ARUP

HSE Ireland

Support services to Operation Zero – Health Service Executive National Roadmap

GHG Emissions Baseline

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Glossary and Acronyms

Term	Definition
Assets	A collective term to refer to all physical assets, including vehicles, buildings, equipment. In the context of the HSE, this refers to all physical assets operated by the HSE, whether the are owned or leased.
Baseline	A detailed assessment of the health sector emissions for the defined geographical scope, covering the core components of the footprint as defined in this Methodology. This baseline provides the basis for future projections and the quantification of emissions mitigation measures.
Bottom-up	Bottom-up emissions calculation methods use detailed reported data relating to an entity's activities and processes (e.g. electricity use or waste generation) coupled with emission factors to estimate emissions.
Carbon dioxide (CO_2)	A greenhouse gas emitted primarily from the combustion of fossil fuels such as coal, oil, and gas. It is the most commonly referenced gas in climate strategies due to its high volume and long-term impact on global warming.
Carbon dioxide equivalent (CO_2e)	Carbon dioxide equivalent. A standard unit of measurement that expresses the impact of all greenhouse gases in terms of the amount of CO_2 that would create the same warming effect, allowing multiple gases to be reported as a single figure that includes all greenhouse gas emissions.
Decarbonisa-tion	Decarbonisation is the process of reducing carbon emissions released. This follows an emissions reduction trajectory depending on ambitions and goals, e.g. aligning with the Paris Agreement.
DEFRA	The UK Government Department for Environment, Food and Rural Affairs.
DESNZ	The UK Government Department for Energy Security and Net Zero.
Methane (CH_4)	Methane is a potent greenhouse gas with a global warming potential significantly higher than CO_2 over a 20-year period.
EEIO	Environmentally-extended input output (EEIO) model. Input-Output (IO) tables model the economic flows between sectors in an economy. EEIO tables combine this with emissions data to quantify links between economic activity and impacts such as resource use, land demand, greenhouse gas emissions, etc. EEIO tables can relate to a single country or region or cover multiple regions with many covering the global economy.
HSE	The Health Service Executive.
Hybrid model	A blend of top-down and bottom-up methodologies that combines the benefits of both. Bottom-up is used where robust data is available and to supplement elements that may not be present in the EEIO model. This allows for maximum coverage, while using the highest resolution data available.

GLEC	Global Logistics Emissions Council. Led by Smart Freight Centre, GLEC is a multi-stakeholder initative in the logistics and freight transport industry, where companies and NGOs are dedicated to drive widespread, transparent and consistent calculation and reporting of GHG emissions. Since its inception in 2014, GLEC developed a universal method for calculating logistics emissions across road, rail, air, sea, inland waterways and transhipment centers. The "GLEC Framework for Logistics Emissions Methodologies" combines existing methods into one framework.
GHG	Greenhouse gases. Gases in the atmosphere that trap heat and contribute to global warming. Key GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. Their impacts are expressed as carbon dioxide equivalents (CO_2e).
GHGP	The Greenhouse Gas Protocol. The GHGP is the world's most widely used standard for greenhouse gas accounting and reporting.
Materiality	A concept used to determine which greenhouse gas (GHG) emissions are sufficiently significant to be included in an inventory or assessment. The materiality of an emission source can be shaped by its proportional contribution to total organisational emissions, the extent over which emission reductions can be undertaken or influenced by the HSE, the contribution to the HSE's risk exposure, the importance of the emissions source to the HSE's key stakeholders and how it fits into other organisational priorities.
Metered Dose Inhalers (MDI)	In a decarbonisation context, MDIs are a source of Scope 1 greenhouse gas emissions due to the use of hydrofluorocarbon (HFC) propellants, which have high global warming potentials. Switching to low-emission alternatives, is a key mitigation strategy.
Net zero	Net zero carbon emissions are achieved when anthropogenic GHG emissions are balanced globally by anthropogenic carbon removals over a specified period.
Nitrous Oxide (N_2O)	Nitrous oxide. In the context of decarbonisation, N_2O is a long-lived greenhouse gas with a global warming potential approximately 265 times that of CO_2.
SEAI	Sustainable Energy Authority of Ireland. SEAI is the national body responsible for promoting sustainable energy practices and managing Ireland's public sector Monitoring and Reporting (M&R) framework for energy and emissions.
Section 38 & 39 bodies	These are publicly funded, non-HSE organizations that deliver health and social care services. Section 38 bodies operate under formal agreements with the HSE and their staff are public servants, while Section 39 bodies receive grant funding but are independent, with their own governance and non-public servant staff.
Top-down	Top-down emissions calculation methods use Input-Output Analysis (IOA) to couple expenditure data with global models of the economy and resource use (known as Environmentally Extended Input-Output, or EEIO, models) to produce an estimate of the share of overall emissions that an entity is responsible for.
Well-to-tank	Emissions associated with the extraction, processing, and delivery of fuels prior to their use in vehicles or equipment. These are indirect emissions that occur upstream of fuel combustion and are included in Scope 3 reporting unless the organisation has control over the fuel production process.

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1.   Introduction

To support targeted action on greenhouse gas emissions (GHG), the Health Service Executive (hereafter referred to as the HSE) has undertaken the development of a comprehensive baseline emissions inventory, capturing direct and indirect scope 1, 2, and 3 GHG emissions across the organisation. This project marks the completion of the HSE's first full organisational inventory covering all three scopes. This report presents the findings of the 2019 GHG emissions assessment and establishes a foundation for future reporting. It provides a detailed breakdown of current emissions and hotspots across operations and the supply-chain, which can be used for developing emissions reduction strategies and planning implementation.

As this year is the first time the HSE has undergone the corresponding data collection, management and accounting processes, there are several measures which could be taken to improve the process and quality of results in future reporting years. The contents of this report provide recommendations to help the HSE to improve the quality and completeness of data collected, precision of GHG emissions derivations, and ease of data collection and emissions calculations in future reporting years. These recommendations are provided for each respective greenhouse gas emissions subcategory for the HSE in Appendix A: Data gaps, assumptions, and recommendations for data quality improvements.

1.1   Legislative, regulatory and strategic context

Ireland's commitment to addressing climate change is enshrined in the Climate Action and Low Carbon Development (Amendment) Act 2021, which legally binds the country to achieve a 51% reduction in greenhouse gas (GHG) emissions by 2030, relative to 2018 levels, and to attain net-zero emissions by 2050. To fulfil these obligations, the Irish Government introduced the Climate Action Plan 2021 (CAP21)[1], mandating public sector bodies, including the Health Service Executive (HSE), to lead by example. A key requirement is a 51% reduction in energy-related GHG emissions from both owned and leased assets by 2030, relative to a 2018 baseline.

CAP21 and its subsequent annual updates also outline specific Monitoring and Reporting (M&R) requirements for public bodies. Since 2014, under Regulation 5(3) of S.I. 426, public bodies have been required to report annual energy consumption data for all owned and leased physical assets, including buildings, vehicles, and equipment[2]. The Sustainable Energy Authority of Ireland (SEAI) manages this reporting process, publishing results in their Annual Reports on Public Sector Energy Performance.

In response to this regulatory framework, the HSE has set ambitious targets in its Climate Action Strategy[3] 2023–2050 and the accompanying Infrastructure Decarbonisation Roadmap[4]:

- Reduce energy-related Scope 1 and 2 GHG emissions by 51% by 2030, using a 2016–2018 average baseline.

- Reduce thermal (heating and transport) related GHG emissions by 51% by 2030, against the same baseline.

- Achieve net-zero emissions by 2050.

The Infrastructure Decarbonisation Roadmap details the HSE's progress toward these goals, reporting an 11.9% reduction in energy-related GHG emissions and a 7% reduction in thermal-related GHG emissions as of 2022, relative to the 2016–2018 baseline.

Furthermore, the Infrastructure Decarbonisation Roadmap sets out both the completed and planned decarbonisation actions led by Capital & Estates. These include initiatives focused on the development of energy-efficient and Net Carbon Zero Ready buildings, as well as the deep energy and carbon retrofit of the existing building stock. These efforts are supported by a broader suite of interventions aimed at

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[1] Department of the Environment, Climate and Communications. (2021). Climate Action Plan 2021.
[2] Irish Statute Book. (2014). S.I. No. 426/2014 - European Union (Energy Efficiency) Regulations 2014.
[3] HSE. (2023). HSE Climate Action Strategy 2023-2050.
[4] HSE. (2024). HSE Capital & Estates: Infrastructure Decarbonisation Roadmap.

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strengthening governance, enhancing monitoring and reporting systems, and building the human capacity required to deliver decarbonisation across the capital estate.

1.2 Assessment standards

This GHG emissions baseline has been prepared in alignment with *Designing a Net Zero Roadmap for Healthcare: Technical Methodology and Guidance*[5], which provides guidance on how to track, manage, and reduce, emissions from national and regional health systems. This guidance aligns with the principles outlined in the GHG Protocol (GHGP) Corporate Accounting and Reporting and Standard[6], and the GHGP Corporate Value Chain (Scope 3) Accounting and Reporting Standard[7]. The Corporate Standard sets out the globally recognised framework for measuring and reporting direct and indirect GHG emissions, while the Corporate Value Chain (Scope 3) Standard provides a methodology for identifying and quantifying emissions across an organisation's entire value chain.

Since the HSE as an organisation provides most of the health sector activities in Ireland, this report is able to more closely align with reporting categories and protocols in the GHGP than is possible for other, more distributed, health sectors in other countries. This study does not cover all public health entities across Ireland, as it excludes emissions associated with the operations and value chain of Section 38 and 39 bodies.

1.3 Sources of emissions from the healthcare sector

All healthcare activities carry a carbon liability, from the energy consumed within the sector's buildings, to the vehicles used to transport patients, staff, and visitors, and the products and services used to facilitate its operations. The GHGP breaks down the total emissions into three scopes:

- **Scope 1 emissions**: Direct emissions associated with the operation of an organisation's facilities or fleet vehicles.

- **Scope 2 emissions**: Indirect emissions associated with purchased electricity, heat or steam.

- **Scope 3 emissions**: Indirect emissions related to an organisation's activities but generated from sources outside of its ownership and control.

Figure 1 provides an overview of high-impact emissions categories related to the healthcare sector more generally, linked to the emissions scopes set out in the GHGP. For indirect scope 3 emissions, emissions can occur either **upstream** or **downstream** of the provision of care:

- Upstream Scope 3 emissions describe emissions generated before goods and services reach the healthcare provider, including the extraction, production, and transportation of pharmaceuticals, medical devices, food, fuel, energy and building materials, as well as the treatment of waste generated in operations, business travel and staff commuting.

- Downstream Scope 3 emissions comprise emissions that occur after the healthcare system has used a product or provided a service, such the end-of-life treatment of medical products sold by healthcare providers or emissions associated with the operation of investments, including debt, equity and project finance.

Not all of these emissions sources will be pertinent to the GHG inventory of the HSE considering their operations; procurement practices; and goods and service offerings. The emissions sources that are material to the HSE have been listed and described in Table 1.

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[5] Health Care Without Harm & Arup, (2022). *Designing a Net Zero Roadmap for Healthcare: Technical Methodology and Guidance*. https://europe.noharm.org/sites/default/files/documents-files/7186/2022-08-HCWH-Europe-Designing-a-net-zero-roadmap-for-healthcare-web.pdf
[6] World Business Council for Sustainable Development & World Resources Institute, (2004). The Greenhouse Gas Protocol: a corporate accounting and reporting standard (revised edition).
[7] World Resources Institute and World Business Council for Sustainable Development. (2011). Corporate value chain (scope 3) accounting and reporting standard: supplement to the GHG protocol corporate accounting and reporting standard.

Figure 1: Emission sources across the entire Health Sector (source: Health Care Without Harm)
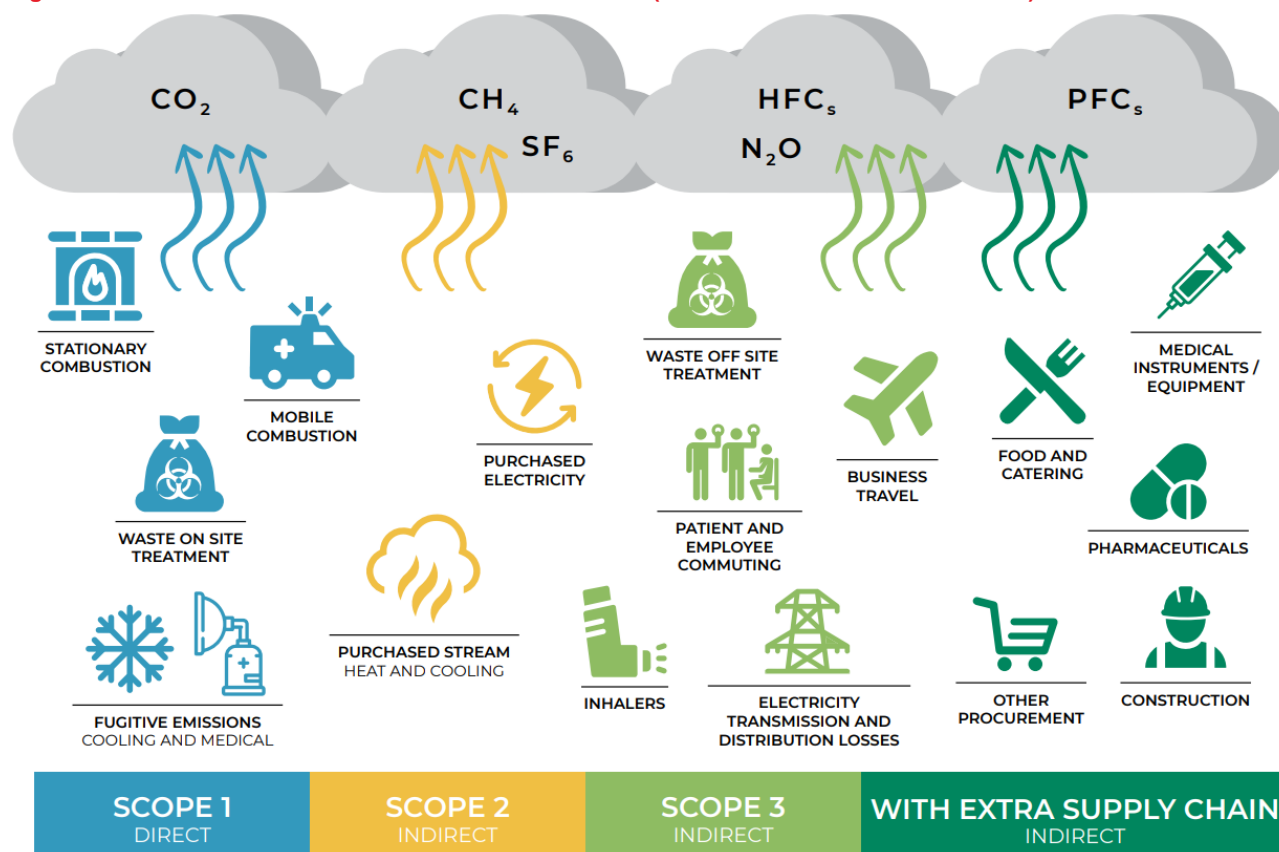
1.4 This report

This report presents the GHG emissions baseline of the HSE for 2019 alongside a summary of the methods and data sources used in the emissions assessment. It sets out a breakdown of the results by emissions source categories and provides analysis of the results, whilst suggesting areas for data collection that would improve assessment accuracy in forthcoming years. This report is divided into seven key sections.

Section 2 provides an overview of the results of the 2019 emissions baseline for the HSE. This is preceded by an explanation of the boundary of emission sources assessed. Results are broken down across Scope 1, 2 and 3 as defined by the GHGP. This framework allows for the identification of emissions "hot spots" that should be prioritised in future decarbonisation planning.

Section 3 provides an overview of the methodology employed in modelling the emissions baseline of the HSE. This includes a summary of the overarching calculation approach; the process for selecting and generating GHG emission factors and calculating emissions by emissions category; results validation and verification checks; alongside a summary of data quality and completeness.

Section 4 provides a summary of the findings from the emissions baseline, whilst discussing the next steps for the project in the development of a decarbonisation roadmap for the HSE.

Appendix A provides a summary of the data gaps, assumptions, and recommendations for data quality improvements for the estimation of the 2019 baseline for the HSE-.

Appendix B gives a more detailed explanation of the approach taken in mapping the HSE categories to EXIOBASE product categories in the spend-based approach to estimate some scope 3 emissions categories using financial data.

2. Emissions Baseline of the HSE

2.1 Boundary of the GHG Baseline

2.1.1 Organisational boundary

Organisational boundaries define which entities, operations, and facilities are included within an organisation's GHG inventory. This determines who is responsible for reporting emissions and ensures consistency and transparency in emissions accounting. Organisations must choose a boundary-setting approach to define how they consolidate emissions across their operations. The GHGP provides two main approaches:

1. Equity Share Approach: Emissions are accounted for based on the organisation's share of equity in an operation, representing its level of ownership or economic interest.

2. Control Approach: The organisation accounts for 100% of emissions from operations over which it has control, regardless of ownership. This includes:

   - Operational Control: Where the organisation has authority over operational policies and practices.

   - Financial Control: Where the organisation can direct financial and investment decisions, typically through majority ownership.

Under the Irish Government's CAP21[1] and under the SEAI M&R-2030 Methodology Guidance[8], emissions associated with buildings and vehicles which the HSE lease are treated as Scope 1 and 2 emissions, thereby aligning with an operational control approach, assuming that the reporting organisations have operational control over their leased assets. Hence, to align with these practices, an **operational control approach** to organisational boundary setting was employed in the development of the HSE emissions baseline.

2.1.2 Operational boundary

The operational boundary sets the scope and extent of an organisation's activity that will be captured within the emissions footprint and for which the organisation will assume accountability. To ensure comprehensive and transparent accounting of the HSE's climate impact, **all relevant scope 1, 2 and 3 emission sources** were included within the operational boundary of this HSE GHG baseline. Please note that data gaps prevented reporting on F-gas emissions relating to refrigerant leakage, as detailed in Appendix A: Data gaps, assumptions, and recommendations for data quality improvements.

Table 1 below provides definitions of all GHG emission categories. Against each category, a judgement and justification are made for whether the emissions category is material to the HSE considering their operations; procurement practices; and goods and service offerings. Recommendations to improve data collection for all material emissions sources are provided in Appendix A: Data gaps, assumptions, and recommendations for data quality improvements.

Table 1: GHG Emissions category definitions and materiality to the HSE

Emissions Scope	Emissions Sub-category	Definition	Materiality to HSE
Scope 1 & 2	Energy-related Scope 1 and 2 emissions (SEAI boundary)	CO_2 emissions from the combustion of fuels in stationary equipment (e.g. boilers, generators) and vehicles (e.g. ambulances, fleet vehicles) controlled by the organisation as well as emissions from the generation of purchased electricity consumed by the organisation.	**Material**: CO_2 emissions generated by fuels combusted for thermal purposes in HSE buildings and equipment and to propel vehicles operated by the HSE. Also CO_2 emissions produced to generate the electricity consumed by physical assets (i.e., buildings, vehicles, and equipment) operated by the HSE.
	Energy-related Scope 1 and 2	Methane (CH_4) and Nitrous Oxide (N_2O) emissions from the combustion of fuels in stationary equipment (e.g. boilers,	**Material**: CH_4 and N_2O emissions generated by fuels combusted for thermal purposes in HSE buildings and equipment and to propel

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[8] Sustainable Energy Authority of Ireland. (2023). Public sector M&R-2030 framework: M&R-2030 methodology guidance.

Emissions Scope	Emissions Sub-category	Definition	Materiality to HSE
	CH_4 and N_2O emissions	generators) and vehicles (e.g. ambulances, fleet vehicles) controlled by the organisation as well as emissions from the generation of purchased electricity consumed by the organisation.	vehicles operated by the HSE. Also CH_4 and N_2O emissions produced to generate the electricity consumed by physical assets (i.e., buildings, vehicles, and equipment) operated by the HSE.
	F-gas emissions	Emissions from the intentional or unintentional release of fluorinated gases from equipment or medical products.	**Material**: F-gases emitted from the use of anesthetic gases, metered dose inhalers (MDIs) and the leakage of refrigerants.
	Process emissions	Emissions from physical or chemical processes other than combustion (e.g. cement production, chemical manufacturing).	**Immaterial**: No such emissions sources from the operatins of the HSE.
	Purchased steam, heating and cooling	Emissions from the generation of purchased steam, heating, or cooling that is consumed by the organisation.	**Immaterial**: The HSE does not procure these utilities.
Scope 3	Category 1. Purchased Goods and Services	Emissions from the production of goods and services purchased or acquired by the organisation (excluding capital goods).	**Material**: The HSE procures a diverse range of goods and service to support their operations (e.g., pharmaceuticals, medical equipment, food and catering, business services, etc.).
	Category 2. Capital Goods	Emissions from the production of capital goods purchased or acquired by the organisation (e.g. medical equipment, infrastructure).	**Material**: The HSE procures multiple types of capital goods (eg., medical machinery) and capital projects (e.g, buildings).
	Category 3. Fuel and Energy Related Activities	Emissions from upstream activities related to fuels and electricity purchased by the organisation (e.g. extraction, refining, transmission).	**Material**: The HSE consumes fuels for direct combustion and electricity.
	Category 4. Upstream Transportation and Distribution	Emissions from the transportation and distribution of goods and services purchased by the organisation, in vehicles not owned or controlled by the organisation.	**Material**: The majority of goods and services purchased by the HSE are transported to HSE facilities in vehicles not operated by the HSE. The HSE also pays for distribution services of goods between its facilities (e.g., blood and speciments).
	Category 5. Waste Generated in Operations	Emissions from third-party disposal and treatment of waste generated by the organisation's operations.	**Material**: HSE generates significant volumes of clinical, hazardous, and general waste across its facilities, with associated emissions from collection, treatment, and disposal. This also includes emissions from third-party treatment of wastewater generated by the organisation, such as effluent discharged to municipal wastewater treatment plants.
	Category 6. Business Travel	Emissions from employee travel for business purposes in vehicles or transport modes not owned or controlled by the organisation.	**Material**: Business travel is undertaken by staff of the HSE (e.g. for training, inter-site visits, and community-based healthcare).
	Category 7. Employee Commuting	Emissions from the transport of employees between their homes and worksites in vehicles not owned or controlled by the organisation.	**Material**: The HSE has a large national workforce commuting dail.
	Category 8. Upstream Leased Assets	Emissions from the operation of assets leased by the organisation (not included in Scope 1 or 2).	**Immaterial**: Under the reporting requirements of the Irish Government's Climate Action Plan emissions from leased building and vehicles are **reported under Scope 1 and 2 emissions**Error! Bookmark not defined.. This aligns with an operational control approach to organisational boundary setting.
	Category 9. Downstream Transportation and Distribution	Emissions from transportation and distribution of sold products in vehicles not owned or controlled by the reporting organisation.	**Immaterial**: The HSE does not produce or distribute products at scale for external sale or delivery, limiting relevance of this category.
	Category 10. Processing of Sold Products	Emissions from processing of intermediate products sold by the organisation by third parties.	**Immaterial**: The HSE does not sell products that require further processing by downstream parties.

Emissions Scope	Emissions Sub-category	Definition	Materiality to HSE
	Category 11. Use of Sold Products	Emissions from the use of goods and services sold by the organisation.	**Immaterial**: The HSE is a public healthcare provider and does not sell products that result in ongoing emissions through their use.
	Category 12. End-of-Life Treatment of Sold Goods	Emissions from waste disposal and treatment of products sold by the organisation at the end of their life.	**Immaterial**: The HSE does not engage in the sale of physical goods that would require end-of-life waste treatment by customers.
	Category 13. Downstream Leased Assets	Emissions from the operation of assets owned by the organisation and leased to other entities (not included in Scope 1 or 2).	**Immaterial**: The HSE does not lease out assets to third parties in a way that would lead to material downstream operational emissions.
	Category 14. Franchises	Emissions from the operations of franchises not owned by the organisation, but operating under its brand or licence.	**Immaterial**: The HSE does not operate under a franchising model.
	Category 15. Investments	Emissions associated with the operation of investments (e.g. equity or debt holdings) made by the organisation.	**Immaterial**: The HSE is not an investment-led organisation and does not hold material financial investments that would drive significant indirect emissions.

Following the organisational and operational boundaries set out above, emissions results for the 2019 calendar reporting year are summarised in the tables and figures below in sections 2.3, 2.4, and 2.4.

2.2 Total Emissions of the HSE by Scope

Table 2 and Figure 2 provide a detailed breakdown of GHG emissions generated the HSE in 2019. Total GHG emissions from for the HSE across Scope 1, 2 and 3 amounted to 881.9 ktCO$_2$e. This inventory excludes GHG emissions generated by organisations that receive funding from the HSE but are not directly managed by the HSE, such Section 38 and 39 bodies. Definitions for these GHG emissions categories are laid out in Table 1.

Table 2: GHG emissions of the HSE by scope	Emissions ktCO$_2$e	Share of total emissions, %
Scope 1 & 2 emissions	259.7	29.5%
Energy-related Scope 1 and 2 emissions (SEAI boundary)	206.6	23.4%
Energy-related Scope 1 and 2 CH$_4$ and N$_2$O emissions	0.8	0.1%
F-gas emissions (i.e., anaesthetic gases & MDIs)	52.3	5.9%
Scope 3 emissions	622.1	70.5%
Category 1a: Purchased goods & services (excl water consumption)	352.2	39.9%
Category 1b: Water consumption	1.7	0.2%
Category 2: Capital goods	50.0	5.7%
Category 3: Fuel- & energy-related activities	33.6	3.8%
Category 4: Upstream transportation & distribution	0.2	0.02%
Category 5a: Solid waste treatment	122.5	13.9%
Category 5b: Wastewaster and effluent treatment	0.6	0.1%
Category 6: Business travel	6.7	0.8%
Category 7: Employee commuting	54.6	6.2%
Total emissions	**881.9**	**100.0%**
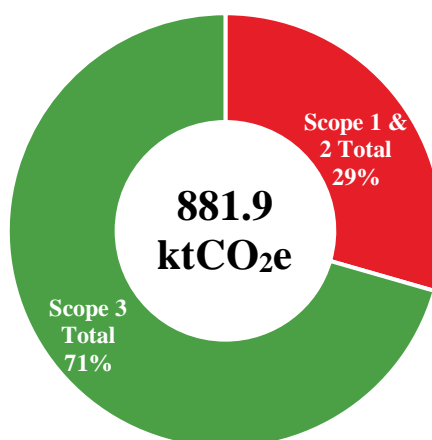
Figure 2: Breakdown of HSE's 2019 GHG emissions between Scope 1 & 2 and 3

2.3 Scope 1 & 2 Emissions

As detailed in Section 1.1, the HSE is required under Ireland's CAP21 to report its annual energy consumption across heating, transport, and electricity use. These consumption values are submitted through the SEAI's M&R system, which applies standardised emission factors to calculate energy-related scope 1 and 2 GHG emissions. The resulting CO$_2$ emissions are referred to in this baseline as "Energy-related Scope 1 and 2 CO$_2$ emissions". They form the basis against which the HSE's progress toward the CAP21 public sector target, a 51% reduction in energy-related scope 1 and 2 emissions by 2030 from a 2016–2018 average baseline, is assessed. To maintain alignment with the SEAI M&R system and to ensure consistency across all HSE reporting (including its Climate Action Strategy and Infrastructure Decarbonisation Roadmap), these energy-related CO$_2$ values are presented unchanged in this baseline. In 2019, they accounted for just under one quarter, 23%, of the HSE's total reported GHG emissions.

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However, it is important to note that SEAI's methodology reports CO_2 emissions only, omitting other GHGs such as methane (CH_4) and nitrous oxide (N_2O), which are also generated during fuel combustion. To provide a more comprehensive inventory, CH_4 and N_2O emissions associated with energy use have also been calculated and included in this baseline. These non-CO_2 emissions represented a minor share, just 0.1%, of the total 2019 inventory.

Additional Scope 1 and 2 emissions include fugitive emissions from anaesthetic gases and metered dose inhalers (MDIs), which collectively accounted for just under 6% of the HSE's 2019 emissions.

Figure 3 illustrates the different Scope 1 and 2 emissions sub-categories and their relative contribution to the HSE's total GHG emissions.
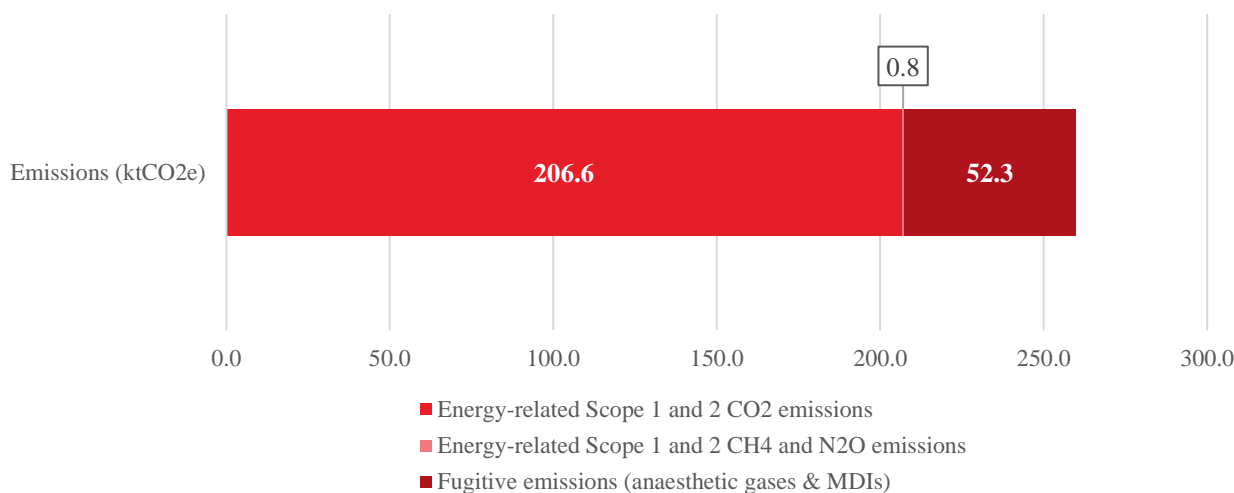
Figure 3: Breakdown of the HSE GHG emissions by Scope 1 and 2 sub-categories

2.4   Scope 3 Emissions

In 2019, Scope 3 emissions accounted for approximately 70% of the HSE's total annual GHG emissions, as defined within the boundary parameters shown in Table 2. Error! Reference source not found. illustrates the magnitude of Scope 3 emissions by sub-category, following the Greenhouse Gas Protocol Corporate Value Chain (Scope 3) Standard, and highlights their significance relative to Scope 1 and 2 emissions.
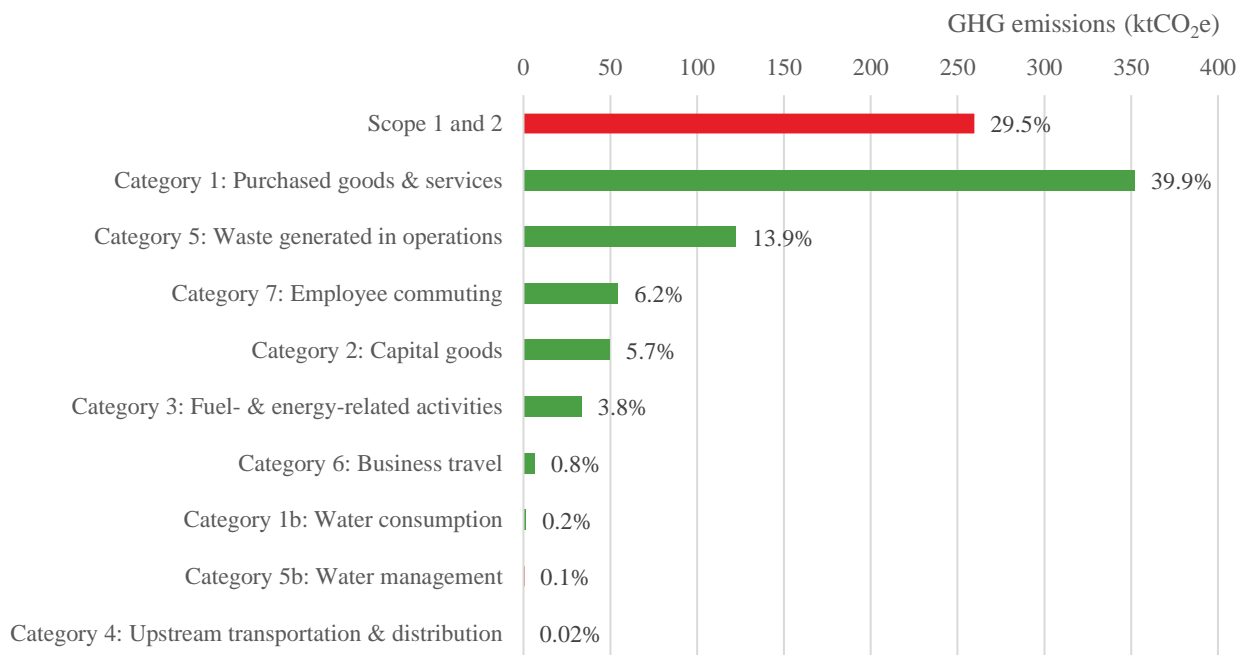
Figure 4: Breakdown of GHG Scope 3 emissions generated by the HSE by category

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The largest share of Scope 3 emissions originated from Purchased Goods and Services (Category 1a), contributing just under 40% of the total GHG inventory, by far the most significant source. Waste generated in operations (Category 5) was the next largest contributor, responsible for 14% of total emissions. This was followed by Employee Commuting and Capital Goods, each accounting for a similar share, at approximately 6% of total emissions. Fuel- and energy-related activities not included in Scope 1 or 2 (Category 3) made up roughly a further 4% of the inventory.

Other Scope 3 categories, including Business Travel (Category 6), Water Consumption and Management (Category 1b and 5b), and Upstream Transportation and Distribution (Category 4), contributed relatively minor shares. Notably, upstream transportation and distribution emissions were limited to blood and specimen transport directly paid for by the HSE. Emissions from the transportation of other goods and services are included under Category 1a due to data limitations, which prevented further disaggregation of upstream sources. Appendix A: Data gaps, assumptions, and recommendations for data quality improvements provides a full explanation of this data limitation for Category 4 emissions.

Since Purchased Goods and Services (excl water consumption) emissions made up a substantial portion of total inventory emissions, Figure 5 provides a more granular breakdown of the goods and services that contributed most to total emissions. Pharmaceuticals, along with medical equipment and instruments, accounted for the largest share, together making up 26% of total GHG across all scopes in 2019.
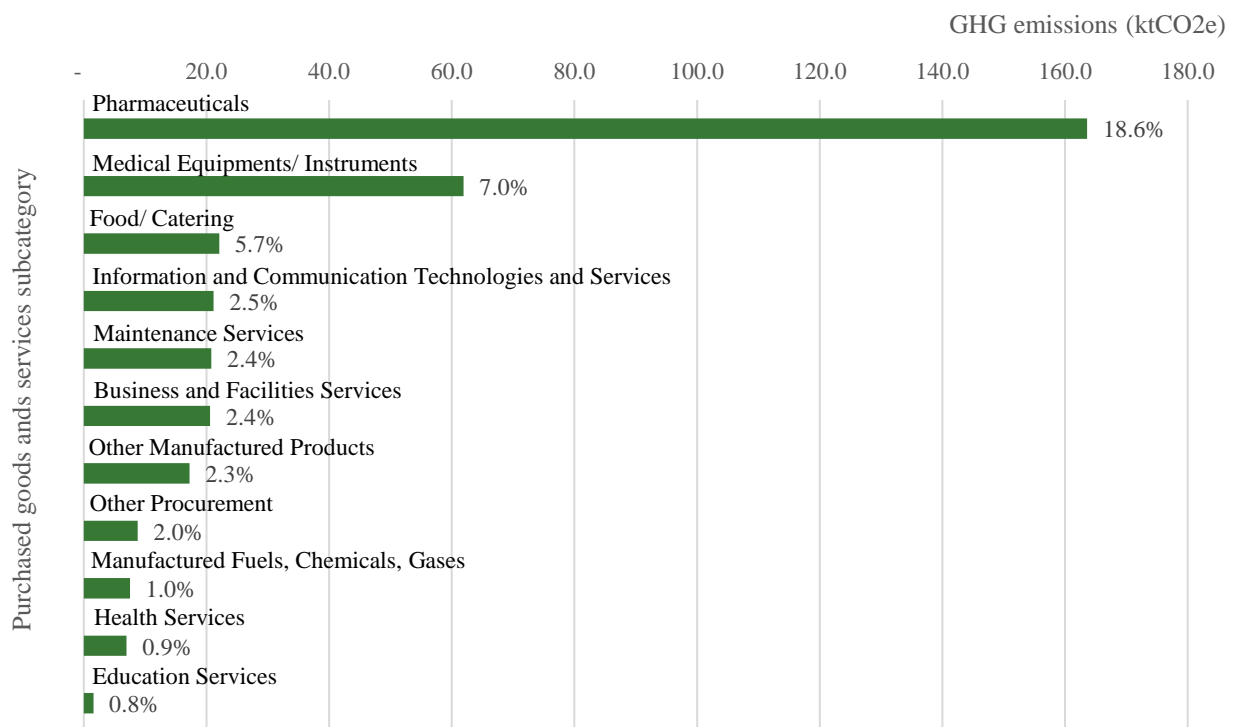
Figure 5: Percentage of total baseline emissions associated with subcategories of Purchased Goods and Services (i.e., Scope 3 Category 1a)

3. Emissions Assessment Methodology

This section provides an overview of the methods used to derive emissions estimates for assets managed by the HSE in 2019. Sections 3.1 to 3.2 describe how emissions were allocated by scope and category and the methods used for calculations. Sections 3.4 and 3.5 summarise the approach used for validation and verification, whilst providing a summary of data quality and completeness across each of the emissions reporting categories. Further detail is provided on methods, assumptions used, data gaps and recommendations for each scope 3 category in Appendix A: Data gaps, assumptions, and recommendations for data quality improvements.

3.1 Emission sources

Applying the GHG emissions framework of the GHGP, the HSE emissions have been reported against the organisational and operational boundaries set out in Section 2.1. All material scope 3 emissions categories, as categorised in Table 1, were included within the analysis.

3.2 Calculation approach

In line with the GHGP guidance, this emissions inventory was developed by combining activity data and emission factors to estimate GHG emissions resulting from organisational and value chain activities. Activity data refers to quantitative measures of an activity that generates emissions, such as litres of fuel consumed, kWh of electricity used, kilograms of waste generated, or monetary expenditure on goods and services. Emission factors are coefficients used to convert activity data into GHG emissions, representing the average emissions per unit of activity.

To reflect the variable quality and availability of data across the organisation, a hybrid model was applied that blends both bottom-up and top-down estimation methods, as illustrated in Figure 6. This approach aligns with GHGP best practices and prioritises accuracy and completeness. A hierarchy of assessment methods was followed to guide the selection of calculation techniques:

- Bottom-up methods, used where detailed activity data was available:

    o Direct measurement method: Based on directly metered or recorded activity data (e.g., kWh of combusted fuel or metered electricity use).

    o Supplier-specific method: Emissions figures provided by suppliers, such as Environmental Product Declarations (EPDs) or verified corporate emissions reports.

- Top-down methods used where detailed activity data was unavailable or incomplete:

    o Average-product method: Uses recognised average emission factors applied to known quantities (e.g., kg of waste or litres of water).

    o Spend-based method: Uses financial data (e.g., € spent) linked to environmentally extended input-output (EEIO) emission factors to estimate emissions based on economic activity.

In some cases, blended approaches were applied, combining specific activity data with expenditure data to enhance accuracy and ensure full coverage.

Data requests were shared to the HSE team, with calculations then being based on received information. Data provided by the HSE team was assumed to be accurate, unless noted otherwise. Not all data received was suitable for inclusion in this assessment. The model developed to execute this approach and used to process, calculate and consolidate the emissions footprint was built in MS Excel.
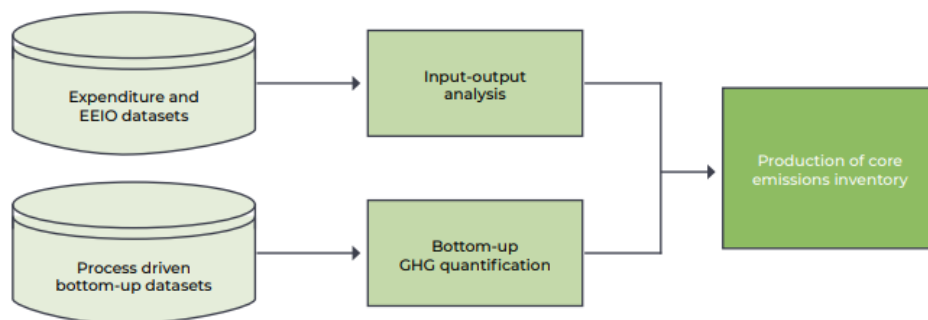
Figure 6. Approach utilised to develop a hybrid emissions inventory using top-down expenditure-based and bottom-up process-based methods

3.3   Selecting and generating emission factors and calculating emissions

In this assessment, emission factors for the direct measurement method were, where available, sourced from the Sustainable Energy Authority of Ireland (SEAI) Conversion Factors dataset[9]. This ensures alignment with SEAI's Public Sector Monitoring and Reporting 2030 methodology and calculation approach[8]. Where SEAI emission factors were not available for a given fuel or activity, the most appropriate alternative factors were sourced from other recognised and reputable datasets to ensure completeness and consistency in the emissions calculations.

In the application of spend-based assessment methods, emission factors tied to Irish products and services were derived using the EXIOBASE 3 Environmentally Extended Multi-Regional Input-Output (EE MRIO) tables[10]. EXIOBASE provides detailed environmental and economic data across various sectors and countries, enabling the estimation of emissions associated with monetary expenditure. EXIOBASE 3 provides year-specific tables for 44 countries, including Ireland. EXIOBASE 3 was chosen as it provides up to date (latest model year 2022) coverage of environmental impacts across 200 product types within the Irish economy. EXIOBASE 3 version 3.8.2 was used to generate emissions factors used in this assessment.

The following sections describes the calculation approach used to estimate the emissions totals for each emissions scope and subcategory reported, including a summary of the data sources and calculations made. A summary of the data quality and completeness for each emissions subcategory is then provided in section 3.4. Appendix A: Data gaps, assumptions, and recommendations for data quality improvements further provides a full list of the emission factors used alongside recommendations to improve the completeness and precision of emissions calculations in future reporting years.

3.3.1   Scope 1 & 2

3.3.1.1   *Energy-related Scope 1 and 2 CO_2 emissions*

For Scope 1 and 2 carbon dioxide (CO_2) emissions relating to stationary combustion, mobile combustion and electricity, calculated emissions totals were taken from the SEAI Monitoring and Reporting system, therefore aligning with those reporting publicly by the SEAI. These emissions totals have been calculated based on annual energy consumption data that the HSE has submitted to SEAI for mandated public sector monitoring and reporting. This includes consumption data relating to all energy and fuel types - including fossil fuels, renewable energy, blended mixtures of fossil and renewable fuels, and electricity - from all sources relating to heating, transport, electrical applications. The emission factors used by the SEAI to calculate emissions through the Monitoring and Reporting system only represent CO_2 emissions and not other GHG emissions, including methane (CH_4) and nitrous oxide (N_2O). These emissions were calculated separately and also reported in order to produce a complete GHG baseline.

3.3.1.2   *Energy-related Scope 1 and 2 CH_4 and N_2O emissions*

The same 2019 consumption data submitted to SEAI for all energy and fuel types - including fossil fuels, renewable energy, blended mixtures of fossil and renewable fuels, and electricity - from all sources relating

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[9] Sustainable Energy Authority of Ireland. (2025). <u>Conversion Factors: SEAI conversion and emission factors.</u>

[10] Stadler, Konstantin, et al. (2021). EXIOBASE 3 (3.8.2) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.5589597

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to heating, transport, electrical applications was also used to estimate associated CH_4 and N_2O emissions. SEAI do not publish emission factors dedicated for or encompassing CH_4 and N_2O emissions. Emissions factors from the U.S EPA's National Inventory Submissions[11] were therefore applied, as recommended by the SEAI in their conversions and emissions factors publication.

3.3.1.3 Fugitive emissions

Anaesthetic gases

Emissions for volatiles, including sevoflurane, isoflurane and desflurane, alongside nitrous oxide and Entonox on a hospital-by-hospital basis were provided in tonnes carbon dioxide equivalent (tCO_2e) by the HSE.

MDIs

Total annual emissions generated by MDI use from facilities managed by the HSE in 2022 were provided from internal calculations performed by the HSE, which the modelling team had no sight of. It was assumed that the MDI emissions data for 2022 are representative of the same activity from 2019.

3.3.2 Scope 3, by category

3.3.2.1 Category 1a, Category 1b, Category 2, Category 4, Category 5b, and Category 6

To estimate emissions for Scope 3 categories 1a (Purchased Goods and Services), 1b (Water Consumption), 2 (Capital Goods), 4 (Upstream Transportation and Distribution), 5b (Wastewater and Effluent Treatment), and 6 (Business Travel), Environmentally Extended Input-Output (EEIO) emission factors were applied to procurement entries in Purchased Ledger (PL) financial data for 2019 provided by the HSE Business Support Service team.

EEIO emission factors estimate the upstream GHG emissions associated with each euro spent on a good or service, including emissions from raw material extraction, manufacturing, and transportation. For this GHG inventory, EEIO emission factors were sourced from EXIOBASE, a globally recognised EE MRIO database. The approach for applying the EXIOBASE emissions factors was as follows:

1. Each procurement entry in the HSE 2019 PL financial dataset was reviewed and mapped to the most appropriate EXIOBASE product category.

2. The procurement entries were then paired with the corresponding EXIOBASE emission factors.

3. Any procurement entries not associated with emissions-generating activities (e.g., taxes, financial transfers) were excluded from the emissions estimation.

4. By multiplying the emission factor by the associated expenditure value, an estimate of the upstream emissions linked to each procurement entry was calculated.

5. Procurement entries were categorised into the relevant scope 3 emission categories based on their GL descriptors, this being either Category 1a, 1b, 2, 4, 5b or 6. This categorisation enabled emissions to be summed by scope 3 category. The HSE Capital & Estates team provided a list of the GL descriptors that related to expenditure on capital goods (i.e., construction activities and capital projects), these were used to classify procurement entries with these GL descriptors as relating to Capital Goods.

6. In some case, sub-categories were used within scope 3 reporting categories to allow for more detailed reporting and exploration of hotspots. This was particularly important for Category 1a (Purchased Goods and Services), where total emissions are high and the ability to differentiate between different areas of procurement is important when identifying GHG emissions mitigation approaches.

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[11] United States Environmental Protection Agency. (2025). GHG Emission Factors Hub.

7. The methodology used to map HSE expenditure categories to EXIOBASE product classifications, including assumptions and matching logic, is detailed in Appendix B: Mapping of the HSE expenditure categories to EXIOBASE product categories.

It is important to note that freight costs were not recorded separately in the PL dataset. The EXIOBASE emission factors include some transportation activities in the supply chain but not shipping from supplier to end consumer. As a result, emissions under Category 4 in this footprint are limited to those associated with blood and specimen transportation paid for directly by the HSE, for which specific expenditure data was available.

In calculating emissions associated with procured pharmaceuticals, the most relevant EXIOBASE factor represents only chemicals in a broad sense, with the dataset lacking a designated factor for pharmaceuticals. Due to the quantity of pharmaceuticals procured by the HSE and the materiality of upstream emissions associated with procured pharmaceuticals across other GHG inventories of health care providers, it was decided that an alternative emission factor would be sourced for use in this model that is more representative of this product class. The UK-based emission factor dataset published by the Department for Environment, Food & Rural Affairs (DEFRA)[12] includes a pharmaceutical factor, which was judged to be a more suitable alternative for use in this analysis.

3.3.2.2   *Category 3: Fuel- and Energy Related Activities*
Upstream Well-to-tank (WTT) emissions for mobile combustion, stationary combustion and purchased electricity were calculated using the same measured energy consumption data (kWh) as that which was used to calculate the respective scope 1 and 2 emissions. These are the emissions that occur in the supply chains for these fuel and energy types and are additional to those accounted for under scope 1 and 2. As the SEAI does not produce WTT emission factors, those from the UK Government GHG Conversion Factors for Company Reporting were applied to estimate WTT emissions associated all fuels and electricity[13].

The SEAI electricity factor includes both scope 2 emissions (as defined in GHG Protocol Corporate Accounting and Reporting Standard[6]) from electricity generation, and scope 3 emissions from transmission & distribution losses. Transmission and Distribution Losses for electricity consumption are therefore accounted for within the scope 2 emissions totals for electricity.

3.3.2.3   *Category 5a: Solid Waste Treatment*
Emissions associated with solid waste disposal and treatment were derived from solid waste tonnage data provided by the HSE from waste management service providers and activity-based waste emissions factors from the UK Government GHG Conversion Factors for Company Reporting 2020[13]. In the absence of waste emission factors from the SEAI, UK Government Department of Energy Security and Net Zero (DESNZ) emissions factors were applied. The UK DESNZ emission factors applied only cover emissions from the collection of materials and delivery to the point of treatment or disposal. They do not cover the environmental impact of different waste management options as these emissions are owned by the waste processor. The collection and transportation aspect of these emissions is recognised to align closely enough with equivalent Irish waste management practices for them to act as an appropriate suite of proxy emission factors for application by Irish organisations.

The solid waste data received from HSE included tonnage from facilities operated by the HSE as well as from Section 38 and 39 bodies. To differentiate between the two, waste tonnage was disaggregated by mapping the names of facilities not operated by the HSE to Customer and Site Names labelled in the dataset. As a result, waste emissions were partitioned to provide a total emissions value for only the facilities operated by the HSE.

3.3.2.4   *Category 7: Employee Commuting*
In the absence of employee survey data on commuting behaviours, a top-down approach was used to estimate employee commuting emissions. This method combines travel distance data, transport mode share by geographic area, and emission factors by transport mode. Recognising that average commuting distance

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and transport mode share vary significantly between rural and urban settings, a single national average was deemed insufficient. Therefore, separate averages for rural and urban areas were modelled.

A split of total employee count between rural and urban areas was therefore also required to estimate emissions. Only data on the total count of employees in 2019 was known by the HSE, with the split of the total between rural and urban being unknown. The 2016 CSO data on the percentage population distribution between rural and urban areas was used to estimate the rural vs urban count of employees of the HSE[14].

Travel distance data was sourced from the CSO's 2022 Census dataset on Employment, Occupations and Commuting[15]. Specifically, average commuting distances by sub-county area (Table F1728), which are tagged as either rural or urban, were used to calculate a weighted average commuting distance for each area type. These averages were then applied to the estimated number of rural and urban HSE employees. Distances were doubled to reflect return journeys and multiplied by a standard annual working day estimate (250 days) to generate total commuting distances for rural and urban employee populations.

Means (i.e., mode) of travel to work by small area population geographic subdivision (SAP2022T11T1SA) was taken from the CSO's 2022 Census dataset, again tagged by rural or urban classification. The dataset was cleaned to exclude work-from-home responses, unspecified modes, and atypical methods (e.g., lorry use), retaining only car, motorbike, bus, train, and active travel modes. This enabled the calculation of average modal share for commuting in rural and urban areas. Combining mode share with total commuting distances allowed for the estimation of total distance travelled by mode in each area type. These distances were then paired with distance-based emission factors from the UK DESNZ, covering both direct fuel combustion or electricity consumption as well as the associated and upstream well-to-tank emissions.

This method enabled the estimation of total employee commuting emissions by mode for 2019, differentiated by urban and rural commuting patterns.

3.4   Results validation and verification

Upon completion of the GHG emissions inventory calculations, each set of results were reviewed by another member of the delivery team who did not perform that initial set of calculations. During this review process, the data input, emissions factor selection, approach and calculations were cross-checked. Files provided by the HSE were utilised and assumed to be accurate, unless noted otherwise.

3.5   Summary of data quality and completeness

Table 3 ranks the data quality and completeness for each scope and category applicable for this reporting year from low to high. Data quality reflects the confidence with which the data provided can be converted into emissions figures. For instance, product- or material-specific data will typically yield more accurate emissions estimates than expenditure-based data. Data completeness indicates the coverage of relevant activities within the HSE reflected in the data provided.

Table 3: Data quality and completeness by scope/category

Scope	Emission Category	Data Quality	Data Completeness	Notes on Quality and Completeness
Scope 1	Energy-related Scope 1 and 2 emissions	High	High	Calculated emissions totals were taken from the SEAI Monitoring and Reporting system based on consumption data provided for electricity and a range of fossil fuels, biofuels and solid biomass types used across all heating, transport, electrical applications. The energy utility data used to calculate these emissions was activity-based consumption data, being of high specificity relative to other average- or spend-based approaches. This data covered the entire reporting period and all facilities of the HSE.
	Energy-related Scope 1 and 2 CH_4 and N_2O emissions	High	High	Energy consumption data submitted to SEAI M&R was was to estimate these emissions, this covered all electricity, fossil fuel, biofuel and solid biomass consumption used across all heating, transport, electrical applications. The energy utility data used to calculate these emissions was activity-based consumption data,

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[14] Central Statistics Office. (2019). <u>Urban and Rural Life in Ireland, 2019</u>.
[15] Central Statistics Office. (2022). <u>Census 2022 Profile 7 - Employment, Occupations and Commuting.</u>

Scope	Emission Category	Data Quality	Data Completeness	Notes on Quality and Completeness
				being of high specificity relative to other average- or spend-based approaches. This data covered the entire reporting period and all facilities of the HSE.
	F-gas Emissions	Medium	Medium	Activity data for F-gas emissions data for anaesthetic gases was complete in terms of both facility and reporting period coverage. Total annual emissions from MDI use associated with the HSE were provided from internal calculations from the HSE. F-gas emissions data related to refrigerant leakage was not available and therefore not reported, despite being a material emissions source.
Scope 2	Purchased & Consumed Electricity	High	High	Calculated emissions totals were taken from the SEAI Monitoring and Reporting system based on consumption data provided for electricity and a range of fossil fuels, biofuels and solid biomass types used across all heating, transport, electrical applications. The energy utility data used to calculate these emissions was activity-based consumption data, being of high specificity relative to other average- or spend-based approaches. This data covered the entire reporting period and all facilities of the HSE.
Scope 3	Cat. 1a: Purchased Goods and Services	Medium	High	Purchase Ledger (PL) financial data was provided for a spend-based approach to estimate the upstream emissions from purchased goods and services. No product-/service-/material-specific data was provided. This data covered the entire reporting period and all facilities of the HSE.
	Cat. 1b: Water Consumption	Medium	High	PL financial data was provided for a spend-based approach to estimate the upstream emissions from water consumption. No product-/service-specific data was provided. This data covers the entire reporting period and all HSE facilities.
	Cat. 2: Capital Goods (reported separately)	Medium	High	PL financial data was provided for a spend-based approach to estimate the upstream emissions from purchased goods and services. No product-/service-/material-specific data was provided. This data covered the entire reporting period and all facilities of the HSE. At the time of reporting, a fixed asset development register with associated whole-life carbon assessments or Environmental Product Declarations (EPDs) for capital goods was not available. National-level public sector methodologies and targets for capital project decarbonisation are currently being developed by the Department of Environment, Climate and Communications (DECC) and the SEAI. In parallel, the HSE Capital & Estates team is progressing the development of a Lifecycle Carbon Impact Assessment Tool, which will align with DECC, SEAI, and Irish Green Building Council (IGBC) initiatives. This tool will ultimately form a key part of how the HSE assesses the embodied carbon impacts of healthcare construction activities.
	Cat. 3: Fuel and Energy Related Activities	High	High	The energy utility data used to calculate these emissions was activity-based consumption data, being of high specificity relative to other average- or spend-based approaches. This data covered the entire reporting period and all facilities of the HSE.
	Cat. 4: Upstream Transportation and Distribution	Low	Low	Within the PL financial data, no entries were provided that solely recorded payments for the upstream transportation and distribution cost component of procuring any good or service. The EEIO emission factors used to estimate the Category 1 (Purchased goods and services) emissions encompass the freight component and so the upstream transportation and distribution emissions for these products and services are bundled into Category 1 emissions estimates. Category 4 emissions in this footprint therefore only represent emissions associated with blood and specimen transportation paid for by the HSE, for which dedicated spend data was available. This data covered the entire reporting period and all facilities of the HSE.

Scope	Emission Category	Data Quality	Data Completeness	Notes on Quality and Completeness
	Cat. 5a: Solid Waste Treatment	Medium	High	The waste data utilised from the waste management service provider reflected the weight of waste generated and whether it was treated through incineration or alternative treatment. This data covered the entire reporting period and all facilities of the HSE. More granular records of how alternatively treated waste was managed or waste-specific scope 1 and 2 emissions data from waste treatment facilities could improve the specificity of data.
	Cat. 5b: Wastewater and Effluent Treatment	Medium	High	PL financial data was provided, allowing for a spend-based approach to estimate the emissions associated with wastewater and effluent treatment. This data covered the entire reporting period and all facilities of the HSE. No service supplier-specific data was provided. To improve accounting for this category, a bottom-up approach based on volume of water used could be developed in future.
	Cat. 6: Business Travel	Medium	High	Purchase Ledger financial data was provided, allowing for a spend-based approach to estimate the emissions associated with business travel. This data covered the entire reporting period and all facilities of the HSE. The specificity of the assignment of emission factors for calculations based on PL data could be improved by classifying business travel procurement entires by transport mode(s). To improve upon the specificity of data beyond PL financial data, more distance-based data (e.g., the origin and destinations of expensed flights) or fuel-based data (e.g., for employee or patient car transport paid for by the HSE) could be used.
	Cat. 7: Employee Commuting	Low	High	In the absence of employee survey data, a top-down estimation method was used, combining publicly available statistics on commuting distances and transport mode shares by urban and rural classifications. To estimate the rural–urban distribution of HSE employees, the 2016 CSO population split was used as a proxy. While this provides a consistent national benchmark, it likely overestimates the proportion of rural-based staff, as HSE employment is concentrated in large hospitals and administrative centres that are predominantly located in urban areas. Rural services tend to be more dispersed and lower in staffing density. Given that rural commuting patterns are generally longer and more emissions-intensive, applying a higher rural staff share than is likely the case results in a conservative emissions estimate, i.e., one that is more likely to overestimate than underestimate actual employee commuting emissions. This strengthens the credibility of the estimate in the absence of HSE-specific commuting data. 2022 CSO Census data provided average commuting distances and modal shares at small area level. This approach allowed for the estimation of total distance travelled by transport mode. This approach covered the entire reporting period and all facilities of the HSE. Distance-based UK DESNZ emission factors, including both direct combustion and upstream well-to-tank emissions, were applied in the absence of equivalent factors from SEAI. While coverage is high and the method draws on robust national datasets, the absence of employee travel data specific to the HSE limits precision and introduces uncertainty into the emissions estimate.

3.6   Assumptions and limitations

Assumptions and limitations for the 2019 baseline calculations are detailed by emissions category in Appendix A: Data gaps, assumptions, and recommendations for data quality improvements. Recommendations for improvements in the quality of data used in the emissions calculations are provided in the appendix against each respective emissions sub-category.

4. Conclusions

This Emissions Baseline Report sets out the annual greenhouse gas emissions profile for the HSE for 2019, illustrating the relative scale of different direct and indirect sources of emissions across the value chain. The annual total of greenhouse gas emissions of the HSE was 881.9 ktCO$_2$e, equivalent to the carbon sequestered by 14.6 million tree seedlings grown for 10 years[16].

In line with the Greenhouse Gas Protocol (GHGP) reporting framework, the majority of the HSE's emissions in 2019, approximately 70.5%, were classified as Scope 3, reflecting the broad range of indirect emissions across its value chain. The largest contributors were Purchased Goods and Services and Waste Generated in Operations, representing 33.9% and 13.9% of total baseline emissions, respectively. Additional Scope 3 sources included Capital Goods and Employee Commuting which, while smaller individually, collectively represent important areas for future data improvement and mitigation. All energy-related scope 1 and 2 emissions made up 23.5% of total emissions. A further 5.9% resulted from fugitive emissions, sourced from anaesthetic gases and metered dose inhalers.

This emissions baseline provides a crucial foundation for understanding the carbon footprint of the HSE and assessing the potential impact of future decarbonisation measures. By quantifying emissions across both direct and indirect sources, this analysis offers a comprehensive overview of the key drivers of greenhouse gas emissions within the organisation and highlights areas where targeted interventions could achieve the most significant reductions.

This work provides a detailed breakdown of current emissions and hotspots across operations and the supply-chain, which can be used for developing emissions reduction strategies and planning implementation. Through ongoing monitoring and refinement of these strategies, the HSE can ensure continued progress towards a net zero health service.

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[16] United States Environmental Protection Agency. (2025). Greenhouse Gas Equivalencies Calculator.

Appendix A: Data gaps, assumptions, and recommendations for data quality improvements for the baseline of the physical assets managed by the HSE

Scope	Emissions Sub-category	Assessment Method and Data Used	Data Type(s) and Emission Factor(s)	Omissions and assumptions	Recommended data quality improvements
Scope 1 & 2	Energy-related Scope 1 and 2 emissions	Activity data method	kWh energy consumption data for a range of fossil fuels and solid biomass types. CO_2 emissions factors from SEAI.	N/A	N/A
	Energy-related Scope 1 and 2 CH_4 and N_2O emissions	Activity data method	kWh energy consumption data for a range of fossil fuels and biofuels. CH_4 and N_2O emission factors from the U.S EPA's National Inventory Submissions.	N/A	Utilise SEAI emission factors for CH_4 and N_2O if they become available in future reporting years.
	Fugitive emissions (anaesthetic gases)	Activity data method	Volume and type of inhaler anaesthetic agents by originally source from hospital pharmacies (for dispensing data on volatile agents including sevoflurane, isoflurane, and desflurane) and from BOC Ltd (for data on N_2O and ENTONOX®, a ready-to-use medical gas mixture consisting of N_2O 50% and oxygen 50% used for analgesia and sedation).	N/A	N/A
	Fugitive emissions (MDIs)	Average data method (assumed)	Total annual emissions from MDI use associated with units dispensed by the HSE were provided from internal calculations performed by the HSE.	These MDI emissions values were taken from internal calculations performed by the HSE which the modelling team had no sight of. It was assumed that the MDI emissions data for 2022 are representative of the same activity from 2019.	Develop an annual inventory of the models and numbers of MDIs dispensed by the HSE. Engage with suppliers to obtain data on the use-phase emissions of purchased MDI models or use publicly available benchmarks for MDI use-phase emissions, to estimate an annual total of MDI emissions.
	Fugitive emissions (refrigerants leakage)	Not reported	F-gas emissions data related to leakage from refrigeration and air conditioning equipment was not available and therefore not reported, despite being a material emissions source.	HSE does not have a national F-gas register. The organisation is actively working to develop this dataset.	Once an F-gas register for refrigeration and air conditioning equipment is complete, this data could inform a bottom-up estimate of GHG emissions relating to refrigerant leakage from refrigeration and air conditioning equipment. As an intermediary approach to developing an F-gas emissions estimate from refrigerants, if the total floor area of facilities using refrigerants nationally is

Scope	Emissions Sub-category	Assessment Method and Data Used	Data Type(s) and Emission Factor(s)	Omissions and assumptions	Recommended data quality improvements
					known, existing sample F-gas register data from a small number of facilities (e.g., St Mary's Campus, National Forensics Mental Health, and Drogheda Department of Psychiatry) could be used to generate an estimate for F-gas leakage per unit of floor area, which could then be scaled.
Scope 3	Cat 1a) Purchased goods and services	Spend-based method	Annual 2019 Purchase Ledger (PL) financial data on € spent on goods and services by the HSE mapped to relevant expenditure-based EEIO emission factors for Irish products and services in 2019 from EXIOBASE[10].	Emission factors from EXIOBASE[10] were assigned to the expenditure line items following the logic in Appendix B: Mapping of the HSE expenditure categories to EXIOBASE product categories.	The HSE can improve the accuracy of its purchased goods and services emissions estimates by collecting Environmental Product Declarations (EPDs) from suppliers for product-level emissions data. EPDs provide third-party verified lifecycle emissions data for specific products, offering a more precise alternative to broad economic input-output (EEIO) factors. By prioritising high-emission procurement categories, such as pharmaceuticals and medical equipment and instruments, the HSE can reduce uncertainty in their Scope 3 reporting and make more informed procurement decisions.
	Cat 1b) Water consumption	Spend-based method	Annual 2019 PL financial data on € spent on water consumption by the HSE mapped to relevant expenditure-based EEIO emission factors for Irish products and services in 2019 from EXIOBASE[10].	Emission factors from EXIOBASE[10] were assigned to the expenditure line items following the logic in Appendix B: Mapping of the HSE expenditure categories to EXIOBASE product categories.	To improve the accuracy of emissions estimates for water consumption, HSE could replace spend-based methods with average-based methods, such as actual volumes of water consumed (e.g., in cubic metres) at site or facility level with associated industry-average emission factors. Applying such emission factors from national inventories or water utilities would yield more precise emissions estimates. Where available, incorporating supplier-specific data on water treatment and supply emissions can further reduce uncertainty and reflect regional variations in carbon intensity.
	Cat 2) Capital goods	Spend-based method	Annual 2019 PL financial data on € spent on construction activities and capital projects by the HSE mapped to relevant expenditure-based EEIO emission factors for Irish products and services in 2019 from EXIOBASE[4].	Emission factors from EXIOBASE were assigned to the expenditure line items following the logic in Appendix B: Mapping of the HSE expenditure categories to EXIOBASE product categories. The HSE Capital & Estates team provided a list of the GL codes that relate to expenditure on capital goods (i.e., construction activities and capital projects), these were used to classify procurement entries with	At the time of reporting, a fixed asset development register with associated whole-life carbon assessments or Environmental Product Declarations (EPDs) for purchased capital goods was not available. National-level public sector methodologies and targets for capital project decarbonisation are currently being developed by the Department of Environment, Climate and Communications

Scope	Emissions Sub-category	Assessment Method and Data Used	Data Type(s) and Emission Factor(s)	Omissions and assumptions	Recommended data quality improvements
				these GL codes as relating to Capital Goods. These GL codes were: • Construction - Design & Build • Construction - Traditional • Electrical • Floor Covering • Glazing • Painting • Plumbing • Roofing • Site clearance • Soft Furnishings • Specialist contractors	(DECC) and the SEAI. In parallel, the HSE Capital & Estates team is progressing the development of a Lifecycle Carbon Impact Assessment Tool, which will align with DECC, SEAI, and Irish Green Building Council (IGBC) initiatives. This tool will ultimately form a key part of how the qesses the embodied carbon impacts of healthcare construction activities. In future reporting years, capital goods emissions should thereby estimate emissions associated with capital goods using supplier-specific data through this tool.
	Cat 3) Fuel- and energy-related activities	Average data method	Well-to-tank (WTT) emissions for mobile combustion, stationary combustion and purchased electricity were calculated using the same measured energy consumption data (kWh) as that which was used to calculate the respective Scope 1 and 2 emissions, being that submitted by the HSE to SEAI for public sector monitoring and reporting in 2019. WTT emissions factors from the UK Government GHG Conversion Factors for Company Reporting 2020[13] were applied to estimate WTT emissions associated all fuels and electricity.	The SEAI does not produce WTT emission factors so those from the UK Government GHG Conversion Factors for Company Reporting 2020[13] were used.	To improve data certainty supplier-specific emissions data related to the production, transportation, and distribution of energy consumed by the HSE should be sought after.
	Cat 4) Upstream transportation and distribution	Spend-based method	Annual 2019 PL financial data for blood and specimen transportation paid for by the HSE was mapped to relevant expenditure-based EEIO emission factors for Irish products and services in 2019 from EXIOBASE[4].	No expenditure or activity data is provided that distinctly reflects upstream transportation and distribution of any goods or services. The EXIOBASE[10] expenditure-based EEIO emission factors used to estimate purchased goods and services and capital goods emissions encompass the freight component of upstream emissions and so the upstream transportation and distribution emissions for these products and services are bundled into these category 1 and 2 emissions estimates. Category 4 emissions in this footprint therefore only represent emissions associated with blood and specimen	To improve data specificity in calculating upstream transportation and distribution emissions for purchased goods, services, and capital goods, the HSE should take steps to separate freight-related emissions from procurement emissions. Ideally, this could be achieved by engaging suppliers to obtain explicit transportation data, including freight distances, transportation modes, and fuel types for high-emission product categories. Where supplier-specific data is available, the HSE can apply logistics-specific emissions factors from sources

Scope	Emissions Sub-category	Assessment Method and Data Used	Data Type(s) and Emission Factor(s)	Omissions and assumptions	Recommended data quality improvements
				transportation paid for by the HSE, for which dedicated spend data was available.	such as those from DEFRA or GLEC to model transportation emissions separately. Where this supplier-specific data is unavailable, the HSE can still makes progress seperating freight-related emissions from procurement emissions through an expenditure-based approach. However, this relies on the collection of spend data relating to freighting of goods and services separately from the rest of the costs.
	Cat 5a) Solid waste treament	Average data method	Solid waste tonnage data was provided for all facilities funded by the HSE, including Section 38 and 39 bodies. This data split by waste type and whether it was treated through 'incineration' or 'alternative treatment'. The UK Government GHG Conversion Factors for Company Reporting 2020[13] emission factor for Commercial and industrial waste treated by combustion was used for all waste.	All solid waste tonnage data received from the HSE was categorised by waste treatment method, between either 'incineration' or 'alternate treatment'. As the definition of 'alternative treatment' was not provided, the UK Government GHG Conversion Factors for Company Reporting 2020[13] emission factor for Commercial and industrial waste treated by combustion was used. This was consistent with known methods of waste treatment associated with waste generated by the HSE. The UK DESNZ emission factors applied only cover emissions from the collection of materials and delivery to the point of treatment or disposal. They do not cover the environmental impact of different waste management options as these emissions are owned by the waste processor. As the emission factors only reflect the collection and transportation activities, in aligning with standard industry practice, these activities were judged to align closely enough with equivalent Irish waste management activities for the emission factors to be applied as an appropriate suite of proxy emission factors for application by the HSE. To differentiate waste tonnage data entries in the dataset between those associated with the HSE and those associated with Section 38 and 39 bodies, waste tonnage was disaggregated by mapping the names of Section 38 and 39 bodies to 'Customer Names' and 'Site Names' labelled in the dataset. 22 Section 38 and 39 bodied were identified in the dataset. The waste data for these facilities was excluded from the quantification of emissions in this assessment. The names of these facilities is provided below:	The explicit mapping of facility names to the solid waste tonnage they are responsible for within the waste management tonnage data would allow for a more reliable disaggregation of waste tonnage data and the resulting emissions between the HSE and Section 38 and 39 bodies. More granular records of the waste management method applied for waste managed through "alternate treatment" or waste-specific scope 1 and 2 emissions data from the downstream waste treatment facilities could improve the specificity of data and the certainty of emissions results.

Scope	Emissions Sub-category	Assessment Method and Data Used	Data Type(s) and Emission Factor(s)	Omissions and assumptions	Recommended data quality improvements
				• Beaumont Hospital • CHI • Cappagh National Orthopaedic Hospital • Coombe Women & Infants University Hospital • Dublin Dental Hospital & School • Mater Misericordiae University Hospital • Mercy Hospital • National Maternity Hospital • National Rehabilitation Hospital • Our Lady's Hospice Harold's Cross Limited • Rotunda Hospital • Royal Hospital, Donnybrook • Royal Victoria Eye and Ear Hospital • South Infirmary – Victoria Hospital • St. Francis Hospice • St. James's Hospital • St. John's Hospital • St. Michael's Hospital • Marymount University Hospital and Hospice • St. Vincent's Hospital Fairview • St. Vincent's University Hospital • Tallaght University Hospital It is recognised that there are more Section 38 and 39 bodies than those listed above. Waste data for these facilities could not be isolated and removed was since 'Customer Names' and 'Site Names' could not be found and mapped to these facilities in the provided dataset. Any reported waste emissions from these facilities in the dataset that were not labelled with sufficient clarity to be identified were grouped into the total emissions for the HSE.	
	Cat 5b) Wastewater and effluent treatment	Spend-based method	Annual 2019 PL financial data for 'wastewater management services' paid for by the HSE was mapped to relevant expenditure-based EEIO emission factors for Irish products and services in 2019 from EXIOBASE[4].	Procurement entries in the PL dataset tagged with the GL descriptor 'water management services' were categorised as spend and therefore emissions relating to wastewater and effluent treatment.	Transitioning from a spend-based approach to a more specific activity-based approach involves collecting detailed operational data (e.g., volume of wastewater treated) and applying average emission factors. This would ideally be emission factors sourced from the contracted service companies, utilising operational data and life cycle assessments

Scope	Emissions Sub-category	Assessment Method and Data Used	Data Type(s) and Emission Factor(s)	Omissions and assumptions	Recommended data quality improvements
					that include GHG emission estimates per unit of effluent treated. Failing this, default industry-average emission factors could be used. These methods would enhance the accuracy of emissions estimates and supports more targeted emission reduction strategies
	Cat 6) Business travel	Spend-based method	Annual 2019 PL financial data on € spent on goods and services for the HSE-managed assets mapped to relevant expenditure-based EEIO emission factors for Irish products and services in 2019 from EXIOBASE[10].	Emission factors from EXIOBASE[10] were assigned to the expenditure line items following the logic in Appendix B: Mapping of the HSE expenditure categories to EXIOBASE product categories.	Data quality could be improved using more distance-based data (e.g., the origin and destinations of expensed flights) or fuel-based data (e.g., for employee or patient car transport paid for by the HSE). If procurement entries for business travel in the PL dataset can be clearly broken down by mode of transport, then activity-based data could be selectively applied for those modes, improving accuracy without requiring full activity data coverage across all travel types.
	Cat 7) Employee commuting	Average data method (with employee profile assumptions)	A modelled approach was used based on publicly available national statistics. Average commuting distances and transport mode shares for rural and urban areas were sourced from the CSO 2022 Census[15]. These were combined with an estimated rural/urban split of the HSE employees. The total employee count for the HSE was provided by the HSE, and CSO 2016 population data was used to estimate the split of these employees between rural and urban locations[14]. Distance-based emission factors from the UK DESNZ, which include both direct fuel/emissions and upstream well-to-tank emissions, were applied to estimate commuting-related emissions by transport mode.	In the absence of employee survey data, this model relies on national statistics rather than HSE-specific commuting data. The rural vs urban classification of HSE employees was estimated using national population distribution data. While this provides a consistent national benchmark, it likely overestimates the proportion of rural-based staff, as HSE employment is concentrated in large hospitals and administrative centres that are predominantly located in urban areas. Rural services tend to be more dispersed and lower in staffing density. Given that rural commuting patterns are generally longer and more emissions-intensive, applying a higher rural staff share than is likely the case results in a conservative emissions estimate, i.e., one that is more likely to overestimate than underestimate actual employee commuting emissions. This strengthens the credibility of the estimate in the absence of HSE-specific commuting data	Conduct a national employee commuting survey to collect data on commuting distance, mode, and frequency of days commuting and working from home for employees across all HSE-managed facilities. In the interim, obtaining employee headcounts by facility or region would allow for a more precise proxy estimate of commuting emissions, refining the current top-down model.

Appendix B: Mapping of the HSE expenditure categories to EXIOBASE product categories

The mapping of the HSE expenditure categories to EXIOBASE product categories was conducted independently, without referencing the HSE's pre-existing category mappings, to ensure an unbiased classification of EXIOBASE categories.

The mapping process can be outlined in three key steps below:

1. Categories listed in Table 4 were considered out of scope for the analysis and subsequently excluded from the emissions calculations.

Table 4. Out of scope categories

Categories	Products that fall into this category	Justification for exclusion
Waste management	All categories that relate to waste management including waste recycling, refuse charges, waste disposal, hazardous and clinical waste disposal, recycling of aids & appliances.	Bottom-up data for waste has been provided by the HSE.
Vehicle and transport	All categories relating to vehicle fuel, such as but not limited to petrol, diesel, oil, lubricating oil.	Bottom-up data for vehicle fuel consumption are modelled separately.
Energy	Categories relating to energy such as natural gas, electricity (including heat power & light), oil, LPG, and other energy sources used for heating or power.	Bottom-up data for energy consumption are modelled separately.
Tax	All categories related to tax expenses, such as local property tax, vehicle tax, and income tax-related settlements.	Taxes are a purely financial flow and excluded from the study boundary.
Refunds and recoupments	Categories involving refunds, such as medical expense refunds, telephone refunds to staff, patient refunds, and recoupment of payments (drug refund schemes are included in the emissions calculations as it is assumed this relates to the purchase and consumption of products which the HSE later reimburses patients for).	Refunds and recoupments, except of drug costs, are considered outside the operational boundaries.
Depreciation	All categories relating to depreciation including the depreciation of office equipment, vehicle depreciation, and other asset depreciation.	Depreciation is an accounting process and does not generate emissions directly.
Registration fees	Categories related to registration fees, such as HIQA registration fees and charging order registration.	These categories have no direct impact on emissions.
Other financial costs	Categories like settlements, debt collection fees, and prompt payment interest.	These categories have no direct impact on emissions.
Miscellaneous	Various categories such as work permits, cash handling fees, and pocket money.	These categories have no direct impact on emissions.

2. A consistent approach to mapping was applied across all product and service categories procured by the HSE, ensuring that the mapping process was uniform and transparent. The EXIOBASE category-specific justifications outlined in Table 5 provide insight into some of the common EXIOBASE categories and identify which products and services are most likely to fall within these categories. As there are no official definitions for EXIOBASE categories, these classifications were deduced through analysing NACE Rev. 2 classifications[17].

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[17] Eurostat (2008) NACE Rev. 2 – Statistical classification of economic activities. Available at: dd5443f5-b886-40e4-920d-9df03590ff91

Table 5. Description of products included in the most common EXIOBASE categories

EXIOBASE category	Description of products included
Radio, television and communication equipment and apparatus (32)	Radio, TV, communication equipment such as mobile phones, car kits (Bluetooth devices), data communication, postal equipment etc.
Post and telecommunication services (64)	Telecommunication charges/ services/ installation/ repair/ maintenance etc. relating to telecom (e.g. mobile phone/ land line usage).
Office machinery and computers (30)	Office machinery such as photocopiers, faxes, audio-visual equipment (only if explicitly office-related), and computers/ computer hardware.
Machinery and equipment n.e.c. (29)	Machinery and equipment for most sectors except medical and office machinery, e.g. washing equipment, catering equipment, farm equipment, grounds equipment etc. Large capital expenditure in ICT infrastructure assumed here (e.g. data centres, servers etc.)
Electrical machinery and apparatus n.e.c. (31)	Electrical machinery or materials, e.g. electric beds, electrical supplies.
Medical, precision and optical instruments, watches and clocks (33)	Medical equipment, radiology equipment, audio-visual equipment, X-ray equipment, watches, clocks etc. beds/ mattresses in healthcare setting. All supplies and instruments in healthcare setting. Explicitly stated 'services' would fall under 'Health and social work services'.
Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods (52)	Repair and maintenance of all machinery and equipment, except computers/ IT related ('Computer and related services'. Shop stock for resale. Service contracts. All random products (e.g. farm materials, catering supplies, spare parts, crockery, hand tools etc.).
Other business services (74)	Professional services or business-related services that support healthcare/ businesses (e.g. consulting, engineering, HR, legal, surveying, facility management, cleaning, security services etc.) and covers installation, technical services, and contracting work related to equipment. Non-clinical secondment charges and conference fees.
Other services (93)	Services not directly related to healthcare and may be external (e.g. part time home helps, overheads, fire safety certifications, investigation costs, outside contractors, meeting room/ conference hires.
Renting services of machinery and equipment without operator and of personal and household goods (71)	Rental of machinery and equipment and vehicles, contracts on equipment (assumed rental unless service contract).
Computer and Related Services (72)	Services relating to computers including maintenance, repair, consultancy etc. ICT/ IT subscriptions, licenses, maintenance, repairs.
Health and social work services (85)	Services relating to healthcare. Secondment clinical, contracts, clinical services, except for education related e.g. training/ courses.
Education services (80)	All education-related clinical/ health services, training, courses etc. including clinical conference fees.
Insurance and pension funding services, except compulsory social security services (66)	Categories including property insurance, professional indemnity insurance, public liability insurance, and other insurance costs like employers' liability and income protection.
Motor vehicles, trailers and semi-trailers (34)	Purchase of vehicles and parts of vehicles.
Supporting and auxiliary transport services; travel agency services (63)	Storage services.
Collected and purified water, distribution services of water (41)	Water rates, charges etc.
Other waste for treatment: waste water treatment	Water management services

3. Each procurement entry in the Purchase Ledger (PL) dataset was assigned two separate reporting category levels. Reporting Category Level 1, classified each entry into a relevant Scope 3 emissions category based on its GL descriptor, namely Category 1a (Purchased Goods and Services), Category 1b (Waster Consumption), Category 4 (Upstream Transportation and Distribution), Category 5b (Wastewater and Effluent Treatment), or Category 6 (Business Travel).

   Entries classified under Category 1 included all procured goods and services except those explicitly identified as falling under Categories 1b, 4, 5b, or 6.

   - Category 1b includes procurement entries relating to water consumption, being under the GL descriptor 'water rates and charges'.

   - Category 4 was limited to expenditure related to blood and specimen transportation paid for directly by the HSE, for which specific spend data was available.

   - Category 5b included entries tagged with the GL descriptor 'water management services'.

   - Category 6 included entries associated with descriptors such as 'accommodation', 'mileage', 'relocation expenses', 'staff transport', 'staff taxis', 'subsistence', and 'travel'.

   The second level, Reporting Category Level 2, assigned a more detailed classification to each procurement entry, enabling a finer-grained breakdown of emissions, particularly within Category 1a. This allowed for clearer analysis and reporting of emissions by type of good or service procured.

4. The quality assurance process involved two steps: filtering and ensuring consistency across all categories (e.g., out-of-scope categories, chemical-related categories, business services, etc.). This was followed by a comparison to the HSE's mappings and emission factors to assess differences.