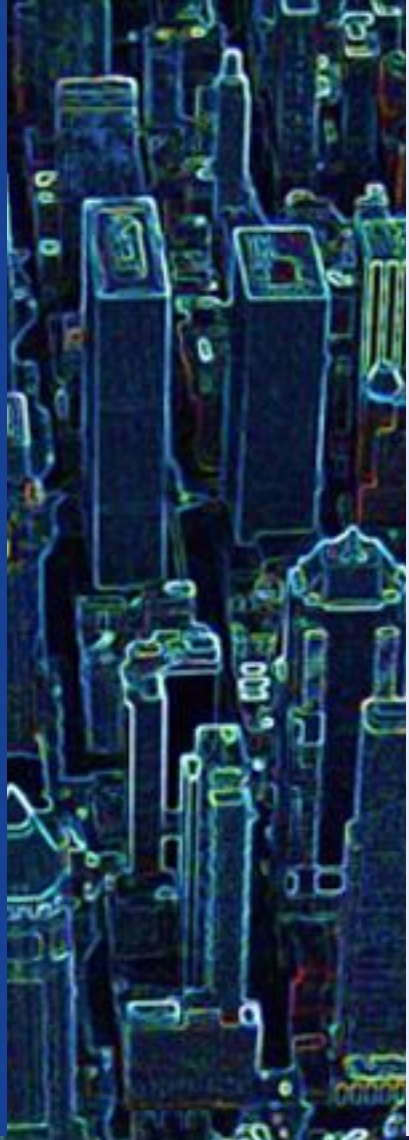

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Inspire Policy Making with Territorial Evidence

ANNEX 2 – CASE STUDY REPORT //

Ireland Case Study Pilot

Quantitative Greenhouse Gas Impact Assessment Method for Spatial Planning Policy

Adjusted Annex // September 2022

This annex 2 – case study report is conducted within the framework of the ESPON 2020 Cooperation Programme, partly financed by the European Regional Development Fund.

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Abbreviations

BER	Building Energy Rating
CLC	CORINE Land Cover
CLMS	Copernicus Land Monitoring Service
CO_2e	Carbon Dioxide equivalent
COICOP	Classification of Individual Consumption by Purpose
CORINE	Coordinated Information on the Environment
CRF	Common Reporting Format
CSC	Carbon-Stock-Change Factors
EEA	European Environment Agency
EIO	Economic Input-Output
EPC	Energy Performance Certificate
ESDAC	European Soil Data Centre
FIPS	Forest Inventory and Planning System
FUA	Functional Urban Areas
GHG	Greenhouse Gas
GWP100	Global Warming Potential over 100 years
HBS	Household Budget Survey
ICE	Internal Combustion Engine
IPCC	Intergovernmental Panel on Climate Change
LCA	Life Cycle Assessment
LPIS	Land Parcels Information System
LULUCF	Land use, land-use change and forestry
MMR	Monitoring Mechanism Regulation
MMU	Minimum Mapping Unit
MRIO	Multi-Regional Input-Output
NEDC	New European Driving Cycle
NFI	National Forest Inventory
NIR	National Inventory Reports
NPF	National Planning Framework
p-LCA	Process-based Life Cycle Assessment
RDE	Real Driving Emissions
RSG	Reference Soil Groups
STL	Street Tree Layer
UNFCCC	United Nations Framework Convention on Climate Change
WADT	Weekday Average Daily Traffic
WRB	World Reference Base for Soil Resources

1 Introduction

GHG emissions were quantified for four case studies to test the GGIA tool methodology in a variety of contexts. The service providers have committed to use a range of spatial scales for the pilot case studies, this is shown through the case study selection that vary in their urban context i.e., rural, urban and suburban, whilst also differing in population sizes and geographic contexts.

Each case study consists of a baseline analysis, the quantification of selected policies and the evaluation of results. The case study pilots have been linked to relevant policy processes and the involvement of the stakeholders has been key to ensure that the link between case study and relevant spatial planning policy is present. The pilot case studies, where possible, reflect the stakeholders' envisaged use of theGGIA tool in each territory, this includes for example national planning frameworks, regional spatial strategies, and local authority development plans. The GHG analysis of the case study plans, follow key emission sectors:

- Buildings – changes in electricity and heating demands
- Infrastructure – changes in transport
- Land Use – changes in land use.

This report provides an insight into the GHG emission inventory for Meath County as well as the data and methodologies applied for each sector.

2 Ireland Case Study Pilot – County Meath

The Irish case study pilot is County Meath, which lies on the border of Dublin. Meath's close proximity to Dublin, makes it a commuter region and provides a good mix of spatial attributes, having both rural, urban and suburban areas. Over the recent years, Meath has experienced a rapid growth in population which has resulted in an increase in land use change, traffic and has boosted the economy in the area.

It is worth noting that the county has been proactive in the area of climate action and this is showcased in Meath's Climate Action Strategy (which covers the period from 2019 to 2024) which is both ambitious and pragmatic with the ability to enable others to take action and inspires them to lead on climate action. Meath is currently in the final process of developing its Meath County Development Plan 2021–2027, and their Climate Action Strategy is very much linked to their County Development Plan. The service providers have tested out the tool on the Meath County Development Plan 2021–2027.

2.1 Baseline

2.1.1 Consumption-based approach

The demand vector representing the average household across the Republic of Ireland was used to describe county Meath. This was to accommodate the varying urban densities present in the area. The stakeholders indicated that the average income of the area is well aligned with Ireland as a whole, and so no further scaling was performed based on this factor. Information was provided by the stakeholders with regards to the average household occupancy and total population of the area, respectively, and this was used to determine the per capita and total emissions for the region.

Table 1. Description of the data situation utilised for the consumption calculations in County Meath.

Data situation: County Meath				
Demand Vector	Household occupancy	Household income level	Population	Further modifications / Notes
Irish average	3.03	Irish average	194,942	N/A

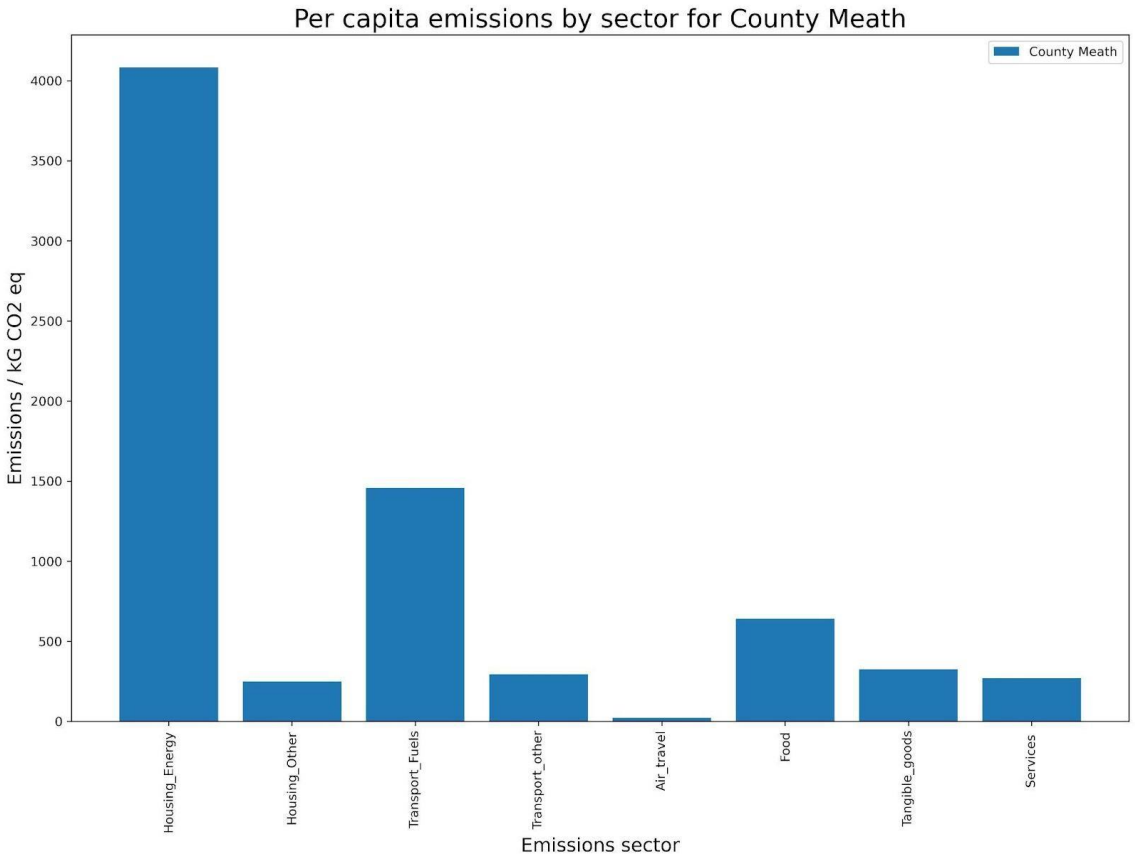

Figure 1. Annual per capita sectoral emissions for County Meath (kgCO_2e/(capita, a)) (2019).

Figure 1 above shows the breakdown of emissions by sector for households in County Meath. Overall, the per capita emissions were 7.3 tonnes CO_2e per annum. The total consumption emissions for the region were calculated to be approximately 1.4 MtCO_2e per annum. The largest contributions to the emissions came from residential energy demand and transport fuels. In turn, residential energy is dominated by so-called 'use phase' emissions, which reflects the large proportion of space heating arising from direct combustion of fossil fuels in the household. The transport emissions are influenced by both the fuel mix and overall expenditure. The proportion of renewable sources in the transport fuels was only around 9 % (21 % for Finland), whilst fuel use was higher than in either Finland or the UK, although emissions from production are lower than in the latter case. The higher household occupancy than the national average (2.73 based on Eurostat figures), leads to a lower per capita footprint than would ordinarily be expected. The emissions from the production phases were rather small, with electricity accounting for a large proportion. One reason for this is due to reduced expenditure in the Household Budget Survey (HBS) being allocated to waste sources (waste allocated to landfill typically show extremely large emission intensities in the Exiobase model). Total household emissions independent of occupation level are higher than Kymenlaakso and Edinburgh. When household occupancy is considered, Edinburgh, Kymenlaakso and County Meath all have rather similar carbon footprints. Total household expenditure in 2015 was rather similar across all regions in Euro terms (higher values in Ireland are somewhat mitigated by the higher household occupancy levels). The results for County Meath are tabulated with greater sectoral detail in the Table 2. These results are also shown graphically along with those for the other case areas.

Table 2. Per capita sectoral breakdown of emissions for County Meath ($kgCO_2e$/(capita, a)) (2019).

County Meath	Direct Production $kgCO_2e$	Indirect Production $kgCO_2e$	Use Phase $kgCO_2e$	Total $kgCO_2e$
Shelter: Electricity, heating and fuels	612	368	3,102	4,082
Shelter: Actual and imputed rent	9	120	0	129
Shelter: construction	33	17	0	51
Shelter: Waste treatment, water supply and misc.	45	23	0	69
Transport fuels	14	135	1,309	1,458
Vehicle purchases	176	90	0	266
Other transport services	17	11	0	28
Air travel	18	5	0	22
Food: Plant-based	36	120	0	156
Food: Animal-based	14	287	0	301
Food nec	6	178	0	183
Clothing	5	76	0	81
Appliances	13	39	0	52
Furniture, household commodities and misc.	23	169	0	192
Services	17	253	0	270
Sum	**1,039**	**1,890**	**4,411**	**7,339**

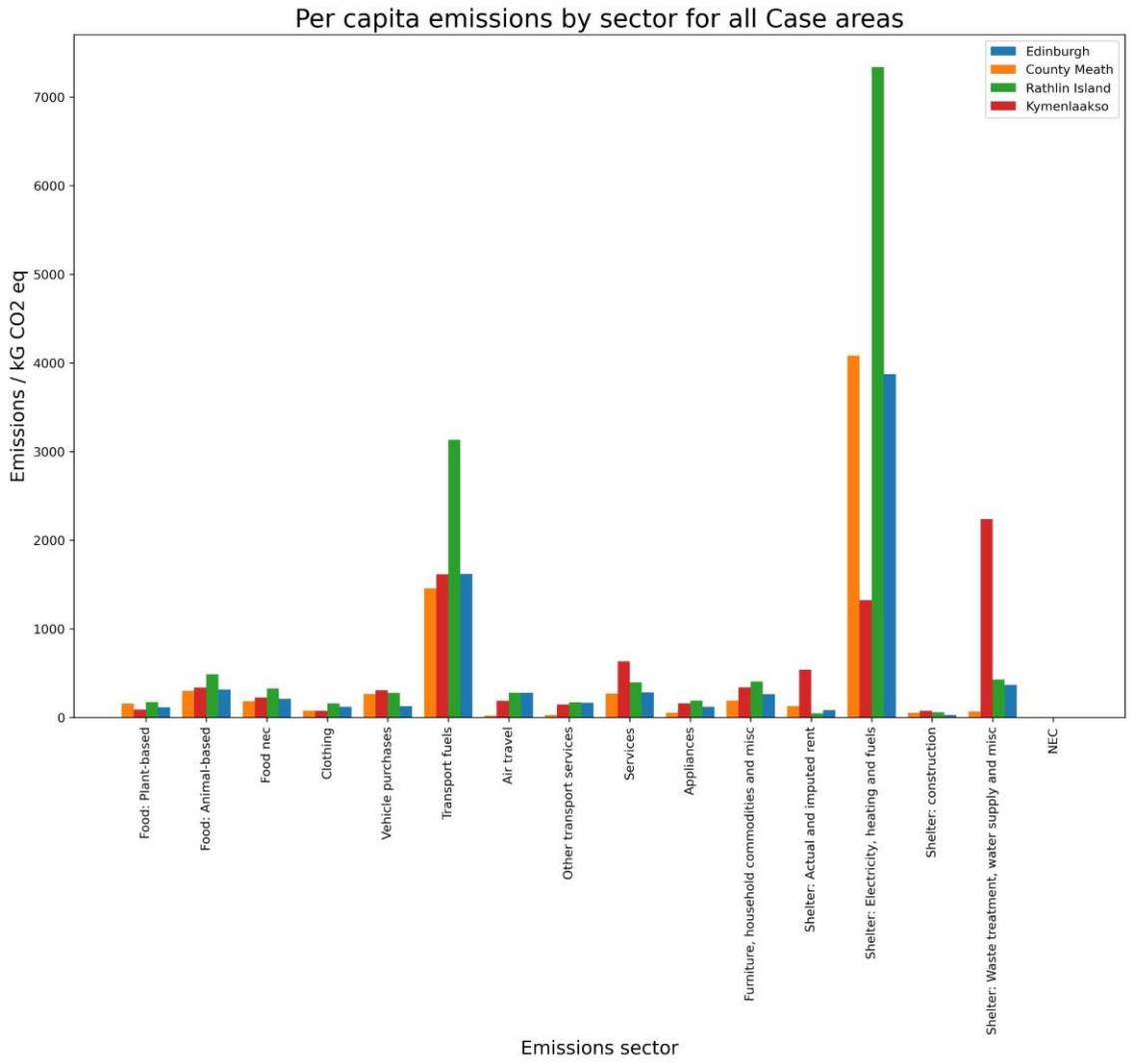

Figure 2. Per capita consumption emissions for all case study areas in 2020.

2.1.2 Territorial approach

2.1.2.1 Buildings

This section looks at the emissions arising from the building sector in County Meath, it includes both residential and commercial buildings and also analysis results from the baseline, which gives insight into the current building stock for County Meath. This baseline information is then used to compare with emissions resulting from spatial planning policy changes.

Residential sector

This methodology is based on two main data sources: Census 2016 and the Building Energy Rating (BER) Research Tool. The Census data for County Meath's residential sector was provided by the Central Statistics Office (CSO). This data was made use of as it is broken down into location, type of housing, and period built, it is also the most reliable data, as it is updated every five years and the data collection for this survey captures the same information in each survey, which makes it especially useful when comparing data over different time periods. This was then applied to the averages calculated from the BER database, which was broken down into four dwelling types and seven periods, providing a total of 28 subsets. Residential units were broken down into:

- Detached
- Semi-detached
- Terraced

- Apartments

This breakdown allows a higher level of accuracy when applying the averages to all the housing stock.

A Building Energy Rating (BER) Certificate is a certificate of energy efficiency of a property. BER certificates are required if a house is being sold, let, is a new build, or has had an energy grant from Sustainable Energy Authority of Ireland (SEAI). Properties which achieve an 'A' rating are the most efficient; meanwhile, properties which achieve a 'G' rating are the least energy efficient properties.

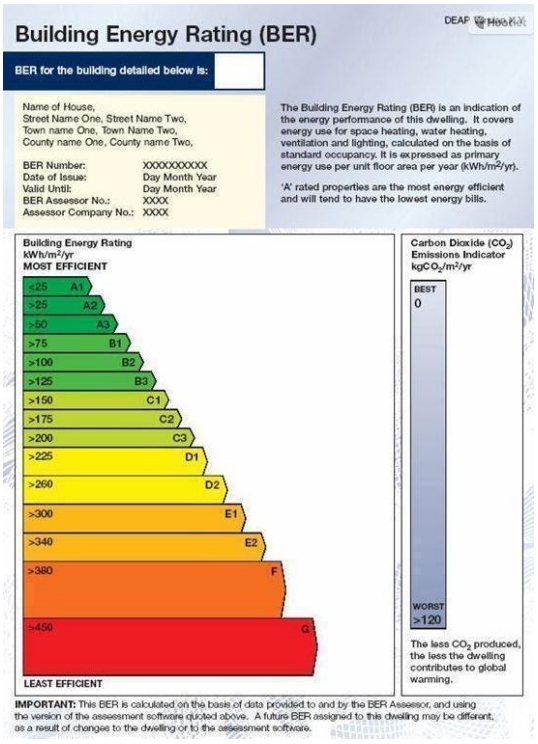

Figure 3. Building Energy Rating.[1]

The BER Research Tool was developed by SEAI and was used in this analysis for the calculation of energy required for normal use of space heating, hot water, ventilation and lighting per metre squared area of a residential unit. The final energy rating given to a household is in kWh/m²/year, and an energy efficiency scale from A to G is applied. It also provides insight into other data, such as type of household, year of construction, location, floor area, and fuel use.

The BERs analysed in this report were broken down by location and included the BERs pertaining to County Meath. This was done by filtering the data location and was then broken down further by type of dwelling (detached, semi-detached, terraced and apartments) and period built. These categories were defined as such to match the information available from the Census for the entire residential housing stock in County Meath.

The drawback of the BER is that a certificate is only required if a house is being sold or rented out after January 1st 2009. This means that it will not give a complete representation of all the housing stock in County Meath. However, the Greater Dublin Area has a higher percentage of sales and rentals than any of the other regions in Ireland, especially given the current housing and rental market, and therefore, this gives a good representation of the domestic energy demands in County Meath.

[1] Source: SEAI.

Analysis

In 2016, the largest share of residential units were detached houses; they made up 54% of the total residential housing stock in County Meath. This was followed by semi-detached houses (29%) and terraced (10%), whilst the lowest share of housing were apartments, comprising 7% of Meath's housing stock.

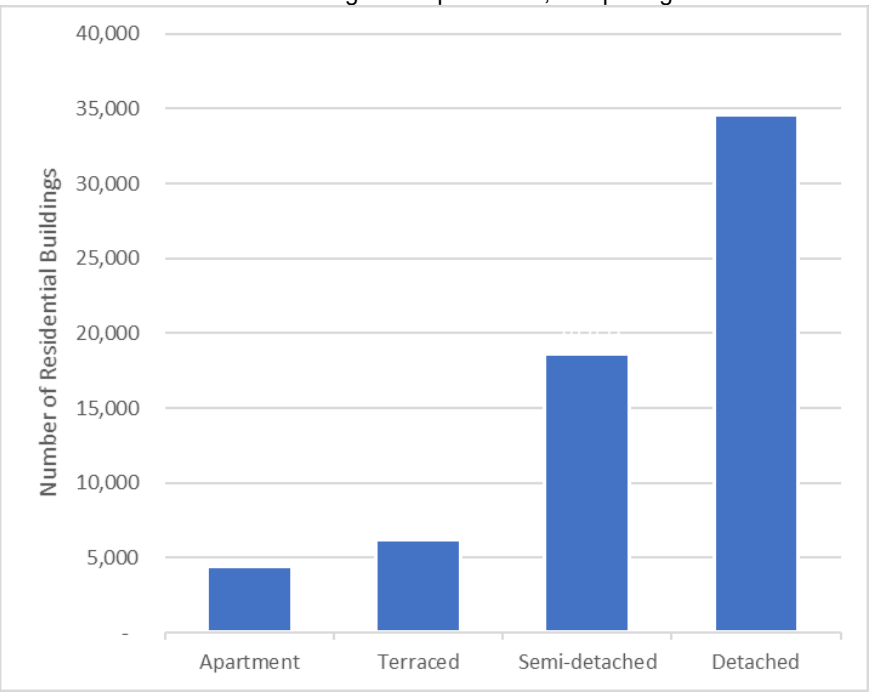

Figure 4. Total number of residential units in County Meath (2016).

Total energy use in the residential sector was 1,454 GWh. The residential fuel split mainly comes from heating oil, which makes up 48% of the total energy use in this region. Natural gas is the second highest fuel in demand, making up 34% of the fuel mix, followed by electricity at 15%.

Figure 5 shows the total final energy use broken down into the different energy demand areas. Most of the energy used was for space heating. Space heating had by far the highest energy demand, accounting for 76% of the total. This is followed by water heating at 19%. Heating overall in the residential sector has the highest energy demand by far, lighting and pumps/fans are the least energy intensive, making up just 4% and 1% of the total demand, respectively.

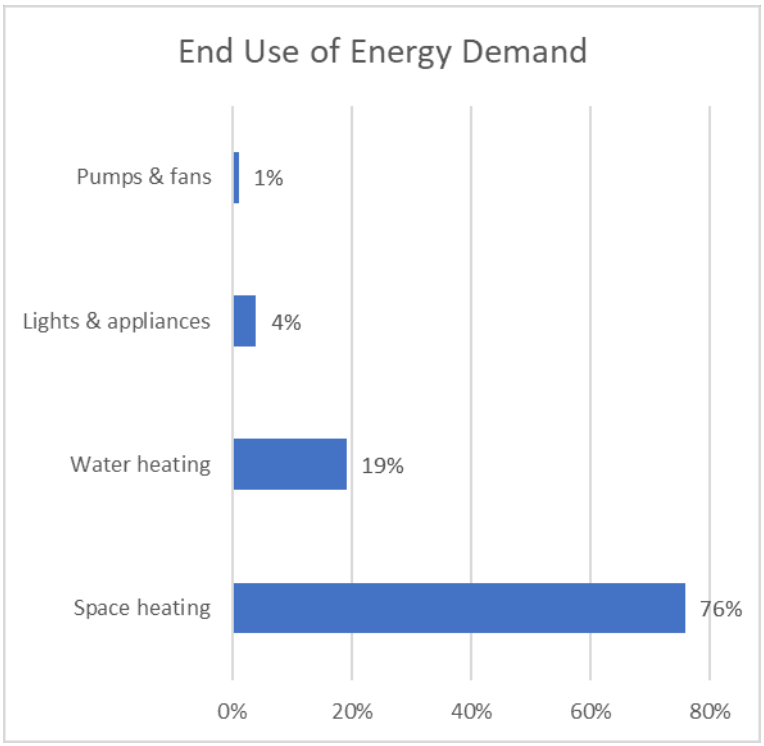

Figure 5. Share of residential energy demand in County Meath (2016).

Total emissions from the residential sector in Meath amounted to 404,590 tonnes of CO_2 in 2016. This equates to 6.3 tCO_2 per dwelling in Meath, which is slightly higher than the national average in Ireland, which was reported to be 5.5 tCO_2 for 2020 (SEAI). This can be due to a number of factors, some of which are: different baseline figures (2016 as opposed to 2020 SEAI figures) and the high prevalence of detached dwellings in Meath, which tend to emit more emissions per m^2 floor area than other types of dwellings. Figure 6 depicts the total emissions grouped by fuel and dwelling type. Detached houses had the highest emissions, accounting for 287,750 tonnes of CO_2, and they also account for the highest share of dwellings (54% of all dwellings are detached houses). This was followed by semi-detached houses, terraced houses and apartments, all of which accounted for 77,100, 26,070 and 13,700 tonnes of CO_2 respectively, of the total emissions in the residential sector.

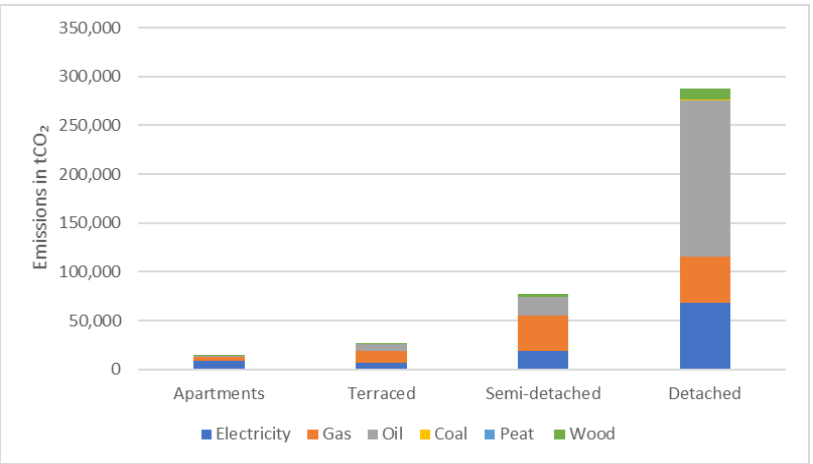

Figure 6. Total emissions in the residential sector by fuel mix and dwelling type (tCO_2e/a) (2019).

The highest emissions in the residential sector come from heating oil, electricity and natural gas, which contribute 46%, 26% and 25% respectively. There was very little peat, coal and biomass (mainly wood) used in the residential sector, only contributing to 3.4% of total emissions.

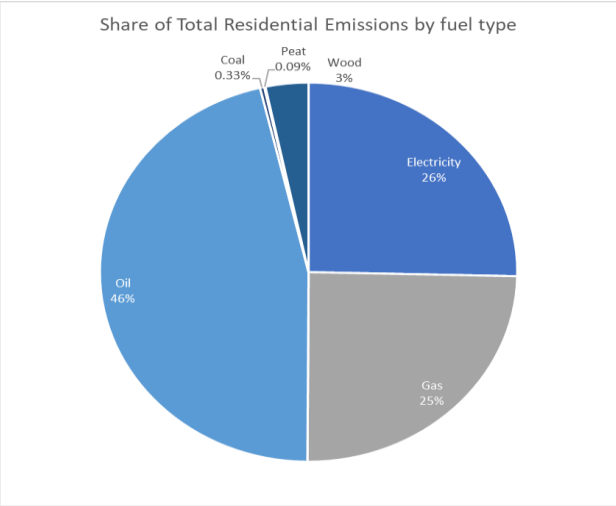

Figure 7. Share of total emissions in the residential sector by fuel type (2019).

Table 3. Total residential emissions in County Meath (tCO_2e/a) (2019).

Residential sector	Fuel						Total
	Electricity	Gas	Oil	Coal	Peat	Wood	
Apartments	8,570	4,619	445	6	2	28	13,670
Terraced	6,398	12,543	6,950	83	24	70	26,068
Semi-detached	19,217	35,639	19,215	457	55	2,515	77,099
Detached	68,341	47,316	160,202	799	277	10,818	287,753
Total tCO_2	**102,526**	**100,117**	**186,812**	**1,345**	**358**	**13,432**	**404,590**

Commercial

The commercial sector includes both the services and industrial sectors. The majority of commercial properties can be categorised as industrial uses, retail, offices and hospitality with only 4% accounting for the remaining commercial properties.

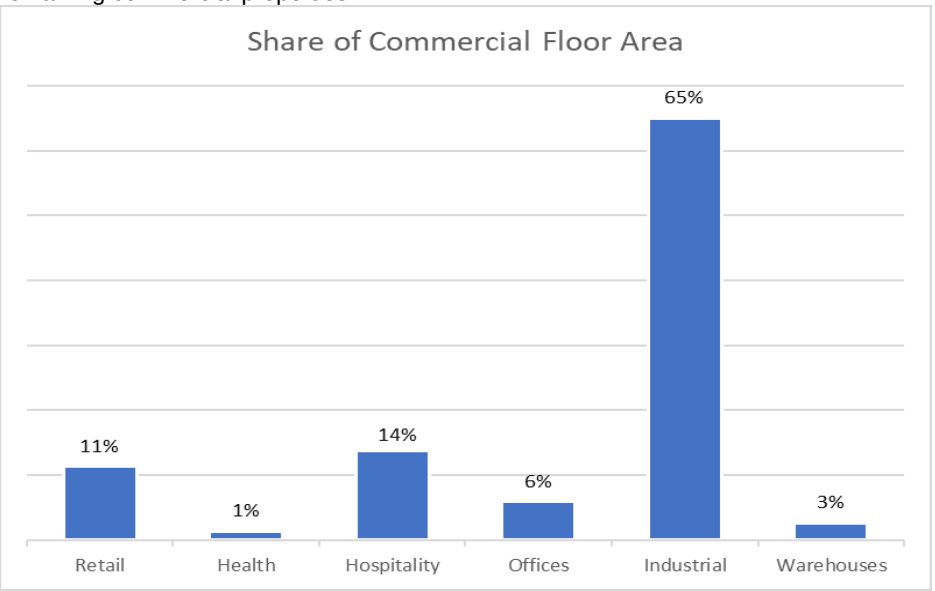

Figure 8. Share of commercial floor area in County Meath.

The methodology used for the calculation of the commercial baseline includes two main data sources - data from the Valuation Office and energy consumption benchmarks from the Chartered Institution of Building Services Engineers (CIBSE).

The Valuation Office provided a list of all the commercial properties and their respective floor areas in County Meath. These properties were also broken down into different categories, type of use, and location.

Currently, there is no energy data available for commercial properties in Ireland, as there is no formal energy reporting required. Therefore, in order to assign energy use to each property, The service providers used energy benchmarks from the UK CIBSE Guide F: Energy Efficiency and TM46 (CIBSE, 2012). CIBSE benchmarks are widely used for such analysis and in fact are also used as a source for reference benchmarks in the Irish Display Energy Certificates that are produced for both the public and private Irish sector. These sources provide typical energy usage per square metre of floor area for different business categories, amalgamated from numerous UK surveys.

The property uses provided by the Valuation Office were then matched with the building descriptions given in the CIBSE guides. The floor areas listed by the Valuation Office were based on the different business requirements. This can be found in the Valuation Office's Code of Measuring Practice (Valuation Office Ireland, 2009). If the measured floor area from the Valuation Office did not match that in the CIBSE guides (gross floor area to net floor area), then a conversion factor was applied.

The energy figures were then applied to all the commercial properties, according to their use. There were over 230 different property types listed in County Meath.

The CIBSE energy figures are only split into either fossil fuels or electricity. Therefore, due to a lack of data at a local level, the 2019 national breakdown of fossil fuels and electricity for energy use in the industrial sector was used instead (SEAI, 2020). However, this presents a limitation as it is not an accurate representation of fuel use in the commercial sector in County Meath.

The advantage of using CIBSE energy benchmarks is that they are based on a large sample set, and as Irish building regulations follow UK regulations, the energy figures are applicable in the Irish context. There are certain limitations, however; climate in the UK is more severe than in Ireland and can affect results when applied to the Irish sector.

Analysis

The different commercial property categories outlined in this section are:

- Health
- Hospitality
- Industrial Uses
- Office
- Retail
- Warehouse.

The total energy used in the commercial sector was 741 GWh. Electricity (390 GWh) and natural gas (175 GWh) accounted for the main share of this energy use. The commercial sector had a high use of heating oil, peat and biomass (wood) which all together made a total of 176 GWh.

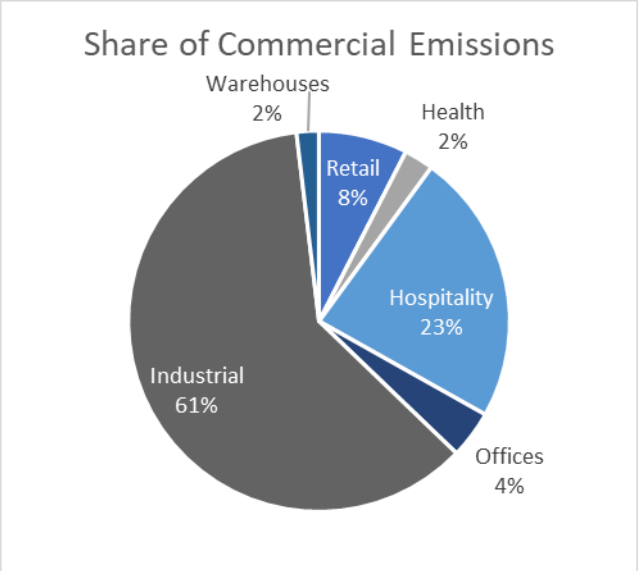

Figure 9. Commercial emissions by property category (2019).

Total emissions from the commercial sector in 2021 amounted to 267,105 tonnes of CO_2. The commercial properties that produced the most emissions were industrial uses, retail, hospitality and offices are the main CO_2 emitters, as altogether they made up 96% of the commercial sector's total emissions.

- Industrial uses: 162,684 tCO_2e
- Hospitality: 61,772 tCO_2e
- Retail: 20,113 tCO_2e.

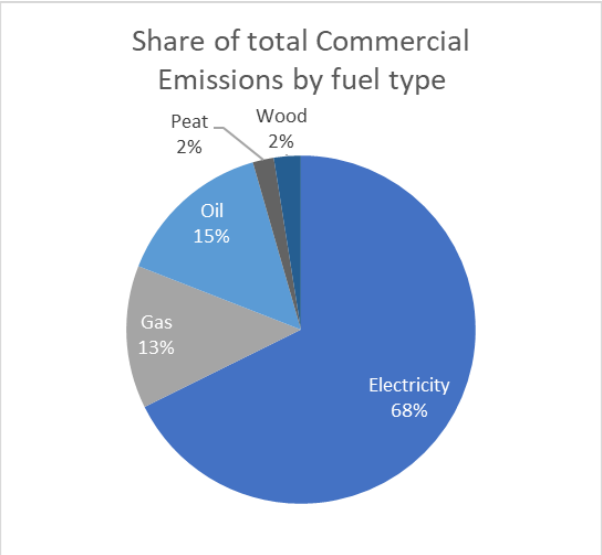

Figure 10. Share of total emissions in the commercial sector by fuel type (2019).

Of the total emissions emitted by the commercial sector, electricity accounts for the largest share of the total emissions (68%), followed by heating oil at 15%. Natural gas also produced significant emissions, contributing 13% to the total.

Table 4. Total commercial emissions in County Meath (tCO_2e/a) (2019).

Commercial sector	Fuel						Total
	Electricity	Gas	Oil	Coal	Peat	Wood	
Retail	20,113	-	-	-	-	-	20,113
Health	6,162	207	228	-	30	39	6,666
Hospitality	51,628	4,163	4,585	-	612	784	61,772
Offices	7,615	1,309	1,441	-	192	247	10,805
Industrial	90,708	29,535	32,534	-	4,345	5,562	162,684
Warehouses	4,539	216	237	-	32	41	5,065
Total tCO_2e	**180,766**	**35,429**	**39,026**	**-**	**5,211**	**6,673**	**267,105**

Total emissions

Total emissions from both the residential and commercial sectors in Meath accounted for 671,690 tonnes of CO_2e in 2016. The residential sector contributed 60% and the commercial sector 40% to the total emissions. The main source of emissions come from electricity (42%), followed by heating oil (34%) and natural gas (20%). The rest of emissions (approximately 4.2%) were made up of biomass (wood), peat and coal.

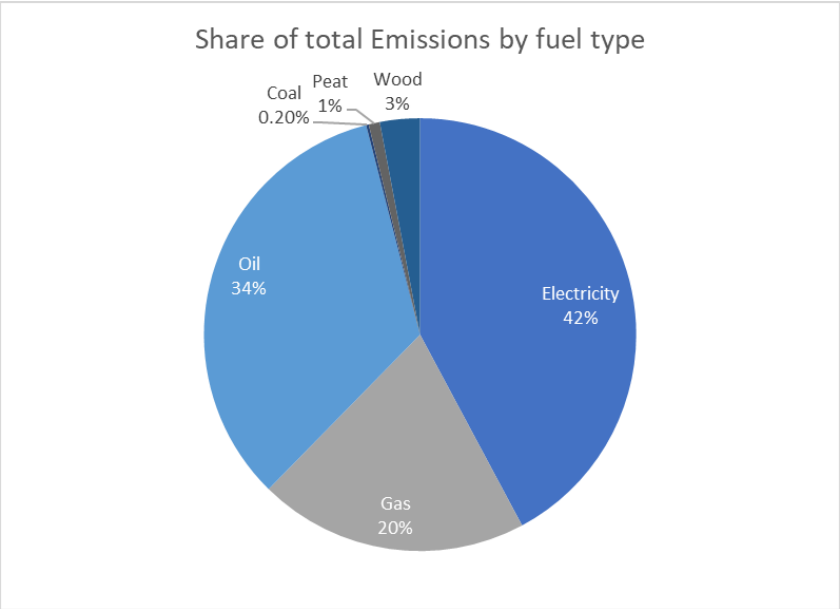

Figure 11. Share of total emissions in the building sector by fuel type (2019).

Table 5. Total emissions from the building sector in County Meath (tCO_2e/a) (2019).

Emissions tCO_2	Fuel						
	Electricity	Gas	Oil	Coal	Peat	Wood	**Total**
Residential	102,526	100,117	186,812	1,345	358	13,432	404,590
Commercial	180,766	35,429	39,026	-	5,211	6,673	267,105
Total tCO_2e	**283,292**	**135,545**	**225,838**	**1,345**	**5,569**	**20,105**	**671,695**

2.1.2.2 Transport

Although the data availability on the transport in Ireland is excellent, the transport activity data for a single county cannot be collected directly from the national or regional statistics, especially when the territorial allocation principle is applied. An advanced model on road transport, such as Eastern Region Model (ERM) in this case, is a great benefit, as the transport volumes can be allocated by the county boundaries. For the rail transport, the respective allocation was done manually, by measuring the track lengths within the borders of Meath County, and utilizing the statistical data on the train services on these lines.

Complementary information is from Transport Trends 2020 publication (Department of Transport, 2021), the database of Transport Infrastructure Ireland and the statistics of Iarnród Éireann.

Road transport

Forecasted 24hr weekday vehicle-kms by vehicle class and road type in County Meath at 2019 (Table 6) are derived from a draft version of the ERM (Eastern Region Model) Model Development Report (not published). The base year for the ERM model is 2016.

The CO_2e emission factors for road and rail transport are mainly from the Lipasto database (VTT, 2021) which specifies emission factors for various types of vehicles as well as for driving on highways and streets. However, for HGVs the Lipasto data is too detailed and would require an analysis on the heavy transport vehicle fleet that operates in Meath. Therefore, the average HGV emission factor from the British DEFRA dataset (DEFRA, 2020) was used in this study.

Table 6. Forecasted 24hr weekday vehicle-kilometres in County Meath in 2019 (ERM).

Vehicle type	Vehicle/km/weekday		
	Urban	Rural	Total
Passenger car	1,084,404	4,946,321	6,030,726
Bus	7,647	27,982	35,628
LGV vans and lorries < 3.5 t	155,372	605,650	761,022
HGV lorries > 3.5 t	54,048	393,945	447,992

No specific annualisation factors were available for the county of Meath. As the data is provided as Average Weekday Traffic, the transport activity for Saturdays and Sundays were estimated using the weekly flow indices (NRA, 2012) as presented in Table 7.

Table 7. Estimates on the transport volumes for Saturdays and Sundays based on WADT[2]

Vehicle type	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Proportion of WADT[3]	0.99	1.02	1.03	1.07	1.15	0.91	0.86
	1.05	1.05	1.05	1.05	1.05	0.91	0.86
Factor for Sat/Sun	1.00	1.00	1.00	1.00	1.00	0.87	0.82

The bank holidays were assumed the same transport activity as Sundays. Although the bank holidays are known to cause congestion on the main motorways, an overview on the traffic count data (Traffic Counts for Transport Infrastructure Ireland (tii.ie)) seems to confirm that the daily vehicle-kilometers on the bank holidays are closest to Sunday volume. Annualisation is based on the standard divisions of the year:

- 253 peaked weekdays;
- 52 Saturdays;
- 52 Sundays;
- 10 Bank holidays (TII, 2017).

The same factors were applied on both passenger and freight transport on roads, although in reality the freight transport volumes are likely to be lower during the weekends and bank holidays.

Passenger transport on rails

The estimate on the transport activity for passenger train transport in the County Meath is presented in Table 8. According to the Iarnród Éireann Commuter Fleet Information[4] the trains are operated with diesel engines.

[2] NRA 2012, Annex B, Weekly Flow Indices – All locations

[3] Weekday Average Daily Traffic

[4] Iarnród Éireann Commuter Fleet Information (irishrail.ie)

Table 8. Estimate on passenger train-kilometres within the borders of the Meath County (2019).

train line	services per week	services per year	Track length in Meath	train-km/a
M3 Parkway Line	276	14352	5.0	71760.0
Sligo Line	131	6812	16.3	111035.6
Northern Line	462	24024	11.3	271471.2
Inter City Dublin-Belfast	112	5824	11.3	65811.2
total				520078.0

Freight transport on rails

The Tara Mines freight movement is the only freight train operator in Meath. Navan is currently served by a freight-only spur railway line from Drogheda on the Dublin-Belfast main line, for freight traffic (zinc and lead concentrates from Tara Mines in Navan to Dublin Port) connecting at Drogheda. Tara Mines drives 3 trains per day from Tara Mines to Dublin Port 5 days per week (Iarnród Éireann, 2021). This equals to 780 trains per year, driving the distance of 26.3+11.3 km within the borders of Meath (Tara-Mines in Navan-Drogheda, Drogheda-Dublin Port). The annual train-km totals 29328.

The Finnish Lipasto database (VTT, 2021) provides an emission factor for a diesel ore train (13.65 $kgCO_2e$/train-km), and this was applied for the Tara Mines trains.

In addition, six intermodal freight trains per week drive between Ballina and Dublin port according to the Iarnród Éireann Freight Fleet Information[5]. This totals 312 trains per year and 5085.6 train-km per year. The Lipasto database provides an emission factor for a diesel container train (12.296 $kgCO_2e$/train-km).

Inland waterways

Meath county has several important waterways, such as Boyne river and Royal Canal, which have served as important transport routes in the past. Nowadays the waterways seem to serve recreational purposes and it is difficult to find any information on commercial transport activity on the inland waterways of Meath. Waterways transportation is therefore assumed zero in this study.

Flight transport

Meath is serviced by Dublin Airport. There are several airfields for recreational flying, but these are not included in this study. The military landing strip at Gormanstown Camp is not actively used for aircraft.

Total emissions

The results of the baseline analysis for transport are presented in Table 9.

In the baseline calculation, the share of passenger rail transport appears very small. In 2018, the total train-km on Irish rails was 2281083 thousand passenger-kilometres[6]. Thus, the estimated passenger-kilometers would be only about 1.4 % of the national passenger transport on rails. One explanation for this could be that only very small part of the main rail connections are located within the borders of Meath County: for example the main connection Belfast-Dublin runs only 11.3 km within the borders of Meath.

[5] Iarnród Éireann Freight Fleet Information (irishrail.ie)

[6] Rail Statistics - CSO - Central Statistics Office

Table 9. Territorial transport baseline GHG emissions in County Meath (2019).

Mode of transport	Driving profile	Million vkm/a	$kgCO_2e/vkm$	tCO_2e/a	tCO_2e/a
passenger car	street	378.094	0.203	76,936	305,496
	road	1724.611	0.133	228,559	
bus	street	2.666	0.949	2,530	8,131
	road	9.756	0.574	5,601	
passenger train, diesel	commuter	0.454	1.685	765	876
	inter city	0.066	1.685	111	
vans, lorries <3.5 t (LGV)	street	54.173	0.255	13,838	55,391
	road	211.169	0.197	41,552	
lorries > 3.5 t (HGV)	street	18.845	0.900	16,960	133,113
	road	137.355	0.846	116,153	
freight train, diesel	ore	0.029	13.650	400	463
	intermodal	0.005	12.296	63	
Total					**503,469**

Table 10. Territorial transport baseline GHG emissions per capita **in County Meath (tCO_2e/(resident, a) (2019).**

Vehicle	tCO_2e/(resident, a)	%
Passenger car	1.566	60.7
Bus, coach	0.042	1.6
Passenger train	0.005	0.2
LGV	0.284	11
HGV	0.683	26.4
Freight train	0.002	0.1
Total	**2.581**	**100**

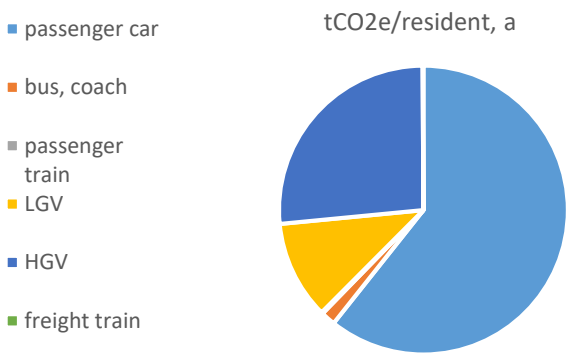

Figure 12. The total transport GHG emissions in County Meath (2019) and the shares of transportation modes.

2.1.2.3 Land use

The distribution of Meath land cover classes and soil types are shown in Figure 12 and Figure 13.

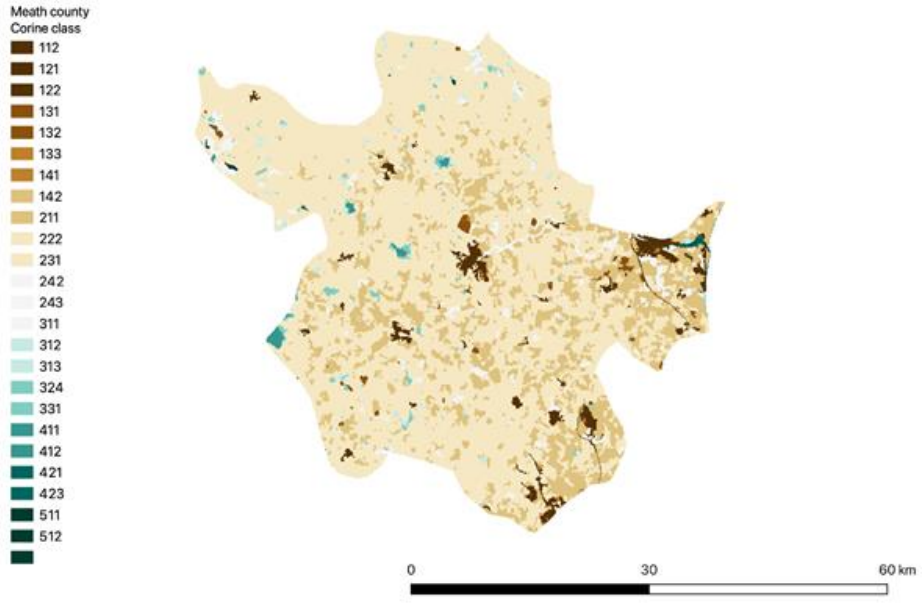

Figure 12. CORINE land cover classes in County of Meath.[7]

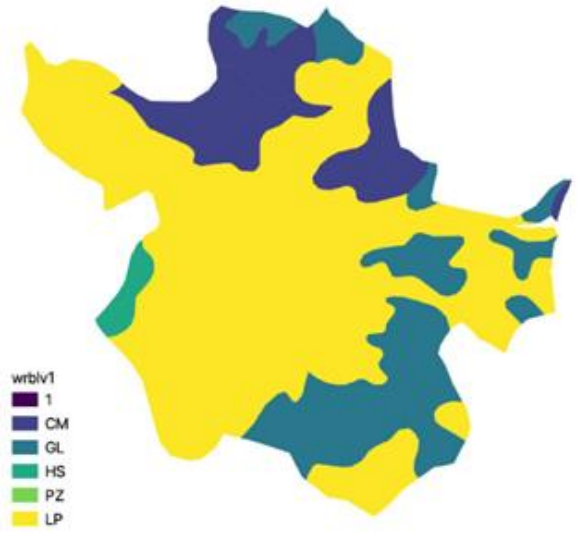

Figure 13. Soil types in County of Meath (European Soil Database).[8]

[7] CORINE classes: artificial areas (112–142); agricultural areas (211–243); forest and semi-natural areas (312–331); wetlands (411–423); water bodies (511–512).

[8] WRB soil classes: 1- no soil/no information available; CM - Cambisol; GL - Gleysol; HS - Histosol; PZ - Podzol; LP – Leptosol.

The dominant land cover is agricultural areas (CORINE class 2 ≈ IPCC cropland, grassland) that constitute 93% of total Meath area (
Table 11). Grasslands (CORINE class 231) cover 71% of total Meath area, which is in good alignment with the overall land use distribution in Ireland. Grassland is the dominant land-use category in Ireland, and the anthropogenic management of grasslands is long standing and profound due to the long-term trends towards livestock production in Ireland since the mid-1800s.

Table 11. County of Meath land use and soil types.

CORINE land class		IPCC land-use category	IPCC soil type (ha)		Total area (ha)
			mineral	organic	
Class 1: Artificial areas	112	Settlements	4,849	20	4,869
	121		565	0	565
	122		547	0	547
	131		917	0	917
	132		290	0	290
	133		280	0	280
	141		83	0	83
	142		1,607	0	1,607
Class 2: Agricultural areas	211	Cropland	41,745	540	42,285
	222		37	0	37
	231	Grassland	155,136	2,152	157,288
	242	Cropland	1,939	0	1,939
	243		2,989	12	3,000
Class 3: Forest and semi-natural areas	311	Forest land	1,367	0	1,367
	312		929	18	947
	313		1,287	0	1,287
	324		1,960	137	2,097
	331	Other land	5	0	5
Class 4: Wetlands	411	Unmanaged wetlands	35	0	35
	412	Unmanaged wetlands and peat extraction sites	348	398	746
	421	Unmanaged wetlands	60	0	60
	423		69	0	69
Class 5: Water bodies	511	Unmanaged land	73	0	73
	512		128	0	128
Total			**217,244**	**3,277**	**220,521**

Artificial areas (CORINE class 1 ≈ IPCC settlements) cover 4% of total Meath area, followed by forests and semi-natural areas (3%) (CORINE class 3 ≈ IPCC forest land, other (unmanaged) land). Wetlands (CORINE class 4 ≈ IPCC unmanaged wetlands, peat extraction sites) and water bodies (CORINE class 5 ≈ IPCC unmanaged land) account for 0.4% and 0.1%, respectively, of total Meath area. According to the European Soil Database, Histosols (IPCC organic soils) constitute 1.5% and mineral soils 98.5% of total area.

Annual carbon-stock-change factors reported by Ireland under UNFCCC 2021 submission and used for the baseline calculations are shown in Table 12.

Ireland uses several simplifications in the land use sector allowed according to IPCC Tier 1 method. Under cropland remaining cropland it is assumed that: below-ground biomass remains constant (CSC reported as 'not occurring'); default estimation of zero emissions or removals are associated with dead wood and litter. Under grassland remaining grassland no significant (zero) change in biomass and dead organic matter is assumed.

Ireland's national inventory report states that no cultivation occurs on organic soils under the cropland category, which is inconsistent with the data derived from the European Soil Database.

Under settlements remaining settlements no account has been made of the potential increased carbon stock in biomass in urban areas, e.g., in parks or roadside planting. It is noted in Ireland's National Inventory Report (NIR) that this may be a significant carbon sink, especially under the policy of actively encouraging urban tree planting along new roads and in new housing developments, but no data is available as yet. Likewise, carbon stock changes for soils under the settlements category are not available.

Table 12. Ireland land use carbon-stock-change factors (NIR, Submission 2021, inventory year 2019).

Carbon-stock-change factors	Biomass		Dead organic matter		Soil	
tC/(ha, a)	above-ground	below-ground	dead wood	litter	mineral	organic
Forest land remaining forest land	1.00	0.17	-0.20	0.01	-0.06	-0.45
Cropland remaining cropland	-0.003	NO	NO	NO	0.04	NO
Grassland remaining grassland	NO	NO	NO	NO	0.14	-6.76
Peat extraction remaining peat extraction	0.12	IE[9]	IE[10]	IE	NO	-3.11[11]
Settlements remaining settlements	NO	NO	NO	NO	NA	NA

NO – not occurring/no emissions are assumed.

IE – included elsewhere.

NA – not applicable/reporting not required.

Negative CSC factors denote decrease and positive increase in the C pool.

[9] Included in aboveground biomass.

[10] DOM and litter are indistinguishable from organic matter in organic soils. Therefore, it is assumed to be included in the assessment of carbon emissions and removals estimated for soils.

[11] Here only on-site carbon-stock-change factor (and resulting emissions from peat deposits due to drainage) from direct land management are shown. Off-site emissions from the extraction of peat for horticultural use are excluded because off-site emissions vary widely and depend directly on the annual amount of peat extracted.

Land use emission estimates in the County of Meath are presented in Table 13. The total annual emission estimate (net removal) of -53,151 tCO_2 does not include emissions from potentially significant sources such as peat extraction sites and cropland organic soils. The presence of cropland organic soils is debatable due to the discrepancies of data provided in different databases (Indicative Soil Map of Ireland vs European Soil Database). The approximate emissions from drained cropland organic soil could be around 16,000 tCO_2 if the organic soil area (551 ha) from European Soil database and the default IPCC emission factor (7.9 tCO_2-C/ha a for boreal and temperate croplands; is used. Another potential underestimation of emissions occurs in the peat extraction category, specifically due to drainage of organic soils. Despite the efforts made by the QGasSP service providers (official queries sent to Bord na Móna) and by the case study stakeholder (EMRA), no information on the current area of active peat extraction sites in the County of Meath was obtained. CORINE class 412 'Peatbogs' includes both natural bogs and peat extraction sites, therefore the area of class 412 cannot be equated to the area of peat extractions and respective emissions cannot be estimated in the current baseline analysis.

Table 13. County of Meath baseline land use emission estimates (tCO_2/a) (2019).

	Biomass		Dead organic matter		Soil		
IPCC Land use category	above-ground	below-ground	dead wood	litter	mineral	organic	**Total**
Forest land	-20,988	-3,491	4,236	-252	1,124	255	-19,116
Cropland	464	NO	NO	NO	-7,424	NE	-6,960
Grassland	NO	NO	NO	NO	-80,423	53,347	-27,076
Peat extraction sites (wetlands)	NE	NE	NE	NE	NO	NE	NE
Settlements	NO	NO	NO	NO	NE	NE	NE
Total	**-20,524**	**-3,491**	**4,236**	**-252**	**-86,723**	**53,602**	**-53,151**

Emissions have positive and removals negative signs.

NO – no (zero) emissions are assumed.

NE – not estimated.

2.2 Spatial planning policies

The Meath County Development Plan 2021–2027 sets out the policies and objectives and the overall strategy for the development of the County over the plan period. This Plan provides a pathway for Meath which will enable the county to continue to make significant contributions to national economic growth recovery by promoting sustainable development and facilitating stable economic growth, and thus, delivering long term benefits for the citizens of the county.

2.2.1 Policies to be quantified

2.2.1.1 Buildings

The County Development Plan (CDP) highlights the importance of reducing the county's reliance on imported fossil fuels and encourages the replacement of these fuels with regionally generated renewable energy, in an effort to ensure security of energy supply. In so doing, it promotes the use of lower carbon fuels in the home and highlights, where feasible and practicable, the provision of photovoltaic solar panels in new residential developments, commercial developments, and public buildings for electricity generation/storage and/or water heating purposes so as to minimise carbon emissions and reduce dependence on imported fossil fuels and reduce energy costs.

It also seeks to improve the energy efficiency of the County's existing building stock in line with good conservation practice and to promote energy efficiency in all buildings in the County. The CDP also promotes and facilitates the design of new energy efficient buildings and helps to support the use of heat pumps as an alternative to gas boilers, where appropriate, for domestic and commercial development.

Actions from the CDP that the tool will quantify for the building sector relate to the promotion and facilitation of energy efficient building design, as well as actions that promote the use of lower carbon fuels in buildings. While there are no policies that have numerical quantities attached in the CDP, nevertheless, the following policies and objectives can be quantified:

- To seek to improve the energy efficiency of the County's existing building stock
- To encourage that new development proposals maximise energy efficiency
- To support the use of heat pumps as an alternative to gas boilers
- To seek to reduce reliance on fossil fuels in the County by reducing the energy demand of existing buildings, in particular residential dwellings.
- To require, where feasible and practicable, the provision of Photovoltaic solar panels in new residential developments, commercial developments, and public buildings
- To support Ireland's renewable energy commitments by promoting the use of district heating systems in urban residential and enterprise developments.

The tool developed will quantify the impact on emissions from:

1) Construction of new buildings, both residential and commercial buildings
2) Retrofits of the building sector – which will also allow for changes in the current buildings' space and water heating to account for changes in technologies, such as changing from boilers to heat pumps or alternatively to account for connections to low carbon heat
3) Changes in urban densification
4) Change in building use (from commercial to residential or vice versa)
5) Increase in renewable energy generation from retrofits and new buildings.

2.2.1.2 Transport

According to the County Meath baseline emissions inventory 2012, the proportion of transport of total emissions is 28.8%.

The emphasis of the CDP is to encourage a modal shift towards walking and cycling; however, it is also important to recognise that some essential travel will continue to be made by cars and goods vehicles, the CDP facilitates improvement in road infrastructure to cater for the required improved efficiencies. It is a strategic aim of the CDP to create efficient compact settlements which reduce the need to travel. Maintaining and improving transport networks remains a priority, particularly in relation to the delivery of important infrastructural development and transport measures which support the economic development strategy for the County.

Achieving sustainable patterns of transport, in accordance with national and regional policies, such as increased public transport provision, coupled with enhanced cycling and walking facilities, will enable settlements to function more efficiently and effectively.

The actions of CDP will have an impact on transport activity, modal share and the fuel shares of transport vehicles. In passenger transport, it is important to estimate the number of residents whose transport performance is affected by each policy (areas, residents/non-residents). The numeric impact (change from the baseline) is estimated with the help of European reference cases and literature, but in every case all estimates assuming behavioural change, contain uncertainty.

The following actions of CDP will be quantified:

- Developing public transport (MOV POL 11); Quantification: adjusting the modal share of passenger transport
- Enhancing walking and cycling facilities

- Provision of Park-and-ride facilities which improve the public transport accessibility (MOV POL 13); Quantification: adjusting the modal share of passenger transport
- Increasing telecommuting (INF POL 54); Quantification: adjusting the passenger transport activity of residents.

2.2.1.3 Land use and land use change

The Meath County Development Plan 2020-2026 only includes urban areas - towns and villages, while no numerical development proposals for non-urban areas (e.g., afforestation, increase of croplands etc) are highlighted. Land Use Strategies mentioned in the development plans are rather generic and indicative, mostly suggesting regenerating and enhancing the natural and physical environment of the settlements. Nevertheless, given the data provided in Ireland's NIR, the following actions can be quantified:

- afforestation - grasslands (dominant land use transition to forestry)/wetlands to forest land
- deforestation - forest land conversion to grassland/peat extraction/settlements
- re-establishment of cutaway peatlands (Ireland applies here IPCC default values for rewetted soils and not country-specific data)
- cropland/grassland conversion to settlements.

2.2.2 Quantification results

2.2.2.1 Building related policies

New buildings

There are no indicative numerical proposals in the CDP, however when addressing actions such as construction of new buildings the projected number of additional household units for the plan period is provided under the Government's Housing Supply Targets (HST) (issued end of 2020). The annual average output projected from 2020 and beyond is calculated as 1,090 units as per the HST.

Territorial emissions

Even though an exact breakdown of residential buildings is difficult to forecast, this study assumes that the new residential buildings built are in the same proportion as those constructed in the same period, then this would mean that 455 apartments, 637 terraced, 1,908 semi-detached and 3,540 detached residential units are to be built over the six years. This increase in residential units would result in an additional 15,338 tonnes of CO_2. When considering densification, accounting for the same increase in housing units (6,540 additional units) the emissions from building energy use would have the same increase as new construction in a new settlement (25,338 tCO_2).

It was assumed that a total of 179,284 m^2 of floor space was created through this policy. Assuming this led to a total development of buildings with an equivalent spatial footprint (18 ha), the total expected emissions in the year of the development would be 3.4 $ktCO_2e$. This was assuming that the original land was originally split between forest land and grassland and between mineral and organic soils. The original land-use was assumed to be settlement in the case of densification, and so no additional land-use change emissions would be expected.

Consumption-based emissions

The same number of housing units and floor area was assumed on the consumption side of the calculations, with the average number of persons per household taken to be the same as in the baseline calculation and the relative income level was set to the national average. The calculations were performed for the year 2026. When considering a construction of a new settlement or densification of an existing settlement, the same energy efficiency of the housing stock was assumed and was taken to be to a higher standard than the existing stock. For the new settlement, the demand vector representing the consumption patterns of a medium density area (Towns) was applied, and that representing a high urban density (cities) was applied in the case of densification. The resulting emissions in 2026 were 4.7 tCO_2e per resident for the new settlement and 3.9 tCO_2e per resident in the case of densification. The equivalent emissions in the baseline for the year

2026 would be 7.1 tCO_2e per resident, with the differences largely arising from the improved energy efficiency of the new housing stock (considering both the new residents and original residents, the average per capita emissions would be approximately 7.0 tCO_2e per resident across the whole of county Meath in both cases). The total additional emissions would be 18 $ktCO_2e$ for the new settlement and 15 $ktCO_2e$ in the case of densification. The total life-cycle emissions from construction are assigned to the year of construction, and would amount to total additional emissions of 0.93 Mt CO_2e in this year. Assigned to the new residents, gives each a footprint of 29 tCO_2e in 2026 in the case of a new settlement and 28 tCO_2e in the case of densification.

Retrofitting

As mentioned previously, the CDP gives no indicative figures on the number of retrofits to take place in county Meath during the duration of the CDP. Even so, national policy objectives outlined in the 2019 Climate Action Plan 2021 aims to achieve the equivalent of 500,000 homes retrofitted to a Building Energy Rating of B2/ cost optimal or carbon equivalent and the installation of 400,000 heat pumps in existing premises to replace older, less efficient heating systems by end-2030.

Territorial emissions

For county Meath, over the CDP six-year timeframe, this would result in the retrofit of 9,564 houses which would be made up of 665 apartments, 932 terraced, 270 semi-detached and 5,177 detached houses to be retrofitted to a B rating. This assumes that the number of buildings retrofitted by type of dwelling are in the same proportion as the current existing housing stock. Assuming that the buildings outlined above are retrofitted from an E to a B rating, then this would result in an emission reduction of 86,335.21 tonnes of CO_2 in building energy use.

Consumption-based emissions

Using the same assumptions as the territorial side, applying the policy to 2026, leads to the retrofitted buildings requiring only 31% of the energy needed before the improvements took place. The retrofits are applied to approximately 15% of the housing stock, leading to overall energy savings in housing of around 10%. This leads to per capita annual emissions of 6.8 tCO_2e, and decreases total annual emissions by 68 $ktCO_2e$.

Renewable energy generation

Renewable energy (RE) generation for the building sector comes from the RE generated in new buildings and retrofitted ones. SEAI (the energy authority in Ireland) states that *'New homes are built to very high standards of energy efficiency and must include 20% of energy use sourced from renewable energy. So the real challenge lies in upgrading the existing housing stock*' (SEAI, 2020).

Territorial emissions

Assuming that all new houses include a 20% RE generation and that houses retrofitted to a B BER generate 10% of RE, this results in an increase of 11,178 MWh of RE. No information on new commercial buildings and retrofits could be found for the County Development Plan. However, it should also be noted that the tool can quantify construction of new commercial developments, retrofits, changes in building use and the effects of urban densification.

Consumption-based emissions

Here, the assumption that 10% of local electricity being generated from the retrofitted buildings was applied, leading to an increase in 1.5% of electricity from renewable sources (assumed to be rooftop PV). The calculation was performed in 2026. This leads to per capita average emissions across county Meath of 7.2 tCO_2e and a subsequent total annual emissions savings of 4.5 $ktCO_2e$, when applied across the whole county.

2.2.2.2 Transport related policies

Improving the provision of public transport

Territorial emissions

The policy aims at increasing the use of public transport and reducing passenger car transport. If a reduction of 20% (from all annual passenger car vehicle-kilometers) is achieved on both roads and streets, the total

transport CO_2e emissions in Meath will be reduced by 54,989 tCO_2e/a, that is 10.9% of total transport emissions. The bus transport activity would need to increase by 60.8% in urban environments and 81.6% in rural environments to cover the respective need for transportation. This is based on an assumption on average occupancy rates (passenger car 1.6; bus 16).

Consumption-based emissions

This policy was applied in 2026. It was assumed to lead to a 20% reduction in private fuel purchases, a 10% reduction in private vehicle and maintenance purchases, and a 20% increase in public transport purchases. This gave per capita emissions of 6.9 tCO_2e in 2026 across the whole of county Meath. The total emissions reductions were 61 ktCO_2e.

Enhanced walking and cycling facilities

Territorial emissions

If the promotion of active transport modes (walking and cycling) can reduce the passenger transport activity on road and rails for all transport activity in Meath County by 20%, the total transport CO_2e emissions will be reduced by 62,901 tonnes of CO_2e/a (12.5%).

Consumption-based emissions

This policy was also applied in 2026, and assumed to lead to a 20% reduction in private fuel purchases and a 10% reduction in private vehicle and maintenance purchases, but without any increase in public transport purchases. This gave per capita emissions of 6.9 tCO_2e in 2026 across the whole of county Meath. The total emissions reductions were 62 ktCO_2e.

Provision of park-and-ride facilities

Territorial emissions

If an attractive park-and-ride system can deliver a 10% reduction in passenger car transport on roads (vehicle kilometres for road driving -10%), the reduction in the total transport GHG emissions is about 20,570 CO_2e tonnes (4.1%). This estimate assumes that the bus transport on roads will increase by 40.8% respectively.

Consumption-based emissions

It must first be noted that changes to the mobility of non-residents travelling into the area cannot be tracked in the consumption-based approach, which can only look at the behaviour of the residents who live within county Meath. The policy was again applied in 2026 and as no further quantitative data was available, an assumption was made that this policy led to a reduction in private transport fuel purchases of 20%, an increase in public transport purchases of 20%, but without any changes in purchases on vehicles and vehicle maintenance. This consequently led to per capita emissions across County Meath of 6.9 tCO_2e and a total emissions reduction of 57 ktCO_2e.

Increased remote working

Territorial emissions

Active promotion of remote working can be expected to reduce the passenger transport in all vehicle categories. Assuming however that the reduction of passengers will have no impact on the bus and train services, the direct savings are gained in passenger car transport of the residents (60% of transport activity). A reduction of 5% in the resident's passenger car transport would reduce the total transport emissions by 15,275 tonnes of CO_2e (3.0%).

Consumption-based emissions

As with the other examples, the year was taken to be 2026, and the lack of quantitative data meant that an illustrative example of a reduction in private fuel purchases of 20% was applied without any changes to vehicle ownership or public transport. Household energy use for heating was assumed to increase by 5 %. Combining these two factors gives an average per capita emissions value of 7.1 tCO_2e and total savings of 19 ktCO_2e. However, it is important to stress that energy use in commercial or municipal buildings, which may decrease with more remote working, can't be tracked using a household carbon footprint approach. Therefore, part of the carbon footprint is being reassigned from people's place of work to the household. Assuming these energy savings would be equivalent to the increase in private households leads to these

factors cancelling out. In this case, the per capita emissions would be 6.8 tCO_2e and a total emissions reduction of 58 $ktCO_2e$ would be found.

Phase || of the Navan railway

Territorial emissions

Extending the M3 Parkway railroad line to Navan is estimated to have an impact on 33% of passenger transport in Meath County. The new connection makes commuter train an attractive option to the citizens of Navan and the surrounding areas. The reduction in total transport emissions would total 19,625 tonnes CO_2e/a (3.9% in the whole county), if this investment manages to reduce 20% of passenger car transport around Navan. This calculation takes into account the increase in passenger train transport (212.9% increase needed to cover the need for transportation). The embodied emissions of the infrastructure investments are not included. The calculation is based on diesel engines. Electrification of the Navan railway line would further reduce the GHG emissions.

Consumption-based emissions

No date of completion or numbers for the expected modal shift between private transport and rail transport could be found. Therefore, the year of completion was assumed to be 2026 and the policy was assumed to lead to 20% and 10% reductions in private fuel and vehicle/maintenance purchases, respectively. Moreover, public transport purchases were increased by 20%, and the share of public transport purchases on rail travel increased from 0.26 to 0.4. This all led to per capita emissions of 6.9 tCO_2e and total savings of 62 $ktCO_2e$.

2.2.3 Results

The results of the policy quantification are summarised in the following table. In general, there was a lack of quantitative numbers linked to specific policies in the reference document, meaning assumptions were required to perform the calculations.

Table 13. Quantifying spatial planning policies for County Meath. building-related policies.

policy	impact	module	quantification in GGIA	CO_2e increase / decrease (tCO_2)	Emissions per capita (tCO_2/capita)
1. a) new construction as new settlement	2022-26	energy use in buildings	additional floor area in all building categories	15,338	
		transport	increase in transport activity (number of residents), modal share as in suburban areas		
		land-use change	land use change (ha) from greenfield (land use type forest and grassland) to settlement	3,400	
		consumption-based	increase in the number of residents, Town demand vector, Improved building efficiency	18,000 (additional 94,000 construction emissions)	New residents 4.7 (in 2026) 29 (including construction)
1. b) new construction as densification	2022-26	energy use in buildings	additional floor area in all building categories	15,338	
		transport	increase in transport activity (number of residents), modal share as in suburban areas		
		land-use change	no impact		
		consumption-based	increase in the number of residents, Town demand vector, Improved building efficiency	15,000 (additional 94,000 construction emissions)	New residents 4.0 (in 2026) 28 (including construction)
2. Retrofitting	2022-26	energy use in buildings	change in energy consumption profile of existing buildings	86,000	
		consumption-based	change in expenditure on energy	66,000	6.8 (in 2026)
3. Increase in renewable energy generation	2022-26	energy use in buildings	change in energy consumption profile of existing buildings	11,178 MWh	
		consumption-based	increase in the share of renewable energy	2,400	7.2 (in 2026)

The construction of the new buildings would lead to total life-cycle emissions of 0.9 Mt tCO_2e in 2026. Assigned to the new residents, this gives each a footprint of 53 tCO_2e in 2026.

Table 14. Quantifying spatial planning policies for County Meath. transport-related policies.

policy	impact	module	quantification in GGIA	CO_2e increase /decrease (tCO_2)	Emissions per capita (tCO_2/capita)
4.1 Improving the provision of public transport	2022-26	transport	reduce passenger car transport; increase bus transport respectively	54,989	
		consumption-based	part of the transport expenditure moves from passenger cars to public transport	59,000	6.9 (in 2026)
4.2 Enhancing cycling and walking facilities	2022-26	transport	reduce transport activity (active modes excluded)	62,901	
		consumption-based	decreas in private transport expenditure	60,000	6.9 (in 2026)
4.3 Provision of park-and-ride facilities	2022-26	transport		20,570	
		consumption-based	part of the transport expenditure moves from passenger cars to public transport	55,000	6.9 (in 2026)
4.4 Increasing remote working	2022-26	transport	change in energy consumption profile of existing buildings	15,275	
		consumption-based	increase in the share of renewable energy	6,000 17,000 (with 5% increased household energy use)	6.8 (in 2026) 7,100 (with 5% increased household energy use)
4.5 Phase II of the Navan Railway line	2022-26	transport	20% reduction of passenger car transport around Navan	19,625	
		consumption-based	part of the transport expenditure moves from passenger cars to public transport	59,000	6.9 (in 2026)

3 Conclusions

This section identifies the key findings from the different carbon emitting sectors for both the consumption and territorial-based approaches, and also discusses the actions from the quantified spatial planning policies that can contribute the most to emission reductions in County Meath.

3.1 Key findings from the baseline

It should be noted that both approaches for estimating emissions, have identified the transport and building sectors as having the highest emissions and consumed more fossil fuels than the other sectors. Thus from this analysis, these sectors should be the main targets of energy and emission reduction initiatives.

3.1.1 Consumption-based approach

- The total consumption emissions for the region were calculated to be approximately 1.4 $MtCO_2e$ per annum.
- The largest contributions to the emissions came from residential energy demand and transport fuels.
- Residential energy is dominated by so-called 'use phase' emissions, which reflects the large proportion of space heating arising from direct combustion of fossil fuels in the household.
- The transport emissions are influenced by both the fuel mix and overall expenditure. The proportion of renewable sources in the transport fuels was only around 9%.
- The higher household occupancy than the national average (2.73 based on Eurostat figures), leads to a lower per capita footprint than would ordinarily be expected. The emissions from the production phases were rather small, with electricity accounting for a large proportion.

3.1.2 Territorial approach

3.1.2.1 Buildings

- In 2016, the largest share of residential units were detached houses; they made up 54% of the total residential housing stock in County Meath. This was followed by semi-detached houses (29%) and terraced (10%), whilst the lowest share of housing were apartments, comprising 7% of Meath's housing stock.
- The commercial properties that produced the most emissions were industrial uses, retail, hospitality and offices are the main CO_2 emitters, as altogether they made up 96% of the commercial sector's total emissions.
- Total emissions from both the residential and commercial sectors in Meath accounted for 671,690 tonnes of CO_2 in 2016.
- The residential sector contributed 60% and the commercial sector 40% to the total emissions.
- The main source of emissions come from electricity (42%), followed by heating oil (34%) and natural gas (20%).

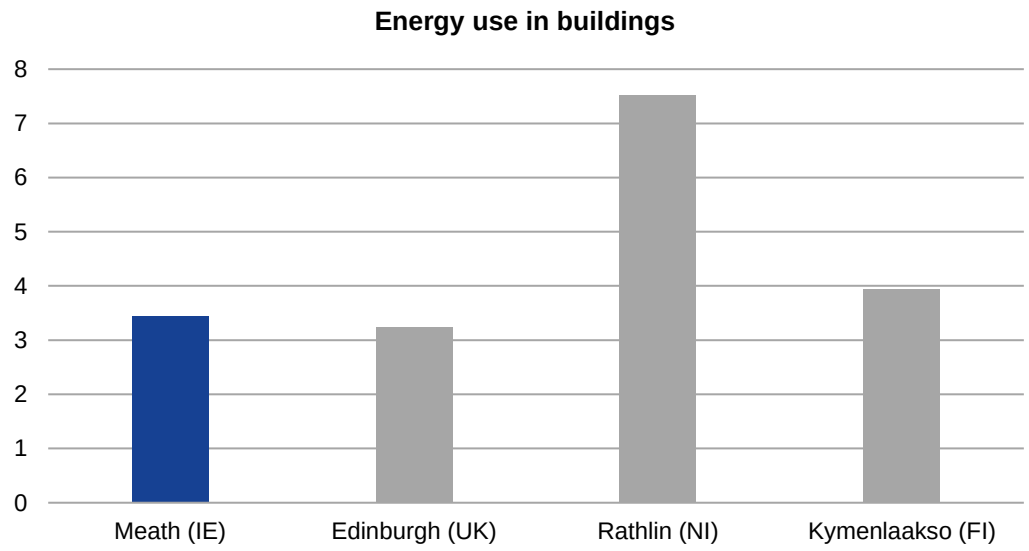

Figure 14. Annual buildings baseline emissions per capita ($tCO_2e/(capita,a)$) (2019).

3.1.2.2 Transport

- The majority of emissions came from passenger cars, which make up 60.7% of the total emissions, followed by heavy goods vehicles, only accounting for 26.4% and light goods vehicles, which contributed 11% to the total transport emissions.

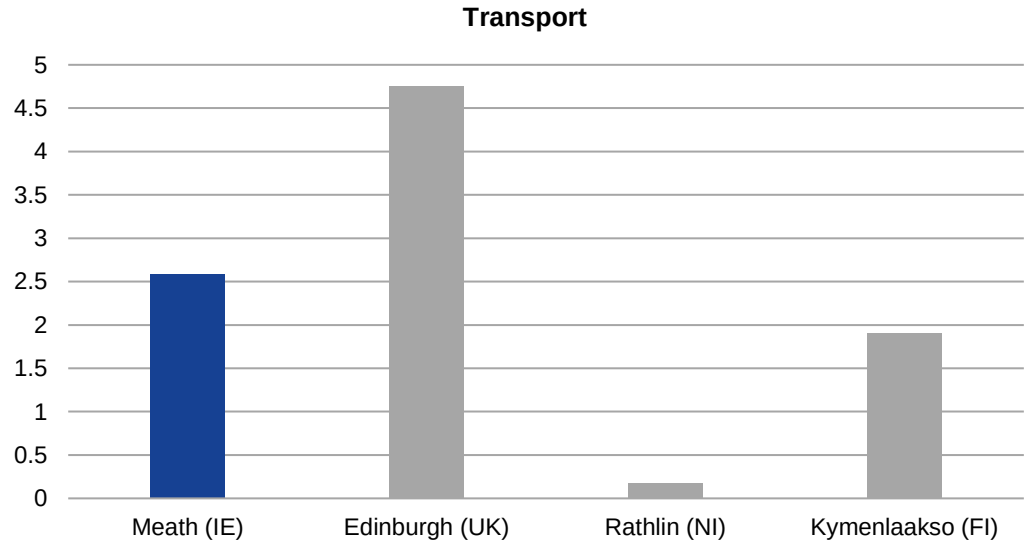

Figure 15. Annual transport baseline emissions per capita ($tCO_2e/(capita,a)$) (2019).

3.1.2.3 Land use

- The dominant land cover is agricultural areas (CORINE class 2 ≈ IPCC cropland, grassland) that constitute 93% of total Meath area.
- Grasslands (CORINE class 231) cover 71% of total Meath area, which is in good alignment with the overall land use distribution in Ireland. Grassland is the dominant land-use category in Ireland, and the anthropogenic management of grasslands is long standing and profound due to the long-term trends towards livestock production in Ireland since the mid-1800s (Ireland's National Inventory Report 2021).
- Artificial areas (CORINE class 1 ≈ IPCC settlements) cover 4% of total Meath area, followed by forests and semi-natural areas (3%) (CORINE class 3 ≈ IPCC forest land, other (unmanaged) land). Wetlands (CORINE class 4 ≈ IPCC unmanaged wetlands, peat extraction sites) and water bodies (CORINE class 5 ≈ IPCC unmanaged land) account for 0.4% and 0.1%, respectively, of total Meath area.
- The total annual emission estimate (net removal) of -53,151 tCO_2. This does not include emissions from potentially significant sources such as peat extraction sites and cropland organic soils.
- The approximate emissions from drained cropland organic soil could be around 16,000 tCO_2 if the organic soil area (551 ha) from European Soil database and the default IPCC emission factor (7.9 t CO_2-C/ha,a for boreal and temperate croplands.

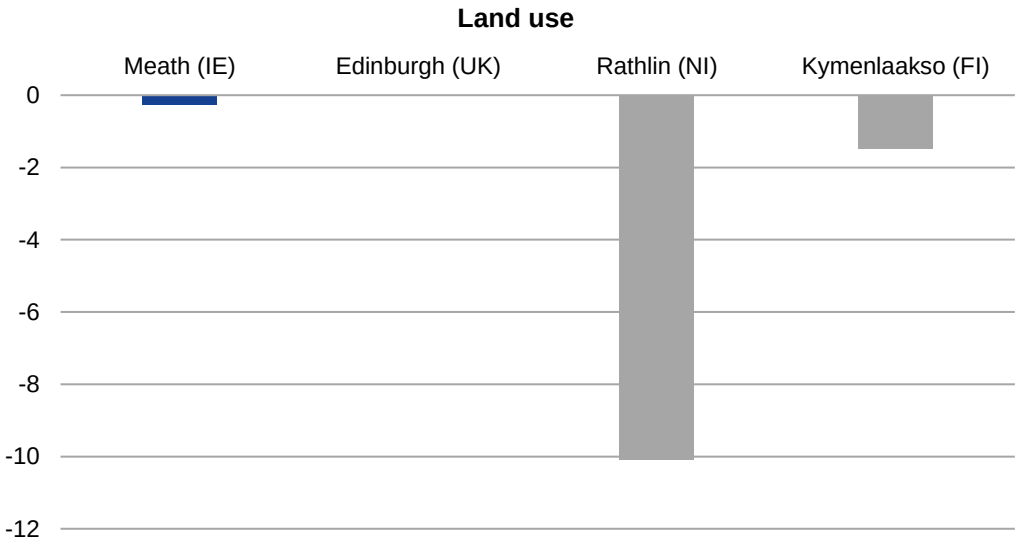

Figure 16. Annual land use baseline emissions per capita (tCO_2e/(capita,a)) (2019).

3.2 Key findings from the action quantification of spatial planning policies

From the actions that were quantified for the Meath County Development Plan 2021–2027, retrofitting and transport related actions had the greatest potential to reduce emissions.

From the analysis carried out for County Meath's residential sector, it was found that over the CDP six-year timeframe, if over 9,500 residential buildings were to be retrofit to a Building Energy Rating of B2/ cost optimal or carbon equivalent, this could potentially result in an emission reduction of 86,335.21 tonnes of CO_2 in building energy use. Renewable energy (RE) generation for the building sector comes from the RE generated in new buildings and retrofitted ones. Assuming that all new houses constructed include a 20% RE generation and that houses retrofitted to a B BER generate 10% of RE, this results in an increase of 11,178 MWh of RE.

As for transport related policies, by improving the provision of public transport, the policy aims at increasing the use of public transport and reducing passenger car transport. If a reduction of 20% (from all annual passenger car vehicle-kilometres) is achieved for all road transport, the total transport CO_2e emissions in

Meath will be reduced by 54, 989 tCO_2e/a, that is 10.9% of total transport emissions. Bus transport activity would need to increase by 60.8% in urban environments and 81.6% in rural environments to cover the respective need for transportation. Furthermore, If the promotion of active transport modes (walking and cycling) can reduce the passenger transport activity on road and rails for all transport activity in Meath County by 20%, the total transport CO_2e emissions will be reduced by 62,901 tonnes of CO_2e /a (12.5%). If an efficient park-and-ride system can deliver a 10% reduction in passenger car transport on roads (vehicle kilometres for road driving -10%), the reduction in the total transport GHG emissions is about 20,570 CO_2e tonnes (4.1%).

From these policies and this project's emission estimations, it is clear that there is great potential to reduce emissions significantly in both the building and transport sectors, which are currently very heavily reliant on fossil fuels.

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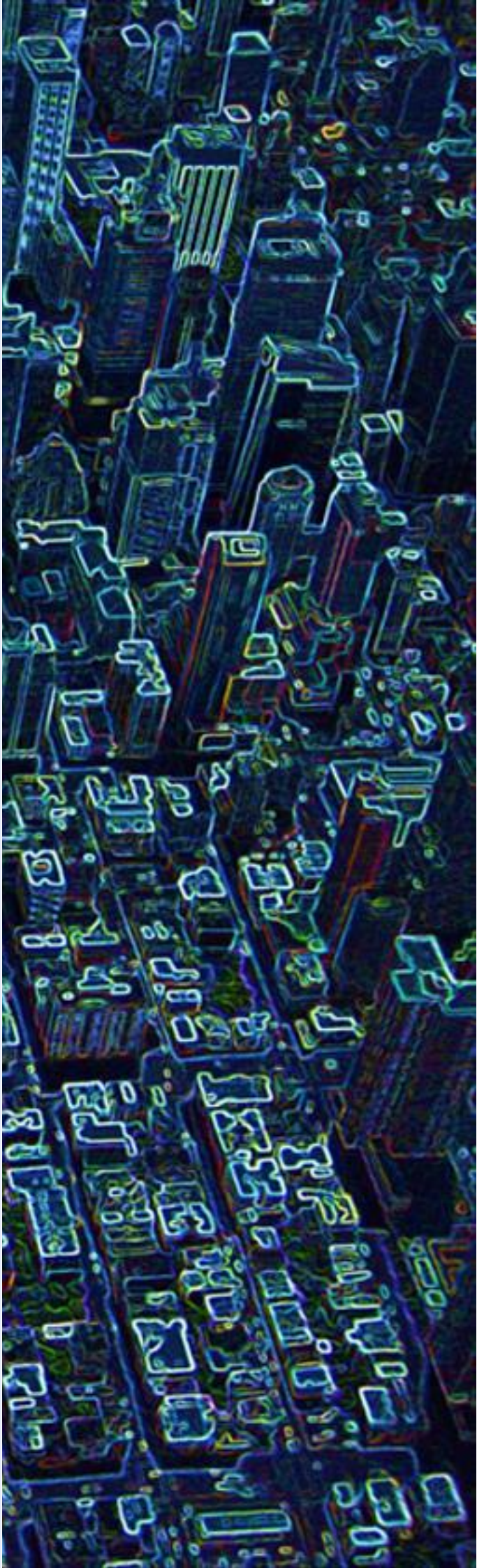

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