per Sector in the County

Sector	Emissions 2018 tCO ₂ -eq	Target Emissions 2030 tCO ₂ -eq
Residential	114,290.0	56,002.1
Commercial and Industrial	49,246.0	24,130.5
Agriculture	266,221.5	130,448.5
Transport	159,910.3	78,356.0
Waste and Wastewater	10,272.0	5,033.3
LULUCF	19,033	9,326.2
Total	618,972.8	303,296.7

A percentage breakdown of emissions in the baseline year is provided in Table 4-1.

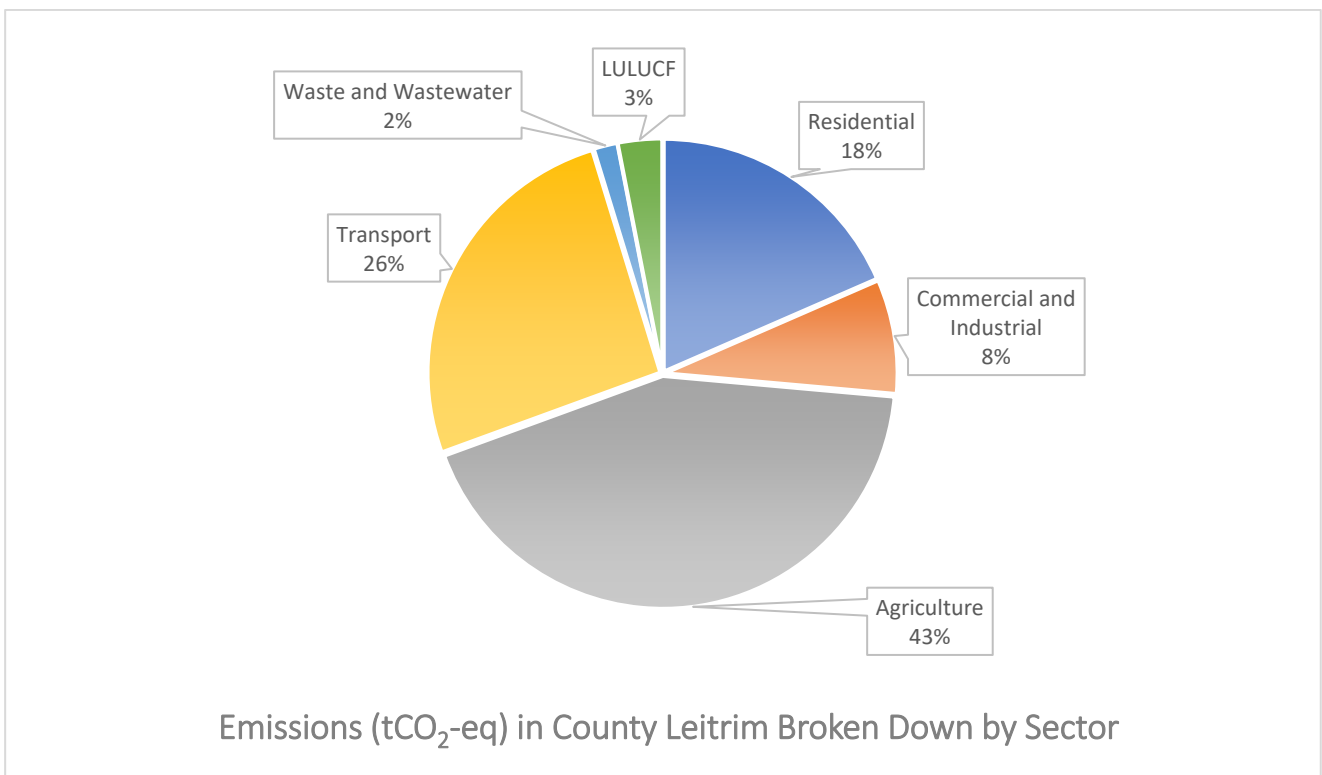


Figure 4-1: Breakdown of Emissions Per Sector in the County



The top three sectors in the county in terms of GHG emission levels were Agriculture, Transport and Residential producing 43%, 26% and 18% of tCO₂-eq respectively, of the total emissions in the county. From this analysis, these sectors should be the main targets of energy and emission initiatives.

The Climate Action and Low Carbon Development (Amendment) Act 2021 commits Ireland to reach a legally binding target of net-zero emissions no later than 2050, and a cut of 51% by 2030. An overall emission reduction of 315,676 tCO₂-eq to 303,296 tCO₂-eq is required for the county across all sectors to achieve the target to reduce GHG emissions by 51% by 2030.

An illustration of the target emissions for 2030 broken down by each sector is provided in Figure 4-2.

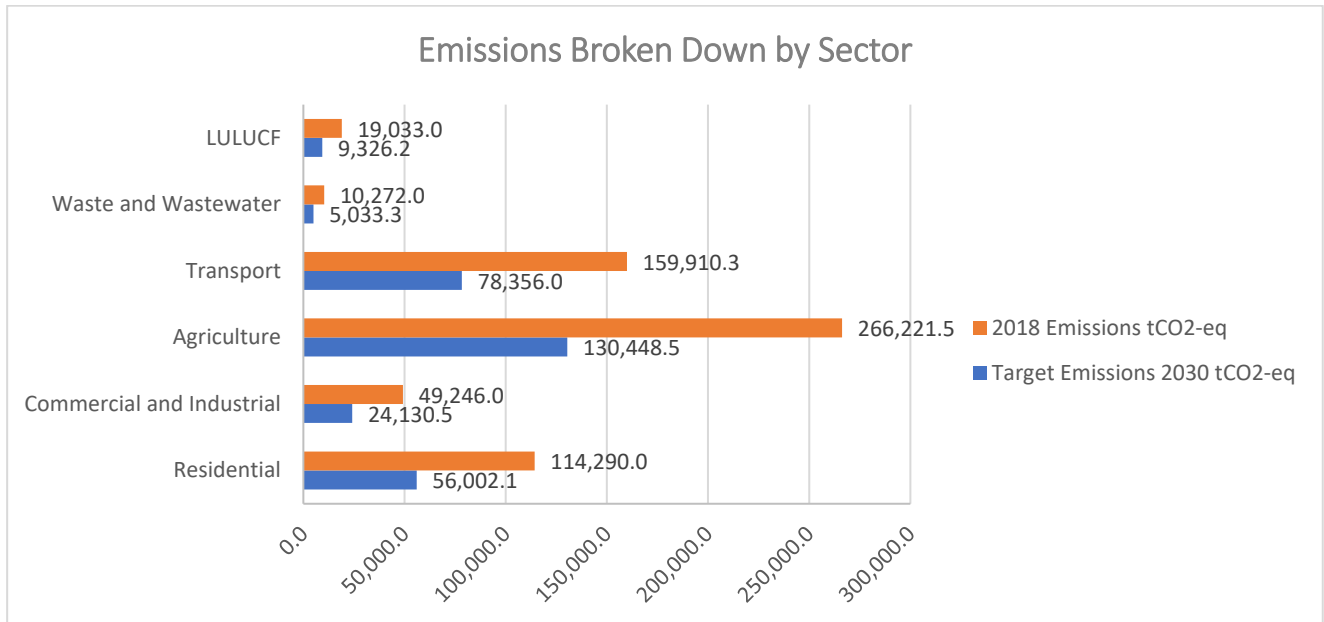


Figure 4-2: Emission Reduction Requirements Per Sector



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APPENDIX 1

Further Explanation of the
Sectors



Detailed Explanation on Subsectors/Subcategories for Each Sector

The sections below provide further detail on particularly complex to understand subsectors/subcategories, including:

- Agriculture - Managed Soils
- LULUCF
- LULUCF - Grassland
- LULUCF - Wetlands (Peatland)

The [EPA's National Emissions Inventory Report](#) (NIR) provides more information on these sectors.

Agriculture - Managed Soils

The 2006 IPCC Guidelines on National Greenhouse Gas Inventories defines managed soils as all soils on land, including Forest Land, which is managed. Nitrous oxide is produced naturally in soils through the processes of nitrification and denitrification. Nitrification is the aerobic microbial oxidation of ammonium to nitrate, and denitrification is the anaerobic microbial reduction of nitrate to nitrogen gas (N₂). Nitrous oxide is a gaseous intermediate in the reaction sequence of denitrification and a by-product of nitrification that leaks from microbial cells into the soil and ultimately into the atmosphere. One of the main controlling factors in this reaction is the availability of inorganic N in the soil.

Under the agriculture sector, GHG emissions from managed soils are therefore estimated based on N₂O emissions.

The emissions of N₂O that result from anthropogenic N inputs or N mineralisation occur through both a direct pathway (i.e., directly from the soils to which the N is added/released), and through two indirect pathways: (i) following volatilisation of NH₃ and NO_x from managed soils and from fossil fuel combustion and biomass burning, and the subsequent redeposition of these gases and their products NH₄⁺ and NO₃⁻ to soils and waters; and (ii) after leaching and runoff of N, mainly as NO₃⁻, from managed soils.

There are two key emission source categories in Ireland (see the [EPA's National Emissions Inventory Report](#)) for agricultural soils, namely 'Direct N₂O Emissions from Managed Soils' and 'Indirect N₂O Emissions from Managed Soils'. These are further explained in the table below:

Emission Source Category	Description
Direct N ₂ O Emissions from Managed Soils	This category includes emissions from inorganic N fertilisers, organic N fertilisers, urine and dung deposited by grazing, crop residues, mineralisation / immobilization associated with loss / gain of soil organic matter and cultivation of organic soils.
Indirect N ₂ O Emissions from Managed Soils	This category includes emissions from atmospheric deposition and nitrogen leaching and run-off from two indirect pathways: (i) following volatilisation of NH ₃ and NO _x from managed soils and the subsequent redeposition of these gases and their products NH ₄ ⁺ and NO ₃ ⁻ to soils and waters; and (ii) after leaching and runoff of N, mainly as NO ₃ ⁻ , from managed soils.

This sub-category is distinct from the LULUCF sector in that it solely relates to GHG emissions which are as a result of land spreading and deposition related to agricultural activity (i.e., fertilizer application emissions, loss of N contained in fertilizer through volatilization or leaching and run-off).

LULUCF

The rate of build-up of carbon dioxide (CO₂) in the atmosphere can be reduced by taking advantage of the fact that atmospheric CO₂ can accumulate as carbon in vegetation and soils in terrestrial ecosystems. Under the United Nations Framework Convention on Climate Change any process, activity or mechanism which removes a greenhouse gas (GHG) from the atmosphere is referred to as a "sink". Human activities impact terrestrial sinks, through land use, land-use change and forestry (LULUCF), consequently, the exchange of CO₂ (carbon cycle) between the terrestrial biosphere and the atmosphere is altered.

LULUCF stands for Land Use, Land Use Change and Forestry. It is defined by the United Nations Climate Change Secretariat as ‘a greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities.’ The LULUCF sector includes the land use categories: Forest land, Cropland, Grassland, Wetlands, Settlements, Other land and Harvested Wood products.

Breaking down LULUCF into its individual terms:

- **‘Land Use’** refers to the human use of the material on land which represents the economic and cultural activities practiced at a given place.
- **‘Land Use Change’** is then the process by which human activities transform the natural landscape, referring to how land has been used.
- **‘Forestry’** refers to the practice of creating, managing, planting, using, conserving and repairing forests and woodlands for associated resources for human and environmental benefits. Note that land cover does not equate to land use (land cover refers to only the physical material on the land).

A description of each land use category is provided in the table below:

Land Use Category	Description ¹
Forest Land	Includes all public and private plantation forests. Forest land is an area of land where tree crown cover is greater than 20% of the total area occupied. It refers to emissions and removals from forest management activities such as timber harvesting, thinning and replanting, and ecological processes such as tree growth and decomposition.
Grassland	Includes improved grasslands, unimproved grasslands and grasslands not currently in use. Improved grasslands include areas identified as lands managed for livestock grazing and grass-based feed and winter fodder production (pasture, silage and hay). Unimproved grasslands are identified as rough grazing for livestock, predominantly sheep or low intensity beef farming. Grasslands not in use are those lands identified as dominated by grass habitats, but not currently managed (in any one year) for livestock.

¹ Table 6.3 Description of Land Use Categories, Ireland's National Inventory Report 2022.

Land Use Category	Description ¹
Cropland	Refers to emissions and removals from annual and perennial cropland, as well as from forest lands and grassland converted to cropland. Cropland includes lands in annual crops, summer fallow and perennial crops.
Wetlands	Includes unmanaged wetlands and managed wetlands. Managed wetland are areas commercially exploited for public and private extraction of peat and areas used for domestic harvesting of peat . Unmanaged wetlands are natural unexploited wetlands.
Settlements	Refers to emissions and removals occurring on developed lands (such as urban environments, transport infrastructure and mining), from land conversion of forests and agricultural land to settlements and the footprint of industrial, commercial/institutional, and residential buildings.

LULUCF - Grassland

Grasslands have a significant amount of carbon content and can act as either as a carbon emitting land use or a land use that sequesters carbon. This depends on a complex array of processes in combination with land use activities occurring on a grassland. GHG emissions associated with grasslands are a function of these processes of affecting biomass and soils containing carbon.

In Ireland, grassland grazing, for example, contributes to grassland related GHG emissions, depending on interactions between soils, plant species, and climate. Rainfall significantly effects carbon releases on grasslands that are subject to grazing. On sites with higher rainfall, grazing generally increases soil carbon releases on sandy, coarse-textured soils, while clay soils respond with weak increases to strong decreases in soil carbon releases. Naturally, the Irish climate is characterized by cool and damp, cloudy and rainy weather conditions throughout the year. This significantly contributes to the release of carbon emissions from grasslands (the same can be said for wetlands).

Emissions from grassland can also be due to their intensive use for food and forage production because of their high natural soil fertility. Carbon stores within grasslands are sensitive to management and are thus vulnerable to losses in soil carbon. Land degradation—which is a long-term decline in plant productivity and the associated soil and water functions that support it—is widespread in grasslands in part due to soil carbon losses.

When grassland becomes degraded, these soils can lose carbon, converting to carbon dioxide in the process. Conversely, when grassland is restored (for example, from cropland), carbon can be sequestered. Emissions here therefore refer to the net balance of these carbon losses and gains from grassland biomass and soils.

Studies have suggested that grassland soils can potentially act as significant carbon sinks. Land management practices can enable sequestration. An article published by Teagasc ([Grassland and carbon sequestration, Teagasc](#)) provides some examples of possible management techniques to increase carbon sequestration. These include:

- Grazed pastures may sequester more carbon than grasslands used for silage or hay production, due to the recycling of organic matter and nutrients from faeces and plant residues.
- Improve fertiliser management. Combine liming treatments with nutrient fertilisation.
- Ensure good grazing infrastructure — this will lead to less grassland damage and less frequent reseeding.

LULUCF - Wetlands (Including Peatlands)

Peatlands are known to be the largest natural terrestrial carbon store. They are able to store more carbon than all other vegetation types in the world combined. In peatlands, year-round water-logged conditions slow plant decomposition to such an extent that dead plants accumulate to form peat. This stores the carbon the plants absorbed from the atmosphere within peat soils, providing a net-cooling effect and helping to mitigate the climate crisis.

Forested peatlands are productive carbon sinks considering trees are good CO₂ sequesters. Combined with the properties of unexploited peatlands, the sequestered carbon from trees remains stored in peat soils.

However, the harvesting and overexploitation and associated degradation of peatlands release large quantities of GHG emissions and are responsible for almost 5% of global anthropogenic CO₂ emissions. Such harvesting has been common place across Ireland for decades, which means that Peatlands are net emitters in an Irish context. Ireland's wet climate results in the disturbed organic soils in these lands being very well drained. This drainage results in soil carbon releases to the environment, which decompose and volatilize as a GHG emission. Peatland rehabilitation and restoration can reduce emissions significantly and change peatlands from net emitters to net sequesters.

For more information on the LULUCF sector, please refer to the following links:

[Land Use, Land-Use Change and Forestry \(LULUCF\) | UNFCCC](#)

[Climate change reporting \(europa.eu\)](#)

[LULUCF | Environmental Protection Agency \(epa.ie\)](#)

[Ireland's forests a source or sink of carbon dioxide? | Gov.ie](#)



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